Reimbursable Advisory Services | JUST TRANSITION TOWARDS CARBON NEUTRALITY IN BULGARIA

Economic, Social, and Environmental Impacts of the Transition in Carbon-intensive Districts

Draft Report

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WORLD BANK GROUP
OPERATIONAL PROGRAMME GOOD GOVERNANCE
ESF 60 YEARS Investing in people European Social Fund
EUROPEAN UNION European Regional Development Fund

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ABBREVIATIONS

ATR auto thermal reforming
BEH Bulgarian Energy Holding
CCS Carbon Capture and Storage
CCSU carbon capture/storage and utilisation
CCU Carbon Capture and Utilization
CDW construction and demolition waste
CEDEFOP European Centre for the Development of Vocational Training
CNG Compressed natural gas
CSD Center for the Study of Democracy
DDP District Decarbonization Pathways
DESI Digital Economy and Society Index
DRI direct reduction of iron
EAF electric arc furnace
EC European Commission
EII energy intensive industries
EIDES European Index of Digital Entrepreneurship Systems
EGD European Green Deal
EOD End of Life
ESO Electric System Operator
ESR Effort Sharing Regulation
ETS Emissions Trading Scheme
EU European Union
EWRC Energy and Water Regulatory Commission
FDI Foreign direct investment
FTE Full-time equivalent
GDP Gross Domestic Product
GHG Greenhouse Gas
GoB Government of Bulgaria
GVA Gross Value Added
HDV heavy duty vehicles
ICT information, communication, and technology
IED Industrial Emissions Directive
ILO International Labor Organization
IOA Input-Output Analysis
IOT Input-Output Tables
I-O Input-Output
IPCC Intergovernmental Panel on Climate Change
JTF Just Transition Fund
JTM Just Transition Mechanism
LDV light duty vehicles
LFS Labor Force Survey
LLL life-long learning
LNB Lukoil Neftochim Burgas
LULUCF land use, land use change and forestry
MCPD Medium Combustion Plants Directive
MoE Ministry of Energy
MoES Ministry of Education and Science
MoEW Ministry of Environment and Water
MSW municipal solid waste

NEA National Employment Agency
NECP national energy and climate plan
NEKNFM National Electric Company
NFM Non-ferrous metals
NIR National Inventory Report
NPP nuclear power plant
NSI National Statistic Institute
NZEB nearly zero-energy buildings
ODS Ozone Depleting Substances
OECD Organization for Economic Cooperation and Development
RAS Reimbursable Advisory Services
RAWM Regional Associations for Waste Management
RES Renewable Energy Systems
RIEW Regional Inspectorates of Environment and Water
R&D Research and Development
SEDA Sustainable Energy Development Agency
SCM supplementary cementitious materials
SLQ simple location quotient
SMR steam methane reforming
SSM Sector System Maps
TJTP Territorial Just Transition Plans
TRL technology readiness level
TVET Technical and Vocational Training
UN United Nations
UNFCCC United Nations Framework Convention on Climate Change
VET Vocational Education and Training
WRO Waste Recovery Organization

PART I

1 EXECUTIVE SUMMARY

BACKGROUND AND CONTEXT

The European Union (EU) has introduced the European Green Deal (EGD) to support the transition to carbon-neutrality by 2050. To overcome the challenges of climate change and environmental degradation, the EU, through the EGD, aims to transform the EU into a modern, resource-efficient and competitive economy. This includes ensuring no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use, and no person and no place left behind. This requires current greenhouse gas emission levels to drop substantially in the next decades. To meet the EU's energy and climate targets for 2030, EU countries need to establish a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030.

The Government of Bulgaria (GoB) has committed in its NECP to decarbonize its energy supply and to prioritize transformation to a circular economy. While there are still many uncertainties regarding this process, it is clear that decarbonization will have far-reaching social, economic and environmental impacts across Bulgaria. In its initial assessment of impacts from the transition to a carbon-neutral economy, the GoB found that the effects would not be confined only to selected regions, but rather would have *nation-wide impacts* requiring deep transition of the economy. As such, there will be huge needs for investments and job reskilling in all regions of the country. Indeed, given the structure of the country's economy, many of its industries could be considered as those that would require transition in the future. Thus, a comprehensive assessment of the impacts of the decarbonization process is urgent for Bulgaria.

This report has been prepared under a Reimbursable Advisory Services (RAS) Agreement signed between the Ministry of Energy (MoE) of the Republic of Bulgaria and the World Bank Group (the Bank) on September 30, 2020. Under this Agreement, the Bank is providing inputs to support MoE in preparing Territorial Just Transition Plans (TJTPs) for the eight most carbon-intensive (non-coal) districts identified by the Government of Bulgaria (GoB). These districts are recognized by the GoB as being the most affected territories and include Varna, Haskovo, Burgas, Lovech, Gabrovo, Targovishte, Sliven, and Yambol. Under Article 11 of the JTF Regulation[1] the focus of TJTPs is on the "economic and social impacts resulting from the transition, in particular with regard to the expected adaptation of workers or job losses in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity".

In line with these EU requirements, the objectives of this report are threefold: (1) to outline the transition process, including potential pathways to decarbonization in eight carbon-intensive districts of Bulgaria, (2) to assess the economic, social and environmental impacts of decarbonization, and (3) to identify economic diversification opportunities for each of the eight districts to address potential negative employment impacts.

The scope of the report is limited in scope in the following ways:

- ***The report does not propose a decarbonization strategy for the eight districts concerned***. As already noted, TJTPs focus exclusively on the mitigation of potential negative employment impacts, not on industrial decarbonization itself.[2] From the planning perspective, TJTPs are expected to be consistent with the national development planning framework, including the National Energy and Climate Plan (NECP) and any other

[1] Regulation (EU) 2021/1056 of the European Parliament and of the Council of 24 June 2021 establishing the Just Transition Fund.

[2] The EU funds do not finance industrial decarbonization, except under very specific circumstances or by dedeicated financial instruments - cf. Article 11(2)(i) of the JTF Regulation and Article 7(1)(b) of ERDF Regulation (Regulation (EU) 2021/1058 of the European Parliament and of the Council of 24 June 2021 on the European Regional Development Fund and on the Cohesion Fund.)

decarbonization-specific strategy. To that end the report should be veiwed as an analytical paper supporting the identification of development needs and objectives and formulation of related interventions to be included in district TJTPs (as an instrument to mitigate potential negative impacts of decarbonization in line with relevant national planning documents) but not as a proposal for a decarbonization strategy or plan for the districts concerned on its own.

- ***The report does not provide decarbonization policy or technology advice to Bugarian national or districts authortities or other stakeholders.*** Such advice is not in the scope of the assignment. The summarised sectoral decarbonization pathways and the 'enabling conditions' for successful decarbonization are presented in the report with the sole purpose to increase the districts' understanding of the possible ways to decarbonize their economy and aid their planning and decision making related to the TJTPs. These should not be viewed as policy advice or technology recommendations to the MoE and the other stakeholders.

The report builds on a series of deliverables developed under the RAS Agreement. These include (i) district profiles and an evidence base for each district; (ii) a stakeholder and institutional mapping exercise; and (iii) a proposed governance mechanism for the preparation and implementation of TJTPs.

The findings from this report will feed into two further deliverables under the RAS Agreement. These cover: (i) the development needs and objectives of the carbon-intensive districts; and (ii) the types of operations that are proposed to be financed under the TJTPs.

METHODOLOGY AND APPROACH

This report is divided into two Parts. Part I provides an introduction, outlines the methodology and approach, maps the carbon-intensive sectors and identifies generic sector-specific decarbonization pathways. **Part II** dives deep into each district's specific decarbonization pathways, identifying direct and indirect effects on different sectors, and describing the potential for economic diversification for each of the eight districts. Building on the sector system mapping and decarbonization pathways of carbon-intensive economic activities at district level, Part II of this report also identifies the economic, social, and environmental impacts of the transition at district level.

The approach underpinning this report is grounded in two interrelated frameworks: Sector System Maps (SSMs) and decarbonization pathways. These SSMs and decarbonization pathways of carbon-intensive economic sectors are intended to enable districts to deepen their understanding of the process of economic decarbonization and of its socio-economic impacts on the district. The objective is to aide the effective planning and decision making related to the TJTPs. SSMs outline the most important elements of economic activities affected by the transition, focusing on four key carbon-intensive economic sectors: i) manufacturing industry, ii) energy sector, including buildings, iii) public transport sector, and, iv) waste sector. The primary focus of the SSMs – and the decarbonization pathways – is on manufacturing industries, which are expected to be mostly affectedby the decarbonization. Other carbon-intensive sectors beyond industry (energy, buildings, transport, waste) are covered in a complementary manner, in so far as those are eligible for financing under the Just Transition Fund.

Sector decarbonization pathways comprise a set of sector-specific and promotable actions to implement transitions in carbon-intensive economic sectors. Due to the numerous uncertainties related to the decarbonization process the sectoral decarbonization pathways are by necessity generic (i.e. of a general, non-entity-specific nature). Even so, these generic decarbonization pathways constitute a useful framework for reference, outlining the scope of the challenges and impacts relevant to sector-specific transitions.

The District Decarbonization Pathways (DPPs) developed in Part II of this report are district-specific in nature. These DPPs build on the 'mapping' process of the SSMs and the sector pathways to outline recommendable sector-specific actions to be implemented by the carbon-intensive economic sectors *at district level*, in order to reduce carbon emissions. The DPPs are therefore targeted mainly at carbon-intensive industrial enterprises or companies, but also at policy-makers, civil society groups (such as trade unions and employers' associations) technology and innovation providers, financiers and investors, and business or service providers along the value chain.

In developing the SSMs and decarbonization pathways, a top-down and bottom-up approach was applied to identify carbon-intensive subsectors in the district economies to be affected by potential decarbonization. The top-down approach used the *United Nations Framework Convention on Climate Change (UNFCCC)* and *EU Emissions Trading Scheme (ETS)* reporting frameworks, which explicitly list carbon-intensive sectors (subject to their reporting requirements). The latter was used as a reference framework to identify the carbon-intensive sectors in each of the eight districts. The bottom-up approach complemented and verified the top-down approach, by identifying the carbon-intensive companies in each district, based on publicly available data, and studying their decarbonization challenges.

It should be noted that due to the multidimensional uncertainties (technological, regulatory, financial, time, etc.) of the decarbonization process, sector-specific milestones and outcomes of the decarbonization process cannot be reliably predicted, and the related impacts cannot be quantified. For that reason, the impact assessment is a qualitative one, based on the assumption of a 'worst-case' scenario, i.e. a potential closure (discontinuation of the activity) of the affected businesses. To that end, the impact assessment concept under the survey method is to measure the potential economic impacts of decarbonization from a structural dimension, by the share (as a percentage) of the affected industries in the district economy (a qualitative assessment).

To assess the scope of the potential economic impacts, a survey was conducted and augmented with an indirect analytical assessment using Input-Output Analysis (IOA). The IOA for economic impacts was used to measure the strategic importance of a sector on outputs and employment (to show backward /forward linkages). The IOA assessed the socio-economic impacts under the hypothetical worst-case scenario, establishing the potential total number of jobs that might be lost in each district under that scenario on the grounds of the inter-sectoral links in the district economy. The assessment of the scope of potential social impacts drew on national statistics and stakeholder interviews. This will be further complemented by data drawn from an ongoing survey of affected workers, which will be presented in a future deliverable under the RAS Agreement.

Finally, the methodology also included a survey of enterprises operating within carbon-intensive industries affected by the decarbonization process. The objective of the survey was to assess the levels of awareness and knowledge of, and opinions and attitudes on, the decarbonization process of enterprises expected to be directly affected by the transition and their readiness to act. In addition to analyzing primary financial and economic data from the enterprises, the survey gathered information directly through detailed questionnaires with six major affected enterprises (from the list of the largest industrial CO_2 emitters).

EMERGING FINDINGS AND CONCLUSIONS

The emerging conclusions highlighted in this report are subject to a variety of uncertainties with regards to the extent of impacts. These uncertainties include, for example, the effects of other countries' decarbonization strategies, market trends, competition, national and EU policies etc. Keeping these uncertainties in mind, the general approach of sector decarbonization pathways suggests that one or more of the following may be technically and economically feasible:

- reducing materials and energy use (including through circular business models);
- increasing the productivity of materials and energy use and/or substitution with low-carbon feedstock;
- introducing low-carbon production processes (decarbonizing required manufacturing processes), and;
- carbon capture and storage or utilisation (CCS/U) technologies applied to process emissions or continued fossil fuel use.

The generic decarbonization pathways have been reviewed in the context of the existing technologies and present state-of-the-art. It has been established that in terms of technological readiness the electrification of heating processes appears to be closest to industrial application in most of the examined cases, while the other available options are still at a pilot or demonstration level (e.g. use of hydrogen, biomass, CCS/U). However even in these cases, which are still at a pilot level, there is also high demand for development of additional infrastructure. The capital and the operational expenditures expected are significant, especially where Hydrogen or CCS/U may be used in the future. The report shows that in all presented industrial sectors there are two major types of CO_2 emissions that should be captured – heat (kiln, combustion) emissions and process (usually as a result of a chemical reaction) emissions. The ratio between these two may vary among different sectors, but as process emissions usually appear harder to abate these are also the cases where CCS/U technologies are mostly expected to develop further especially in industries where process emissions prevail (e.g. cement, lime). Other measures suggested in the decarbonization pathways provide for additional CO_2 savings but usually at much smaller scale. Material recirculation and substitution of materials, for example, could be pushed further in sectors like cement, glass or non-ferrous metals and most of the industry players could also put greater effort in the introduction of energy management systems and applications as these can provide additional CO_2 cuts estimated at 10% to 20%.

Drawing on the data collected at national and district level, the report identifies economic, social and environmental impacts of the transition at district level and by sector. In terms of economic impacts at sector level, the report found that the manufacturing industry will be most strongly impacted by the decarbonization process in the eight districts. This is due to the prevalence of industrial manufacturers among the GHG emitters in the districts. Decarbonization of the industrial sector is expected to directly affect carbon-intensive industries in the districts, as well as a number of sectors in their supply chains, which will be indirectly affected. Depending on the size and structure of the district economy, in some districts the potential cumulative impacts cover sectors, which together account for a significant share of the output, added value, employment and salary income of the district economy (e.g. Targovishte, Gabrovo, etc.). In larger district economies (e.g. Varna and Burgas) the scope of the economic impacts is limited, however the number of potentially affected jobs is still substantial. The Input-Output analysis of the inter-sectoral relations within the district economies confirmed the broad magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses.

Decarbonization within the energy sector is expected to lead to decentralization of energy production and a correlated increase in economic activity at district level. For buildings and the construction sector, there is also expected to be an increase in economic activities and the number of employees due to activities for building renovation, on-site installation of renewable energy sources, and construction of nearly-zero energy buildings.

In the public transport sector, no major impacts on the economic performance of the sector, or on employment, are forecasted, since the main function of the transport sector will remain the same. However, decarbonization measures might support new employment opportunities such as in the development and maintenance of charging infrastructure for electric and hydrogen vehicles, e-mobility, walking and cycling, and shared mobility model.

The analysis showed that decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. It might be expected that more sophisticated waste management, treatment and utilization could actually generate jobs – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis.

The environmental impacts of the decarbonization process are expected to be generally positive. The analysis indicates that activities reducing GHG emissions will bring several positive environmental effects, including better air quality (through reduction in air pollutants emissions due to the decrease in fossil fuels' use), which has subsequent positive effects on public health. Qualitative environmental impact assessment focused on the following main decarbonization activities: (1) switching from fossil fuels to lower-carbon fuels, (2) improved energy efficiency and system optimization for cleaner production processes, (3) materials' recycling, and (4) Carbon Capture and Storage (CCS) or Utilization (CCU). These activities have the largest potential to reduce GHG emissions in carbon-intensive industries in the eight districts.

The social impact analysis identified several expected social impacts, primarily related to impacts on workers and employment. Firstly, in all eight districts, three main impacts on jobs are expected:

1. Some of the jobs destroyed in an industry will be in occupations replicated in growing industries, offering potential employment opportunities for workers from shrinking industries;
2. Net new jobs will be created that will require uptake of relevant skills and formal training for potential labor market entrants; and
3. Some jobs will be lost without vacancies opening in the same occupations in different industries.

Overall, the analysis shows that the transition towards a low-carbon economy will affect jobs directly and indirectly, ranging from 2 to 12 percent of total employment. Based on the analysis, Varna, Sliven, Burgas and Gabrovo are the districts which are expected to experience the highest numbers of job potentially affected. Indeed, and contrary to the phasing out of (or decline of) the mining and extractive sectors, the industrial sectors are not likely to shut down in their entirely but rather transition.

Other key findings from the social sector analysis are that manufacturing represents the largest share of employment in the districts, and that workers already face large skills mismatches, especially for lower skilled jobs. In addition, three districts (Haskovo, Sliven and Yambol) have a large share of commuters to Stara Zagora, working at the Maritsa Iztok mining complex. According to the 2011 Census (the latest extensive assessment of the scope of daily labor migration), 2,268 workers commute daily from the district of Sliven, an additional 2,676 from the district of Haskovo, and 1,336 from the district of Yambol. These social factors need to be carefully considered in designing specific decarbonization pathways for each district.

Results from the enterprise survey indicate a clear desire for participation in the formulation of policies and measures that would effect the private sector. The survey also revealed that respondents expect both positive and "negative" or "rather negative" effects on business as a result of decarbonization. Many were concerned about potential loss of markets or market contraction, as well as rising costs of production associated with decarbonization. In terms of expected positive effects, the top expectations were the stimulation of innovation, more efficient methods of production, a healthier lifestyle, modernization of the sector, increased international cooperation and new export opportunities. Most respondents indicated that they have a "high level" of technological readiness, but noted that **the "biggest obstacle" is the large amount of up-front investment needed to prepare for the transition.** Relatedly, the survey also indicated that the highest need in terms of state support is financial support.

Finally, across the eight districts, between nine and 19 'rapidly growing' sectors were identified – these sectors are expected to provide opportunities for growth, economic diversification potential and generation of new jobs. Varna, the largest district economy included in the analysis, had the highest overall number of identified rapidly growing sectors at 19, followed by Yambol (17), Sliven and Gabrovo (15), Burgas (14), Lovech (12), Haskovo (10) and Targovishte (9). The analysis identified small, mid-size and large rapidly growing sectors – the small, but rapidly growing sectors represent emerging sectors with growth potential, which are expected to positively affect the structure of the district economy. The mid-size and rapidly growing sectors demonstrate mature growth and diversification potential for the district economy – these are particularly important for the generation of job opportunities to mitigate the potential negative employment impacts of the decarbonization process.

The sectors with growth and economic diversification potential belong mostly to the manufacturing industry, but various services and other sectors were also identified as rapidly growing. In the manufacturing industry, fast growth sectors included: manufacturing of beverages and food products, paper and paper products, metal products, apparel and textiles, and furniture were among those identified across several districts. The service sectors with diversification potential are related mostly to trade (retail and wholesale trade), which have been dynamically developing over the last decade. Other important rapidly growing sectors include food and beverage service sectors, which are an inherent part of the tourism industry, and provide growth and diversification potential for the Black Sea coast districts of Burgas and Varna, as well as Haskovo, Lovech, Sliven and Yambol. Prominent 'high-technology' sectors, such as computer programming, telecommunications, consultancy and information services were identified as emerging sectors with a diversification potential for a number of districts (including Burgas, Yambol, Gabrovo, Haskovo, Sliven and Varna districts). The identified sectors with growth and economic diversification potential can serve as a starting point to outline the key areas for targeted business support operations within the TJTPs.

Looking forward, the analysis and emerging conclusions presented in this report will be the foundation for two future deliverables under the RAS. The first of these successive reports will dive deeper into development needs and objectives (by 2030) in view of reaching climate neutrality and consistency with other national, regional or territorial strategies and plans. The second report will examine the types of operations that are proposed to be financed under the TJTPs and their expected contribution to alleviate the impact of the transition. An analysis of the program-specific indicators for the transition will also be developed. As such, this report is an important building block towards both increasing the eight districts' understanding of the scope of impacts from decarbonizing their economies, and in aiding their strategic planning and decision-making related to the preparation and implementation of TJTPs.

2 INTRODUCTION

The European Union (EU) has introduced the European Green Deal (EGD) to support the transition to carbon-neutrality by 2050. To overcome the challenges of climate change and environmental degradation, the EU, through the EGD, aims to transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use, and no person and no place left behind. This requires current greenhouse gas emission levels to drop substantially in the next decades. As an intermediate step towards climate neutrality, the EU has raised its 2030 climate ambition, committing to cutting emissions by at least 55% by 2030.

The EU is working on the revision of its climate, energy and transport-related legislation under the 'Fit for 55 package' in order to reach the 2030 and 2050 targets in in a fair, cost-efficient and competitive way. The Fit for 55 package is a set of inter-connected proposals to revise and update EU legislation and to put in place new initiatives with the aim of ensuring that EU policies are in line with the climate goals agreed by the Council and the European Parliament. Overall, the package strengthens eight existing pieces of legislation and presents five new initiatives, across a range policy areas and economic sectors: climate, energy and fuels, transport, buildings, land use and forestry. The chosen policy mix is therefore a careful balance between pricing, targets, standards and support measures.

To meet the EU's energy and climate targets for 2030, EU countries need to establish a 10-year integrated national energy and climate plan (NECP) for the period from 2021 to 2030. The Plans constitute a framework for Member States to outline their climate and energy goals, policies and measures from 2021 to 2030 in the domains of: energy efficiency, renewables, greenhouse gas emissions reductions, interconnections, and research and innovation. Milestones and pathways presented in the NECPs should help to understand the pace and scope of the transition process, as well as its social, economic, territorial and environmental impacts, that are to be addressed – in case of the most affected territories - by the TJTPs.

The Government of Bulgaria (GoB) has committed in the NECP to a process of decarbonizing its energy supply, but it also recognizes this will impact territories, industries, workers, and communities. Bulgaria's NECP sets out the strategic goals and priorities in the area of energy and climate across five dimensions:

- ***Decarbonization.*** Increase the share of energy from renewable sources in gross final energy consumption and reduce GHG emissions, with the national targets of (a) 0% of GHG emissions by 2030 as compared with 2005, for non-ETS sectors (building stock, agriculture, waste management and transport), and (b) 27.09% for the share of renewable energy in gross final energy consumption by 2030.

- ***Energy Efficiency.*** Achieve energy savings in final energy consumption, focusing on improvement of the energy performance of buildings and on energy generation, transmission and distribution, with the nationl targets of a 27.89 % reduction in primary energy consumption and a 31.67 % reduction in final energy consumption by 2030 as compared with the PRIMES 2007 reference scenario.

- ***Energy Security.*** Diversify the sources of - and the routes for – its natural gas supply. Increase energy security by diversifying energy supplies, making efficient use of domestic energy resources and further developing energy infrastructure.

- ***Internal Energy Market.*** Develop a competitive market by fully liberalising the market and integrating it into the regional and wider EU market, with the target to achieve an electricity interconnection level of at least 15% by 2030 in line with the EU target for a minimum level of electricity interconnection.

- ***Research, Innovation and Competitiveness.*** Promoting scientific progress in the area of innovative energy technologies, including clean power generation.

Nevertheless, Bulgaria's current NECP (2019) is a rather high-level document covering national level plans for energy transition. The NECP of Bulgaria projects that the share of net installed capacity of solid fuel power plants in the total electricity production will decrease from 34.6% in 2020 to 18.1% in 2030. Further, Annex 1 to the NECP[3] foresees a gradual reduction of solid fuel use for electricity production in the period 2021 – 2030 (23% reduction in 2030 compared to 2021). The NECP, however, doesn't provide a commitment to a specific timeline for coal phase out. It also doesn't provide detailed actions specific to sectors, such as industry or transport.

Proposed measures to reduce GHG emissions in the energy sector focus primarily on energy efficiency, whereas the industrial sector is projected to see emissions increases (rather than decreases) by 2030. The measures of the NECP aimed at achieving decarbonization milestones are mostly qualitatively described; there is no quantified correlation between these measures and the NECP decarbonization milestones.

The NECP doesn't present detailed actions to reduce carbon intensity by region or district. There is also no specific territorial top-down decarbonization pathways nor mention of the contribution of the regions or districts to achieving national milestones.

This makes it difficult to define and quantify the detailed potential negative impacts of the transition on employment and on economic development in different sectors and in the carbon-intensive districts. Still each TJTP needs to be aligned with the NECP and propose adequate and territory-specific measures aimed at alleviating negative impacts of the transition process by 2030.

On the other hand, decarbonization policy poses significant social and economic challenges with a strong influence on emission-intensive sectors and regions. The latter are at risk of loss of wealth and jobs and therefore require targeted measures. The coal mining sector is currently concentrated in three districts (Stara Zagora, Pernik and Kyustendil) but it should be noted that 25 % of the workers and employees of the Maritsa Iztok Plant in Stara Zagora are residents of neighbouring municipalities with poorly diversified economies in the districts of Haskovo, Sliven and Yambol, which are closely integrated into the added value chain of the energy sector. Potential power plant decommissioning, a situation in which the respective capacities will no longer be part of the electricity system, may have serious social and economic implications.

The transition to a climate-neutral economy will also affect Bulgaria's industrial centers. All sectors with high levels of greenhouse gas emissions in gross industrial added value that are also major employers in the sectors mostly strongly affected by the transition will require

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3 Annex 1, Part 2, 12 NECP2019v2_21-02-2020-end.xlsx provided from the MoE on 11 February 2021.

support. This creates a need for a social and economic analysis of the consequences of transition and requires specific transition enabling policies.

As suggested by the Center for the Study of Democracy (CSD)[4]**, to achieve the transition to a climate-neutral economy, Bulgaria would need to adopt an ambitious long-term decarbonization and fossil fuel phase-out strategy**. Such a strategy needs to encompass all economic sectors, including the economic restructuring of the coal regions, the re-alignment of the country's investment priorities with the EU Industrial Strategy, and the adaptation of the regulatory framework in critical policy areas to streamline the green recovery process. CSD developed three scenarios for delivering Bulagria's green recovery:

1) decarbonization based on behavioral changes;

2) technology-driven decarbonization; and

3) GreenPlus – a third-way towards a carbon-neutral economy.

The least costly way to decarbonize is to transform the electricity supply mix. This would mean the fastest possible phase-out of lignite-fired power plants, a transformational shift in Bulgaria's renewable energy sector, leveraging private investments in new technologies such as offshore wind and geothermal energy, and the accelerated electrification of buildings, industry and mobility. The uptake of low-carbon technologies requires the modernization of the power grid and more investments in sustainable mobility infrastructure.

Initial assessment of transition impacts for carbon-intensive districts conducted by the Government of Bulgaria

The GoB's analysis of the effects of the European Green Deal shows that the shift towards climate neutrality would not be confined to particular regions, but rather would have a nation-wide impact that would require deep transition of the economy, with huge needs for investments and job reskilling in all regions of the country. The structure of Bulgaria's economy is such that most of its industries would be transforming. The Bulgarian economy is the most resource-intensive within the Union. In 2017 it used 6.5 times more resources per unit of Gross Domestic Product (GDP) than EU average. The amount of waste generated in the production process was also estimated to exceed EU average by a multiple of 6.4. The Bulgarian government has already declared its aim at reducing the resource intensity of the economy with a focus on transforming the country's linear economy into a circular one, but a catch-up trend has not been established.

Bulgaria has the most energy intensive economy in the EU[5]. Despite some achievements, the economy consumes more than 3.6 ton per Gross Value Added (GVA). Historically, those levels were supported by the presence of secure local energy resources, which would change under the pressure of climate and environmental policies. As a border country, Bulgaria runs a very high risk of carbon leakage – most of the industries are a few kilometers away from the less strict regulations

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[4] "*Green recovery pathways to Bulgaria's carbon neutrality by 2050*", Policy Brief No. 101, June 2021, Center for the Study of Democracy

[5] https://ec.europa.eu/commission/sites/beta-political/files/energy-union-factsheet-bulgaria_en.pdf – Energy Union Factsheet Bulgaria, November 2017

in the Western Balkans and Turkey, also heavily dependent on coal-generated energy. Another argument in this direction is the strategic autonomy of the EU, which the Commission has announced as one of its flagship policies. Furthermore, this geographic location determines that the post-pandemic negative economic effects are most likely to echo longer.

Bulgaria is the Member State with the lowest income per capita and with five of the eight least developed regions in the EU. Green policies will inevitably push energy prices up, which could have a negative side effect on energy poverty. Households in regions subject to energy poverty will turn to burning highly polluting coal and waste. Bulgaria needs a thorough approach to the decarbonization of its whole territory in order to be able to implement the Green Deal policies. It will help combat regional disparities, depopulation of regions and high concentration of population in the big industrial centers of Bulgaria, which are the cornerstones of the Cohesion policy. At present, the lack of attractiveness of these regions results in extremely negative demographic trends.

GoB argues that the EC's analysis for Bulgaria in determining the eligibility for the Just Transition Fund (JTF) should consider factors beyond the specific location of coal mines and coal-fired power plants in Bulgaria. These mines and plants are concentrated in Stara Zagora, Kyustendil (Bobov Dol) and Pernik. However, the GoB believe that at least two additional criteria should be considered by the EC in the case of Bulgaria:

- **Social criteria** – a number of the workers in the coal mining and coal-fired power plants live in districts neighboring the identified coal district of Stara Zagora;
- **Impacts on carbon-intensive industries** – carbon-intensive enterprises from the manufacturing industry will be strongly affected by decarbonization, e.g. those from the mineral industry, chemicals, metal industries, etc. GoB clams this could lead to potential closure or scaling down of their operation and related negative impact on employment in districts with carbon-intensive industry, as this negative impact would extend beyond the directly affected carbon-intensive companies to their whole value/supply chain, both upstream (feedstock and energy suppliers) and downstream (distribution, use and product EOL[6]), which companies will be thus indirectly affected by the transition (secondary effects of the transition on the value added and employment for the economy as a whole).

The additional eight districts are considered to be territories that will be either socially affected by future phase out of coal mining or by the impacts of the energy transition on carbon-intensive industries. Based on data about employment relations in the four main enterprises[7] in the Maritsa East Complex (Stara Zagora coal district), GoB estimates that 25 percent of their workforce are residents in the neighboring districts of Haskovo, Sliven and Yambol, in particular from municipalities with poorly diversified economies, which are integrated into the value-added chain of the energy sector.

According to GoB's analysis, the districts of Haskovo, Varna, Burgas, Lovech, Targovishte and Gabrovo, besides the three coal districts, are reporting GHG-intensive industrial processes much above the JTF inclusion criterion (if apllied at NUTs 3 level), while hosting significant businesses and employment in related and/or secondary affected industries.

[6] End of Life.

[7] Maritsa East Mines EAD and the three largest power plants - TPP Maritsa East 2, TPP ContourGlobal Maritsa East 3 and TPP AES Galabovo.

Based on the above, GoB argues for the eligibility of these additional eight districts under the Just Transition Mechanism (JTM) to take advantage of JTF-funded projects and those funded by the second (InvestEU) and third (EIB Public Sector Loans) pillars of the JTM. GoB believes this is important to ensure a socially acceptable transition by putting in place plans that identify targeted interventions to address locally identified transition challenges in close partnership with the affected populations and economies. GoB argues that this will be a crucial step in ensuring that Bulgarian industries do not face the risk of carbon leakage (see the following box for more information)and that no one is left behind in the transition process.

Box 1. Risk of Carbon Leakage in Bulgaria

Carbon leakage and industrial sectors at risk

According to the EU, carbon leakage refers to "the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laxer emission constraints". [8] To prevent carbon leakage, the EU emissions trading system (EU ETS) has offered special treatment and higher share of free allocation to industrial sectors at significant risk of carbon leakage. According to Phase 3 of the scheme, an industrial sector or sub-sector is identified to have a significant risk of carbon leakage if:

1) the production cost of the sector is increased by at least 5% (as a porportion of the gross value added) due to the direct and indirect costs associated with the EU ETS directive; and

2) the trade intensity with non-EU countries of the sector is above 10%.

There are several channels of sector-led carbon leakage initiated by uneven carbon constraints, the three most important include: i) the ***short-term competitiveness channel***, where EU carbon-constrained industrial products lose international market shares to the benefit of unconstrained competitors; ii) the ***investment channel***, where differences in returns on capital associated with unilateral climate mitigation action provide incentives for firms to relocate capital to countries with less stringent climate policies; and iii) the ***fossil fuel price channel***, where reduction in global energy prices due to reduced energy demand in climate-constrained countries triggers higher energy demand and CO2 emissions elsewhere, all things being equal.

Under industrial studies[9], the sectors subject to loss of competitiveness under uneven carbon constraints and potentially to carbon leakage are the **internationally trade-exposed, GHG-intensive industries**. These industrial activities would support a high mitigation cost and can see their products' market challenged by foreign competitors as a result of stringent emission objectives. Primary aluminum, refineries, cement, pulp and paper, iron and steel and chemicals fit in this category, to varying degrees. The carbon-leakage risk could be further exacerbated by the fact that in practice all of the GHG-intensive companies belonging to those sectors are subsidiaries of internationally operating sectoral conglomerates which are

[8] European Commission. 2021. "Climate Action – Carbon Leakage". https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en

[9] Reinaud, J. (October 2008). *"Issues behind Competitiveness and Carbon Leakage- Focus on Heavy Industry. IEA information paper"*. International Energy Agency (IEA), Head of Communication and Information Office, 9 rue de la Fédération, 75739 Paris Cedex 15, France. p. 122. Archived from the original on 2010-06-15. Retrieved 2010-05-12.

potentially able to close or transfer production to their industrial facilities located in third countries, and/or substitute their EU production with imports from such locations.

Those risks are to be addressed not at district level, but at Union level, by the carbon border adjustment mechanism (CBAM) proposed by the EC[10], alternatively to the measures that address the risk of carbon leakage in the EU ETS[11] which are expected to be phased out between 2026 and 2035. In July 2021, a new **Carbon Border Adjustment Mechanism (CBAM)**[12] was proposed by the EC to address carbon leakage. With the goal to prevent the production of carbon-intensive goods shifting from EU to non-EU countries, CBAM will apply a carbon price to a selection of carbon-intensive imports, including aluminum, cement, iron and steel, electricity and fertiliser.

The EC is planning the **CBAM to be fully operational only in 2026**. Under the Commission's proposal, importers will have to report emissions embedded in their goods without paying a financial adjustment in a transitional phase starting in 2023 and finishing at the end of 2025, giving time for the final system to be put in place. The CBAM transition period until 2025 leaves the need to introduce additional measures to mitigate the risk of carbon leakage within this period.

Risk of carbon leakage in Bulgaria

An official list of industrial sectors and sub-sectors in Europe that are identified as having a significant risk of carbon leakage has been provided and updated by the EC since 2013[13]. The first and second list were applied from 2013 to 2020, and the most recent list[14] was published in May 2019 and will be used for Phase 4 of the directive from 2021 to 2030. According to the list, industries in energy-intensive sectors may be at a higher risk of carbon leakage.

This corresponds to the findings from the literature, which suggest that there is a potential risk of carbon leakage for industrial sectors in Europe that are energy or carbon-intensive. A 2008 study[15] reveals that sectors that are carbon-intenstive and internationally trade-exposed are subject to potential carbon leakage. Another study[16] that focused on the impact of EU ETS on carbon-intensive industries by examining the imports and exports in these industries between the EU and China also found evidence of carbon leakage in the steel industry.

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[10] https://ec.europa.eu/info/sites/default/files/carbon_border_adjustment_mechanism_0.pdf

[11] Such as the free allocation of emission allowances to the sectors at carbon leakage risk.

[12] European Commission. 2021. " Carbon Border Adjustment Mechanism". https://ec.europa.eu/taxation_customs/green-taxation-0/carbon-border-adjustment-mechanism_en

[13] European Commission. 2021. "Climate Action – Carbon Leakage". https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en

[14] European Commission. 2019. ANNEX to the Commission Delegated Decision supplementing Directive 2003/87/EC of the European Parliament and of the Council concerning the determination of sectors and subsectors deemed at risk of carbon leakage for the period 2021 to 2030. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1146-Carbon-Leakage-List-2021-2030_en

[15] Reinaud, J. 2008. "Issues behind Competitiveness and Carbon Leakage- Focus on Heavy Industry. IEA information paper". International Energy Agency (IEA), Head of Communication and Information Office, 9 rue de la Fédération, 75739 Paris Cedex 15, France. https://web.archive.org/web/20100615082600/http://iea.org/publications/free_new_Desc.asp?PUBS_ID=2057

[16] Zhou, H. and J.C. Cheng. 2014. Has EU-ETS caused carbon leakage in the EU carbon-intensive industries. *China Population Resources and Environment,* 24(1): pp. 87-93.

Under this circumstance, the following carbon-intensive sectors in the 8 districts of Bulgaria are exposed to the risk of carbon leakage, as they are directly affected by Bulgaria's decarbonization and also on the EC's Carbon Leakage List 2021 – 2030[17].

NACE Rev. 2 Code	Description	District
16.21	Manufacture of veneer sheets and wood-based panels	**Burgas, Lovech**
20.13	Manufacture of other inorganic basic chemicals	**Varna**
20.15	Manufacture of fertilisers and nitrogen compounds	**Varna, Haskovo**
23.11	Manufacture of flat glass	**Targovishte**
23.13	Manufacture of hollow glass	**Targovishte**
23.32	Manufacture of bricks, tiles and construction products, in baked clay	**Targovishte, Lovech, Sliven, Haskovo**
23.42	Manufacture of ceramic sanitary fixtures	**Lovech, Gabrovo**
23.51	Manufacture of cement	**Varna, Lovech**
23.52	Manufacture of lime and plaster	**Burgas**
24.10	Manufacture of basic iron and steel and of ferro-alloys	**Burgas**

The non-EU neighbors of Bulgaria are in the process of accession negotiations with the EU which implies alignment with the EU acquis communautaire. Nevertheless, the timeline of this process with each country and under each negotiation chapter is individual and can take a long time. Additionally, unlike the other non-EU neighbors of Bulgaria, Turkey is not a contracting party to the Energy Community[18], which obliges its parties to transpose and implement a number of EU environmental directives.

Bulgaria's response to carbon leakage at national level

Given the risk of carbon leakage in the GHG-intensive sectors, actions has been taken by the Bulgarian government at national level to support the EU ETS directive and prevent potential carbon leakage. According to a report by the Ministry of Environment and Water of Bulgaria, the country designed its climate change policy based on the EU and national legislations. It follows Directive 2009/29/EC on ETS and ensures that its installations will receive free

[17] European Commission. 2019. ANNEX to the Commission Delegated Decision supplementing Directive 2003/87/EC of the European Parliament and of the Council concerning the determination of sectors and subsectors deemed at risk of carbon leakage for the period 2021 to 2030. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/1146-Carbon-Leakage-List-2021-2030_en

[18] https://www.energy-community.org/

allocations according to EU benchmarks and risk of carbon dioxide leakage[19]. Moreover, the Bulgarian Climate Change Mitigation Act was amended in 2020 to allow for the implementation of Directive (EU) 2018/410, with the goal to provide financial support and state aid for companies in industrial sectors that are at significant risk of carbon leakage[20]. Under this bill, it is estimated that about 190 Bulgarian companies with rising indirect costs of production due to GHG emission quotas in electricity pricing were eligible for applying for this aid until the end of 2020.

EC's position on the Bulgaria NECP and initial assessment of transition impacts for carbon-intensive districts

The EC notes that Bulgaria's 2030 target for GHG emissions not covered by the EU Emissions Trading System (non-ETS) is 0% compared to 2005, in line with the Effort Sharing Regulation (ESR). By implementing the additional policies specified in the plan, it is projected that Bulgaria would meet this target, assuming that the land use, land use change and forestry (LULUCF) no-debit commitment is kept. However, it is important to note that the conclusion depends on the 2005 emission values used for the calculations. When using the 2005 base year value of the Effort Sharing Decision, Bulgaria's WAM projections do not meet its 2030 ESR target. The plan does not look at what planned level of overachievement might be cost-efficient with a view to using transfers to other Member States and contributing to growth and jobs.

The EC considers that that the target of a 27.09% share of energy from renewable sources in the gross final consumption of energy for 2030, as established in the final NECP, is adequate as Bulgaria's contribution to the EU's renewable energy target for 2030. However, as regards energy efficiency, Bulgaria's contribution to the EU's 2030 target is 17.5 Mtoe for primary energy consumption and 10.3 Mtoe for final energy consumption, which are respectively low and very low. Bulgaria's plan therefore leaves plenty of scope to further develop and step up policies and measures on both renewables and energy efficiency, so as to contribute more to the EU climate and energy targets and strengthen the green transition.

On renewables, Bulgaria committed to an overall renewable energy target of 27%, differentiated through sectoral projections. The country would benefit by having more specific sectoral targets and specific actions, in addition to the policy measures already described in the plan. This would also make it easier to assess and monitor contributory measures and actions in the future, to ensure a better overall result. In the heating and cooling sector, specifically, Bulgaria would benefit by maximising the role of renewables and promoting the role of waste heat. In addition, the penetration of renewable electricity would be significantly enhanced by ensuring a level playing field in the electricity market. In this context, a careful assessment of the regulatory,

[19] Ministry of Environment and Water of Bulgaria. 2015. Bulgaria's SECOND BIENNIAL REPORT In Compliance with the Obligations under the United Nations Framework Convention on Climate Change According to Decisions 2/CP.17 and 19/CP.18 of the Conference of the Parties. https://unfccc.int/sites/default/files/resource/Bulgaria%20bg_br2.pdf

[20] CMS Law-Now. 2019. Bulgaria to aid companies for carbon leakage due to indirect emission costs. https://www.cms-lawnow.com/ealerts/2019/06/bulgaria-to-aid-companies-for-carbon-leakage-due-to-indirect-emission-costs?cc_lang=en

structural and administrative system would assist the removal of any barriers and burdensome procedures, streamline licensing, and promote the uptake of power purchasing agreements.

Regarding energy efficiency, Bulgaria would benefit if it were to adopt and implement additional policies and measures designed to achieve further energy savings by 2030. As regards energy security, Bulgaria would benefit if it were to combine its strategy of obtaining access to different sources of natural gas, including decarbonized gases, with specific measures to integrate relevant sectors. This would help optimise and transform the energy system as a whole, instead of decarbonizing and making separate efficiency gains in each sector independently.

The EC notes that Bulgaria faces the challenge of taking account of just and fair transition aspects in its efforts to shift the energy system towards low-carbon sources. In particular, the country needs to develop a more comprehensive assessment of the social, employment and skills impact of planned objectives, policies and measures. This applies particularly to coalmining regions, carbon-intensive and linked industries. The measures proposed to mitigate the impact of the transition will also require further detail and analysis. In this context, the Just Transition Mechanism, as part of the European Green Deal, provides an opportunity to intensify efforts by making financial and technical assistance available.

3 HOW are the carbon-intensive sectors identified?

A combined top-down and bottom-up approach was applied to identify carbon-intensive subsectors in the district economies to be affected by potential decarbonization. The top-down approach uses the UNFCCC and EU ETS reporting framework to establish the carbon-intensive industrial sectors, which are to be used as a reference framework to identify the carbon-intensive sectors in the district economy. The bottom-up approach complements and verifies the top-down approach, by identifying the carbon-intensive companies in the district economy, based on publicly available data, and studying their decarbonization challenges.

The structure of the GHG emissions in Bulgaria under the UNFCCC, being the starting point of the carbon-intensity analysis of the district economy, is presented in Table 1 below.

Table 1. GHG emissions in Bulgaria in 2019

№	Emission sector[21]	GHG emissions		
		t. CO_2 eq.	% of sector	% of total
1	Energy	40 228.06		71.89%
	Energy industries	23 613.87	58.70%	42.20%
	Manufacturing industries & Construction	4 304.40	10.70%	7.69%
	Transport	10 459.30	26.00%	18.69%
	Other sectors, incl.	1 758.34	4.37%	3.14%
	Commercial/institutional	354.05	0.88%	0.63%
	Residential	910.18	2.26%	1.63%
	Agriculture/Forestry/Fisheries	494.11	1.23%	0.88%
	Other	92.15	0.23%	0.16%
2	Industrial Processes and Product Use	6 359.87		11.37%
	Mineral industry (mainly cement & lime)	2 325.24	36.56%	4.16%
	Chemical industry (mainly ammonia & nitric acid, soda ash)	1 899.68	29.87%	3.39%
	Metal industry (mainly iron & steel)	160.70	2.53%	0.29%
	Non-energy products from fuels and solvent use	100.55	1.58%	0.18%
	Product uses as substitutes for ODS[22]	1 818.55	28.59%	3.25%
	Other product manufacture and use	55.15	0.87%	0.10%
3	Agriculture	6 249.25		11.17%

[21] The emissions structure reported under the UNFCCC is based on the sources of GHG, as established by the Intergovernmental Panel on Climate Change (IPCC), the UN body for assessing the science related to climate change.

[22] Ozone Depleting Substances.

4	Land Use, Land-Use Change and Forestry (LULUCF)	-9 562.01		
5	Waste	3 118.09		5.57%
	Total (excl. LULUCF)	55 955.27		

Source: National Inventory Report (NIR) 2021, submission under the UNFCCC[23]

The above GHG structure was used as a starting point of the carbon-intensity analysis, subject to certain limitations, stemming from the narrower thematic and eligibility scope of the TJTPs. The focus of TJTPs as per Article 11 of the JTF Regulation is on the *"economic and social impacts resulting from the transition, in particular with regard to the expected adaptation of workers or job losses in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity"*. Therefore, the sectors of Agriculture and LULUCF are not covered by the analysis, as those sectors are outside of the eligibility scope of the TJTPs, i.e. thematic actions fundable under the JTM as outlined in Article 8 of the JTF Regulation. In addition, the carbon-intensity analysis of the Transport and Waste sectors was limited only to those sectoral aspects which fall under the thematic and eligibility scope of the TJTPs, i.e. sectoral decarbonization actions fundable under the JTM. In particular, for the Transport sector the analysis was limited to local public transport and urban mobility. For the Waste sector, it was limited to prevention/reduction of waste generation and waste recyling. The carbon-intensity aspects of the Buildings sector (building stock) were paid specfic attention within the the Energy sector analysis.

Thus, carbon intensity analysis of the district economy is mainly focused on the energy and manufacturing industry sectors. Under the NACE Rev. 2 economic classification those two sectors are aggregated into Industry (covering sections B to E, excluding F Construction). For each of the key sectors covered by the carbon-intensity analysis (manufacturing industry, energy industry, buildings, public transport and waste), the full details of the scope, limitations and methodology applied to determine the most carbon-intensive subsectors and identify carbon-intensive companies are available in Annex 1.

This section contains a summary of the methodology of identifying the carbon-intensive sectors of the district economy in the form of Sector System Maps /SSMs)**.** Detailed SSMs, together with relevant decarbonization pathways and identified diversification opportunities for the eight districts, can be found in Part II of this report.

3.1 Sector System Maps of carbon-intensive sectors

The economic sectors in each district expected to be affected by the decarbonization have been identified and outlined in the form of '*Sector System Maps' (SSMs*).

The SSMs include entities or industries, subject to both i) the direct and ii) the indirect impacts of the decarbonization process. Thus the SSMs outline the most important elements of the 'ecosystems' of all economic sectors affected by the transition.

[23] https://unfccc.int/sites/default/files/resource/bgr-2021-nir-15apr21.zip

Following the approach of limiting the scope of sectoral analyses only to JTF-fundable thematic aspects[24], the SSMs cover separately i) manufacturing industry, ii) energy sector, incl. buildings, iii) transport sector, and iv) waste sector.

The results of the SSMs will allow the districts to deepen their understanding of the process of industrial decarbonization and of its socio-economic impacts on the district economy, thus aiding their effective planning and decision making related to the TJTPs.

3.1.1 SSMs of Manufacturing Industry

The objective of the industrial SSMs is to identify and outline the carbon-intensive industrial sectors of the district economy and illustrate the scope of potential impacts of their low-carbon transition on the district economy.

The carbon-intensive industrial sectors were identified and analyzed through a **combination** of **bottom-up** and **top-down methods**.

A bottom-up **survey** was used to identify the carbon-intensive industries and sectors, operating in each of the districts, which are expected to be **directly affected** by the decarbonization, and establish the scope of potential impacts. All CO_2-intensive companies in the district, expected to be directly affected by the decarbonization process, were identified[25], using data obtained from various industrial emission registers, as described above. Based on the business statistics dataset provided by NSI, the main structural economic indicators outling the role of these sectors in the district economy and the potential impacts of their decarbonizartion, were established.

For **indirectly affected sectors**, a hybrid approach was used for identifying and outlining the decarbonization impacts. The team started with a **survey-based approach to directly identify and analyze the companies included the value chain of each of the directly affected companies.** Although resource intensive, this approach allowed for greater accuracy in not just identifying the type of impacts, but also the magnitude and other parameters of interest. The approach required obtaining complete information from each directly affected company about its value/supply chain partner companies. However only four of the identified 26 operational carbon-intensive companies[26] (directly affected) did provide structured information on their supply chain partners, located in Bulgaria. These were: 1) Solvay Sodi AD, Varna district; 2) Zlatna Panega Cement AD, Lovech district; 3) Trakia Glass EAD, Targovishte district; and 4) Lukoil Neftochim Burgas AD, Burgas district. Based on that information businesses, included in the supply chains of those four major CO2 emitters in the 8 analized districts, were identified and studied. This allowed to directly establish the supply chain impacts, taking place in the 8 districts., i.e. the indirectly affected sectors, caused by the decarbonization of those four CO2-emitters.

Table 2. Distribution of the supply chain partners of the 4 surveyed industrial emittes, per district

[24] Cf. Annex 1 to Part I.

[25] Applying also certain exclusion criteria – cf. Annex 1 to Part I.

[26] The full list of surveyed carbon-intensive companies, formed under the methodology decsribed above, comprised of 31 companies which filed reports for year 2019 in relevant indusrial registers or/and were available in those registers at the time of the survey (May- July, 2021). In the course of the survey it was however found out that 5 of these 31 companies were not operational (had ceased their reported activity).

CO_2-intensive company	Number of supply chain partners in Bulgaria, per district									
	Burgas	Varna	Sliven	Yambol	Lovech	Gabrovo	Targov.	Haskovo	Other	**Total**
Zlatna Panega Cement AD		2			3			1	17	**23**
Trakia Glass EAD		4		1			5		14	**24**
Lukoil Neftohim Burgas AD	7	1							15	**23**
Solvey Sodi AD		16		1					11	**28**
Total	**7**	**23**	**0**	**2**	**3**	**0**	**5**	**1**	**57**	**98**

Due to the limited scope of the supply chain survey, the list of 'indirectly affected sectors' presented in the SSMs is a non-exhaustive one, covering only the selected supply chains. Although incomplete in terms of coverage, those case studies brought valuable in-depth information on the practical implications of the decarbonization process in four major CO2-intensive sectors, which could not be otherwise obtained.

To account for the lack of comprehensive data for indirect impacts, an alternative method has also been used to augment the analysis. The team implemented an Input-Output (I-O) analysis as an *indirect method* to identify the indirectly affected sectors and estimate the socio-economic impacts. That method complemented the survey approach by assessing the socio-economic impacts more broadly, based on the inter-sectoral relations within the district economy. Existing national I-O tables (IOTs) that illustrate the flows between the sales and purchases (final and intermediate) of industry outputs were used to create regional IOTs, under certain assumptions. The regional IOTs enabled the calculation of sectoral employment impact multipliers.

Applying the latter to the carbon-intensive sectors of each district allowed the team to find out the hypothetical number of FTE[27] jobs that might be lost in each district under a hypothetical worst-case scenario (discontinuation the activity of those sectors in response to the climate policies and regulations).[28] This included both the initial direct jobs to be lost in the directly affected businesses themselves, as well as the indirect jobs to be lost in the district because of the backward linkages in their relevant value chains. (*Further details on the methodology and findings of the I-O analysis are provided in section 5.1.1 below, dedicated to the economic impact assessment*.)

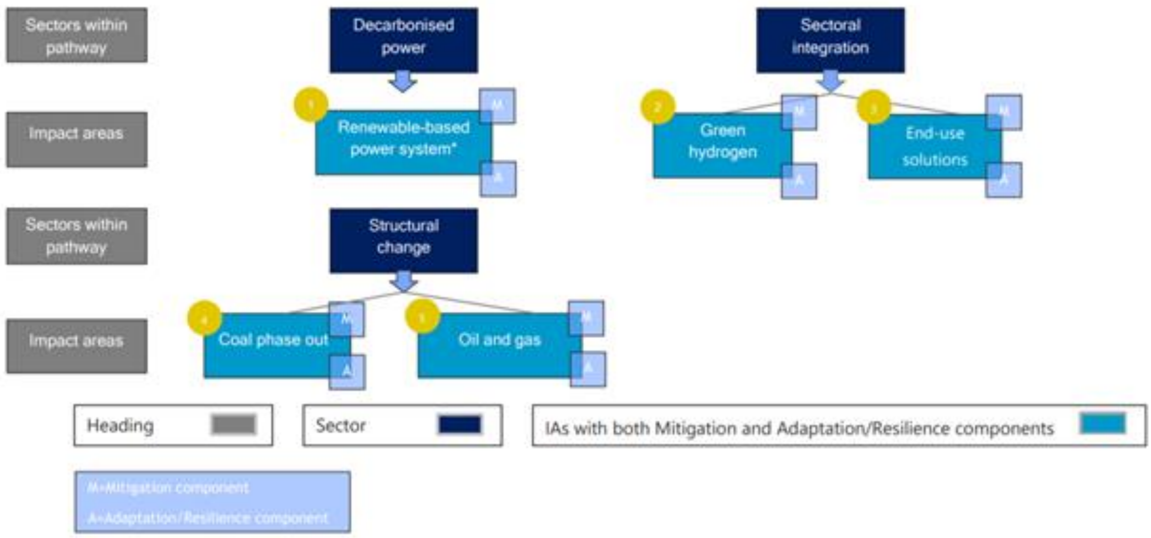
[27] Full-time equivalent.

[28] A methodological assumption enabling a qualitative assessment, not a speculation or prediction that the affected businesses will in practice cease to operate as a result of the decarbonization process.

3.1.2 SSMs of Energy sector

The main actors for the structural changes needed for decarbonization include: Policymakers (national, subnational, local levels); Financial Institutions; Technology Providers and Innovators; Business and Service Providers; Civil Society. According to the report of UNFCCC, the energy sector also intersects with health, water, and gender, and is critically linked to the efforts to advance a Just Transition[29] . The UNFCCC document presents an action table (Figure 1) which includes three sub-sectors ("Decarbonized power", "Sectoral integration", "Structural change") and each containing respective impact areas, represented in separate tables (1) Renewable-based power system, (2) Green hydrogen, (3) End-use solutions, (4) Coal phase out, and (5) Oil and gas.

Figure 1. Action table

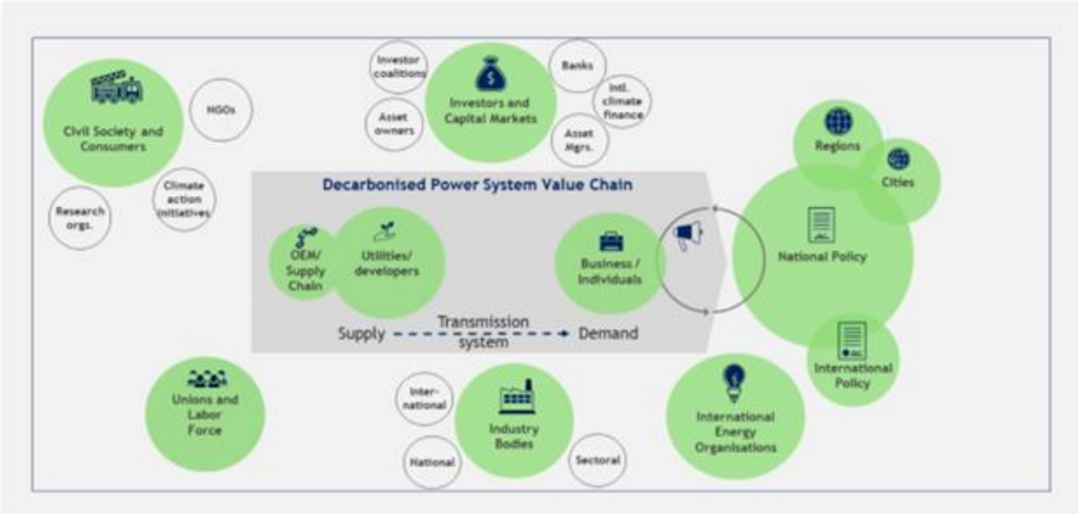


Source: Climate Action Pathway Energy UNFCC

The decarbonized power system map is presented in the document as an integration between national policy, investors, utilities/developers, civil society, labour/bussines and international organizations, business and individuals and the supply chain as depicted in Figure 2.

Figure 2. Decarbonized power system

[29] Climate Action Pathway Energy https://unfccc.int/sites/default/files/resource/Action_table_Energy.pdf



Source: Climate Action Pathway Energy UNFCC

Most actors operate at national levels, however cities and regions or municipalities could also influence the process of decarbonization by setting local targets, promote and demonstrate transition operations by involving all stakeholders. Using public private partnership or other initiatives with the local business will lead to various benefits for local people and economy. Attracting local educational institutions, academia and research and innovation divisions is essential for a faster penetration of new technologies and behavior change.

Energy planning for resilient decarbonization is important due to the impact of the process on energy prices, employment in the energy sector (especially in fossil fuel operating plants and networks), security of supply and other factors that might influence the economy of each country. Involvement of all stakeholders in the process will facilitate changes and mitigate negative impact. The proper management and development of the energy infrastructure require good planning, state and private investments and balancing of resources in the conditions of liberalized market. Both strategic and operative planning are connected to the needs of digitalization and capacity building.

There are currently no estimates made by the government or the national electricity system operator on the impact of decarbonization of transport sector and industry by electrification. The final energy consumption in Bulgaria in 2019 was 9698.7 thousands toe, of which 312.5 coal, 3631.4 oil products and 2589.8 thousands toe electricity[30]. If coal phase out is done and half of oil products are replaced with electricity, this means that the economy needs double amount of energy from electricity. This amount could be produced and utilized on site or transmitted by the electricity network but investments are needed in Renewable Energy Sources (RES) or low-carbon plants, the network and for balancing (storage, back-up, others). In transport sector in 2019 only 0.9% of the final energy consumption comes from electricity, 89.7% are oil products, 4.2% natural gas and the rest are biofuels[31]. There is no national strategy for decarbonization of the sector with clear indicators for the use of electricity and hydrogen from RES.

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30 Energy Balance, NSI

31 https://www.nsi.bg/bg/content/4196/%D0%BE%D0%B1%D1%89-%D0%B5%D0%BD%D0%B5%D1%80%D0%B3%D0%B8%D0%B5%D0%BD-%D0%B1%D0%B0%D0%BB%D0%B0%D0%BD%D1%81 – Energy Balance, NSI

The sector in Bulgaria is regulated by the Energy and Water Regulatory Commission (EWRC), responsible for licensing, price regulation, adopting secondary legislative acts, approving the common conditions of the contracts and many others[32] . Installations using RES with capacity ≤5 MW for electricity prodiction and ≤10 MW for heat production are not subject of license by (EWRC) and information for such plants is available in SEDA but only if they operate for production electricity from RES and apply for certificates for origin. There is no a register of other source of information for Installations used to cover the own needs of industrial enterprises and buildings.

The Bulgarian Energy Holding (BEH) plays a significant role in Bulgaria's energy market. It manages the most important companies in the energy sector (the Kozloduy nuclear power plant (NPP), three thermal power plants, the National Electric Company (NEK), fifteen hydro power plants, Electric System Operator (ESO), Bulgargaz, Bulgartransgaz. The Independent Bulgarian Energy Exchange was established in January 2014, as a fully-owned subsidiary of the Bulgarian Energy Holding EAD. It holds a 10-year license by the Energy and Water Regulatory Commission for organizing a Power Exchange for electricity in Bulgaria. In the middle of 2021 there are 50 licensed by EWRC traders with electricity in Bulgaria. The market is centralized and the impact of the electricity price is not district-specific.

The focus of the SSM will be on energy companies and other stakeholders which are eligible for financing under JTF[33] and acts for:

- Investments in research and innovation activities, including by universities and public research organisations, and fostering the transfer of advanced technologies;
- Investments in the deployment of technology as well as in systems and infrastructures for affordable clean energy, including energy storage technologies, and in greenhouse gas emission reduction;
- Investments in renewable energy in accordance with Directive (EU) 2018/2001 of the European Parliament and of the Council, including the sustainability criteria set out therein, and in energy efficiency, including for the purposes of reducing energy poverty;
- Rehabilitation and upgrade of district heating networks with a view to improving energy efficiency of district heating systems and investments in heat production provided that the heat production installations are supplied exclusively by renewable energy sources;
- Investments in digitalisation, digital innovation and digital connectivity.

Data for energy sector in Bulgaria are collected and aggregated by:

- National Statistical Institute (NSI) – Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics (with 5 amendments). Data are provided also to EUROSTAT for EU level statistics and analysis. NSI is responsible for the energy balances, energy market statistics, statistics on RES and district heating and cooling systems.

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[32] https://www.dker.bg/en/about-ewrc.html

[33] REGULATION (EU) 2021/1056 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 June 2021 establishing the Just Transition Fund https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R1056

- Sustainable Energy Development Agency (SEDA) – RES electricity with certificates for origin.
- Energy and Water Regulatory Commission (EWRC) – data for licenses, price analysis and regulation, business plans analysis and adoption.
- Ministry of Environment and Water – for emission trading scheme, regulation of water for hydropower plants.
- Others - other institutions.

One of the main characteristics of the sector is that the transmission and distribution systems are operated mainly at national level (apart from local gas distribution companies). Data are not summarized at NUTs3 (district) level and hence the indicators that can be used at this level are limited. There are data available at district level for power generation from renewables for the purposes of the certificated for origin (from SEDA) – installed capacity and energy produced. Another indicator is the number of registered installations by type of RES. Although currently there are no statistics for green hydrogen installations and production, such information should be collected at local and district level indicating also integration of these technologies in energy sector as there are indications for transformation of thermal power plants and district heating companies from using natural gas to green hydrogen based generation. Energy storage will play an increasing role for electricity and gas market regulation therefore such capacities should be also included in the indicators. Cogeneration continue to be a supported technology and where applicable, this indicator will be included.

EUROSTAT collects statistical information at country level for the Employment in the environmental goods and services sector. For sector D (NACE Rev.2) Electricity, gas, steam and air conditioning supply the trend for Bulgaria is quite positive, as for renewable energy sources we have increase from 1576 in 2012 to 4062 full time equivalent in 2018 [34]. Data are not collected at district level but gives an overview of the trends and the positive impact that the sector could have on job creation. EurObserv'ER provides a wider picture on all jobs created, including for trade, installation and other activities, as solid biomass is the most job-intensive sector as shown in the table below [35].The statistical data are provided for economic activities of registered enterprises in each district. Although there is no statistical data available for the companies operating in the district but registered in another district, data could be also used for evaluating impact. Such for sector D Electricity, gas, steam and air conditioning supply data are the number of enterprises, the number of employees and revenues.

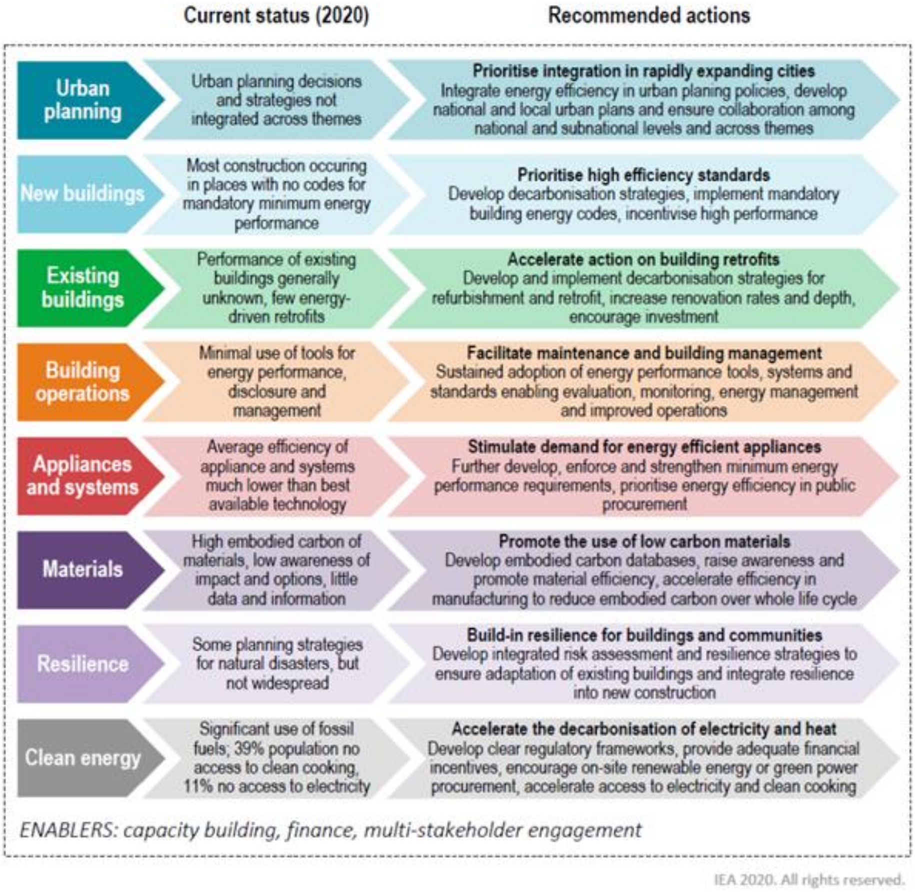
3.1.3 SSMs of Buildings sector

The possible roadmap developed by GlobalABC Roadmap for Buildings and Construction 2020-2050 presents the complexity of interactions of stakeholders in buildings and actions needed.

[34] Source of data EUROSTAT http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.d

[35] Source of data EurObserv'ER https://www.eurobserv-er.org/eurobserver-policy-files-for-all-eu-28-member-states

Figure 3. Roadmap summary timelines [36]



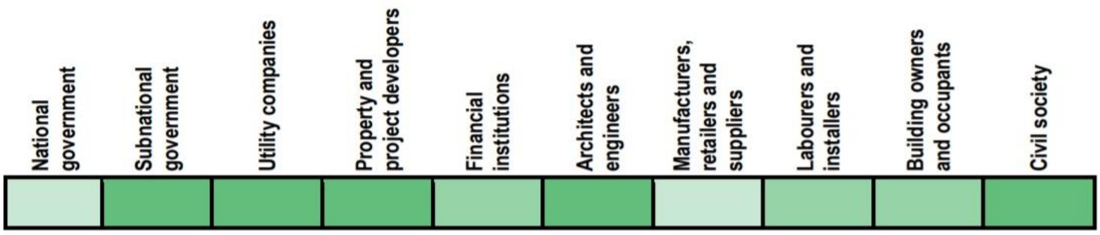
Source: IEA 2020.

The contribution of local authorities to a higher penetration of renewable energy and to the creation of conditions for renewables self-consumption and consumption of renewable energy by separate 'renewable energy communities' at local level is noted as essential for the cost-effective development of renewable energy in the country in the Integrated Energy and Climate Plan of the Republic of Bulgaria (2021-2030). Directive 2018/2001 require that opportunities for the use of renewable energy be considered when planning, designing, building and renovating urban infrastructure, including industrial, commercial and residential areas, and energy infrastructure, with a special focus on the use of heating and cooling from renewable energy sources.

Local authorities are obliged to develop long-term and short-term municipal programmes for promotion of the use of energy from renewable sources and biofuels within each municipality, as well as for developing energy efficiency programmes at local level. Increasing energy efficiency and use of RES is included also as a local policy in the Plans for Integrated Development which each of municipalities in Bulgaria have to develop for the period 2021-2027. The main stakeholders in urban planning process are presented in the figure below:

Figure 4. Stakeholder mapping for urban planning and new buildings

[36] https://globalabc.org/sites/default/files/inline-files/GlobalABC_Roadmap_for_Buildings_and_Construction_2020-2050_3.pdf



Source: GlobalABC Roadmap for Buildings and Construction 2020-2050

The desktop analysis of plans and programmes for energy efficiency and ES and the conducted interviews show that several shortcomings in the process of urban planning would need to be overcome in future. For instance, the process of energy planning and development of the energy supply networks is highly centralized. Communications with utility companies are mainly carried out to ensure energy supply and for short-term planning, but often not for strategic planning and development. The level of digitalization in planning and construction process is still low. There is limited access to financing resources (grants are dominating energy efficiency measures, even for bankable projects) and lack of incentives for public-private partnership and using financial mechanisms. And finally, the involvement of all stakeholders in the process of planning and development is limited to the budget of concrete projects and capacity of the authorities to develop and implement communication and engagement plan.

Indicators to assess the impact of decarbonization

- Data for energy sector in Bulgaria are collected and aggregated by:
- National Statistical Institute (NSI) – Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics (with 5 amendments). Data are provided also to EUROSTAT for EU level statistics and analysis. NSI is responsible for the energy balances, energy market statistics, statistics on RES and district heating and cooling systems.
- Sustainable Energy Development Agency (SEDA) – Building stock characteristics and analysis based on certificates.
- Energy and Water Regulatory Commission (EWRC) – data for licenses, price analysis and regulation, business plans analysis and adoption.
- Ministry of Environment and Water – for emission trading scheme, regulation of water for hydropower plants.
- Others - other institutions.

Building sector data are not summarized at NUTS3 (district) level and hence there are limited indicators that can be used at this level. There are data available at district level for building stock from energy efficiency auditing (from SEDA). Unfortunately data for RES production and own use in buildings are derived from the national energy balance and also not at district level.

As the benefits from energy efficiency measures in building sector are multiple as presented in Figure 5, indicators could include social, environmental and economic impacts.

Figure 5. Multiple benefits from energy efficiency in Buildings

Source: ODYSSEE project 37

For example by reducing energy consumption and focusing on indoor climate issues when renovating, co-benefits can be achieved such as improved health due to less air pollution and a better indoor climate, both of which also lead to fewer hospitalisations and improved worker productivity. Based on methodology of Calculating and Operationalising the Multiple Benefits of Energy Efficiency in Europe (COMBI) project it is estimated that annual savings of 2 917 GWh in 2030 will lead to additional income of 3 035 thousand BNG per year in Bulgaria 38.

For the purposes of impact assessment of the decarbonization process in the building sector the following indicators at district level could be used:

- Average annual specific final energy consumption in residential and in administrative buildings, kWh/m2a
- Expected CO2 equivalent savings per year
- New buildings constructed
- Number of vulnerable consumers
- Although there is no statistical data available for the building construction sector, data for the overall construction sector could be also used for evaluating impact. Such data are:
- Number of enterprises

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[37] https://www.odyssee-mure.eu/data-tools/multiple-benefits-energy-efficiency.html

38 Long-term Strategy for Renovation of National Building Fund of Residential and Non-residential Buildings untill 2050)

- Number of persons employed
- Revenues

3.1.4 SSMs of Public Transport sector

The Transport sector contributed around 18% to total GHG emissions in Bulgaria in 2019[39]. Furthermore, within the Transport sector, road transport is responsible for 98% of the total CO_2 emissions from transport in 2019. With regards to road transport, the main vehicle types, as categorized in Bulgaria's National Inventory Report (NIR), are: motorcycles, passenger vehicles (cars), light duty vehicles (LDV), heavy duty vehicles (HDV), including buses.

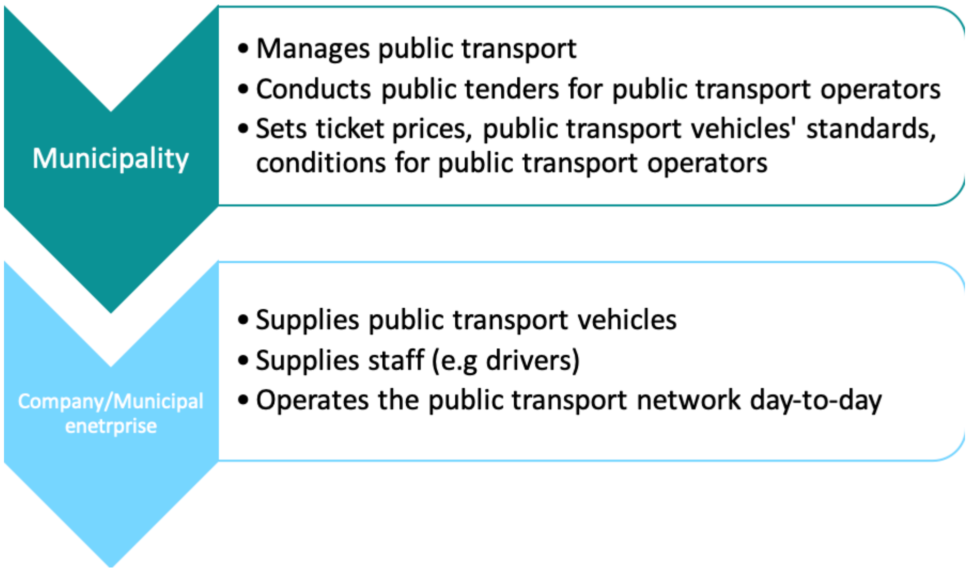
The current analysis focuses on public transport vehicles as support for smart and sustainable local mobility is the only eligible transport measure under the Just Transition Fund (JTF). Private passenger transport and freight transport, albeit contributing to GHG emissions, are outside of the scope of the current analysis not only because of the limited eligibility of transport measures under the JTF, but also because these types of transport are largely not managed on regional and/or municipal level. Private passenger and freight transport are also influenced by national policies and regulations, as well as private individuals' and companies' decisions. Nevertheless, improving the attractiveness and sustainability of public transport will contribute to reducing the need of private passenger vehicle use and improving local mobility. In addition, urban mobility measures implemented by local authorities such as transport demand management, Low Emission Zones, designation of bus and bicycle lanes, etc. can also reduce car use within cities and urban centers.

Municipalities are tasked with managing and organizing public transport within their territories. This means that municipalities have the power to influence how public transport is run and hence, can make a real contribution to sustainable local mobility. For instance, municipalities can set the standards for buses that operate the public transport network – these can be either minimum EURO standards for diesel and compressed natural gas (CNG) buses or requirements for only electric buses. Therefore, local authorities have the tools to influence the process of public transport's decarbonization by having direct impact on the choices of vehicles, and consequently, fuels, that are used to operate public transport.

Usually the day-to-day operation of public transport networks are managed by companies selected through public tenders or by municipal transport enterprises. These companies and/or municipal enterprises are the ones that actually run the public transport network and supply vehicles for public transport. The figure below describes the general set-up of public transport organization in municipalities.

Figure 6. Generalized set-up of a public transport system in Bulgaria

[39] National Inventory Report 2021: Greenhouse Gas Emissions in Bulgaria 1988-2019. Available at: https://unfccc.int/documents/273453



Another role that local authorities play in the promotion of smart and sustainable mobility is the development of infrastructure (e.g. charging stations) for the new generation vehicles – electric and hydrogen. In addition, local authorities can promote electric and hydrogen vehicles through local regulations such as – exemption from parking charges, preferential access to certain areas in the city, restrictions or fees for the use of fossil fuel-propelled vehicles in the city or certain areas of the city (through Low Emissions Zones, for instance). Moreover, local authorities can promote walking and cycling as sustainable mobility options through improving attractiveness of these mobility modes – designating bicycle lanes, expanding pedestrian areas and improving pedestrian and bicycle access, among others.

Indicators to assess the impact of decarbonization

Decarbonization in the public transport sector and local mobility generally means switching from fossil fuel-propelled vehicles to electric (and potentially green hydrogen) vehicles, walking and cycling and using less carbon-intensive modes of transport. Another way to achieve GHG emission reductions is to implement smart traffic management systems at city level in order to optimize transport flows. The decarbonization process in public transport and local mobility will have the largest impacts on some environmental aspects. In addition, those impacts will be mostly positive. Potential indicators to assess the impact of decarbonization in public transport and local mobility are presented in Table 3 below.

Table 3. Potential indicators to assess the impact of decarbonization of the public transport sector

Indicator	Measurement
GHG emissions	Decarbonizing the public transport sector will reduce GHG emissions. This can be measured using the methodology, described in Section 2.4 of this report.
Share of walking, cycling and public transport in local trips	Moving towards a smart and sustainable local mobility would potentially reduce the use of private vehicles locally and increase the share of walking, cycling and use of public transport. This can be measured by local modal split studies – taking a baseline year and comparing to the baseline

	in a given year after decarbonization measures are implemented. This can also be measured if statistics are collected regarding the passenger km per transport mode.

Other environmental impacts from the switch from fossil fuel-propelled vehicles to electric or hydrogen ones and from car-based mobility to walking and cycling include, improvements in air quality, and generation of hazardous (heavy metals) waste from batteries.

3.1.5 SSMs of Waste sector

The waste sector was responsible for 5.6% of the total GHG emissions in 2019 in Bulgaria[40]. The main GHG emitted from the Waste sector is methane (CH_4). Solid waste disposal accounted for 86% of the total reported CH_4 emissions from the Waste sector in Bulgaria in 2019.

The current analysis focuses on municipal solid waste (MSW) management since solid waste disposal is the main source of GHG from the Waste sector. The activities that the JTF will support are also in line with waste management practices that can be influenced by local authorities. The following activities in the Waste sector are eligible for support from the JTF:

- Enhancing circular economy;
- Waste prevention and reduction;
- Resource efficiency;
- Reuse;
- Repair;
- Recycling.

Waste management cuts across administrative borders and involves institutions from all levels of government. The Ministry of Environment and Water (MOEW) and its Regional Inspectorates of Environment and Water (RIEW) establish and control the execution of the national policy on waste management. Funds for regional waste collection systems, waste infrastructure and local awareness campaigns are also allocated by the central government. Municipalities are responsible for the overall organization of waste management on their territories, including ensuring the availability of waste containers, collection and transportation of waste, recycling and proper treatment of different waste streams as defined by the legislation (e.g. e-waste, textile waste, motor oil waste, etc.). Municipalities are obliged to introduce separate collections from households for at least paper and cardboard, plastics, metal and glass. The January 2020 recycling target for solid waste that municipalities have to achieve is at least 50% by weight. Moreover, Bulgaria has to meet the 2025 EU recycling target of at least 55%.

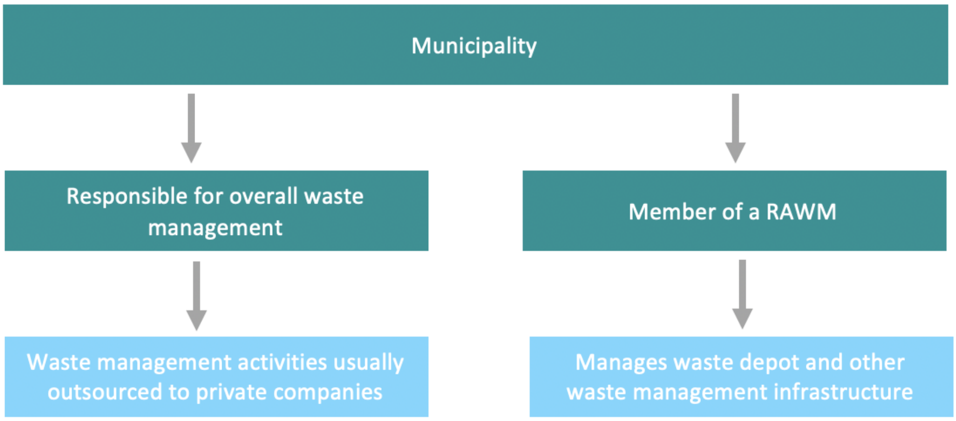
Municipalities with population over 5,000 people must be associated with a private sector Waste Recovery Organization (WRO). Usually, municipalities conduct public tenders for the collection, treatment and overall management of the different waste streams. The private

[40] National Inventory Report 2021: Greenhouse Gas Emissions in Bulgaria 1988-2019. Available at: https://unfccc.int/documents/273453

companies that win the public tenders then organize the waste management activities in the given municipality. The municipality sets the conditions and requirements for waste management and controls the execution by the chosen waste management company. It is possible that different companies execute the management of different waste types (e.g. packaging, textiles, e-waste, etc.), so it is often the case that more than one waste management company conducts waste management activities in a given municipality.

In addition, Regional Associations for Waste Management (RAWM), which members are municipalities using the same waste depot and other waste management infrastructure (e.g. preliminary treatment of waste, treatment of biodegradable waste, etc.), are defined by the Minister of Environment and Water. RAWMs are managed by a General Assembly, where the members are the mayors of each participating municipality in the given RAWM. District governors are members of the RAWM's General Assembly, but do not have voting rights. RAWMs are not defined strictly on a district (NUTS 3) level and can include municipalities from different districts. Such a structure of waste management makes it difficult to follow a district approach in the current analysis. Figure 7 below provides a simplified illustration of local waste management in Bulgaria.

Figure 7. Local waste management in Bulgaria



Indicators to assess the impact of decarbonization

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

In terms of social impacts from waste decarbonization measures, it might be expected that more sophisticated waste management, treatment and utilization could actually generate jobs – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis[41]. Nevertheless, the effect onf jobs is also highly dependent on the local context and waste management practices pursued.

Environmental impacts from decarbonization of the Waste sector will be mainly positive. Table 4 below provides some suggestions for indicators to assess the environmental impact of decarbonization in the Waste sector.

Table 4. Potential indicators to assess the impact of decarbonization of the waste sector

Indicator	Measurement
GHG emissions	Decarbonizing the waste sector will reduce its GHG emissions due to the expected lower levels of solid waste disposal. Each waste depot submits annual emission reports where GHG emissions are reported.
Share of waste recycled	This information is available on district level from the National Statistics Institute – taking a baseline year and comparing to the baseline in a given year after decarbonization measures are implemented.
Share of waste used as raw material/re-used	Local studies have to be implemented in order to compile the necessary data on waste used as raw material. Examples of industrial symbiosis can also be used to generate a value for this indicator for specific enterprises.

Other environmental impacts from the decarbonization of the Waste sector include improved air quality and improved water and soil quality through reduced amounts of landfilled and from leakage of harmful substances from the landfill.

[41] European Commission, 2018. Cooperation fostering industrial symbiosis market potential, good practice and policy actions. Available at: https://op.europa.eu/en/publication-detail/-/publication/174996c9-3947-11e8-b5fe-01aa75ed71a1/language-en

4 WHAT WILL DECARBONIZATION LOOK LIKE?

4.1 The decarbonization pathways

The decarbonization pathways outline recommendable sector-specific actions to be implemented by the carbon-intensive economic sectors in order to reduce CO_2 emissions and achieve the goal of zero-emissions, i.e. becoming climate-neutral, by 2050. The focus of the decarbonization pathways is on technology improvements and changes needed to decarbonise relevant manufacturing processes, however they cover also the infrastructural, financial, regulatory, behavioral and other types of changes inter-linked with the technology ones. The decarbonization pathways are addressed primarily, but not only, to the companies operating in the carbon-intesnive sectors, which are the ones to directly implement the technology improvements needed to reduce CO_2 emissions. To the extent that the decarbonization pathways comprise of a complex set of interlinked technological and other societal changes, the decarbonization pathways are ultimately addressed to all key actors/stakeholders of the transition process (viewed as 'change levers'), as identified in the stakeholder and institutional mapping, namely:

- policy makers (enabling policy framework);
- business and service providers (along the value chain);
- technology and innovation providers;
- financiers and investors community, and;
- civil society, including trade unions, employers associations and special interest groups.

Thus the decarbonization pathways constitute a coherent set of specific and promotable actions with a sector-based approach to implement the transition in carbon-intensive economic sectors, addressed to the key stakeholders in the process. Due to the numerous uncertainties (technological, regulatory, financial, time-wise, etc.), related to the actual decarbonization process, the sectoral decarbonization pathways are *by necessity* generic, i.e. of a general, non-entity-specific nature. Because of that general(ised) nature, the sectoral decarbonization pathways presented below can neither be viewed as company-specific transitions with concrete timeframe and milestones, nor be used to precisely predict and quantitatively assess the expected impacts on individual companies, and on the district ecomony and employment. Still, those generic decarbonization pathways constitute a useful reference framework, outlining the scope of the sector-specific transition challenges and their related impacts, which will allow the districts to deepen their understanding of the process of industrial decarbonization and aid their effective planning and decision making related to the TJTPs.

4.2 Decarbonization pathways for industrial sectors

4.2.1 Overview

Industry is considered to represent the largest end-use sector, both in terms of final energy demand and GHG emissions. Its direct CO_2 emissions currently account for about 25 per cent of total energy-related and process CO_2 emissions. In addition to that emissions increased at an average annual rate of 3.4 percent between 2000 and 2014, significantly faster than total CO_2 emissions. This is even more the case for energy intensive industries (EII), such as steel, cement, glass or plastics, which emit roughly 15% of overall worldwide CO_2 emissions. In order to stop global warming, these carbon emissions will need to be reduced and eventually eliminated altogether. Energy intensive industries often use high temperatures and/or chemical processes, and high temperatures are easy to reach by burning carbon fuels, leading then to greenhouse gas emissions. Carbon is often used both as a source of energy and as a feed-stock.

An additional challenge for the energy intensive industries is that their CO_2 emissions are, in some cases, partially a by-product of the chemical transformation process during the production of these materials, and this is why it is not easy to decarbonise. Hence the technological solutions for decarbonization should be regarded as process specific and also made to fit for the specific stage of the production process.

Decarbonization in industry would be an important step towards making Europe carbon neutral by 2050 and reaching the goals of the Paris agreement. As an intermediate step, Europe has committed to reducing its CO_2 emissions by half already by 2030.

The decarbonization pathways, presented below, were derived from a number of recent industrial decarbonization studies, the most important of which are listed in Box 2.

Box 2. Main sources of industrial decarbonization pathways

1. Material Economics (2019). Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry
2. Industrial Value Chain. A Bridge Towards a Carbon Neutral Europe
3. Towards Deep Decarbonization of Energy-Intensive Industries: A Review of Current Status, Technologies and Policies (Energies | Free Full-Text | Towards Deep Decarbonization of Energy-Intensive Industries: A Review of Current Status, Technologies and Policies (mdpi.com))
4. UNFCCC Global Climate Action Pathway – Industry, Marrakech partnership, 2020
5. Vision 2050, FuelsEurope (Vision 2050 - FuelsEurope);
6. Decarbonization options for the Dutch refinery sector (2020, Report);
7. Refinery 2050: Conceptual Assessment. Exploring opportunities and challenges for the EU refining industry to transition towards a low-CO2 intensive economy. CONCAWE, Brussels, 2019 (Refinery 2050: Conceptual Assessment. Exploring opportunities and challenges for the EU refining industry to transition towards a low-CO2 intensive economy (Concawe Report 9/19) - Concawe)
8. Carbon Free Steel Production – Study of EPRS, April 2021
9. Position paper of Glass Alliance Europe. The European glass sector contribution to a climate neutral economy (2021-05-05-gae-position-paper-on-decarbonization-v2_file.pdf (glassallianceeurope.eu))
10. A review of decarbonization options for the glass industry (A review of decarbonization options for the glass industry - ScienceDirect)
11. Paving-the-way-to-green-ammonia-and-low-carbon-fertilizers-digital.pdf (fertilizerseurope.com)
12. Decarbonization options for the Dutch fertiliser industry (pbl.nl)
13. Metals_for_a_Climate_Neutral_Europe.pdf (ies.be)
14. www.esapa.eu/default.aspx (Eurpean Soda Ash Producers Association)

15. European Ceramic Industry Association Roadmap, “Paving the way to 2050” - cu_ceramic_industry_roadmap_en.pdf (ceramtec.com)

16. DECARBONIZATION OPTIONS FOR THE DUTCH CERAMIC INDUSTRY – Report, 2020, Netherlands Environmental Assesment Agency.

17. A-Competitive-and-Efficient-Lime-Industry-Technical-report-by-Ecofys_0.pdf (eula.eu)

4.2.2 Characteristics and scope of the industrial decarbonization pathways

Generic nature

It should be noted that due to the numerous uncertainties (technological, regulatory, financial, time-wise, etc.), related to the actual decarbonization process, the sectoral decarbonization pathways are *by necessity* generic, i.e. of a general, non company-specific nature. There are two reasons for that. *First*, it is generally recognized in decarbonization theory and practice that there are four main generic decarbonization pathways/strategies which are applicable in all industrial sectors, adapted to the specificity of each sector.[42] The decarbonization of any sector will in the typical case be a mix of those 4 major decarbonization pathways/strategies. The ‘depth’ of decarbonization (the extent of decreasing the carbon intensity) results from, i.e. is an outcome of, the ‘decarbonization mix’ actually applied, as it is the prevalence of certain decarbonization strategy/ies within the ‘mix’ (different for various sectors) that can ensure maximum decarbonization results, i.e. ‘deepest decarbonization’. *Second*, any company-specific decarbonization strategy is determined by a number of sector- and company-specific circumstances, such as: type of product; manufacturing process (currently) applied; technology readiness level (TRL) of the production techniques to be implemented under various sectoral decarbonization pathways; regulatory considerations; availability of a financial framework promotive to the implementation of decarbonization investments, etc. Resulting from these two factors, any company-specific decarbonization strategy will ultimately be a mix of the generic setoral decarbonization pathways, tailor-made to produce the optimal effect for that individual company.

District and sectoral approach

The industrial decarbonization pathways, presented below, are addressed to all carbon-intensive sectors of the economies of the eight districts, as identified in the SSMs. Thus the decarbonization pathways for Bulgaria have been developed by taking into account the districts of Varna, Burgas, Lovech, Targovishte, Haskovo, Yambol, Sliven, Gabrovo and the carbon intensive companies and sectors situated/presented within these districts. The CO_2-intensive sectors can be split into two groups: i) carbon-intensive sectors *per se*, i.e. sectors which due to the specific features of their manufacturing process generate high volumes of CO_2 emissions, and ii) sectors non-carbon-intensive *per se*, to which one or more identified carbon-intensive companies belong. Although not carbon-intensive *per se*, the latter sectors would also be subject to decarbonization, in so far as one or more of their companies will be subject to transformation aimed at GHG reduction under the existing and forthcoming EU climate law. The full District Decarbonization Pathways are presented in Part II of this report.

[42] Cf. ‘Routes for decarbonization...’ below.

That led to an overall identification of nine carbon intensive industrial sectors (which actually include Bulgarian companies from the ETS register) as well as six additional sub-sectors which though not considered as carbon intensive might still have a significant carbon footprint (as they represent enterprises, which are in the ETS register or operate combustion installations with a capacity ≥ 1MW).

Table 5. Industrial sectors, available in the eight districts

Carbon intensive sectors	Other sectors, in which large or mid-size combustion installations are used
Refined oil; Fertilisers and Nitrogen compounds; Inorganic Basic Chemicals; Glass; Ceramics; Cement; Lime; Iron and Steel; Non-Ferrous Metals	Preparation and spinning of textile fibres; Manufacture of veneer sheets and wood-based panels; Manufacture of pharmaceutical preparations; Manufacture of other plastic products; Processing and coating of metals; Production of corrugated cardboard (pulp and paper).

Source: Enterprise survey implemented by the team

Routes for decarbonization: Feasibility and Technology Readiness Level (TRL)

Decarbonization pathways

The decarbonization pathways for each of the sectors identified above reflect the relevant industrial specifics and also make an attempt to outline the technological readiness (including in some cases the TRL of the technology in question) as well as the economic and financial conditions that should be in place for making the necessary steps towards full decarbonization. The general approach applied suggests that decarbonizing is considered to be technically and economically feasible through one or more of the following generic pathways (routes):

- reducing materials and energy use (including through circular business models);
- increasing the productivity of materials and energy use and/or substitution with low-carbon feedstock;
- decarbonizing required production processes, and;
- carbon capture/storage and utilisation (CCSU) technologies applied to continued fossil fuel use and for bioenergy (and other uses of bio-feedstocks).

The relative emphasis on these components within each sector varies substantially, given the diversity of sectoral value chains and footprints and low-carbon economic and technical development opportunities.

Direct electrification is usually reviewed as the primary route to decarbonization, since it is the cheapest and most energy-efficient option in most applications. However, in some applications, it is not currently feasible and in others, it is not cost effective. In most cases it is possible to achieve decarbonization by combining direct electrification with three other technologies:

1. Hydrogen as an energy carrier. Hydrogen is an energy carrier whose energy density, storability and suitability for high-heat applications make it superior to electricity in some

specific applications. Low- or zero-carbon hydrogen can be produced either through electrolysis of water using zero-carbon power ("green hydrogen") or from methane using either Steam Methane Reforming (SMR) or auto thermal reforming (ATR), in both cases combined with CCS (so-called "blue hydrogen"). Hydrogen can in turn be used to produce hydrogen-based fuels (e.g. ammonia, synfuels). Aside from its potential use in making blue hydrogen,

2. CCS/U can also be applied to multiple industrial processes, or to thermal power plants continuing to provide flexible power supply within primarily renewable power systems. Its cost-effective use will depend on the local availability of suitable and safe storage capacity.

3. Biomass can in principle meet a wide variety of applications, including industrial heat, chemical feedstock, flexible thermal power supply and transport fuels, but the total scale of its use across all sectors must reflect the limited potential supply of truly sustainable biomass.

In each of the most important heavy industry sectors – like steel, cement, chemicals and aluminium – there are feasible ways to remove both energy-based emissions and emissions resulting from the chemical processes involved. These usually represent a mix of direct electrification, use of hydrogen, use of biomass, and CCS/U in applications that guarantee long-term storage.

Technical and economic conditions for decarbonization

A general overview of the existing technologies and the present state-of-art provide additional insight in the process of identifying and selecting the optimal decarbonization mix for each of the energy intensive industrial sectors involved. In terms of technological readiness regarding the decarbonization routes described above, the following has been also taken into account:

Table 6. Technology process and status

Technology process/approach (cross-sectoral)	Technology status
Electrification of heating	High TRL except for some furnaces used in the glass and cement industry
Electrification of processes	In most cases not reached demonstration stage
Process integration	Pilot and demonstration plants
Hydrogen	Pilot and demonstration plants (but usually also requires development of extensive H2 infrastructure)
Biomass	Pilot and demonstration plants, small-scale use (but limited availability in a number of cases)
CCS/U	Pilot and demonstration plants (CCU commercialization for carbonation and synthetic fuels); requires development of extensive infrastructure.

Source: Institute for European Studies, 2018[43]

[43] Institute for European Studies, 2018. Industrial Value Chain A Bridge Towards a Carbon Neutral Europe. https://www.ies.be/files/Industrial_Value_Chain_25sept.pdf

In most of these cases where there is a high demand for development of additional infrastructure – the capital and the operational expenditures are also expected to be significant. As for the other technological approaches these costs vary from sector to sector. However, in general, much higher costs are expected in the cases where Hydrogen or CCS/U shall be used in the future.

The following table shows the best applicable options for Energy-Intensive Industries (EII), which have been considered in the process of structuring the most adequate decarbonization mix for each of the sectors involved:

Table 7. Best applicable options for EII

EII Sector	Decarbonization technologies (X – high level of applicability for the sector)				
	Electrification (heating and mechanical)	Electrification (processes)	Hydrogen	CCS/U	Biomass
Steel	X		X	X	
Fertilisers	X	X	X	X	X
Cement				X	X
Lime				X	
Refining			X	X	X
Ceramics	X				
Glass	X				X
Non-ferrous metals	X	X			X
Chemicals	X	X	X	X	X

Source: Institute for European Studies, 2018[44]

Enabling conditions for achieving the set decarbonization objectives

The sectoral decarbonization pathways are to be analyzedin the context of a set of enabling conditions that should effectively contribute for the practical achievement of the decarbonization objectives until 2050. **These enabling conditions in most of the cases include:**

- R&D (breakthrough technologies). Industrial R&D has a task to support the later stages towards providing fully commercial technical solutions for emission abatement.

[44] Institute for European Studies, 2018. Industrial Value Chain A Bridge Towards a Carbon Neutral Europe. https://www.ies.be/files/Industrial_Value_Chain_25sept.pdf

- Sufficient, reliable and competitively priced low-CO_2 electricity. The new low-CO_2 processes will require significant new amounts of electricity to operate.

- Infrastructure needs. As already mentioned the decarbonization routes may require new infrastructure or connection to a natural gas grid, electricity grid, CO2 transportation, handling of end-of-life materials etc.

- CAPEX and OPEX challenges. Existing analysis of the costs for achieving net-zero emissions reveals that there will be significant additional cost of reducing emissions to zero.

- Regulatory framework. The transition to carbon neutrality requires a number of policy measures concerning both the competitiveness of the companies and the compliance with technical standards and requirements (e.g. carbon transport and storage, hydrogen supply etc.).

These enabling conditions are described in bigger details in the section following the decarbonization pathways for various industrial sectors.

4.3 Decarbonization pathways for the cement industry

Role of cement industry

Cement and concrete are vital for a few industrial sectors. Half of European cement is used in the construction of new buildings, and 30% in infrastructure. The remaining 20% are used for various forms of maintenance and repair work across these two categories. The large majority of cement is used for concrete. Concrete is aggregates (sand, gravel, crushed stone), water and cement. Cement has a key role as it is the ‘glue’ that gives concrete its structural stability. Although cement makes up just 7–20% of concrete, from a climate perspective it is the key constituent, with 95% or more of the CO2 footprint. The European cement industry produced 167 million tonnes (Mt) of cement in 2015 and the cement sector contributes €4.5 billion to direct added value in the EU, and employed 38,000 people. There are around 200 active cement kilns, and another 100 plants that perform grinding of cement.

In Bulgaria cement production is concentrated mostly in the districts of Lovech and Varna where the two major companies (cement producers) have an overall annual turnover of more than 220 mln BGN and more than 480 employees. These sectoral decarbonization pathways is relevant for Varna and Lovech districts, where companies belonging to the sector are located.

Sources of CO_2 emissions

Nearly all the emissions from concrete production (95%) result from the production of cement, and specifically the production of cement clinker, the main binder component. Clinker is produced through the calcination of limestone, whereby the rock is crushed and combined with a small amount of clay and other ingredients and heated to temperatures of 1,450°C or more.

CO2 originates from **two distinct sources** in this process:

- One source is the fuel used in the kiln. Although the cement industry uses a range of fuels, the large majority (54%) use coal or petcoke, which is suitable for the very high temperatures of 1,400°C or more required for calcination, but also has a high emissions intensity.
- The second source are the process emissions. The chemical process of calcination releases the carbon contained in the rock itself. Clinker is made by calcining a mixture of approximately 80% limestone (to provide calcium) and 20% aluminosilicates. Raw materials are heated up to 1,450 °C, transforming limestone to calcium oxides and sintering the mixture. The resulting CO_2 is all but irreducible. Clinker production therefore inevitably results in 0.54 tonnes of CO_2 for every tonne of clinker. These emissions are among the hardest to address. They cannot be avoided except by reducing production or by switching the raw material. Once produced, they must be captured if they are not to be released to the atmosphere.

The carbon dioxide released in the process chemical reaction accounts for 65% of the clinker CO_2 footprint. The remaining 35% arise from the burning of fossil fuels to provide heat for the kiln.

Generic decarbonization strategies for the cement industry

1. Better material efficiency and circular business models

Materials efficiency in the this case can never reduce emissions to zero. However, it eases many of the challenges of transitioning to net-zero emissions. A key insight is that major contributions towards lower emissions rest not with the cement industry itself, but with actors in entirely different sectors. Today, concrete typically contains 300 kg or more of cement for every cubic metre (m3) of concrete. This practice is based on widely established practices to ensure sufficient concrete strength, corrosion resistance, and other properties for a given application.

However, the same requisite strength, reliability and durability can be achieved with significantly lower cement content. There are opportunities to reduce the amount of cement in concrete by as much as half. These opportunities fall in two categories. The first is to reduce over-specification. The second opportunity is to modify production to achieve the same strength of concrete with a much lower cement content.

2. Material recirculation and substitution with low-carbon feedstock

Unlike plastics or metals, cement is not easily recycled by re-melting or similar processes, and the original chemical process cannot be reversed. End-of-life concrete is typically either not recycled at all and instead sent to landfill, or downcycled into aggregates for use in low-value applications such as road base. However, it is possible to recycle concrete fine particles ('fines') as a source of calcium for new cement. This has immediate CO_2 benefits, as the 0.54 t CO_2 of process emissions from producing new clinker can be avoided.

Recycling of fines requires regrinding and medium-temperature heating, both of which are substantially easier to render low-CO_2 than the high-temperature heat of calcination or the production of clinker from limestone. The main obstacle is common to many forms of recycling: ensuring that the end-of-life stream is not contaminated by other materials that downgrade quality. Additional option is an increased **use of supplementary cementitious materials**. **Some of**

the clinker in cement can be replaced with other materials with the binder properties required for concrete. These typically are referred to as 'supplementary cementitious materials (SCMs). Use of SCMs has immediate CO_2 benefits, as they typically only require grinding without heating, and do not release any CO_2 as process emissions. **The potential to increase** the use of the current main SCMs is limited. **The main contenders** for alternative SCMs are pozzolans, which can be either natural or calcined. Calcined clays can be combined with limestone to reduce the clinker content of to 50%. Though thermal energy is needed, the temperatures are lower than in the production of clinker and thus easier to switch to low-CO_2 sources, including electricity. **A major limiting factor** for both natural pozzolans and calcined clays is the local availability of raw materials.

3, Clean (low CO_2) production processes

Cuts in CO_2 kiln emissions could be achieved through a switch of the energy carriers. These options include:

- Fuel switch to natural gas. Natural gas can achieve a reduction of fuel emissions by approx. 35% compared to current fuel mix.
- Electrification of the cement kiln and fuel switch to biomass can both eliminate fuel emissions from clinker production.

Using electricity for heat input to cement production however poses a considerable challenge, because the production processes require temperatures up to 1450°C. There are no commercially available solutions so far. On the other hand EU cement production already derives 15% of its energy from biomass. However, increasing this share significantly could prove challenging, chiefly because of the many competing claims on this resource. Other options include:

- Plasma generators can generate the very high temperatures needed for some of the steps in cement production, with an efficiency of 85–90%. These generators are available at suitable output ranges and are already proven in industrial contexts. While no single commercial plasma generator can output more than 7 MW, it is possible to run several generators in parallel to supply higher power levels. However, one disadvantage is that the generators are sensitive to dust, so they tend to require maintenance every 200–300 hours.
- Using microwave energy for heating has the potential to reduce energy consumption by up to 40%. This is because microwaves can be uniformly absorbed throughout the entire volume of an object, whereas traditional fuels warm an object gradually from the outside inwards. To date, high-temperature microwave heating has not been used at scale in industrial processes.
- Hydrogen offers a dense source of energy that does not emit CO_2, provided the hydrogen is made using a net-zero emissions technology. It has a higher technology readiness than microwave energy, so electrification through hydrogen could be deployed at an earlier date.

4. Carbon capture and storage or usage (CCS/U)

The main challenge with clinker production are the CO_2 emissions from the limestone. This is a rare example of carbon capture being all but indispensable if emissions to the atmosphere are to be avoided. There are two main ways that CCS can be applied in cement production:

1. Capture CO2 emissions from both the burning of fuels and from process emissions from limestone. The fuel emissions are the most challenging. They contain many other gases than CO2, making high capture rates difficult to achieve. There is only limited practical experience of real-world trials of CCS on cement production. While there are many potential CCS technologies, the oxyfuel CCS is considered by different experts as the likeliest long-term option to capture both fuel and process emissions. When fully developed, oxyfuel CCS could achieve a capture rate of up to 95%.

2. Handle fuel and process emissions separately. In today's kiln designs, the two streams are mixed. If they can be separated, the very pure flow of process CO2 could be relatively easily captured at rates close to 100%. Such separation of CO2 would require modification to kiln design (to indirectly heat the limestone), but it has the major attraction that no other capital expenditure would be necessary, except for equipment to compress the CO2 before it is transported and stored. With process emissions captured, fuel emissions could be eliminated through electrification.

Focus of the decarbonization mix for the cement industry

Any net-zero roadmap for cement/concrete must consider options to achieve close to zero CO_2 emissions from cement kilns, as well as ways to cut process emissions. Fully eliminating CO2 emissions is restricted to two main routes: either full carbon capture from both combustion and process emissions, or a combination of replacing the energy used for heating with a zero-CO2 source, and capturing process emissions. Though different pathways and strategies could be adopted, it is obvious that carbon capture and storage lays as a prerequisite for a major CO2 cut. The energy efficiency options are primarily relevant for clinker production, and include strategies such as improving refractories and energy management processes within kilns. The accelerated uptake and use of alternative non-fossil based fuels (e.g. residual waste) and materials (e.g. slag, fly ash or calcined clays) can deliver emissions reductions in the short term.

In addition, the improved material efficiency of the concrete and recirculation and substitution of concrete content (at least as a first step towards zero-carbon production activity) could contribute for a decrease in the CO2 emissions. The estimates show that global primary demand could be reduced by up to 35% in a scenario where the potential of circular economy strategies is realized. This will be primarily driven by an increase in recycle and reuse, materials efficiency (e.g. using less concrete per square metre) and developing innovative materials for the built environment sector.

***Box 3.* Case Study: Three CCS pilot projects developed by Heidelberg Cement Group (parent company of Devnya Cement AD)**

In the framework of a survey carried out among ETS companies in Bulgaria, the company of Devnya Cement confirmed plans for introducing a CCS technology in its plant. These plans are in co-relation with the projects developed by the mother company of HeidelbergCement, presented in the case study below.

CO2 capture, liquification and intermediate storage facility in Norway

In June 2020 it was announced that Norcem (HeidelbergCement's Norwegian subsidiary) and the engineering company Aker Solutions signed an agreement for the supply of a **CO_2 capture, liquification and intermediate storage facility** at the Norcem Brevik cement plant in Norway. Using Aker Solutions' Advanced Carbon Capture (ACC) technology, Norcem is planning to realise the first industrial-scale carbon capture plant at a cement production facility in the world.

The project is an important step to considerably reduce otherwise unavoidable process-related greenhouse gas emissions. Thus Brevik could become the world's first large-scale carbon capture plant of the cement industry, with 400,000 tonnes of CO2 captured annually and transported for permanent storage.

LEILAC CO_2 capture technology (pilot projects)

As part of LEILAC 1, a CO2 capture pilot installation with a capture capacity of 25,000 tonnes of CO2 per year was constructed at HeidelbergCement's Lixhe plant in Belgium in 2017.

In February 2021 it was announced that a sesond phase (LEILAC 2) is to be launched. An installation around four times as large will be operated in Hanover, which will capture 20% of the cement plant's capacity, corresponding to around 100,000 tonnes of CO2 per year. The first project design phase is to be completed by the end of June 2021, and the demonstration installation is expected to be ready by the end of 2023. Including design, construction, commissioning and extensive testing, the overall project is expected to be completed by 2025.

With the patented LEILAC technology, the CO2 released during cement production can be captured in a highly pure form via a separate waste gas stream and used in another process. In cement production, two thirds of the CO2 emissions consist of process-related emissions that are released when heating the limestone and are therefore unavoidable. Thus the project demonstrates that this unavoidable process CO2 can be successfully captured and that the technology also works in practice on a larger scale.

A CCS installation for full-scale capture of CO_2

In June, 2021, HeidelbergCement announced its intention to upgrade its plant on the Swedish island of Gotland to become the world's first carbon-neutral cement plant. The installation at the Slite plant of HeidelbergCement's subsidiary Cementa will be scaled to capture up to 1.8 million tonnes of CO2 annually, which corresponds to the plant's total emissions. Additionally, the use of biobased fuels in the cement production at Slite will be increased in line with the Group's commitment to significantly raise the share of biomass in the fuel mix. The full-scale capturing of the plant's CO2 emissions is targeted by 2030.

The captured CO2 will be safely transported to a permanent storage site offshore several kilometres down in bedrock.

Source: Heidelber Cement Group press releases

4.4 Decarbonization pathways for the lime industry

Role of lime industry

The term lime commonly refers to all types of lime products such as quicklime and slaked lime. There are many qualities of lime products, depending on:

- the presence of magnesium in the raw material, and thus in the product;
- the execution of a hydration step (called 'slaking');
- the temperature in the kiln.

Lime products are used for many purposes, including as a filler and bonding agent in the construction sector, as well as cleaning wastewater, preparing drinking water, removing acid gases from flue gases, soil stability, and the production of construction materials, paper, plastics, cosmetics, etc.

Sources of CO_2 emissions

Two major types of processes can be outlined within the lime work operations: quarrying, crushing, and size grading of minerals and combustion of fuels in lime kilns. Limestone quarries are usually developed in a number of benches or lifts. For primary blasting of the limestone, holes are made by drills operated by compressed air. The excavated limestone is transferred for crushing and grinding. There are several types of crushing and grinding machines to produce limestone of sizes suitable for several designs of kilns. During the kiln operations the limestone reaches temperatures as high as 900 °C, and carbon dioxide is driven off limestone to leave so-called quicklime. The quicklime descends through the cooling zone and is discharged at the base of the kiln. To generate the energy for the lime production process, fossil fuels are burned. The combustion of fossil fuels causes CO2 emissions. The vast majority of emissions from fossil fuel combustion originate in the kilns. At the same time, two-thirds of all carbon emissions in lime production (as with the cement) are released from the raw material during the production process.

Decarbonization pathways for the lime industry

There are **two major pathways** for decarbonization of the Lime industry. These are particularly relevant for **Burgas District.**

1. **Implementation of clean (low CO2) production processes, in two dimensions**

- Technological improvements.

The use of vertical kilns has proven to be most energy efficient within the sector. Lime can be produced in different kinds of kilns. Over the past decades, new kiln types have been developed and existing kilns have been improved. Newer vertical kilns are considerably more energy efficient than horizontal kilns.

Usage of heat exchangers in horizontal kilns to recover heat from flue gas. In horizontal kilns heat exchangers can be used to recover some of the heat from the flue gases produced in the kiln and use this heat to preheat the feed limestone. This could generate – on average – a fuel saving of around 25%. However, this potential reduction is only applicable to horizontal kilns.

- Switch of fuels used.

Using natural gas as a fuel instead of fossil solid fuels. The abatement cost is about 90 €/t CO2 and it leads to about 30% reduction in combustion emissions; however, the cost of natural gas is high and it requires connection to the natural gas grid.

Other options include use of waste and biomass as fuel.

2. Carbon capture and storage and usage (CCS/U)

- Carbon Capture & Storage or Carbon Capture & Usage represent the measures with the biggest abatement potential of all, and are, in fact, the only ones tackling process emissions during the manufacture of lime products.

Its costs are high in comparison with the production costs of lime. Given the right technological development, economic situation and infrastructural requirements, and with an incentive to not harm the EU lime industries competitive position, the industry could embrace this technology.

Focus of the decarbonization strategy for the lime industry

For one-third of all emissions that originate from energy production, the lime industry can apply 'usual' abatement measures like fuel switch and energy efficiency. One option to reduce emissions from energy production is the switch to fuels with reduced carbon intensity, such as natural gas or biomass. Switching to gas may have a positive impact on the quality of the produced lime, but is in many cases more expensive than solid fossil fuels-based production. Switching to biomass requires additional investments, especially when switching from natural gas. However, two-thirds of all carbon emissions in lime production are released from the raw material during the production process and can be reduced by Carbon Capture and Storage or Utilization which at present is still not considered to be a feasible solution mostly because the costs are too high and will directly affect the competitiveness of the sector.

4.5 Decarbonization pathways for the ceramics industry

Role of the ceramics industry

The production of ceramics is usually divided into four categories, based on the defined categories by the BREF for the ceramic industry (EC, 2007)[45]:

- Bricks and roof tiles,
- Floor tiles;
- Wall tiles;

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[45] Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry (August 2007, European Commission) - cer_bref_0807.pdf (europa.eu)

- Refractory products.

The European ceramic industry today employs over 200,000 people in the EU-27, around 80% of them in SMEs. Over 1,000 ceramic installations are covered by the EU Emissions Trading Scheme (ETS), representing more than 10% of all industrial installations covered by the scheme. With 25% of production exported outside the EU, a positive trade balance of €3.7 billion and with an annual production value of €28 billion, this industry makes a substantial contribution to the European economy. Housing and construction represent around 55% of the ceramic industry's turnover and supplies to other industries account for more than 30%.

Ceramic production is well developed in Bulgaria as well. There are ceramic companies (at least one or two) in each of the 8 districts for which decarbonization pathways should be developed and according to national statsitics (2019) their number is largest in the district of Lovech. There are also five ceramic companies, covered by the EU ETS in Bulgaria, whose total annual turnover is more than 430 MBGN (largest share has Ideal Standart in district of Gabrovo) and total number of employed persons is above 3 500 (again Gabrovo being the leader), though in most cases that type of companies have a hundred employees on average.

One of the important specifics of the ceramics is that it is a capital-intensive sector with long investment cycles. Kilns for ceramic production e.g. can last more than 40 years which inevitably shall reflect any future plans for kilns modernisation. Manufacturing can account for up to 90% of some ceramic products' carbon footprint. In the same time it should be pointed out that the inherent energy savings during the use phase together with the durability of ceramic products give them longer lifespans over which time the environmental impact of the production phase is significantly reduced compared to other materials. Hence the contribution of such products to resource and energy efficiency can only be appreciated with a holistic approach that considers the complete lifecycle of the product.

The ceramics decarbonization pathways described in this section are most relevant to these districts: Burgas, Sliven, Targovishte, Lovech, Haskovo, Gabrovo and Yambol.

Sources of CO_2 emissions

CO2 emissions can be related to two types of emissions during the manufacturing process, namely fuel emissions and process emissions. Fuel emissions result from the burning of natural gas and process emissions result from the calcination process of the ceramic material when it is heated to certain temperatures. The process emissions are on average 26% of total emissions, and the total specific CO2 emissions of a ceramic product ranges from 0.18 to 0.48 tCO2 per tonne end product. Carbon dioxide emissions are not only related to energy consumption, e.g. fuel-related emissions, but also to process emissions. Process emissions are carbon dioxide emissions caused by the breakdown of carbonates in raw materials such as limestone, dolomite or magnesite. As these are inherent in the raw material, these process emissions are a natural by-product of the firing process and cannot be avoided.

Ceramic products are designed to be durable. This is achieved through high-temperature firing of a wide range of minerals, from locally-sourced clay to natural or synthetic high-quality industrial minerals. High-performing and durable ceramics must be fired at high temperatures. As such, the most energy-intensive process in ceramic manufacturing is kiln firing and in some cases the drying and shaping processes. These continuous processes used in the ceramic industries all require uninterrupted, secure and affordable fuel and electricity supplies as unplanned interruptions can cause severe kiln damage resulting in shutdown and production loss for several months.

The ceramic industry predominantly uses natural gas as it is more energy efficient at the high temperatures required to fire clay and other industrial minerals.

At least 2/3 of CO2 emissions are due to fuel combustion. Electricity and process emissions are accounting for about. 18% and 16% respectively. The three main processes that emit fuel related CO2 are: spray drying (only wall and floor tiles), drying and firing.

Decarbonization pathways for the ceramics industry

Having in mind the sources of CO2 emissions identified and the specifics of the ceramics production process itself, the following pathways could be identified.

1. Improvement of production processes

- Energy efficiency is the most obvious way to reduce fuel emissions. Energy consumption can be further reduced if improved kilns, dryers, thermostats and seals are installed and by implementing automated controls.

- Recovery of excess heat is also an option as it reduces fuel consumption.

A significant amount of heat from the firing kiln is lost through hot flue gases (100 – 200 °C), which cannot be ventilated to the drying process due to the corrosive elements present in these flue gases. By using a heat exchanger, the heat could be transferred to clean drying air and used for the drying process. The technology is newly developed and still in a testing phase (pilot versions developed).

Additional option in that aspect are Industrial closed heat pumps. They are applicable to the drying process of the ceramic industry. The heat pump allows waste heat to be upgraded to a temperature that is sufficient for drying.

2. Clean (low CO_2) production processes

- Alternative carbon neutral fuels such as green gas and hydrogen, and renewable electricity can substitute the natural gas that is used for firing and drying by the ceramic plants.

For high-temperature firing, the most promising way to reduce fuel emissions is to replace natural gas by biogas or syngas from biomass or waste, modifying existing kilns through retrofitting. (the technology though still requires significant development).

At present the green gas option is considered to be commercially available and could be applied in ceramic plants.

- Electrification of kilns using low-carbon electricity could be an option to reduce fuel emissions, particularly for large kilns making bricks, roof tiles, wall and floor tiles.

Electric heating could potentially fully replace the use of natural gas and related CO2 emissions in the fire kiln by using renewable electricity as energy input. Furthermore, the extra heat that is required for drying could also be supplied by electric heating. On a smaller scale, this technique is used by pottery bakers. However, the production capacity of these installations cannot be compared to large scale ceramic plants. Electric furnace kilns have not yet been implemented on a large and continuous scale (i.e. in tunnel kilns). The feasibility of applying electric kilns in large scale ceramic production plants therefore remains unproven.

- Alternative fuels and renewable electricity could also be used in the enrgy mix regarding the process emissions. Several countries have started using renewable energy for some brick, roof tile and clay pipe sites.

3. Carbon capture and storage and usage (CCS/U)

Carbon Capture and Storage (CCS) could be a solution to reduce CO2 emissions in some sectors. However, ceramic factories are more numerous, smaller in size and more widely-dispersed geographically than, for example, those in the steel and cement sectors. The exhaust stream from ceramic plants is too CO2 dilute, too hot and contains too many other substances for efficient, cost-effective CCS at present. Until cost-effective breakthrough CCS technology is developed on an appropriate scale for the ceramic sector, the installation of CCS is likely to remain prohibitively expensive for some time after it is installed in other energy-intensive sectors.

Focus of the decarbonization mix for the ceramics industry

Decarbonizing the ceramics industry is still a challenge at present. The measures which could be applied in the short-term are mostly related to improving the efficiency of the production process (e.g. improving the existing equipment and introduction of excess heat recovery technologies). In the midterm the European Ceramic Industry Association itself works with a hypothesis where half of all kilns could be converted to electricity in the period 2030-2050 and the remainder retrofitted to syngas or biogas co-fired with natural gas. In that case the emissions could be reduced by around 78% compared to 1990 levels. Further success could only be achieved if a technology such as Carbon Capture and Storage (CCS) could reduce process emissions but for now it is technically more challenging and less economically viable than for many other sectors.

An additional option is provided in the case study below.

Box 4. Case Study: Extended turnnel kiln

In 2010, the ceramic sector in the Netherlands initiated the concept of an extended tunnel kiln. This extension is many tens of meters, thus 30 – 50% of the initial tunnel kiln length. This extension allows the bricks to dry without using forced cool air making the tunnel kiln more energy efficient. Another advantage of this concept is that the drying process can be decoupled from the firing kiln, as there is no residual heat from the firing kiln’s cooling down section, which is a required condition to apply hybrid drying. A simulation showed that gas use lowers from 51 m3/t to 35 m3/t (a reduction of 30%) when extending a tunnel kiln with an annual production capacity of approximately 80,000 tonnes.

4.6 Decarbonization pathways for the glass industry

Role of the glass industry

The glass industrial sector is both part of the energy intensive industry and having wide application in a number of other sectors with high emissions reduction potential as well (i.e. energy, building and transport). It generally comprises five sub-sectors covering different glass products, applications and markets – i.e. container glass, flat glass, continuous filament glass fibre, domestic glass and special glass. The segments of the glass industry, e.g., container or flat glass, are quite diverse and attribute to different glass products with different requirements to product quality and various process options. Over 80 percent of the industry output is sold to other industries, and the glass industry as a whole is very dependent on the building, and the food and beverage industries. The down value chain is also related to the automotive industry as well as to end consumers of domestic products and the up value chain is mostly related to the mining industry which represents the main source of raw materials needed for glass production.

The **EU Glass production** is estimated at approx. 39 tonnes in 2020 (according to Glass Alliance Europe statistics). As per the same there are 3 289 employed in the sector in Bulgaria from a total of 186 292 for EU.

In the production of glass, most of the energy consumed is required to provide the high temperatures necessary to melt the raw materials to be used. The container and flat glass segments of the industry account for approximately 80 -85 % of European glass production and emmissions (where largest-size furnaces are used) with a share of emmissions of 47% and 33% of the total glass industry, respectively, whereas natural gas is predominantly used as a fuel. Both segments are represented in Bulgaria as well.

The decarbonization pathways described in this section have particular relevance to Targovishte district.

Sources of CO_2 emissions

The diversity of the glass industry results in the use of a wide range of raw materials. The majority of these materials are solid inorganic compounds, either naturally occurring minerals or man-made products. They vary from very coarse materials to finely divided powders. Liquids and, to a lesser extent, gases are also used within most sectors. Granular and powdered raw materials are delivered and transferred either pneumatically or mechanically to bulk storage silos. Pneumatic transfer of the materials requires them to be essentially dry. Displaced air from the silos is usually filtered. In large continuous processes, the raw materials are transferred to smaller intermediate silos from where they are weighed out, often automatically, to give a precisely formulated 'batch'. The batch is then mixed and conveyed to the furnace area, where it is fed to the furnace. Due to its abrasive nature and larger particle size, cullet is usually handled separately from the primary batch materials and may be fed to the furnace in measured quantities by a separate system.

Glass making is to be defined as a high-temperature, energy-intensive process. The energy is provided either directly by the combustion of fossil fuels, by electrical heating or by a combination of both techniques. Melting of the individual raw materials at high temperature to form a molten glass is the central phase in the production of glass. There are numerous ways to melt glass depending on the desired product, its end use, the scale of operation, and the prevailing commercial factors. The conventional and most common way of providing heat to melt glass is by burning fossil fuels above the batch blanket or batch piles and above the molten glass. The batch material is continuously fed into and then withdrawn from the furnace in a molten condition. The temperature necessary for melting and refining the glass depends on the precise formulation, but is between 1300 and 1550 °C. The glass melt must be completely homogenised and free of bubbles before it can be formed into products. Just after melting or fusion of the raw materials, a viscous melt with dissolved gases (air, CO2) and smaller (seeds) or larger gas bubbles (blisters) will be formed.

In the context of the above described processes most of the CO2 emmissions (80%) are related to the use of fossil fuel for heating the furnaces. Process emmissions on the other hand (20% on average) occur due to the decarbonization of the carbonate raw material in the process input, mainly sodium carbonate Na_2CO_3, limestone $CaCO_3$ and dolomite $CaMg(CO_3)_2$.

Decarbonization pathways for the glass industry

Having in mind the CO_2 emissions identified above and the specifics of the glass production process itself, the following pathways could be identified. In many cases they usually depend on the type of glass produced and the combination between them is not always possible.

1. Optimization of the recycling schemes

Almost all container and flat glass manufacturers have the potential to use more cullet (=recycled glass) on the condition that it is available at the right quality. This route to lower emissions is consistent with sustainability efforts in the industry and the EU Circular Economy aspirations however its potential is limited to the theoretical maximum of amounts of waste glass that is available every year in the EU (container glass is already highly recycled (74%) and waste building glass quantities not yet recycled are limited in the EU).

The recycling schemes should aim at collecting and recycling post-industrial or post-consumer glass waste, in particular in the container glass sector. Apart from that limitation, the technological readiness and potential ot the proposal could be defined as high (TRL 9).

2. Material recirculation and improvement of production processes

Additional reduction of emmissions but again in the context of the limitation stated in the previous point could be achieved through addition of recycled cullets to the batch. That should accelerate the melting process and save energy, as the chemical reactions between the individual glass components are already complete (direct energy savings, an increase of 10% cullets by weight leads to an improved energy efficiency of 2.5–3%). In addition, the overall amount of batch and cullets entering the glass melting furnace is reduced, as 100 kg of cullets substitute about 118–122 kg of primary raw material. In particular, synthetically-produced raw materials such as soda ash require high portions of energy along their production routes. Therefore, cullet recycling also results in indirect energy savings.

For cullet recycling, a 10% cullet share increase was assumed, accounting for energy and process-related CO_2 savings.

3. Clean (low CO_2) production processes

In terms of production processes – there are technological solutions which could contribute for reduction of the CO_2 process emmissions. Alternatives usually considered relate to introduction of waste heat recovery options in the production process as well as use of batch and cullet preheating systems.

Waste heat recovery is already extensively applied in the glass industry to preheat the combustion air entering the furnace at temperatures higher than 1,000°C.

Pre-heating the raw materials is limited to preheating of either cullet only or batches containing more than 40% cullet, otherwise clogging problems and dust carry-over would occur. This is why the necessity to increase the availability and affordability of good quality cullet is crucial for the effective application of that technology. It must also be noted that pre-heating raw materials cannot be coupled with electric melting, as the flue gas temperature in this case is too low.

These proposals could lead to a 5-15% reduction of CO_2 process emmissions and in most cases could be defined as already applicable in real conditions (TRL 6-8).

Regarding the melting process which is in the core of the glass production - a switch to **all electric melting** using decarbonized electricity would eliminate CO_2 emissions from glass melting which are generated from the combustion of fossil fuels. However promising this technology may be, its implementation is still limited today by the size of the installations, the glass composition, and the quantity of cullet contained in the batches. Electric melting is available for small furnaces (< 200 t/day), but it still needs to be demonstrated for large furnaces used in flat or container glass production (from 200 to 1.000 t/day). For certain glass compositions (e.g. E-glass for continuous filament glass fibers) there are technical aspects (associated with the electrical conductivity) which limit the proportion of electrical energy for melting.

For that reason alternative **solutions for switching to carbon neutral energy** are reviewed. Those include:

- Switch to almost full-electric (~80%) melting;
- Oxy-fuel combustion (and use of decarbonized electricity to produce the oxygen);
- Use of biogas, acknowledging that the activation of this potential is limited by the quantities of biogas required by the sector and the quantities available;
- The addition of carbon-free hydrogen to the gas grid. However, any alternative fuel (especially hydrogen) must be modified as hydrogen flames are much less luminous than natural gas flames, making the heat transfer to the glass melt much less efficient.

In most of these cases the CO_2 savings are estimated at approx. 75-85%. In the same time the technological readiness and applicability of the solutions is satisfying for most of them (TRL 7-9) except for the 100% Hydrogen Technology and the Electric melting in the two cases described above.

4. Carbon capture and storage and usage (CCS/U)

Carbon capture is interesting to consider for addressing the process emissions (estimated between 15 and 25% of today's emissions) in glass manufacturing which cannot be avoided by an energy switch, provided carbon neutral energy is used for the CCS process. Nevertheless, CCS demands a number of barriers to be overcome to be considered as an option (today, it is limited to a theoretical potential only). Carbon capture and storage would require creating extensive transport and storage infrastructures for carbon capture and storage to be a large-scale solution by 2050. Hence it could not be considered as technologically applicable solution in the short term (TRL 4).

Focus of the decarbonization mix for the glass industry

Decarbonizing the diverse glass industry requires not one, but a variety of solutions:

- Since energy-related CO_2 emissions represent the largest share of the glass industry, it is necessary to substitute fossil energy carriers with CO_2 neutral ones, while at the same time focusing on more efficient energy utilization. I.e. an increase in the share of electrical energy for the furnaces used in the glass melting process should be foreseen. Initially, electrical boosting can be introduced respectively increased until finally the share of electrical energy predominates (hybrid melting) or accounts for almost 100% of the energy input (all-electric melting). The energy portion that is not provided by electric power should be replaced by combustion of hydrogen, whereby combined hydrogen oxy-fuel combustion is recommended.

- As for the decrease of process emmissions, which usually vary between 15 and 25% of the overall amount, the changes may include different options such as furnace design or combustion system adjustments. In the event that substantial amounts of waste heat are available (energy is provided by combustion not all-electric melting), it should be examined how it can be used most reasonably. Here, the combined use of air or oxygen regenerative with cullet or batch and cullet preheating systems should be aimed at. An increase of the share of cullet in the batch is an additional option to be considered as well. The improvement of the production processes described above should by all means go together with the introduction of more effective recycling schemes as they are the prerequisite for providing more cullet with better quality as the cullet is quite often the most important prerequisite for the relevant technological optimization.

4.7 Decarbonization pathways for the iron and steel industry

Role of the steel and iron industry

Steel is a central input material for many products in the European economy, positioning the iron and steel sector with close links to several other industries in manufacturing or construction sectors. Depending on the production route, steel is divided into primary steel, originating mostly from iron ore which is traditionally being produced in a blast furnace/basic oxygen furnace route (BF/BOF), and secondary steel, originating mostly from recycled steel and which is traditionally being produced in an electric arc furnace (EAF). A second dimension is the steel type which can be flat or long steel. Flat steel products are made from steel slabs and require high-quality steel or iron as input. Typical applications for this kind of high-quality steel are the automotive or aviation sectors. Conversely, long steel products are made from blooms or billets, with lower quality. Long steel products are for example utilised in infrastructure and construction projects.

Steel is used in a wide range of sectors, **such as buildings and infrastructure, mechanical equipment, automotive and metal products.** Inherently, semi-finished steel products affect the decarbonization targets in the above-mentioned sectors as they are part of the supply chain. In terms of relative shares steel users could be grouped as follows:

- construction and infrastructure (42% of demand),
- transportation (31%),
- industrial machinery (16%)
- other metal products (11%)

Bulgaria has 0.4% share of steel production in EU (and is ranked 18 in EU for 2019) with a major production site situated within the district of Pernik. As for the eight districts for which decarbonization pathways should be developed - steel production companies are present in only one of them – the district of Burgas where the company PROMET STEEL, covered by the EU ETS, is operating. Steel production is also a significant source of greenhouse gas emissions – more than 200 Mt CO_2 per year in the EU. It was responsible for 4% of greenhouse gas emissions in Europe (EU28) in 2018-2019 with an overall production rate of 157Mt of crude steel. The steel sector is one of the most challenging sectors to decarbonise and has recently received special attention on account of the potential use of low-carbon hydrogen to reduce its fuel combustion and process-related carbon emissions.

The decarbonization pathways described in this section have particular relevance to Burgas district.

Sources of CO_2 emissions

The production of steel can be represented in a simplified way as a two-stage process. In the first step, the oxygen is removed from iron ore molecules. This is done by a chemical reaction in the presence of a reducing agent. This is an energy-intensive process at elevated temperatures and depending on the reducing agent it is also a CO2-intensive process. The second step is to produce liquid steel, suitable for further processing. In this process, impurities are removed, and the material is melted if required. In the integrated route of steel and iron production, carbon plays multiple roles. First, it is a reducing agent in the blast furnace, taking out the oxygen from iron ore to produce iron. Second, it is the energy source producing the high temperatures required to melt steel and also to drive the multitude of processes in the overall production system. Third, some carbon is in fact a necessary ingredient of steel, up to 1% for high-carbon steel.

That leads to the conclusion that CO2 is emitted from all main stages of steel production, including the downstream phase of continuous casting and hot rolling. In the latter case (which is actually applicable to the case viewed in Bulgaria) there are heat emmissions as a result of the continous casting and hot rolling.

Decarbonization pathways for the steel industry

As for the core steel and iron production processes the focus may fall on **use and application of hydrogen which can replace the fossil fuels required to reach high temperatures,** as well as the carbon used in the reduction of iron ore. To guarantee complete decarbonization of steel production, the production of hydrogen has to be carbon-free (so-called green hydrogen) and the remaining electricity used in the production process has to originate from renewable energy sources (RES).

Currently, 60% of the steel produced in Europe originates from integrated blast furnace/blast oxygen furnace route (BF/BOF) which emits around 1.9 tCO2/tsteel. To avoid these emissions, the direct reduction of iron ore (DRI) based on 100% low-carbon hydrogen (H-DRI) seems to be a promising production route. That is partly relevant to the downstream phase of continuous casting and hot rolling where heat emmissions occur as well. **As such, efforts could be additionally focused on achieving higher levels of circularity in the sector,** like the reduction of losses in the production of semi-finished and finished products, the prevention of down-cycling to lower-quality materials, the reduction of contamination of end of life materials streams, the development of new and more efficient separation technologies (for instance, to remove copper from steel which would allow up to 90% recycling of steel). That also is closely related to availability of steel scrap re-entering the production cycle (material recirculation) as CO_2 emissions from recycled steel are significantly lower than those from production of new steel. The energy required is only 10-15% of that required in the production of primary steel from iron ore.

There is one more option which should be mentioned though it could not addressed as ready to be implemented at present – application of CCS/U technologies. Technical requirements have to be met to enable alternative pathways to further decarbonise the steel sector employing carbon capture & storage (CCS) and utilisation (CCU).

Focus of the decarbonization mix for the steel industry

Based on the information in the previous section and the major sources of CO_2 identified, the decaronization mix for the steel industry in the present case **should focus mostly on clean (low CO_2) production processes, possibly with use of Hydrogen and electricity from RES in a combination with better material efficiency and material recirculation.** That includes reduction of losses, reduction of contamination of end of life materials streams, development of separation technologies and use of steel scrap in the production cycle. While the first proposal concerns the production process itself, the rest of available options are mostly related to treatment of semi-finished and finished products and end of life materials as well as introduction of new and more efficient separation technologies.

4.8 Decarbonization pathways for the oil refining industry

Role of the oil refining (petroleum) industry

Refining of crude oil leads to a vast array of products that fulfil the needs of both citizens and businesses. About 65% of the crude oil processed in EU refineries is transformed into transport fuels, which are mostly liquid; about 10% goes to petrochemical feedstocks; and about 25% is employed for other products. On a refinery site, crude oil is processed into smaller carbon-chain components, of which some fractions are converted into valuable substances. These products can be used as fuels, both for heat generation and for mobility purposes. Additionally, some oil outputs serve as feedstocks for the petrochemical and chemical industries (i.e. naphtha, lubricating oils, bitumen and paraffins/waxes). A refinery can also produce, as by-product, steam and power. Today the EU has about 80 operational refineries, which jointly convert approximately 650 Mt/a of crude oil into transport fuels, fuel oil and LPG for heating and power generation, and petrochemicals. Their capcaity generally matches the EU refined product demand. Specific demand however differs widely per oil product, country and region. Many chemical and refining sites are integrated. Out of the 58 steam crackers (petrochemical units) located in the EU, 41 are integrated with refineries located, on average, less than two kilometres away.

Lukoil Neftochim Burgas (LNB), located in district Burgas, falls within that number of so called "mainstream" refineries. LNB has an annual turnover of approx. 6 billion BGN and around 1300 employees. As such, the following section has particular relevance to Burgas district.

Oil refining stages and sources of CO_2 emissions

Refining (as a process) breaks crude oil down into its various components, which are then selectively reconfigured into new products. All refineries have three basic steps:

- Separation

Modern separation involves piping crude oil through hot furnaces. The resulting liquids and vapors are discharged into distillation units. All refineries have atmospheric distillation units, while more complex refineries may have vacuum distillation units. Inside the distillation units, the liquids and vapors separate into petroleum components called fractions according to their boiling points. Heavy fractions are on the bottom and light fractions are on the top. The lightest fractions, including gasoline and liquefied refinery gases, vaporize and rise to the top of the distillation tower, where they condense back to liquids. Medium weight liquids, including kerosene and distillates, stay in the middle of the distillation tower.

Heavier liquids, called gas oils, separate lower down in the distillation tower, while the heaviest fractions with the highest boiling points settle at the bottom of the tower.

- Conversion

After distillation, heavy, lower-value distillation fractions can be processed further into lighter, higher-value products such as gasoline. This is where fractions from the distillation units are transformed into streams (intermediate components) that eventually become finished products.

The most widely used conversion method is called cracking because it uses heat, pressure, catalysts, and sometimes hydrogen to crack heavy hydrocarbon molecules into lighter ones. A cracking unit consists of one or more tall, thick-walled, rocket-shaped reactors and a network of furnaces, heat exchangers, and other vessels. Complex refineries may have one or more types of crackers, including fluid catalytic cracking units and hydrocracking/hydrocracker units. Cracking is not the only form of crude oil conversion. Other refinery processes rearrange molecules to add value rather than splitting molecules.

- Treatment

The finishing touches occur during the final treatment. To make gasoline, refinery technicians carefully combine a variety of streams from the processing units. Octane level, vapor pressure ratings, and other special considerations determine the gasoline blend.

The refinery processes described above result in direct emissions associated with processes, such as fuel combusted at a refinery and downstream emissions at the end-of-life for the products (e.g., transport fuels). These processes require a lot of energy. Typically more than 60 % of refinery air emissions are related to the production of energy for the various processes. Hence - power plants, process furnaces, boilers, heaters, flare systems, incinerators and catalytic cracking are the main sources of emissions of carbon monoxide and dioxide. A typical complex refinery, shows more than 10 emission sources.

The CO2 emissions **grouped by main source** of refinery activity include:

- emissions originating from combustion from furnaces – approx. 50% share (presenting the biggest share);

- CHPs and boilers, FCC units - approx. 20% share;
- Hydrogen production (SMR + gasification) – approx. 20% share.

Decarbonization pathways for the oil refining industry

In the present case the range of applicable measures/options may include:

1. Improvement and optimization of technical and logistical processes – in several aspects

- Operational measures to maximise energy efficiency such as: Reduction in the burning of liquid fuel; Reduction of routine flaring in refineries; Use of low-grade heat resulting from refinery operations to produce electricity for internal and external use.
- Some areas may include the extension of heat-pump technology to achieve higher temperatures and alternatives to electric power.
- Closer integration with other industries such as petrochemicals, which are often located within the same industrial hub. This also provides further options for energy efficiency measures – e.g. shared utilities, which result in greater economy of scale and better optimisation of heat, steam and power.
- Residual heat usage. In general, refinery processes generate a large amount of residual heat at different temperature levels, which can be utilised for several purposes, such as district heating and electricity generation

2. Introduction of clean (low CO_2) production processes

That is to be focused on:

- **Electrification**. Electrification of the heat supply seems to be an interesting solution in the refinery sector, since a large part of its emissions is due to thermal processes (around 70%). Gas-fired Electric furnaces present significant potential to reduce energy related emissions. Electricity-based processes can use electric currents (resistance heating) or electromagnetic fields (induction and dielectric) to heat materials.

The furnaces and steam generation systems are the main targets for this option.

- **Biomass/bio-fuel**. Besides process improvements, the refinery industry can decarbonise its production plant by fuel switching to low carbon feedstock (biomass and hydrogen). Conventional refineries (whose feedstock is crude oil) can be transformed into "bio-refineries" for the production of a different range of biofuels and other products from biomasses. The option implies a transition from petroleum refinery to biorefinery or as an integrated industry.
- **Use of Hydrogen as fuel**. The aim of this option is to replace fossil-based gas by hydrogen as fuel for furnaces. Since the combustion of hydrogen generates water, the substitution of natural gas and/or fuel gas in fired processes by hydrogen results in the reduction of CO_2 emissions. However, hydrogen should be produced via low CO_2 processes.

There are already projects aimed at using or producing so-called "green hydrogen", i.e. hydrogen produced from renewable electricity. This provides the double advantage of lowering emissions from fuels and other refining products, while at the same time allowing the storage of excess renewable electricity generated when supply exceeds demand.

3. CCS/U to be used across refineries.

The majority of CO2 emissions in a refinery are related to gas-fired process heaters, the on-site utilities for power and steam generation, gas-fired furnaces and hydrogen production. There are currently two options for carbon capture that are relevant for refinery sites: pre-combustion capture and post-combustion capture.

Still at the higher end of the CCS cost range is the application of CCS in refining. For refining, recent simulations of retrofitting CCS in integrated oil refineries estimate the cost of CO2 capturing at EUR 138- 185 t/CO2 avoided.

In the same time the successful implementation of CO2 capture (and storage or usage) appears crucial to reducing EU refineries emissions in the longer term. Total 2050 emissions savings would jump from 50% with no CCS to 70% with the effective deployment of CCS projects throughout the industry. However, the degree of penetration of CCS and the associated timeframe remain uncertain.

Focus of the decarbonization mix for the oil industry

It should be emphasized at the very beginning that even an optimal mix of measures still shall have the potential to contribute to CO2 emission savings close to 80% in 2050 compared with 1990 levels. However this is a case when the refinery oil sector typical production processes are being reviewed and that does not include a complete overview especially through the downstream value chain.

Nevertheless when looking at the emerging opportunities for reducing CO2 emissions at a refinery site, different categories of opportunity become apparent and applicable in the short and in the mid-term. At present this generally include:

- Low-carbon energy carriers: the gradual decarbonization of the EU electricity grid or the natural gas network will offer new ways to integrate low-carbon electricity and gas into the production system.
- Process efficiency technologies introduced at the industrial sites to minimise energy consumption and, therefore, avoid CO2 emissions.
- Carbon capture technologies to enable refineries to make CO2 available for either storage (CCS) or use (CCU), thereby integrating the EU refining system into a circular economy.

A summary of the decarbonosation plans of Lukoil Neftochim Burgas AD, Bulgaria's only crude oilrefinery, is presented in the case study below.[46]

[46] The detailed information about the decarbonization plans of Luk Oil Neftochim Burgas was provided by the company's management within a standardized interview and an additional decicated videoconference.

Box 5. Case Study: Decarbonization plans of Lukoil Neftochim Burgas

Lukoil Neftochim Burgas AD (LNHB) is a crude oil refinery with a petrochemical profile, located on the Black Sea coast, 15 km from the city of Burgas. The refinery has access to rail, sea, and road transport and an oil product pipeline to the central regions of the country. The refinery processes various grades of crude oil. The main conversion processes are a catalytic cracking unit (FCC) and an H-Oil complex (vacuum residue hydrocracking). The overall prcessing capacity is 7 mton/year of crude oil

Regarding the applicability of the main technological strategies for reducing carbon emissions in industry, the company considers applicable and works actively in: Increasing materials efficiency (increasing the productivity of materials, raw materials, and energy used, including replacing materials and energy with low-carbon ones;

Reducing the consumption of materials and energy by increasing the recycling of materials (circular economy, industrial symbiosis); Implementation of new production processes with low carbon emissions, incl. electrification of production processes for which fossil fuels are used.

With regard to the use of technologies for capture and storage or use of carbon emissions, the company considers this strategy to be completely inapplicable due to the lack of developed storage infrastructure and sufficiently efficient CO2 capture technologies.

During the period 2020-2030, LNHB is **planning to invest more than $ 800 mln in lowering CO_2 emissions** and optimizing energy and resources consumption in the following directions:

- Process & technology optimisation – New PSA (nitrogen generation system) unit with CO2 reduction of 83 kt/y, Usage of SMR Off-gas instead of natural gas with CO2 reduction of 46 kt/y; Optimization of refinery feedstock CO2 reduction – up to 5-7% of total emissions;
- Program «Energy breakthrough» 2021 – 2030 - 28 projects, aimed on optimisation of fuel, heat and energy consumption with CO2 reduction of 104 kt/y
- New Polypropylene unit and new ETBE unit (offers equal or greater air quality benefits than ethanol, while being technically and logistically less challenging) - production of high-value plastics with long life cycle, ETBE use bio-ethanol as feedstock with CO2 reduction of 23 kt/y.
- Green projects - Green hydrogen project with CO2 reduction of 149 kt/y , Second Generation biofuels with CO2 reduction of 70 kt/y, Depolymerization of plastic waste with CO2 reduction of 58 kt/y.
- Thermal power plant reconstruction – modernisation, utilization of extra amounts of refinery gas and integration with photovoltaic park - CO2 reduction of 90 kt/y.

In a midterm period, LNHB evaluated the investments if further decarbonization projects on more than 720 mln. $ till 2040. The main goal of these investments is to assure the transition of LNHB to low-carbon production and clean energy, in accordance with EU climate ambitions. LNHB will rely on new technologies for further decarbonization of the production and lowering CO2 emissions.

According to the company's management, it is still too early to talk about a complete abandonment of mineral fuels. Modern technologies related to the use of renewable energy and electric transport do not offer enough flexibility and security, especially in exceptional circumstances (natural disasters, etc.). On the other hand, the company is active in the development of hydrogen technologies, solar energy, biofuels, and carbon-based synthetic fuels. A pilot installation for the production of green hydrogen has also been developed. The company is working on many development projects related to biodegradation and chemical recycling of waste. The main concerns mentioned were the lack of a consolidated assessment of the cost of the transition at the sectoral level. The cost of emissions is also becoming an important factor in determining the cost of fuels.

The company's management relies on support from the transition programs and the state in the following areas:

- Financing science to business projects
- Financing of green hydrogen projects
- Business support policies should be made a national priority instead of investing in infrastructure.
- Creating a regulatory framework for decarbonization
- Creating a sectoral-specific decarbonization policy.
- More complete and up-to-date sectoral information on the dimensions of decarbonization.

4.9 Decarbonization pathways for the ammonia fertilizer industry

Role of ammonia fertilizer industry

According to the sector association *Fertilizers Europe*, the total European fertiliser production in 2016 was 16.6 million tonnes. Of this amount, 73% consisted of nitrogen (N) fertilisers, 11% of phosphorus (P_2O_5) fertilisers and 16% of potassium (K_2O) fertilisers. In 2018 the total EU-28 consumption was estimated at 20 million tonnes (of nutrient) and the production raised to 18.1 million tonnes (of nutrient). The production of nitrogen compounds mainly takes place for fertiliser consumption in the agriculture sector. For nitrogen-based fertilizers, the largest product group in the sector, the process starts by mixing nitrogen from the air with hydrogen from natural gas at high temperature and pressure to create ammonia. Approximately 60% of the natural gas is used as raw material, with the remainder employed to power the synthesis process. The ammonia is used to make nitric acid, with which it is then mixed to produce nitrate fertilizers such as ammonium nitrate (AN). Ammonia may also be mixed with liquid carbon dioxide to create urea. Both these products can be further mixed together with water to form UAN (urea ammonium nitrate) solution.

Ammonia production is the most energy-intensive process in the fertiliser industry. In the conventional ammonia production process, ammonia is produced by steam methane reforming of natural gas combined with Haber-Bosch NH_3 synthesis. Alternatively, hydrogen with a lower CO_2 footprint (e.g. green hydrogen) can be produced on-site or supplied from external sources. Ammonia plants produce large flows of almost pure CO_2 gas, which are potentially well suited for carbon storage (CCS). **Urea** is a downstream product of ammonia production. The basic raw materials for urea production are ammonia (NH_3) and carbon dioxide (CO_2). Both can be obtained from a ammonia-synthesis plant, and therefore urea production is often integrated in ammonia plants. In Europe, most of the **nitric acid** (HNO_3) is produced by the high-temperature catalytic oxidation of ammonia. This process typically consists of three steps: ammonia oxidation, nitric oxide oxidation, and absorption.

There are around 50 major fertiliser plants in Europe: two of them situated in Bulgaria – districts of Haskovo and Varna, as other smaller facilities are situated in the districts of Varna, Gabrovo and Targovishte. Both the ETS companies in Bulgaria (district Varna and district Haskovo) have a total annual turnover of approx. 700 MBGN and more than 1500 employees. As such, the following section has particular relevance to the districts of Varna and Haskovo.

Manufacturing stages and sources of CO_2 emissions

The major steps of ammonia production include:

Step 1: Desulfurisation of natural gas

The first step in the ammonia production process is to remove the sulfur content from the natural gas as the catalyst used in the steam reforming process is very sensitive to any sulfur compounds.

Step 2: Reforming

The reforming is divided into primary and secondary reforming. In primary reforming, the desulfurised gas enters the primary reformer at a temperature in the range of 400–600 °C and is mixed with the steam. After the primary reformer, the gas mixture enters to the secondary reformer and air is entered at this stage that is needed for the production of ammonia. As only about 60% of feed-gas was reformed in the primary reformer, the reforming process is completed in the secondary reformer. A high temperature is provided in order to increase the conversion rate of hydrocarbons. It is achieved by the internal combustion of part of the reaction gas and the process air that is also a source of nitrogen.

Step 3: Shift conversion

In the shift converter, a reaction is carried out in two steps to convert the 10% CO left over in the secondary reformer into CO_2 and H_2. The main goal of this water gas shift reaction is to produce hydrogen gas. The reaction is exothermic. A copper-based catalyst is currently used for low-temperature water gas shift reactions.

Step 4: Carbon dioxide removal and methanation

The residual CO_2 content in the reaction gas is usually in the range of 50–3,000 ppmv. Both physical and chemical absorption processes are used to remove carbon.

Step 5: Ammonia synthesis

The ammonia synthesis is the last step in the ammonia production plant. It takes place in the presence of an iron-based catalyst at a pressure of 100–150 bar and a temperature that ranges from 300–550 °C.

Based on these production processes CO_2 arises from two separate sources in ammonia production. First, steam methane reforming creates CO_2 as a by-product. The resulting stream of CO_2 is around 70% of the direct emissions of CO_2 from ammonia production (or half if CO_2 from electricity generation is also counted). The remaining emissions come from the energy inputs to the process steps. In the EU, natural gas is typically used for heating, and the process also requires electricity for compressors.

Carbon emissions from ammonia production arise from the flue gases of the combustion processes and from the reforming reaction. The CO2 released from the reforming step is highly concentrated and is captured. Part of this CO2 could be used as feedstock for urea production or other downstream utilisation. The CO2 from exhaust gases of heat generation are more difficult to capture and are currently emitted to the air.

Decarbonization strategies for the fertiliser/ammonia industry

Though a number of additional measures could be put in place in order to achieve lower CO2 production, there are two major pathways that stand out:

1. Clean (low CO_2) production processes

- Green hydrogen produced from electrolysis of water

In the conventional ammonia production process, ammonia is produced by steam methane reforming of natural gas combined with Haber-Bosch NH3 synthesis. Alternatively, the hydrogen that is required for the Haber-Bosch process can be produced by electrolysis of water. In an electrolyser, an electric current splits water into hydrogen and oxygen. No plants using electrolysis to produce ammonia are currently operational[47].

- Blue hydrogen produced from natural gas with carbon capture and storage

Blue hydrogen is produced from natural gas, usually via steam-reforming, with carbon capture and storage.

- Hydrogen from biomass gasification

Gasification of (ligno-)cellulose from wood can produce a syngas, which is a mixture of hydrogen, carbon monoxide and carbon dioxide. This gas can be used as a feedstock to produce ammonia. A major limiting factor for this technology is the availability of the feedstock. Biomass gasification also requires a high capital expenditure for process equipment.

2. Carbon capture and storage and usage (CCS/U)

Ammonia plants produce large flows of almost pure CO2 gases, which are well suited for carbon capture and storage (CCS). The CO2 is already captured, but needs to be further compressed and transported to a storage location.

Focus of the decarbonization mix for the fertiliser industry

Technically, CO2-free ammonia production is feasible using the same Haber-Bosch process as is used today; the crux is the inputs. Hydrogen would need to be produced without release of CO2, as would electricity. The production of low-CO2 hydrogen could take place through two main routes: water electrolysis using zero-carbon electricity, or the use of carbon capture and storage (CCS) in steam methane reforming (SMR) plants. For genuinely low-CO2

[47] Industry, p. 28 (quoting a 2017 Report of the Institute for Sustainable Process Technology) - Decarbonization options for the Dutch fertiliser industry (pbl.nl)

production, however, two additional things are needed. First, as noted, the process CO_2 is only around half of the total. The emissions from combustion must also be addressed. One option is to fit the furnace, too, with CCS. The other would be to electrify the source of heat input. The second requirement is infrastructure to compress, transport, and store the CO_2.

4.10 Decarbonization pathways for the soda ash industry

Role of soda ash industry

Soda ash is a critical raw material in the production of glass, representing approximately 20% of the weight of the finished glass. Hence the principal user of soda ash is the glass industry, accounting for over 60% of demand. Other important customers include the chemicals industry and the detergents industry. Dense soda ash is the preferred form of the product for use in the glass industry and for economic transportation over long distances.

There are 16 soda ash plants across 9 European countries and Turkey: Bosnia-Herzegovina, Bulgaria, France, Germany, Italy, Poland, Romania, Spain and the United Kingdom. Their combined capacity represents over 10 million t/year and one quarter of global production. There are six producers of soda ash in EU with Solvay being the largest. **The Solvay plant in Bulgaria is considered the largest in Europe in terms of production capacities.**

The range of capacities per plant vary from 160 to 1020 kt per year, i.e. approximately from 440 to 2800 tonnes per day (assumed onstream factor of 360 operational days per year). The total number of people employed directly by European producers is estimated at about 8500 persons (or about 900 t per person employed per year). These numbers depend upon the boundary of operation and vary from site to site. Furthermore, there are a certain number of subcontractors working in the plants on activities such as bagging, loading, transport, engineering, construction, and maintenance. These activities can be estimated as needing 14000 persons, and thus about 22500 people are employed, directly and indirectly, in the production of soda ash and derivatives in the EU (the statsitics in this paragraph is based on EU 25 calculations from 2007). In comparison to that the Solvay plant in Devnya, Bulgaria had almost 500 employees in 2019 with an annual turnover of approx. 230 MEUR.

Soda ash production and consumption (including sodium carbonate, Na_2CO_3) results in the release of pollutants among which is carbon dioxide (CO_2). However soda ash cannot be considered a final CO_2 sink, as the main part of the CO_2 is emitted again in the downstream sectors (e.g. the glass industry) in which soda ash is used to yield new value added products.

The decarbonization pathways described in this section are of particular relevance to Varna district.

Sources of CO2 emissions

Two major ways for soda ash production could be distinguished based on the raw materials used as an input. Since the 1940s, soda ash has been increasingly obtained from trona, especially in the United States, where the proportion of soda ash produced from trona has increased continuously from 15 % in 1960, to 100 % in 1986. As trona deposits are not available in

Europe, soda ash in the EU is almost entirely manufactured by the Solvay process, using the locally available salt brine and limestone of the required quality. The key environmental impacts of the Solvay process are the atmospheric emissions of CO_2, where the excess CO_2 emitted from soda ash production originates from coke oxidation. The atmospheric emissions are also associated with the calcination of limestone and carbonation of ammoniated brine. During $CaCO_3$ burning to CaO in the lime kilns, CO and CO_2 are produced from the combustion of coke and decomposition of limestone. The Solvay process needs an excess of CO_2 above that stoichiometrically required. Some of the excess is required to compensate for non-ideal absorption of CO_2 in the carbonation towers. They also have an outlet for the discharge of gases that have not reacted in the process.

Further excess CO_2 may be beneficially used in the production of sodium bicarbonate. However any surplus CO_2 is vented as kiln gas to the atmosphere. The amount of CO_2 vented to the atmosphere from a standalone soda ash process is in the range of 200 to 300 kgCO_2/t soda ash. The split of losses to the atmosphere depends on the detailed plant configuration. CO gas is virtually inert throughout the process. All CO produced must therefore be vented to the atmosphere either at the kilns or through the carbonation tower at the outlet of gas scrubbers. CO generation is in the range of 4 to 20 kg CO/t soda ash, depending on the conversion of CO to CO_2 during the limestone calcination step. When released into the atmosphere, the CO is converted by natural processes into CO_2.

The CO_2 emmissions generated in the soda ash production process are mostly related to the chemical reactions described above so they could be defined as process emmissions. Energy in the form of steam is required for the thermal decomposition of crude sodium bicarbonate to soda ash where sodium bicarbonate crystals are separated from the mother liquor by filtration, then sodium bicarbonate is decomposed thermally into sodium carbonate, water and carbon dioxide.

Although the majority of CO_2 generated in the lime kilns is absorbed into the finished products, there is inevitably some loss of unreacted carbon dioxide from the carbonation and bicarbonation reactions. The CO_2 excess is needed to compensate the incomplete absorption of CO_2 in the carbonation stage, in the different washers, and its losses in the treatment of the mother liquid in the distillation area. This CO_2 excess is generated by combustion of (normally) coke, which provides energy used for limestone decomposition and is the additional source of CO_2. Burning of the limestone (natural form of $CaCO_3$) is carried out in a temperature range of 950 to 1100 °C. The operating conditions of a lime kiln fitted to soda ash production are critically different from those used for lime production, because of the need to produce a gas with the maximum concentration of carbon dioxide for its subsequent use in the process.

The energy carriers for steam forming and for thermal decomposition of sodium bicarbonate could be a separate source of CO_2 emmissions. However that is a specific issue which depends on the degree and level of integration of the soda ash plant with associated boiler/power plant at the site and the sources of energy used there.

Decarbonization strategies for the soda ash industry

1. Materials efficiency and circular business models

The specifics of soda ash production allow (also in terms of technological readiness) the capture of CO_2 and its return in the manufactring process.One of the key concepts of the Solvay process is the captive usage of both CO_2 and lime downstream in the process, in order to keep material efficiency in the process at a high level and to avoid excessive CO_2 emissions from the soda ash plant. To this end, both a stable and a highly balanced flow of concentrated CO_2 gas is required within the so-called 'CO_2 recovery cycle' – a dominating loop in the process.

Apart from maintaining the required stable flow of CO_2 gas and high operational flexibility between, on the one hand, the lime kiln section (typically several kilns are in operation) and, on the other hand, the calcination of the crude bicarbonate section (typically several calciners are in operation) and then, via the CO_2 gas compression section (typically several turbo-compressors are fed with washed and cooled CO_2 gas), to the carbonation section (again several carbonation columns are in operation).

2. Clean (low CO_2) production processes

Clean production processes in the case of soda ash production could be linked to the change of the energy carriers for the boiler/power plants providing energy for the steaming and decomposition processes.

Box 6. Case Study: Solvay unveiling decarbonization plans

As announced on May 5, 2021 Solvay (Belgium) is planning to completely phase out the use of thermal coal at its soda ash plant in Rheinberg, Germany. After commissioning a first biomass boiler, which will go into operation in May 2021, Solvay is unveiling plans to build a second biomass boiler, which will complete the thermal coal phase-out by 2025 and make Rheinberg the first soda ash plant in the world to be powered primarily by renewable energy. Both biomass boilers use scrap waste wood chips - a mixture of used wood, from industrial residues and demolition - as fuel to produce steam and electricity. These projects must reduce CO_2 emissions at the Rheinberg soda ash plant by 65% relative to 2018.

Focus of the decarbonization mix for the soda ash industry

Based on the information provided in the previous section the **decarbonization pathways which could most easily be applied for the soda ash production sector encompass the following:**

1. direct process optimisation of several plant production sections, with regard to decreasing the amount of CO_2 released to the atmosphere. This pertains in particular to the limestone burning and operational parameters maintained in this process step, including as narrow as possible temperature profile in the kiln and as little as possible excess air used to reach a high concentration of CO_2 gas;

2. maximum utillization of CO_2, its capture and return in the manufacturing process including for the production of sodium bicarbonate;

3. Change of the energy carriers used in boilers/power plants and transition to biomass or other renewable energy sources.

4.11 Decarbonization pathways for the non-ferrous metals industries

Role of non-ferrous metals industry

Non-ferrous metals (NFM) are essential for a number of other industrial sectors as their value chains connect to vital infrastructure like buildings, transport, electronics; strategic sectors like defence; as well as almost every other economic sector such as food and jewellery. The non-ferrous metals industry in Europe is worth EUR 120 billion employing around 500,000 persons directly and more than 2 million people indirectly. The sector consists of 931 facilities (out of which 20 located in Bulgaria), including mining (54 facilities), primary and secondary production of NFM (464) and further transformation (413).

Within the EU, the total primary production of non-ferrous metals stood at 7.4 million tonnes (Mt) in 2016.

Aluminium is the most used non-ferrous metal by volume and the second most widely used metal after iron both in the EU and globally. **Lead** is a significantly large base metal sector and is usually found in and extracted in ore with zinc, copper and silver. The lead industry in Europe consists of 60 plants, employs 5400 persons and has a turnover of EUR 3 billion. **Zinc** is the fourth-most used metal after iron, aluminum, and copper. The zinc industry in Europe is well established with 12 plants located regionally providing direct employment to around 5,000 people and indirect employment to more than 50,000 people with a turnover of EUR 5 billion approximately. The EU's primary production of non-ferrous base metals in 2016 represented 10% of global metals production in 2016 (13 Mt out of 128 Mt). For primary base metals production EU's in global share was 6% (6.5 Mt out of 101 Mt) and for secondary production this was 24% (6.5 Mt out of 27 Mt).

The decarbonization pathways described in this section are of particular relevance to Gabrovo and Yambol districts.

Production processes and CO_2 emissions in NFM industry

The primary **production of aluminium** involves three processes after the extraction of bauxite ore:

- purification of bauxite or to aluminium oxide (alumina)
- synthesis of cryolite and aluminium fluoride for the electrolytic reduction process
- electrolytic reduction of alumina to aluminium

Primary aluminium is produced from bauxite that is converted into alumina (aluminium oxide). Around 100 tonnes of bauxite produces 40 to 50 tonnes of alumina, which can then produce 20 to 25 tonnes of primary aluminium. Most of the bauxite is mined outside Europe, but there are several alumina production facilities within Europe. In the refining process of bauxite (Bayer's process) bauxite ore is first crushed and dissolved in hot sodium hydroxide. The iron and other oxides are removed as insoluble "red mud". The solution is then precipitated and goes through a calcination process to produce a dry white powder, alumina. Manufacturing of primary aluminium utilizes a carbon anode in the smelting (Hall-Héroult) process. The carbon is consumed during the electrolytic process therefore a constant supply is required for the smelting process. Carbon anodes are produced by heating up of coke or tar pitch. The Hall-Héroult process is the primary process for commercial aluminium production. The process takes place in an electrolytic cell or pot, consisting of two electrodes, anode and cathode. Alumina is dissolved into a cryolite bath and serves as an electrolyte for the process. High amounts of electrical current are passed through the molten bath and reduces alumina to form liquid aluminium at the bottom of the cell or pot. Primary production of aluminium is a highly electro-intensive process with 14-16 MWh electricity use per tonne primary aluminium produced. More than 90 per cent of the emissions stem from the primary production process, and two thirds are energy related.

Downstream treatment of aluminium includes rolling mills, extruders and casters. Secondary aluminium production involves using recovered or recycled aluminium from waste streams as raw material to produce aluminium. Secondary aluminium production uses far less energy than primary aluminium production due to the lower heating temperature. The process starts with the sorting and pre-treatment of the scrap feedstock according to their quality and characteristics. Various furnace types are available for the melting process, including reverberatory and induction furnaces and emerging technologies such as rotary arc and plasma furnaces.

There are two main processes for **production of zinc**: the electrolytic process and the thermal process. Over 90% of the world's production comes from the electrolytic process.

The electrolytic process has four stages:

- concentration of the ore at the mining site
- roasting of the ore with air
- conversion of zinc oxide to zinc sulfate
- electrolysis of zinc sulfate solution

Nickel is primarily extracted from nickel sulphide ores, which contain about 1-3.5% nickel content, and the iron-containing lateritic ores limonite and garnierite, which contain about 1-2% nickel content. With regard to secondary production, nickel scrap can be used in melting processes as addition to refined nickel. Moreover, efficient recycling of nickel takes place in the stainless-steel industry, which is the major first use of nickel.

Lead CO2 emissions occur from smelting and reducing with gas and coal. Kettles used for the refining processes are indirectly heated with gas and oil.

Decarbonization strategies for the NFM industries

There are three decarbonization routes for the industry.

1. Materials efficiency and circular business models

Aluminium is a key material for the circular economy, with an enormous decarbonization potential stemming from its circular properties: Aluminium has been recycled from the beginning of its industrial production 125 years ago and, as a result, today about 75 percent of all aluminium ever produced remains in use. Around half of the aluminium produced in Europe originates from recycled materials, with recycling levels of 90-95 percent for end-of-life vehicles and building parts and close to 75 percent for beverage cans.

While most metal production processes have been optimised for years or even decades (e.g. the Hall-Heroult process), there still remains potential for further (relatively) small efficiency improvements in metals production. The options include better, smarter and integrated control systems, increased efficiency of burners and increased heat recovery.

2. Clean (low CO_2) production processes

Due to the high level of electricity use, decarbonization of EU power production will be the most important factor in the decarbonization of non-ferrous metal production.

While non-ferrous metals production is already very electro-intensive, there still exists potential for further shifts to replace fossils fuels with electricity. In zinc EU production, this shift has been outspoken over the past 20 years. It is conceivable that in the EU, some smelting processes and in particular recycling and metals recovery processes could see a shift over the next decades to the more electro-intensive (and energy-efficient) hydrometallurgical leaching or bio-leaching processes.

In addition to that the **following options could provide lower CO2 emissions**:

- Higher efficiency of primary aluminium electrolysis process. Lowering the temperature of primary aluminium production (from 950˚C closer to the melting point of 680˚C) while maintaining stable operation can bring about important energy savings.
- Hydrogen as smelting reducing agent. Hydrogen can be considered as a replacement to coke or natural gas as the reductant in some pyrometallurgical processes of non-ferrous metals. Hydrogen produced via electrolysis has the benefit of having oxygen as a by-product, which can also be used in some of the smelting processes. This can improve the business case of using electrolysis-based hydrogen as a reducing agent.
- Fuel switching can lead to lower CO2 emissions. For example, shifts from liquid fuels to gas, or the use of biogas where possible. There is potential for low-carbon and bio-based inputs to replace fossil fuels in copper production and other smelting and re-melting of metals (including reducing agents), once economically competitive and available in sufficient quality.

3. Carbon capture and storage and usage (CCS/U)

Carbon capture and storage does not seem like an economically viable option for metals producers on their own, due to the high capital cost vis-à-vis the relatively low emissions compared to e.g. integrated steel plants, cement production or basic chemicals.

Metals smelting processes which operate in a high oxygen environment might see flue gases with high CO2 concentration (after cleaning) and consider the use of CCS. CCS could also be applied to capture the CO2 emissions from embedded carbon in concentrates and secondary raw materials and from the treatment of slag and leaching residues. However, the investment costs might be high vis-a-vis the total amount of emissions captured.

Focus of the decarbonization mix for the NFM industry

There is a theoretical potential for the non-ferrous metals industry to reduce its GHG emissions by more than 90% compared to 1990 levels. The most important mitigation will come from the decarbonization of the EU power sector which according to EU data could reduce the remaining emissions from EU non-ferrous metals production by 51%, based on 2015 emissions and production figures. This alone would lead to a theoretical 81% total reduction of the secto's emissions compared with 1990 levels. For the industry's remaining emissions, there are a wide-range of technological options with major potential for achieving GHG reductions in line with climate-neutrality by 2050.

Higher recycling volumes will lower the metals industry's overall carbon footprint on a lifecycle basis, as recycling processes require less energy than extraction and primary production operations (although recycling of some metals from complex waste fractions could incur higher energy requirement due to low metal concentrations and/or small volumes).

Additional CO2 cuts could be achieved through a mix of measures including the following:

- Important energy savings are possible mostly related to digitisation and automated process management and efficiency in furnaces (Applicable to all NFM).
- Further electrification of pyrometallurgical processes and/or shift to hydrometallurgical processes in some smelting processes. Electrification (heat) in downstream processes. High temperature electrification might not yet be mature or too expensive compared to natural gas-based heating. Shift to hydrometallurgical processes can be limited and will most likely be applied in secondary and waste streams.
- Fuel shift and bio-based inputs. Fuel shift from fuels/coal to gas has occurred in non-ferrous metals industry where possible. Further shifts to natural gas and bio-feed (including reducing agents) are possible.
- Use of Hydrogen as reducing agent. This can be relevant for some pyro smelting processes (e.g. copper). Limited application of H2 in ferro-alloys. Can be relevant for recovery of metals from smelting slag or leaching residues.

4.12 Decarbonization pathways for non-carbon-intensive industrial sectors

Non-carbon intensive industrial sectors

These are general decarbonization pathways, applicable to all non carbon-intensive industrial sectors, which have a notable carbon footprint mostly due to operation of a combustion installation, utilising fossil fuels and/or other energy from non-renewable sources and/or some other energy intensive production processes. The decarbonization pathways for the sector include a set of solutions which could be defined as cross-sectoral due to the fact that usually the major source of emissions is related to fuels used for the heat and/or energy processes. In particular, the present decarbonization pathways are generically applicable to the sectors of:

- manufacture of corrugated cardboard;
- manufacture of wood-based panels (chipboard);
- manufacture (processing) of textiles;

- manufacture of pharmaceuticals;
- manufacture of plastics (secondary production);
- manufacture of dyes, glues, heat isolation materials and other construction materials;
- manufacture of machinery and equipment

Decarbonization pathways

There are two generic pathways for the decarbonization of the said non-carbon-intensive sectors, which could be summarized as follows:

1. A switch to alternative energy carriers (e.g. natural gas), electrification of processes (use of renewable energy sources) and/or use of bio-fuels.

Though it is out of the question that **a switch to electricity** from RES or to **bio-fuels** is a preferred solution regarding tha amount of estimated CO2 emission savings, that could not always be easily achieved especially in the mid-term due to a number of practical limitations (e.g. low level of technological readiness or insufficient supplies of biomass). Hence a switch to natural gas often represents a better and more important – ready to apply option that shall result in CO2 emission savings. It is also clear that switching between unabated consumption of fossil fuels, on its own, does not provide a long-term answer to climate change, but there can be significant CO_2 benefits from using less emissions-intensive fuels. Since 2010 coal-to-gas switching has already saved around 500 million tonnes of CO_2. The clearest case for switching from coal to gas comes when there is the possibility to use existing infrastructure to provide the same energy services but with lower emissions. Given the time it takes to build up new renewables and to implement energy efficiency improvements, this represents a potential quick win for emissions reductions.

Most of the gas and coal produced today is used for power generation and as a source of heat for industry and buildings. While there is a wide variation across different sources of coal and gas, an estimated 98% of gas consumed today has a lower lifecycle emissions intensity than coal when used for power or heat. **Estimates show that, on average, coal-to-gas switching reduces emissions by 50% when producing electricity and by 33% when providing heat.**

Enhanced efforts from the gas industry on the other hand to ensure best practices all along the gas supply chain, especially to reduce methane leaks, are a cost-effective means to reduce the emissions intensity of gas supply and are essential to secure and maximise the climate benefits of switching to gas.

As for the process itself – the task in that case is to replace inefficient fuels with cleaner and economically advantegous alternatives, such as substituting coal or kerosene for natural gas. Complimented by modern equipment upgrades, fuel switching is a simple approach to reducing energy consumption and costs for end-users, while also curbing carbon emissions. The flexibility and energy performance of gas is beneficial for processing industries to improve product quality, reduce waste and lower costs. Switching from coal or oil to natural gas could produce significant though partial emissions reductions. Nevertheless that repesents a mid-term solution only. **Gas-based transition pathways should be followed** if there is a clear subsequent path to complete decarbonization either through the retrofitting of CCS/U or through the shift to another “green gas” – presumably hydrogen.

In case the companies are using external sources – they should also take measures to procure renewable energy and phase-out of coal for the production of industrial heat.

2. Introduction of energy-efficient processes and management systems in industrial processes

Technical energy efficiency can still be improved across multiple applications in the sector. Improvements of up to 20% are theoretically possible based on estimates for different industry sectors.
In addition, digital technologies have the potential to significantly contribute to these energy productivity improvement opportunities by offering both end-use and system efficiency benefits. They can:

- facilitate reductions in energy use in manufacturing (e.g., 3D printing, light weighting);
- improve the monitoring of efficiency losses and the provision of automated responses (e.g., industrial energy efficiency monitoring, load management in logistics);
- enhance energy demand monitoring and management at the energy system level.

This sectoral decarbonization pathway is particularly relevant to Sliven, Yambol, Lovech and Gabrovo districts.

4.13 Decarbonization pathways for the energy sector and buildings

Generic decarbonization pathways are provided by UNFCCC which are fully applicable for the energy sector in Bulgaria. They are relevant to the NECP projections in energy sector, namely in terms of energy efficiency in production and distribution and for increasing the share of RES in the electricity production mix.

Measures on supply side include:

- Improved efficiency of electricity and heat generation
- Use of RES and green hydrogen as fuel

Measures in the transmission system includes efficiency in transformation and transmission, RES, storage and balancing. They are applicable mainly for power distributors and district heating network operators. Measures for the end users (demand side) includes energy saving obligations (applied by energy suppliers – electricity, natural gas, heat energy) and smart cities and digitalization (applied by local authorities and energy distributors).

These decarbonization pathways are applicable for all power plants, namely the thermal power plants in Sliven (also district heating), Haskovo and Varna, and CHP for district heating in Burgas, Varna, Gabrovo.

Decarbonization pathways for district heating includes supported activities (Article 8, REGULATION (EU) 2021/1056 for establishing the Just Transition Fund) for rehabilitation and upgrade of district heating networks with a view to:

- improving energy efficiency of district heating systems;

- investments in heat production provided that the heat production installations are supplied exclusively by renewable energy sources;

European and world practices show possible use of the following sources:

- Solar thermal energy – https://www.solar-district-heating.eu/
- Geothermal energy – geothermal energy could be utilized directly or with heat pumps with the advantage of providing also cooling in the summer or for some processes.
- Biofuels and waste- currently used in combination with coal and natural gas with a perspective for share increase.
- Green hydrogen- green hydrogen produced via electrolysis from renewable power, mainly wind and solar;
- Waste heat – waste heat might be available from industrial sites or from cooling data centers/shopping centers, sewage water system and others;
- Combination of technologies (hybrid systems) – this includes combination of conventional fuels (mainly natural gas) with biomass, solar thermal energy, green hydrogen;
- Seasonal storage – could ensure flexibility, especially when using renewables.

New district heating networks running on RES could be developed for small districts and providing heating/cooling for public and residential buildings but also for industrial purposes. Co-generation (power and heat generation) should be applied when feasible for year-round operation.

District heating should be so able to provide flexible and competitive services for their customers, including energy management, building renovation, combination of centralized heat supply and on-site heat production and others. The other challenge is providing heat with low distribution losses for low-energy (newly constructed nearly zero energy buildings or deeply renovated) buildings. The new generation of district heating networks (also known as the 4th generation) have lower temperatures of operation that enable the utilisation of additional heat sources and reduce the heat transmission losses.

Digitalization in district heating will enable optimization of plant and network operation while empowering the end consumers. This will also enhance the usage of renewable.

Single measures and packages of measures for building renovation were proposed in the Long-term Strategy for Renovation of National Building Fund of Residential and Non-residential Buildings untill 2050. Apart from the building envelope, measures includes also interventions in the installations and use of RES.

Energy efficiency measures in buildings might include:

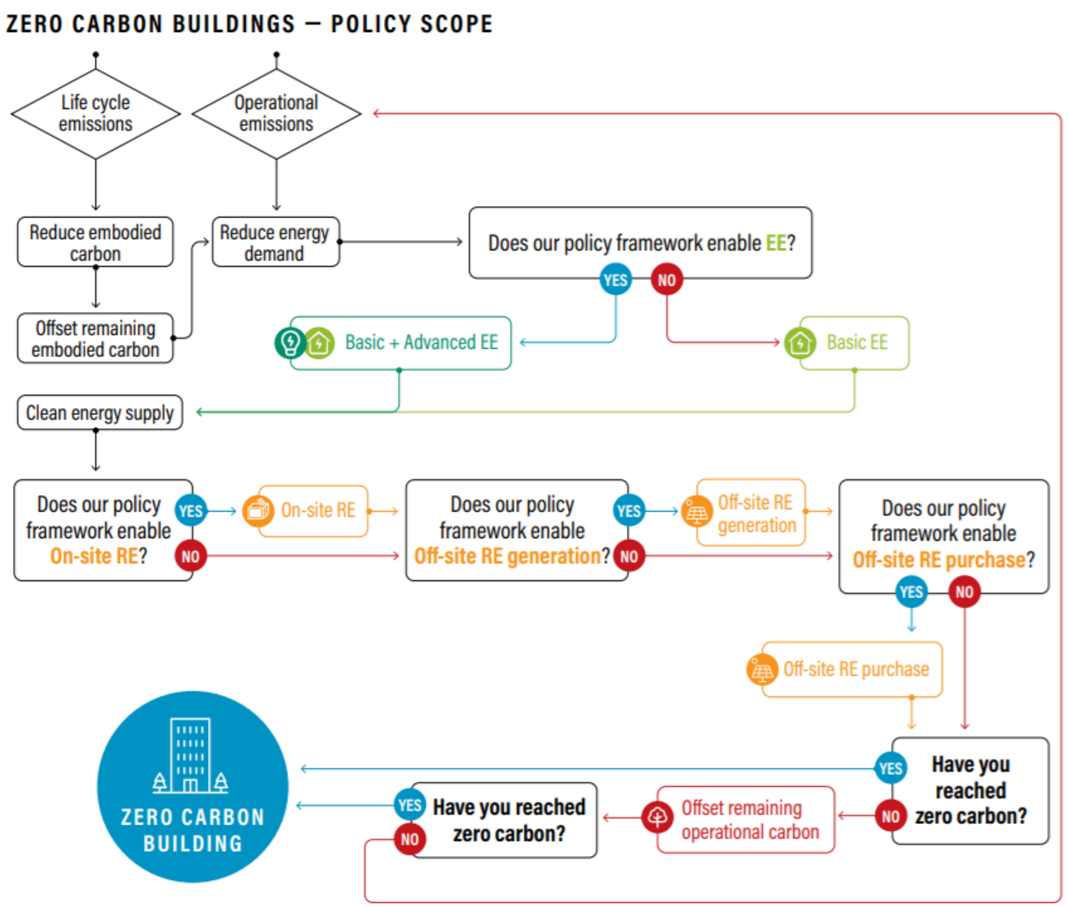
- Building envelope: thermal insulation, windows and doors replacement, tightening, shading and others.
- Building installations – retrofit of the heating and domestic hot water installations, RES integration, energy management, energy efficient lightening and equipment and devices, building automation, others (including passive measures).

Measures for use of renewables might include:

- Heat pumps for utilizing aerothermal, and geothermal energy
- Solar thermal and solar PV systems
- Heat recovery from the ventilation system
- Biomass boiler
- Others

World Resources Institute proposed a deeper decarbonization strategy through the the following decision tree to develop policy pathways for zero carbon buildings and could be partly or fully implemented for a specific building or generally for the building stock. Energy efficiency and on-site and off-site renewable energy generation are the main options for decarbonization as they are connected to energy and building planning and home automation and smart grids.

Figure 8. Decision tree for zero carbon buildings



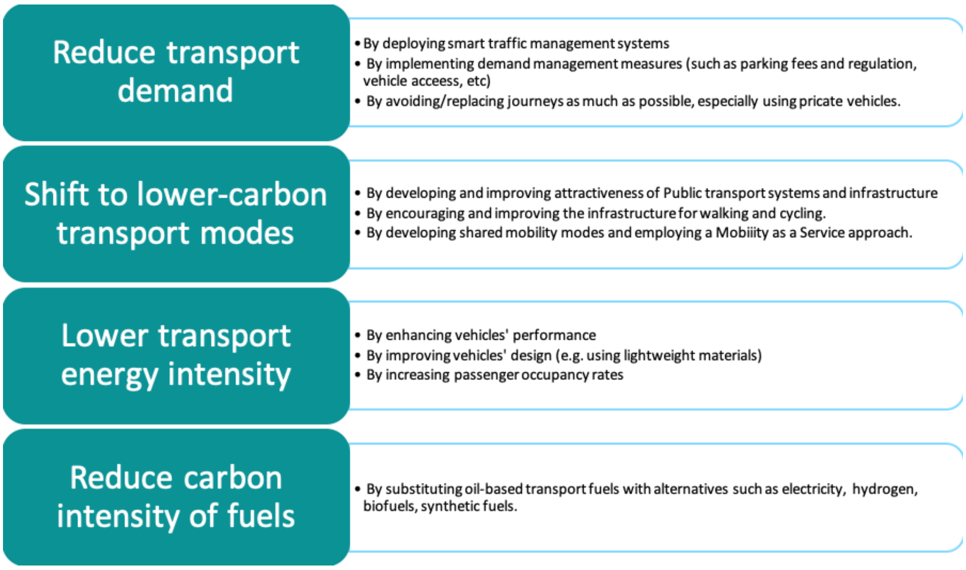
Decision Tree to Help Identify Suitable ZCB Policy Pathways, Combining Energy Efficiency (EE), Renewable Energy (RE), and/or Carbon Offsets as a Last Resort.

4.14 Decarbonization pathways for public transport

Decarbonizing the transport sector is likely to be more challenging than for other sectors, given the continuing growth in global demand for freight and passenger transport. Transport emissions are still strongly correlated with economic growth and unless strong decoupling of emissions from GDP growth is achieved, decarbonization of the transport sector seems like a dauting task[48].

There are four general decarbonization pathways in the transport sector[49], as shown in Figure 9 below.

Figure 9. General decarbonization pathways and measures in the transport sector



With regards to public transport, the most common decarbonization measure implemented by local authorities seems to be the carbon intensity reduction of fuels; namely, the substitution of diesel buses with CNG and electric buses. In addition, efficient traffic management systems can optimize travel times for public transport and thus, make it more attractive to citizens. Other demand management measures can also improve the attractiveness of public transport by making it more expensive or difficult to travel by a private vehicle. Bulgaria's NECP[50] projects an insignificant reduction in GHG emissions from the Transport sector – 0.4% in 2030, compared to 2015. Moreover, private passenger transport is projected to continue to increase until 2030. The 0.4% reduction in GHG emissions from the Transport sector in 2030, compared to 2015, is projected to come mainly from the increase of biofuels' use and the increased levels of electrification of the transport sector. Therefore, less emphasis is placed on demand management and behavioral measures (such as choosing lower-carbon transport modes), which are areas that local authorities can directly influence.

[48] Sims R., R. Schaeffer, F. Creutzig, X. Cruz-Núñez, M. D'Agosto, D. Dimitriu, M.J. Figueroa Meza, L. Fulton, S. Kobayashi, O. Lah, A. McKinnon, P. Newman, M. Ouyang, J.J. Schauer, D. Sperling, and G. Tiwari, 2014: Transport. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available at: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter8.pdf

[49] *Ibid* and United Nations Global Climate Action, Marrakech Partnership. Transport – Climate Action Pathway. Available at: https://unfccc.int/climate-action/marrakech-partnership/reporting-tracking/pathways/transport-climate-action-pathway#eq-1

[50] Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030. Available at: https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf

4.15 Decarbonization pathways for the waste sector

As mentioned in Section 2.5, the main GHG from the waste sector is methane (CH_4). Moreover, the main share of CH_4 emissions is due to municipal solid waste disposal[51]. Therefore, measures in the municipal solid waste disposal are key to decarbonizing the waste sector. Decarbonization pathways in the municipal waste disposal sector follow the general waste hierarchy as defined in the Waste Framework Directive[52]. Namely, moving from waste disposal (the least preferred option for waste management) towards prevention of waste (the preferred option). The waste hierarchy is illustrated in Figure 10 below.

Figure 10. Waste hierarchy

Source: European Commission

The concept of circular economy plays an important role in moving towards waste prevention and is at the heart of practices for reduction of waste, re-use of resources and recycling. Moreover, industrial symbiosis provides tools for companies to redesign their traditionally linear business models (raw materials > product > waste from production) to a circular integrated system where the waste from production is turned into raw materials or valuable resources. Industrial symbiosis can be achieved at the enterprise level where waste streams from a particular process might be fed as resources into another process (with or without the need for treatment) within the same enterprise; the so-called internal waste utilization. Alternatively, wastes from a certain production process in an enterprise might be provided as raw materials to another enterprise – external waste utilization. In both cases, enterprises benefit from reduced waste management and raw materials' costs. Industrial symbiosis requires systems thinking and logistics optimization as especially in the case of external waste utilization, there can be significant logistics involved. Table 8 below provides some examples of potential opportunities for industrial symbiosis that can also be achieved in Bulgaria.

Table 8. Potential opportunities for industrial symbiosis

[51] Ibid

52 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02008L0098-20180705&from=EN

Waste-producing sector	Potential waste utilization as	Potential industrial symbiosis in sectors
Construction	Recycled/re-used construction materials New construction materials created from construction waste	Construction Infrastructure (e.g. roads, pavement)
Food and other organic waste	Compost Biogas Animal feed Bio plastics	Agriculture Energy Plastics
Metal works	Products for the metal processing industry Household utensils	Metal processing Glass production
Chemical industry	Various chemical industry wastes can be transformed to raw materials in other industries	Chemical industry Plastics Construction

Source: Adapted from: denkstatt Bulgaria, 2019[53]

Bulgaria lags behind EU targets for preparation for reuse/recycling of municipal waste. Therefore, municipalities, SMEs and industries need to boost their recycling rates and go beyond simply treatment of residual waste, as well as improve collection and treatment of biodegradable waste. The 2019 European Semester Country Report Bulgaria[54] reiterates that ”the potential of new circular economy business models is not being exploited” and waste management continues to be a challenge, despite municipal waste generation being below the EU average. A World Bank report[55] identifies plastic waste and especially construction and demolition waste (CDW) as having good potential for circular economy models. For instance, circular economy, applied to CDW reduces waste flows at the municipal level and can supply local industrial and economic actors with raw materials.

Bulgaria's NECP projects over 25% reduction in GHG emissions from the waste sector in 2030, compared to 2015. Projected emission reductions in the sector arise mainly from the implementation of programmes for reduction of biodegradable waste going to landfills and landfill methane capture and incineration.

The NECP concludes that there is a significant potential in Bulgaria for "improvement in both waste prevention and waste management, better utilisation of resources, opening new markets and job creation in parallel to lowering the harmful impact of waste on the environment"[56].

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53 https://www.bia-bg.com/uploads/files/Projects/Combined%20Report_SWAN_denkstatt_190430.pdf

54 https://ec.europa.eu/info/sites/info/files/2019-european-semester-country-report-bulgaria_en.pdf

55 Diagnostic Analysis for Circular Economy Interventions in Bulgaria, 2021.

56 Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030. Available at: https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf

4.16 Enabling conditions for successful decarbonization

While many different industrial strategies and pathways can be combined to achieve net-zero emissions, most, if not all, of those decarbonization pathways require a number of preconditions. These are related to level of readiness of various decarbonization technologies to be implemented at an industrial scale, the financial framework promotive to funding those investment, promotion, inter-alia by regulators, inter-sectoral circular economy business models, ammending existing industry standards to support increased materials efficiency, and similar.

Some of the most important challenges and enabling conditions needed for successful decarbonization are summarized below. Their presentation is intended to contribute to a comprehensive and holistic outlining of the magnitude of transition challenges, with the goal to increase the understanding of district and other stakeholders of the scope of industrial decarbonization and aid their planning and decision making related to the TJTPs. However, these should not be viewed as decarbonization policy or technology recommendations to the GoB or a proposal for concrete actions. As in the case with the decarbonization pathways – the specific conditions should be identified and analized in-depth in the next steps of the decarbonization process related to affected districts and/or entities.

R&D challenges

Industrial R&D is strongly required at present for a successful transition. Its most important task is to support the later stages towards providing fully commercial technical solutions for emission abatement.

Most of the technologies assessed at present are at technology readiness levels (TRLs) between 5-7, with a large number of other technologies still awaiting to reach TRL 5. Designing and building a pilot or demonstration plant at scale forms remains one of the biggest challenges for most of the low-CO_2 options and respectively for the R&D sector. Hence innovation should be able to rely on direct public finance for demonstration, emphasise early learning by doing (deployment), and develop models for large demonstration plants.

Investment (CAPEX and OPEX) challenges in an international competitive environment

All pathways for decarbonization require an increase in capital expenditure. Whereas the baseline rate of investment in the core industrial production processes is around 4.8–5.4 billion EUR per year, it may reach 12–14 billion EUR per year (or three times more) in the 2030s. Investment in other parts of the economy also will be key, including some 5–8 billion EUR per year in new electricity generation to meet growing industrial demand.

Existing analysis of the costs for achieving net-zero emissions reveals that the additional cost of reducing emissions to zero are estimated at approx. 40-50 billion EUR per year by 2050 and the average abatement cost is 75-91 EUR per tonne of CO2. Financing of these costs is contingent on establishing a regulatory framework promotive to sustainable investments and adequate provision of different finding sources (public and private).

Securing sufficient, reliable and competitively priced low-carbon electricity

It is clear that higher levels of electrification and new low-carbon processes will require significant new amounts of electricity to operate. In that aspect electricity must be CO2 free in the first place. In any other case emissions would shift to the energy sector. It also needs to be affordable (some estimates assume a price of 40–60 EUR per MWh, depending on the application). The main ways to reduce electricity needs in the following years is to achieve a more circular economy, which can reduce requirements or large-scale deployment of CCS. A crucial issue in terms of sufficiency is also how to provide weekly or seasonal balancing where there are major seasonal swings in either supply or demand (eg, mid- and high-latitude countries with large winter heating needs), especially as variable renewables become a high share of power provision capacities. Providing such seasonal balance will always be a more complex and expensive challenge, but here too there is a wide range of possible solutions – whether via seasonal energy storage in the form of hydrogen, dispatchable hydro power or a continued role for thermal power plants.

Mapping infrastructure needs

There is an urgent need to strategically map the infrastructure needs in relation to low-carbon transition. Technical conditions should be put in place in order to ensure that companies can access large amounts of clean electricity and other new inputs and infrastructure they need (e.g. connection to a natural gas grid, electricity grid, CO2 transportation, handling of end-of-life materials).

Regulatory framework

Different decarbonization pathways are often related with an already identified necessity for a change of the existing regulatory models. That includes for example regulation of carbon transport and storage, hydrogen supply for major industrial facilities, an accelerating electricity system transition, as well as modified incentives for biomass use. There should also be measures encouraging symbiosis for heat, hydrogen and other flows. In addition to that there is a set of general questions related to transition to carbon-neutral economy including: protection against unfair international competition; full carbon leakage protection; mission oriented RD&I programs; competitively priced, carbon-neutral energy; better alignment of the environmental state aid guidance.

5 WHAT WILL BE THE IMPACTS?

5.1 The economic impacts of the transition

5.1.1 Assessment methodology

The economic impacts of the transition to carbon-neutrality of the district economies were assessed through a combination of top-down and bottom-up approaches, a summary of which is presented below.

It should be noted that the report applies **a qualitative impact assesssment approach**, stemming from the specifics of the decarbonization process. Due to the numerous uncertainties (technological, regulatory, financial, time, etc.), related to the scope, depth and timeline of decarbonization process at sectoral and company level (including, inter-alia, uncertainties resulting from the unavailability (yet) for industrial implementation of major sector-specific decarbonization technologies, many of which are at early stages of development), **sector-specific milestones of the decarbonization process cannot be reliably predicted and the economic impacts cannot be quantified**[57].

It is not possible to predict which specific combination of decarbonization pathways and technologies will ultimately be implemented by individual carbon-intensive industries. The unknowns related to decarbonization technologies do not allow to project in a quantitative manner the economic impacts for the affected industries. The operational staff requirements of the new technoogoes are also not known, which makes it impossible to estimate the expected employment impacts. It is also not possible to predict in quantitative terms which (types of) jobs, and how many of them, will be affected in different industries as well as how these jobs will be affected (will they become obsolete and be lost, or the (number) jobs will be preserved as the same (number of) workers will continue to be employed, subject to re-skilling /up-skilling to be able to operate the new technologies.

All these "unknowns' render a quantitative impact assessment impossible. For that reason the economic impact assessment approach, applied in this report, is a **qualitative assessment, based on the assumption of a hypothetical 'worst-case scenario'**, i.e. a potential discontinuation of the activity of the businesses affected by the decarbonization. **Two particular aspects of this assessment approach need to be explicitly clarified, in order to avoid misunderstanding**. *First,* the impossiblity to reliably quantify decarbonization scenarios at sector and company level necessitated the use of the **'worst-case scenario'**, i.e. the discontinuation of the activity of the businesses affected, as a methodological assumption for the purpose of the impact assessment.

It should be noted that **this scenario is not a speculation or prediction that the affected carbon-intensive industries will cease to operate as a result of the decarbonization**

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[57] It is not possible to predict which specific combination of decarbonization pathways and technologies will ultimately be implemented by individual carbon-intensive industries. The unknowns related to the decarbonization technologies do not allow to project in a quantitative manner the economic impacts for the affected industries. The operational staff requirements of the new technoogoes are also not known, which makes it impossible to estimate the expected employment impacts; it is not possible to predict in quantitative terms which (types of) jobs, and how many of them, will be affected in different industries as a result of the decarbonization, as well as how will these jobs be affected (will they become obsolete and be lost, or the (number) jobs will be preserved as the same (number of) workers will continue to be employed, subject to re-skilling /up-skilling to be able to operate the new technologies.

process, but a methodological hypothesis enabling a qualitative assessment. It seems quite probable for many reasons that this hypothetical situation will not happen, as these industries will continue to perform in the current and projected, national and international competitive environment. Still, the 'worst-case' methodological assumption is **useful as it makes it possible to outline the full scope of potential impacts**.

Second, the qualitative impact assessment under a worst-case scenario is based on **the notion of impacted (affected) sectors /industries /businesses**. While the impact cannot be quantified, its magnitude can be defined. Based on the implemented analysis, the report finds that the magnitude of the socio-economic impacts would **range** from closure of business and loss of jobs (improbable) to a (need for) re-skilling/up-skilling of the workers to operate the new low-carbon technologies (most probable). The actual impact within that range would vary from industry to industry, depending on a variety of sector and company-specific factors, which currently cannot be quantified

5.1.1.1 Assessment of the economic impact of the industry

Survey method

A bottom-up enterprise survey was used to identify the CO2-intensive industries operating in each of the districts and establish the scope of potential impacts of their decarbonization on the district economy. This approach has the advantage of being situation-specific, allowing for rather precise identification and estimation of the immediate impacts (both direct and indirect), while its disadvantage are its heavy reliance on the completeness of survey responses, as well as the time (and cost) of carrying out the survey.

The financial and economic data, needed for the assessment of impacts on the directly affected companies, as well as on their identified supply chain partners, was collected from three main sources. The primary source was the financial data, provided by the surveyed carbon-intensive companies themselves. Six of the identified 26 operational carbon-intensive companies (directly affected) provided to the team their detailed financial data (NSI annual financial reports). The needed finacial and economic data for the rest of the directly affected companies, as well as for all their identified supply chain partners, was obtained from two additional sources:

- data from publicly available business registers, mainly the Trade Register, and
- data from privately maintained company databases[58].

The data from all these sources was obtained, verified for consistency and processed into a set of economic indicators, compatiable with the NSI business statistics sectoral indicators[59], for each of

[58] 'Ciela Info' company database.

[59] It should be noted in this respect that official NSI calculation formulae of the set of indicators are based on the company's detailed annual statistical report. However due to many refusals from survey respondents (16 refusals, of which 7 from ETS companies) the team had to obtain the needed financial data for most of the surveyed companies from alternative sources, mainly from public business registers. The data available in such registers is rather summarized, as it lacks some of the individual values needed for the NSI calculation formulae. For that reason a **simplified calculation formulae**, accomodated to the available summarized data from the business registers, were applied by the team instead. The simplified formulae lead to some imprecision of the indicator values (vs. their calculation as per the complete NSI formulae). That 'rate of imprecision' is estimated to be in the range of 5-10 % of the value of various indicators at company level, which is considered by the team an acceptable approximation for the purpose of assessing the economic and employment impacts of the decarbonization of district economies.

those companies. The company-level indicators were then aggregated at sectoral and territorial (district) level.[60]

As above explained, a **qualitative impact assessment** was applied**, measuring the potential economic impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy**.

The following set of economic indicators [61] was established for the purpose of that assessment:

- Sectors affected (4-digit NACE Rev. 2 code)
- Number of affected companies
- Production value (output)
- Value added at factor cost
- Profit
- Investment in tangible fixed assets
- Number of employees
- Wages and salaries

The values of each indicator ware established at three levels: affected 4-digit sector, the 2-digit sector to which the latter belongs, and the district economy as a whole (non-financial enterprises)[62]. The impact assessment covers separately the directly affected sectors and the indirectly affected ones, as their sum is presented as the cummulative impact of the decarbonization on the district economy.

As already discussed in section 3.1.1, due to the limited scope of the supply chain coverage, the assessment of the indirect impacts produced by the survey method does not provide an exhaustive outline of those impacts, and should therefore be regarded only as a 'case study' of the impact on the selected supply chains, but not a complete review of those.

Input-Output analysis

Accounting for the survey data defficiencies, the report authors also implemented an Input-Output Analysis (IOA). It complemented the survey approach by assessing the socio-economic impacts more broadly, based on modelling of the inter-sectoral relations within the district economy. The IOA, using historical data of inputs and outputs for various sectors in the economy (Input-Output tables - IOTs) provided a series of links between each carbon-intensive sector's output, its demands on other sectors, including its demand for labor. This allowed to draw up a comprehensive outline of the indirect employment impacts of the decarbonization on the economy of each of the eight districts.

Summary of the method

Input-Output analysis (IOA) is routinely used to assess economic impacts. It is relatively simple, transparent and its multipliers are appropriate for estimating employment, based on changes. IOA can be used to measure the strategic importance of a sector on output and

[60] More details on the scope, sources of data and implementation results of the industrial enterprise survey were presented in section 3.1.1 above.

[61] The set of indicators was also chosen based on data availability.

[62] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

employment through economic impact or multiplier analysis, that is the impact of a change in the sectoral final demand on production and employment and backward and forward linkage indices (NSW: 2018)[63].

In the IO analytical model, the (change of) production by a sector has economic effects on other sectors, affecting their supply or demand. If a sector increases its output, its demand on the sectors whose production is used as inputs, is going to increase (a 'backward linkage' between sectors). The increased production (i.e. supply) by that sector means also that other sectors, relying on its supplies, will increase their demand (a 'forward linkage' between sectors)[64]. Larger linkages are in general more beneficial for the economy. Comparisons of the backward and forward linkages in a single economy provide a mechanism for identifying the key sectors in that economy (Miller and Blair: 2009)[65].

In terms of dependency **backward linkages are dependency on other sectors**, where **forward linkages are other sectors being dependent**. Combing both linkages, four distinctive economy groups could be established, based on the above average of backward and forward linkages: key sector (both above average) (K), strong backward linkage (BW), strong forward linkage (FW), and weak linkage categories (W) (Temursho: 2016)[66].

Typically output, added value and employment (jobs) multipliers are calculated under IOA. Employment multipliers seem most relevant in the context of the TJTPs, whose ultimate goal is the mitigation of potential negative employment impacts from climate response policies. The employment multiplier is used to observe the impacts of direct change in output on the (sectoral) employment in the region. There are several types of employment multipliers, as two of these seem to be most informative in the context of developing TJTPs. *Simple employment multiplier* is the ratio between the total effect on employment by a change in final demand for domestic (regional) output of this product category and a change in final demand. *Type 1 employment multiplier* is the total effect on employment of a change in final demand for domestic output of this product category and the initial change (FPB: 2010)[67].

Stages of implementation and data sources

The team implemented the IOA for each of the 8 districts in the following steps:

- Adaptation and aggregation of the national IO table sectors
- Regionalization of the national IO table
- Establishing backward and forward linkages
- Key and backward sectors estimation
- Calculation of employment multipliers
- Establishing indirect employment impacts

In order to recreate the IOA on a district level, the latest available I-O table of the Bulgarian NSI was used (2014)[68]. It consisted of 63 sectors of economic activity, at 2-digit level, compiled and

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[63] Office of Financial Management (2009). Employment support estimates - methodological framework. New South Wales Treasury.

[64] A simplified model, based on a number of assumptions including, inter-alia, infinite elasticity of supply.

[65] Miller, R., & Blair, P. (2009). Input-Output Analysis: Foundations and Extensions (2nd ed.). Cambridge University Press.

[66] Temursho, U.(2016). Backward and forward linkages and key sectors in the Kazakhstan economy. Asian Development Bank.

[67] Federal Planning Bureau (2010). Multipliers: User's guide. Federal Planning Bureau, Belgium.

[68] https://www.nsi.bg/bg/content/13455/ecc-2010

combined following the industry-technology assumption, product-by-product, with total flows and valued at basic values in current prices. The structure was optimized to match the data available at regional level, as additional aggregation was done to 54 sectors, keeping the granularity in view of the presence of the affected sectors at 4- digit level[69].

The regionalization of the national IOTs at district (NUTS 3) level was carried out based on the *simple location quotient (SLQ)*, measuring a degree of self-sufficiency at the regional level. Despite some limitations, SLQ is considered as a robust method, especially considering missing experience on national and regional sensitivity parameter that controls the degree of convexity, used in FLQ/AFLQ methods (Lamonica: 2017)[70]. The IO table for a specific district is based on production value (output) for 2015, which was the earliest annual data covered by the dataset from NSI available to the team. The missing data for several sectors (due to the confidentiality constraints applicable to the statistical data) was constructed through aggregating the financial statements of the enterprises belonging to those sectors in the respective districts, obtained from privately maintained company database[71].

For this particular impact assessment, key and BW sectors were identified by calculating backward and forward linkages (Rasmussen: 1956)[72] drawing on entries in the Leontief inverse. The results are shown below.

Table 9. Economic sectors by type of linkages, per district

	Burgas	Garbrovo	Haskovo	Lovech	Sliven	Targovishte	Varna	Yambol
BW	6 (1)	3	2	4 (1)	4	5	5 (1)	7 (1)
FW	2 (1)	3	3	3 (1)	4	3	3	3
K	3 (1)	2 (1)	4 (1)	3 (1)	2 (1)	3	3 (1)	3
W	30	33	32	31	31	30	30	28

Note: The ciphers in brackets (.) show the number of sectors directly impacted by the decarbonization, as established for each district under the survey method, among the relevant group of sectors.

Only K and BW sectors, which could experience the direct impact from decarbonization[73], were considered for the impact assessment. FW sectors were not taken into consideration, assuming import in the district could relatively easily satisfy the demand.

The identified K and BW sectors are presented below.

Table 10. Key sectors and sectors with strong backward linkages in the district economies

	Burgas	Gabrovo	Haskovo	Lovech	Sliven	Targoviste	Varna	Yambol

[69] Sectors under NACE Rev. 2 sections O-S and K have been eliminated due to unavailability of such district-level data.

[70] Lamonica, G. R., & Chelli, F. M. (2018) The performance of non-survey techniques for constructing sub-territorial input-output tables. Papers in Regional Science, 97: 1169– 1202.

[71] Ciela Info database.

[72] Rasmussen, P. (1956). Studies in Inter-Sectoral Relations. Copenhagen, Einar Harks.

[73] For the purpose of the current analysis the average was estimated for all to be above 1, relying on strong connection within a district, taking into account also the time distance to last available national IOT.

K sectors	C24	C22	C20	C17	C13-15	-	C20	-
BW sectors	C16	-	-	C16		-	C23	C28

Employment multipliers for relevant K and BW sectors were calculated at the next step. The employment multiplier required the use of sectoral employment to calculate the labor input coefficient. The number of persons employed, provided by NSI, for the respective year, were used. Based on that, *simple employment* and *Type 1* employment multipliers were calculated.

Table 11. Type 1 employment multipliers (EM) for relevant K / BW sectors, per district

Sector / Type I EM	Burgas	Gabrovo	Haskovo	Lovech	Sliven	Targovishte	Varna	Yambol
C13-15	-	-	-	-	2.32	-	-	-
C16	2.59	-	-	1.94	-	-	-	-
C17	-	-	-	1.85	-	-	-	-
C20	-	-	2.75	-	-	-	4.02	-
C22	-	3.01	-	-	-	-	-	-
C23	-	-	-	-	-	-	2.22	-
C24	2.97	-	-	-	-	-	-	-
C28	-	-	-	-	-	-	-	1.7

Outcomes

Applying the Type 1 employment multipliers to the 2019 district data allowed to establish the potential number of FTE[74] jobs that might be lost in each district under a hypothetical worst-case scenario, i.e. discontinuation of the activity of those sectors in response to the climate policies and regulations[75]. This included both the initial direct jobs to be lost in the directly affected industries themselves, as well as the indirect jobs to be lost in other sectors in the district because of the backward linkages in their relevant value chains. *(The concrete results of the IOA are presented below in the sections dedicated to each district.)*

[74] Full-time equivalent.

[75] A methodological assumption enabling a qualitative assessment, not a speculation or prediction that the affected businesses will cease to operate as a result of the decarbonization process.

It should be noted that these results should be used only as supplemental to survey data and other analytical tools, due to the shortages of national IO tables, the deficiencies related to some sectoral data at district level because of confidentiality restrictions, the uncertainties related to the regionalization of the national IO tables at district (NUTS 3) level, the constraints stemming from the granularity of that particular analysis (the district is a too small object of an IO analysis), and the standard deficits[76] of the IO model itself.

5.1.1.2 Assessment of the economic impact of decarbonization in other sectors

Sectors of energy and buildings are among the main carbon emmission emmiters from one side and from the other important sectors for the national economy. NACE codes of affected enterprices include:

- Sector D — ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY
- Sector F - CONSTRUCTION

Construction sector includes various activities, including such related to infrastructure projects, but only these related to buildings are rfered here as expected to be positively affected due to the expected increase of the activities for renovation, construction of new buildings with higher requirements and installation of new heating systems and RES.

Indicators to assess the potential impact of decarbonization of both economy sectors (D and F) includes:

- Sectors affected (NACE code);
- Number of employees;
- Wages and salaries (of the employee);
- Installed capacity of RES (thermal and electricity) .

Table 12. Economic indicators for impact assessment

Economic indicator	Value for all companies from the sector	Impact on the district economy[77]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)			

[76] Static, linear production function, no substitution or economy-of-scale effects, infinite elasticity of supply, high level of sectoral aggregation.

[77] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Number of employees (number)			
Wages and salaries (BGN '000)			

Assessment of decarbonization impacts in the public transport and waste sectors included analysing results from municipal surveys in the eight districts, as well as interviews with the main municipalities in each district. In addition, economic impacts of decarbonization in the public transport and waste sectors was generally asssessed through desktop research and information from international studies

5.1.2 Overall Findings

5.1.2.1 Industry

The decarbonization of the industrial sector is expected to affect directly the carbon-intensive industries in the districts, as well as a number of sectors in their supply chains, which wil be indirectly affected. Depending on the size and structure of district econnies, in some districts the potential cummulative impacts spill over to sectors, providing a significant share of the output, added value, employment and salary income of the district economy (e.g. Targovishte, Gabrovo, etc.). In larger district economies (e.g. Varna and Burgas) the scope of the economic impacts is limited, however the number of potentially affected jobs is still essential.

The Input-Output analysis of inter-sectoral relations within the district economies confirmed the broad magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses.

5.1.2.2 Energy

Decarbonization of energy sector is expected to lead to decentralization of energy production and hence increase of the economic activity at district level. Local people will be involved in planning and design, construction/installation, exploitaion and operation and maintenance activities and it is expected to have an increase also in the number of employees in sectors D — ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY and F - CONSTRUCTION.

5.1.2.3 Buildings

In the construction sector (construction activities related of buildings) there is also expected increase of economic activities and number of employees due to activities for building renovation, on-site installation of RES, construction of nearly-zero energy buildings. The cost of energy is expected to increase which will affect the vulnerable people suffering from energy poverty. Establishment of compensating mechanisms is foreseen in the NECP for the price of electricity.

Long-term Strategy for Renovation of National Building Fund of Residential and Non-residential Buildings untill 2050 foresees creation and sustain of 17 600 new jobs for the period 2021-2030 on the territory of the whole country. The additional growth of GDP is estimated to be 557 mln. BGN in 2030.

5.1.2.4 Public Transport

Overall, the function of the public transport service and local mobility remains the same – moving people and goods from one point to another. **Therefore, no major impacts on the economic performance of the sector or on employment are forecasted in the eight districts.** In essence, due to decarbonization measures, one type of bus (diesel or CNG) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on the same route as before this change in bus types. In addition, public transport companies or municipal enterprises will still be needed to manage the public transport networks in the relevant municipalities in the eight districts.

Moreover, decarbonization measures might support new employment opportunities such as in development and maintenance of charging infrastructure for electric and hydrogen vehicles, e-mobility, walking and cycling, and shared mobility modes[78]. Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have negative impact on jobs directly connected with fossil fuel logistics (refining, transport, distribution) or to jobs related to the repair and maintenance of vehicles with internal combustion engines that are expected to be replaced by electric or hydrogen vehicles.

5.1.2.5 Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

Reported recycling rates for municipal solid waste in the eight districts are generally low and range between 1% and 9%, according to 2018 data from the National Statistical Institute. **Therefore, it might be expected that more sophisticated waste management, treatment and utilization could actually generate jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis[22]. Nevertheless, the effect on jobs is also highly dependent on the local context and waste management practices pursued.

[78] https://www.iea.org/data-and-statistics/charts/employment-multipliers-for-investment-in-the-transport-sector

5.2 The social impacts of the transition

5.2.1 Context

Bulgaria is undergoing both a rapid demographic transition and a significant structural shift in its economy. Increasing longevity combined with low birth rates and emigration have made Bulgaria's age structure increasingly top-heavy and its dependency ratios higher. At the same time, the economic sectors that absorbed low-skilled workers during the high-growth early 2000s, such as construction and manufacturing, were those that contracted most during the 2008–09 economic crisis and they have not yet recovered. Meanwhile, activities demanding high-skilled labor, such as financial and business services and information, communication, and technology (ICT), have been faring relatively well.

The labor market is not yet responding adequately to Bulgaria's demographic challenge, partly due to skills mismatch. Bulgaria's demographic situation implies that its economic future will depend in large part on how well it can utilize the available human resources. The formal education system has been slow to respond to the evolving demands of labor markets, resulting in high share of NEETs and the underutilization of human recourses from specific groups (such as Roma).[79] The country has an opportunity to mitigate the challenge of rising dependency ratios by bringing into the labor force currently under-utilized groups, such as youth (particularly Roma) and older adults, Bulgaria seems not to be prepared to meet this challenge, largely because its labor market has not performed well in recent years.[80] In several surveys, employers in Bulgaria have indicated that finding candidates who are appropriately educated and skilled has become increasingly difficult, particularly in such innovative sectors as IT and high-value-added manufacturing. The widening skills mismatch is also reflected in the growing gap between the unemployment rates of higher- and lower-skilled workers.

The education system faces persistent challenges in terms of provision of quality education and effective development of basic skills. Bulgaria's skills system is scored among the lowest-performing in the EU ranking 26th in CEDEFOP's European Skills Index 2020.[81] Poor performance is registered with regard to skills development (index value of 38 out of 100, rank 28th) and skills activation (index value of 28 out of 100, rank 30th). At the same time, a relatively strong performance is registered in the skills matching component (index value of 70 out of 100 (rank 8th)), which could be attributed to the fact that the structure of employment is still dominated by low and medium-low technology jobs, which do not require specialized skills. However, the increasing demand for technical and green skills is expected to gradually put more pressure on the skills matching component in the medium-term.

Bulgaria is one of the lowest performing EU countries with respect to the human capital dimension of the Digital Economy and Society Index (DESI).[82] The DESI human capital dimension reflects both the overall level of basic digital literacy of the population, and the prevalence of advanced ICT skills in the economy. Bulgaria is lagging behind in terms of percentage of people having at least basic digital skills. The largest skills deficit has been registered in the use

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[79] The country has a relatively low labor force participation rate (LFPR) of 68.6 percent, and the second-highest rate in the EU of youth not in employment, education, or training (NEET).

[80] According to the data from the latest national census, about 93 percent of ethnic Roma and 70 percent of ethnic Turks do not complete upper secondary education, compared to 30 percent of ethnic Bulgarians. 92.2 percent of the population aged 25-64 living in cities has upper-secondary post-secondary non-tertiary and tertiary education, compared to only 66.6 percent of those living in rural areas (Eurostat, edat_lefs_9913).

[81] https://www.cedefop.europa.eu/en/publications-and-resources/data-visualisations/european-skills-index

[82] https://digital-strategy.ec.europa.eu/en/policies/desi.

of software for content manipulation, with only 31 percent of Bulgarians having at least basic software skills (the lowest share among the EU countries). One out of four people have never gone online. At the same time, the country's scores on the advanced skills and development sub-dimension are close to EU average, suggesting rather good potential to develop the digital economy. In addition, the country ranks last in the European Index of Digital Entrepreneurship Systems (EIDES), with low overall scores in regard to human capital and knowledge creation, and close to EU average scores on the digital dimension of the human capital.

The objective of this section is to improve understanding of the workforce in the eight districts. The just transition is expected to affect the local population through two main channels of transmission. First and foremost, the transition towards a low-carbon economy will shake existing labor market dynamics: some positions will become obsolete and disappear, other occupations will require retraining and upskilling to become greener, and new jobs will be created in emerging sectors. As a consequence, if adequate skills development measures are not put in place to match labor supply and demand, unemployment may rise, dismissed workers may incur income losses, and migration trends may intensify towards larger and more dynamic economic centers. Second, households may be affected through the change in energy sources: energy prices may rise, residential buildings and houses may need to be adapted to new sources of heating, both implying larger household expenses.

In particular, this section aims at documenting the anticipated labor and social impacts from transitioning to greener sources of energy, with a view on managing reallocation and reskilling of workers.

5.2.1.1 Methodology and data sources

Secondary data sources

The section on the impact of the labor and social impacts of the transition uses the most recent available data sets from the National Statistical Institute (NSI), the Ministry of Education and Science (MoES), the Bulgarian Employment Agency, and Eurostat. It combines those secondary data with the findings from stakeholders' meetings held between April and September 2021. In addition, an *ad hoc* quantitative skills survey is being conducted by the World Bank, which results will be integrated in a future deliverable.

The primary data source is the National Statistical Institute (NSI). Most of the data are readily available in NSI's regular quarterly and annual publications but some of the district-level series and breakdowns have been specifically requested. The main NSI publications used include the Labor Force Survey (LFS), the European Survey on Income and Living Conditions (EU-SILC), the Annual Statistics on Employment and Labor Costs and the NSI's regular statistical publications pertaining to demographics.

The evaluation of the number of workers and companies in carbon-intensive industries is based on two sources of data: NSI's employment and labor cost statistics and the national firms' register. First, the list of affected sectors at the 4-digit NACE Rev. 2 level were shared with NSI, which extracted the information on all firms pertaining to these sectors, as of 2019. Due to data confidentiality, NSI was only able to share information about labor at the aggregated level (all eight districts together). Second, the list of firms in the affected sectors from the 8 districts of interest was extracted from Bulgaria's national firms' registry as of 2019.[83]

In addition, the chapter on the labor and social impact of the transition also makes use of administrative data from the National Employment Agency (NEA), as well as data from the Ministry of Education and Science (MoES).

Primary data sources: labor and skills survey, and stakeholders' meetings

Due to data limitations, an *ad hoc* skills survey will be implemented in the eight districts of interest. Data limitations included the limited availability of information at the national and subnational levels on education and skills, and limited availability of data on the characteristics of the labor force in the affected sectors of the eight districts. To fill the knowledge gap, the World Bank is fielding a labor and skills survey of the workforce potentially affected by the transition.

The survey targets two main groups of workers who will need to adapt to a greener environment: those who need upskilling and those who need retraining. A first group of workers will have to perform the same job as before, but in a greener environment, and thus they may need to adapt their hard and soft skills to this new reality (for instance, an electrician who currently works in a coal-fueled power plant but who will need to work in a hydrogen-fueled power plant as a consequence of the transition). A second group of workers, whose jobs will be redefined as a consequence of the transition, may need more extensive reskilling, potentially to different types of occupations (for instance a worker whose profession is linked to coal as an energy input, and whose job will completely disappear).

The survey will answer two set of questions, related to workers' general characteristics, and soft and hard skills. First, the labor and skills survey will shed light on the exact characteristics of the workforce engaged in the affected sectors of economic activity (age structure, educational attainment, type of occupation, etc). This information is usually available through the Labor Force Survey (LFS), but due to the small level of analysis, this data source could not be utilized. Second, the labor and skills survey will answer questions related to soft and hard skills of the affected workforce: current core skills, readiness of the workforce for greener jobs, re- and up-skilling needs to transfer to greener tasks.

The labor and skills survey consists of a self-assessment instrument measuring core skills needed for transition: *occupational self-efficacy* to enable workers to commit to change, *cognitive*, *technical, digital* and *learning skills* to perform under new requirements; *organizational*, *problem solving,* and *teamwork skills* to manage transformation; *communication and negotiation skills* to promote change; *adaptability* and *flexibility* to enable application of new technologies and processes; *creativity* and *innovation skills* to identify and utilize opportunities within the changing occupational landscape. The skills questions and scales follow existing skills surveys developed by the Organization for Economic Cooperation and Development (OECD), the International Labor Organization (ILO), the World Bank, and European Centre for the Development of Vocational Training (CEDEFOP).

A representative sample of affected workers will be interviewed. The sample consists of three strata: (i) a sample of 500 employees from firms with over 100 employees; (ii) a sample of

[83] This list was accessed through the Lakorda database, and corrected with information from the industry team from the World Bank.

100 employees from firms with 1 to 99 employees; and (iii) a sample of 100 employees from the districts of Haskovo, Sliven and Yambol commuting to the mines and power plants located in Stara Zagora. Power computations were run to ensure that the results can be disaggregated at the district level. Data is being collected in a controlled environment where individuals fill in a self-assessment of their own skills.

The labor and skills survey is conducted in parallel to the industry survey mentioned above. The objective of the industry survey was to assess possible labor impacts of industrial decarbonization in directly and indirectly affected enterprises in the eight carbon-intensive districts. The main data collection instrument is a quantitative questionnaire covering data regarding the structure of employment within companies, mid-term staff forecast, wage distribution and social benefits received by employee. Due to the low response rate of the survey, data collected will be used only as case studies.

Finally, stakeholders' meetings were used to collect qualitative information about possible labor and social impacts. The key stakeholders interviewed were representatives of local authorities (municipalities and districts administrations), district development councils, regional employment offices, regional social assistance offices and local representatives of the trade unions and employers' organizations. The main topics of discussions covered the expected regional social and labor impacts due to the decarbonization process, the local capacity to cope with future challenges and take advantage of emerging opportunities. The main findings and observations are embedded in the main analysis to illustrate and explain the quantitative analysis. Table 13 summarizes the main indicators used to assess the labor and social impact of the transition.

Table 13. Key labor and social indicators

Population
Dependency ratio
Old-age dependency ratio
Net migration
abroad
of 20-39 y.o.
Labor
Employment rate
Unemployment rate
Share of manufacturing in total employment
Share of 25-54 in employment
Share of employed with tertiary education
Share of job openings for high-skilled jobseekers
With skills survey: profile of workforce in affected sectors (gender and age distribution, education, occupations, years of experience, skills)
Skills
Share of employed with tertiary education
Jobseekers/vacancies ratio (low-skilled)
Share of TVET in IT/engineering curricula

With skills survey: occupational self-efficacy, use of reading/writing, use of numeracy, computer-use, internet-use, organizational, problem-solving, learning to learn, communication, organizational, teamwork, conflict management, negotiation, adaptability and flexibility, creativity and innovation.	
Social inclusion	
Poverty rate	
Number of energy beneficiaries	
Share of energy beneficiaries using solid fuels	
Labor impact	
Share of workers employed in carbon intensive sectors	
Number of commuters	

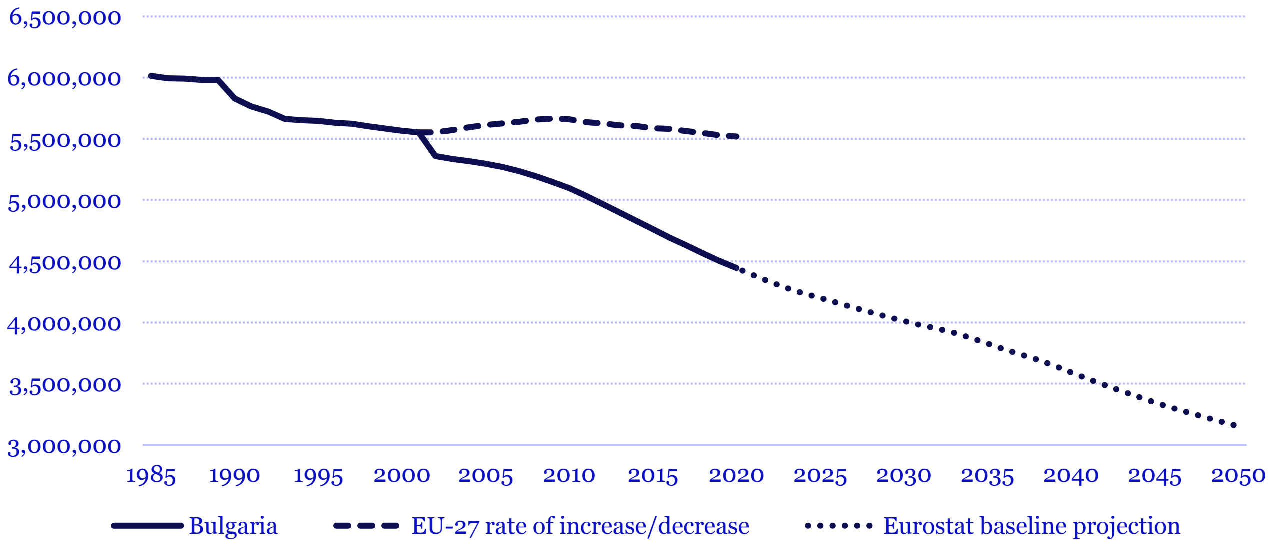
5.2.2 Overall Findings

The transition towards a low-carbon economy is just one of many transitions that are taking place, involving a wide range of sectors and socioeconomic groups. The socioeconomic repercussions may be felt through two main channels of transmission: a shift in labor market dynamics, which may reinforce outmigration, and increasing energy prices.

5.2.2.1 Shrinking of the working-age population

The decline in the working-age population in Bulgaria is the steepest of the EU-27. The population aged 15 to 64 dropped from its peak of 6 million in 1985 to 4.4 million in 2020. In 2050, the working-age population is expected to be two thirds of that, or 3.2 million (see Figure 11). This significant decrease, which is partly due to the sharp decline of the total fertility rate in 1988-1997, has been exacerbated by the large numbers of workers leaving Bulgaria for other countries, especially within the EU.

Figure 11. Bulgaria displays the steepest working-age population decline in the EU-27



Note: working-age population (15-64-year-olds).

Source: Eurostat. Tables: demo_pjanbroad and proj_19np.

The eight districts lost about 150 thousand working-age individuals over the past ten years (Eurostat, *demo_r_pjanaggr3*). This average 12 percent decrease is on par with the national average decline of 12 percent, but the situation across districts shows 3 different scenarios. First, two districts with large economic centers display lower population decline than the national average: Varna and Burgas. Second, three districts display population decline on par with the national average: Targovishte, Haskovo and Sliven. Population decline in Sliven is cushioned by higher-than-average fertility rates which can be explained with the relatively high share of the Roma population. Finally, Yambol, Lovech and Gabrovo display higher-than-average population decline, largely due to outmigration.

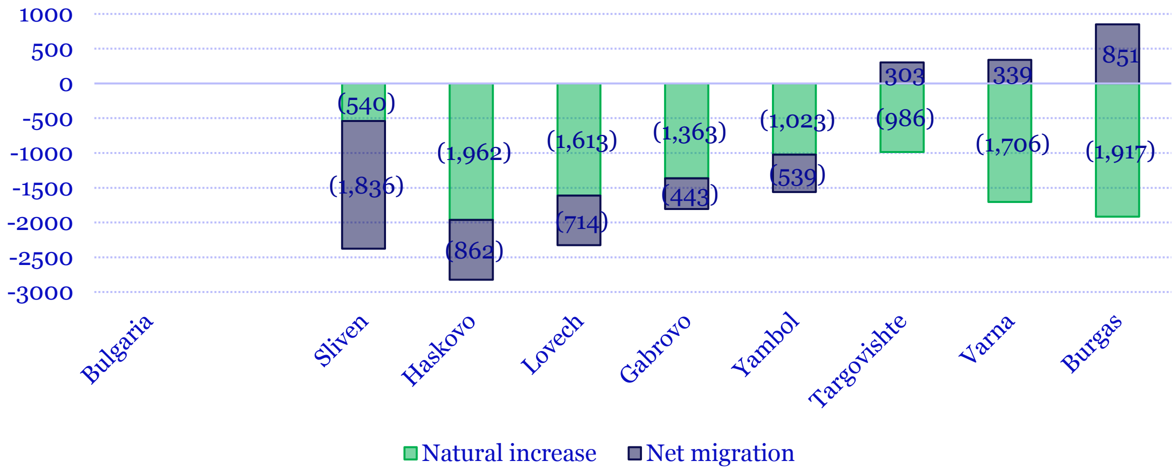
The shrinkage of the working-age population, coupled with rapid population aging, is causing dependency ratios to surge. Bulgaria's population is aging fast: the dependency ratio, i.e. the population aged 0-14 and 65+ over the working-age population, increased by 10 percentage points in the past decade, from 46.4 percent in 2011 to 56.4 percent in 2020 (Eurostat, *demo_pjanind*). In other words, only one in two persons in Bulgaria is of working age. Dependency is mainly driven by the surge in the old-age dependency ratio, i.e. the population aged 65+ over the working-age population, which went up by almost 7 percentage points in the past decade. The trend also reflects the gradual increase in life expectancy in the country.

Again, the picture varies across the eight districts of focus, which can be explained by economic opportunities. Sliven displays a relatively young population, as it records the second largest share of Roma population, 12 percent according to the 2011 Census, marked by higher fertility and lower life expectancy. Varna displays an excess of prime-age adults (population aged between 20 and 50), as the economic center attracts working-age individuals looking for labor opportunities. Haskovo, Targovishte and to a lesser extent Burgas are aging districts, missing prime-age workers who have left elsewhere to find better economic opportunities. Finally, Lovech, Yambol and Gabrovo are missing both, youth and prime-age workers .

The effects of ageing are compounded by rapid outmigration (both internally and out-of-country), especially of younger populations groups. Net emigration, which is both a cause and a consequence of domestic labor market issues, has caused about 15 percent of Bulgaria's total population decline in 2007-2019. Sliven stands out with the highest levels of outmigration, especially among younger generations (less than 30-year-olds),[84] and mostly to the capital city of Sofia. This pattern is mostly explained by the limited opportunities offered on the labor market and by the educational system. Haskovo, Lovech, Gabrovo and Yambol all have large outmigration flows. Varna, and to a lesser extent Burgas, contrast with these 6 districts, as they are both net receivers of migration flows: Varna is both the largest economic and academic center in Northern Bulgaria, and Burgas is a large economic center with a rather balanced distribution of economic activities (see Figure 12).

Figure 12. Drivers of population change, 2015-2019

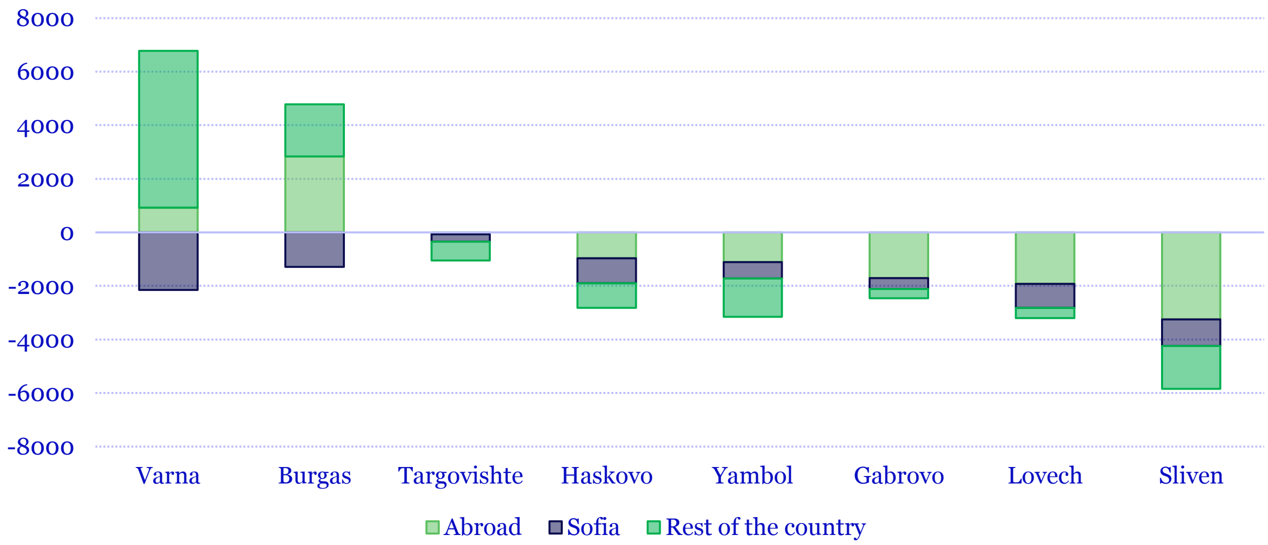
[84] In 2019, 1 in 2 migrants from Sliven were aged 10-29.



Source: National Statistical Institute (NSI), 2019.

Three profiles of migration flow emerge among the eight districts: the net receivers, those experiencing national outmigration, and those sending migrants abroad. Varna and Burgas are net receivers of national and international migrants. On the other hand, Targovishte, Haskovo and Yambol experience domestic outmigration: in the case of Haskovo, equally to Sofia and the rest of the country, Yambol and Targovishte, mostly to nearby urban centers (respectively Burgas and Varna). Finally, Gabrovo, Lovech and Sliven experience large migration flows abroad (see Figure 13).

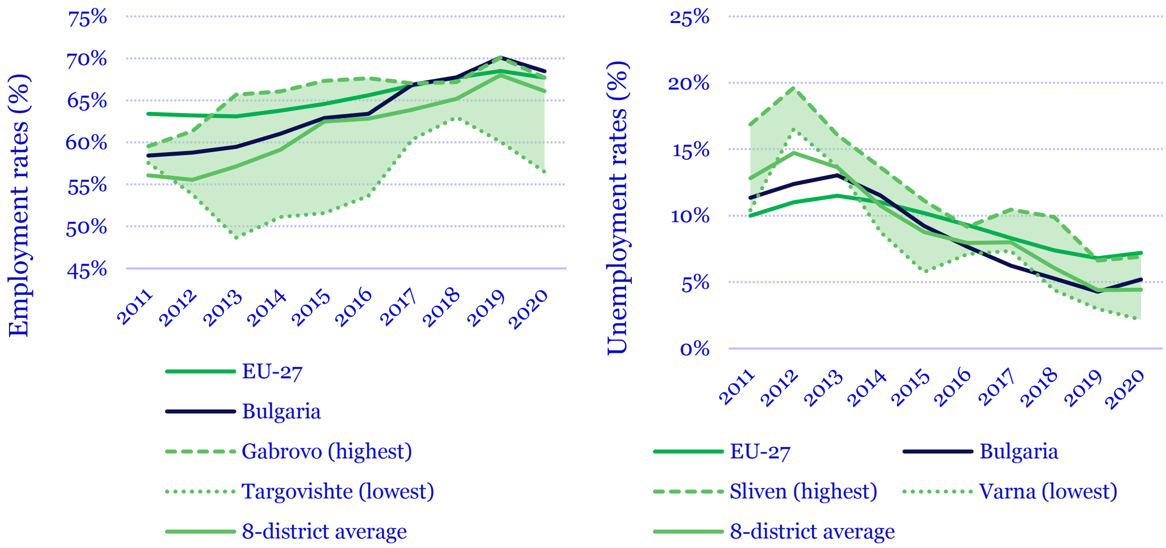
Figure 13. Where do people migrate (net migration)



Source: National Statistical Institute (NSI), 2019.

Labor force participation and employment rates have caught up with EU-27 average since the global economic and financial crisis of 2008-09, and unemployment rates are below the EU-27 average. Employment rates rose steadily from 2011 to 2019, from 58 to 70 percent, dropping marginally in 2020. Unemployment rates dropped from 11 to 4 percent from 2011 to 2019, and only increase to 5 percent in 2020 (see Figure 14). Targovishte and Sliven recorded the lowest employment and highest unemployment rates throughout the past decade, reflecting lower economic opportunities; while Gabrovo and Varna display more dynamic economies and employment opportunities, with the highest employment and lower unemployment rates throughout the decade.

Figure 14. Employment and unemployment rates (2011-2020)



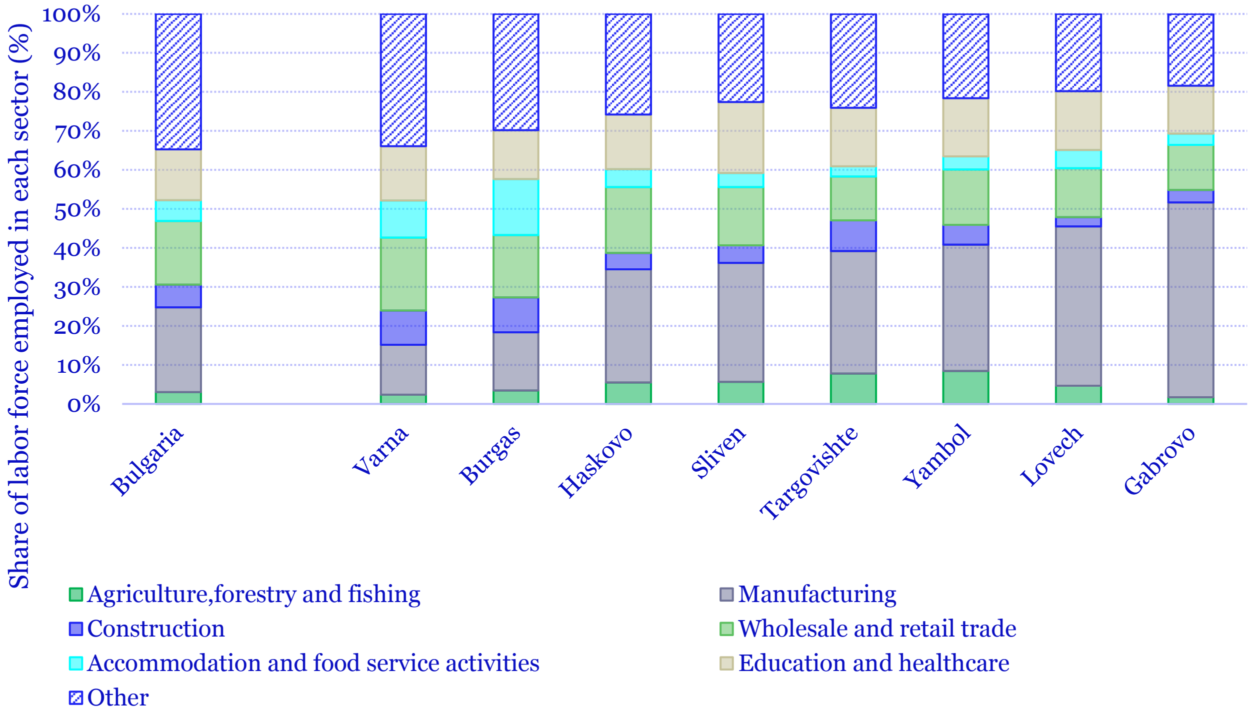
Note: the working-age population are those 15-64 years old. The employment rate is the percentage of people employed relative to the population of working age. The unemployment rate is the percentage of people unemployed relative to the active population of working age (employed + unemployed).

Source: National Statistical Office (NSI) and Eurostat (tables: lfsi_emp_a and lfsa_urgan).

5.2.2.2 Manufacturing represents the largest share of employment in the overwhelming majority of the districts

This is especially true for Gabrovo, where half of the workforce is engaged in manufacturing. On the other hand, Varna and Burgas stand out as more diverse economic centers, where the different sectors of activity are more equally represented.

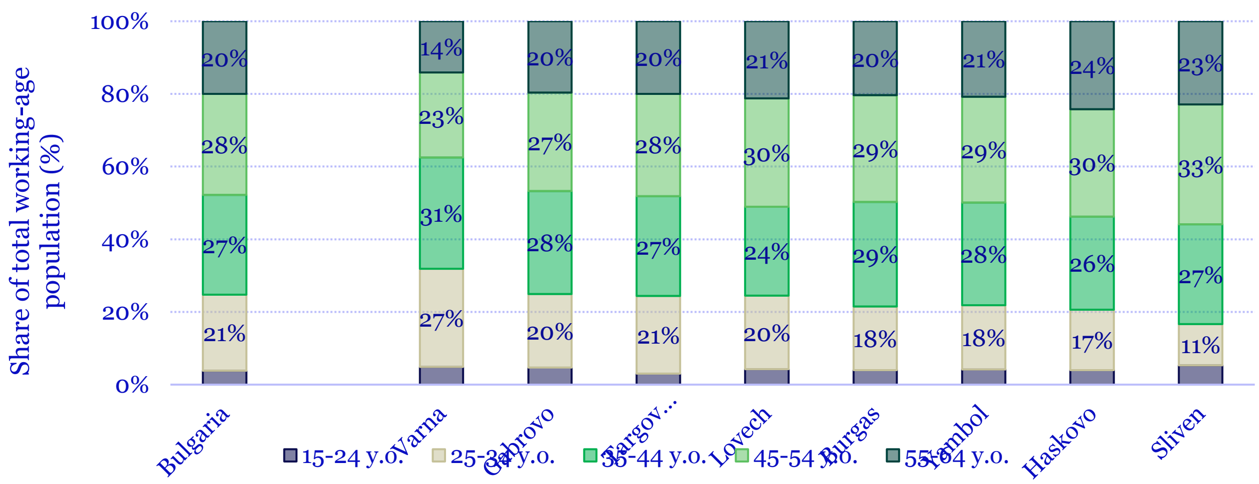
Figure 15. Employment structure



Source: National Statistical Institute (NSI), 2019.

At the district level, the age distribution of the workforce mostly reflects the age distribution of the population. At the national level, one fourth of the workers are below the age of 34, 27 percent are in the 35-44 age group, another 28 percent are in the 45-55 age group, and finally about 20 percent are older than 55. There is little variation in the age distribution of the labor force across districts, with the notable exceptions of Varna and Sliven. The working-age population of Varna is much younger, partially reflecting the attraction of larger urban centers for the youth, but also the large share of vacancies in wholesale and trade, accommodation and catering, and construction, which tend to attract younger individuals (see Figure 16).

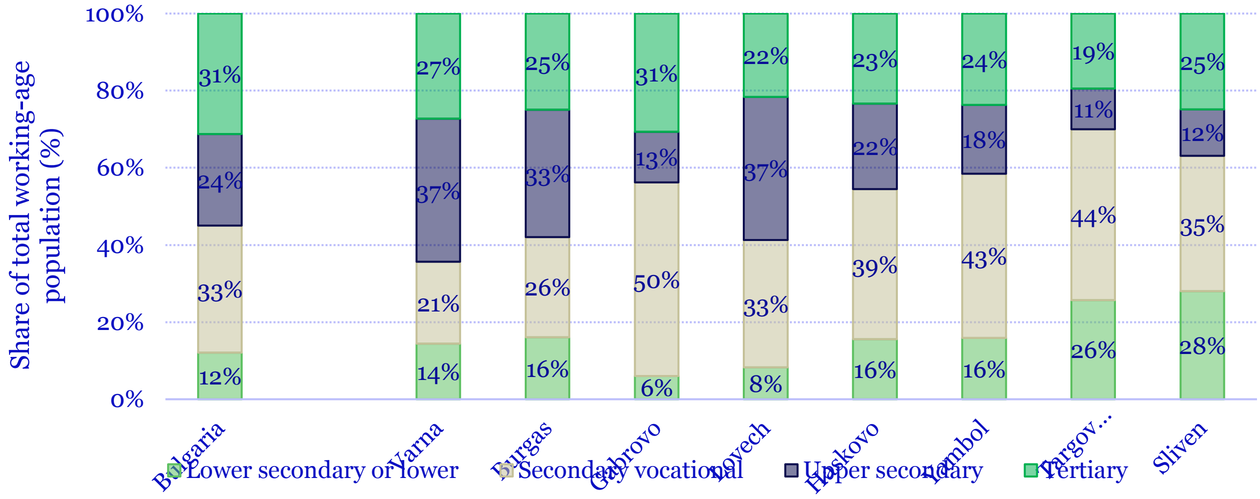
Figure 16. Distribution of the workforce by age



Source: National Statistical Institute (NSI), 2019.

In 2019, 45 percent of the population in Bulgaria graduated from less than upper-secondary school or vocational education. An additional 24 percent graduated from upper-secondary school, and 31 percent graduated from university. Varna – and to a lesser extent Burgas[85] – have a combination of educated workforce, and high-school graduates, reflecting both, opportunities for university graduates, as well as entry-level service jobs requiring little qualifications (wholesale, accommodation and catering). Gabrovo has the largest share of tertiary educated workforce, as well as a large share of Vocational Education and Training (VET) graduates, reflecting both, demand for university graduates as well as qualified technical professions. Lovech has relatively few university graduates, but also few individuals with less than upper-secondary education. Haskovo and Yambol have a large share of VET graduates. Targovishte and Sliven have a large share of high-school drop-outs: Sliven registers one of the highest relative shares of repeaters (3.4 percent) and drop-offs (5.7 percent), as well as some of the lowest results at the state matriculation exams. + few economic opportunities for high educated workers (see Figure 17).

Figure 17. Distribution of the workforce by educational attainment



Source: National Statistical Institute (NSI), 2019.

In most of the eight districts, the largest group of Technical Vocational Education and Training (TVET) students is enrolled in technical and engineering professional areas. Numbers vary from 22 percent in Lovech to 54 percent in Yambol. One notable exception is Burgas, where the largest professional area is "Hotels, restaurants and catering," concentrating 16 percent of all TVET students in the district. Students in Yambol and Targovishte still have a strong preference for agricultural professions ("plant growing and livestock breeding").

The choice of specialization does not seem to be demand-driven. A large share of TVET students opts for "Hotels, restaurants and catering" trainings, even in districts where tourism is not developed (such as Sliven, Lovech or Yambol). On the other hand, less than 10 percent of TVET students are enrolled in computer and applied information sciences in any of the district under study, and the shares are particularly low for Yambol and Lovech, at respectively 3 and 2 percent.

TVET doesn't seem to provide a considerable competitive advantage on the local labor market. A recent VET graduate tracking study in Burgas shows that VET graduates enter the local labor market relatively quickly (3.5 months after graduation on average). At the same time, only a small share manages to find a job in their professional area during their first

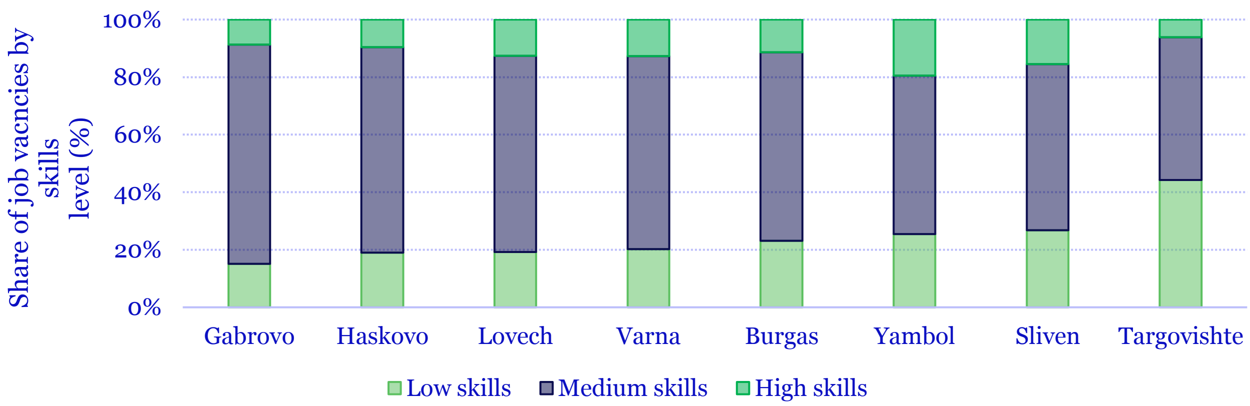
[85] The ongoing decline of the attractiveness of local universities has resulted in a significant contraction of the number of students in the district in the last decade.

year on the labor market, even when considering the broadest possible matching range. The highest levels of occupational matching were found in "forestry" (20 percent of graduates were employed in the same professional area), "chemical products and technologies" (16 percent), "electrical and power engineering" (17 percent), and "hotels, restaurants and catering" (14 percent). Occupational matching in professional areas typically associated with greener industries (e.g. computer sciences, electronics, environment protection, etc.) is insignificant during the first year after the transition from education to the labor market, raising questions about whether poor skills activation outcomes are due to the limited relevance of the trainings to employers' needs, the limited quality of VET provision, or existing skills mismatches

5.2.2.3 Workers, especially the lower skilled, face large skills mismatches

Limited information is available to assess the effectiveness of skills activation during the transition to the labor market and the extent to which skills are effectively matched on the local labor market. Both VET graduate tracking and skills anticipation data are missing on national and on local (regional, district level). For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

Figure 18. Job vacancies by skills levels



Note: Demand for skills is calculated based on the ILO's mapping86 of the four ISCO-08 skill levels to ISCED-97 levels of education.

Source: Own calculations based on data, provided by the national employment agency, 2019.

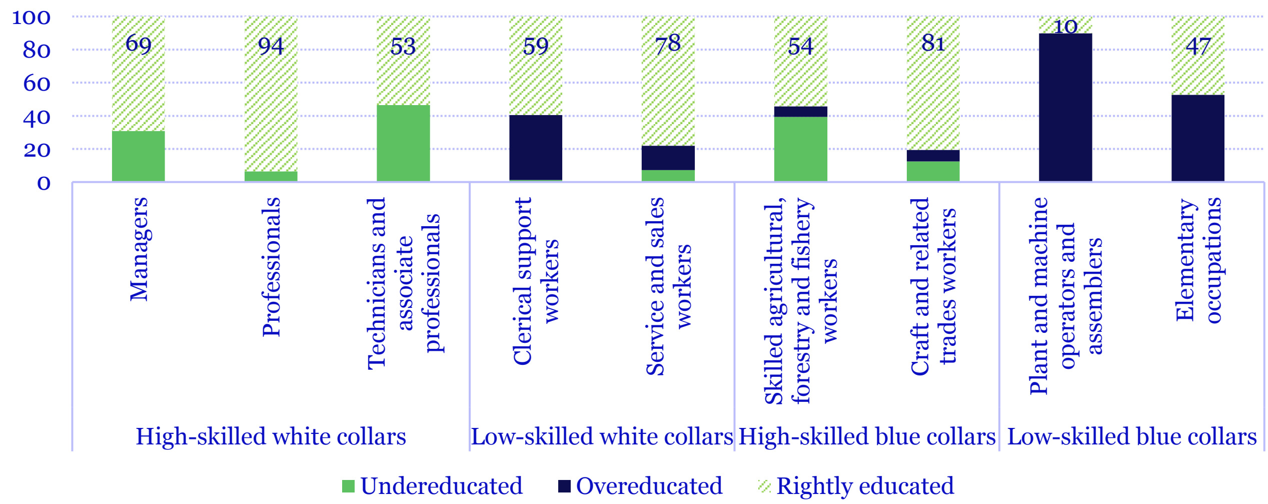
In most districts, the demand for skills is concentrated in the medium- and low-skills spectrum. This is particularly the case in Sliven and Targovishte (see Figure 18).

Most occupations in Bulgaria display skills mismatches, especially among low-skilled blue collars (see Figure 19). Beyond professionals, whose educational attainments largely match

[86] ILO. International Standard Classification of Occupations: Structure, group definitions and correspondence tables. Geneva, 2012, p. 14 https://www.ilo.org/public/english/bureau/stat/isco/docs/publication08.pdf

the requirements of their jobs (only 6 percent are undereducated), there are important skills mismatches across the different occupations. Crafts and related trade workers, as well as those engaged in services and trade, are also relatively well matched. But on the other hand, low-skilled white and blue collars especially are often overeducated, suggesting that skilled white and blue collars are facing limited work prospects and accept positions below their qualifications, either as clerical support workers (white collars), or as plant and machine operators and assemblers (blue collars) where 90 percent of the workforce is overeducated. This suggests that these sectors fail to attract employees with the right education and employ lower educated workers instead.

Figure 19. Skills mismatches between occupations and education in Bulgaria, 2020

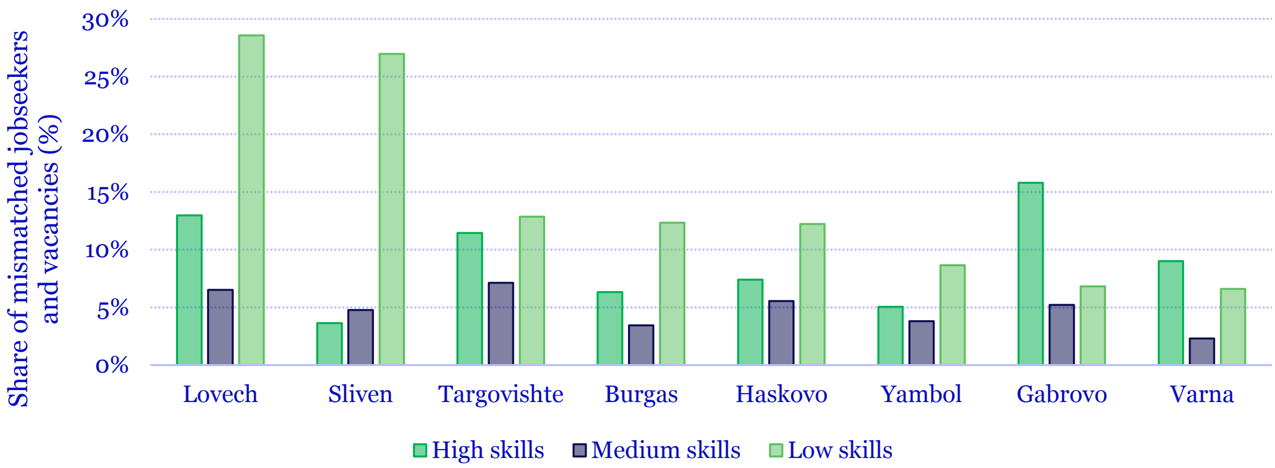


Note: the correspondence between occupations and skills is using the International Labor Organization (ILO) nomenclature. High-skilled white collars are expected to have tertiary education (ISCED 5-8), low-skilled white collars and high-skilled blue collars are expected to have more than upper-secondary non-tertiary education (ISCED 3-4), and low-skilled blue collars are expected to have up to upper-secondary education (ISCED 0-2).

Source: Authors' computations, Eurostat, 2020 (Indicators: lfsa_egised).

Looking at jobseekers and vacancies registered with the public employment services, mismatches between demand and supply appear highest among low-skilled workers. This is particularly the case in Lovech and Sliven, where more than one in four low-skilled jobseekers will experience skills mismatched. In all eight districts, individuals with medium skills are the ones experiencing lowest skills mismatches (around 5 percent of them). Finally, individuals with high skills are less likely to find a job corresponding to their level of competencies, especially in Gabrovo (16 percent) – see Figure 20.

Figure 20. Skills mismatches between supply and demand



Note: Supply of skills is calculated based on the number of registered unemployed as of December 31 in a given year using ESS-ISCED classification. Demand for skills is calculated based on registered job vacancies during Q1 of the following year using ILO's mapping of the four ISCO-08 skill levels to ISCED-97 levels of education.

Source: Own calculations based on data provided by the national employment agency, 2019.

5.2.2.4 Three districts have large shares of daily commuters to Stara Zagora

A substantial part of the population of Haskovo, Sliven and Yambol commutes daily to the nearby district of Stara Zagora, home to the mining complex of Maritsa East.[87] According to the 2011 Census (the latest extensive assessment of the scope of daily labor migration), 2,268 workers commute daily from the district of Sliven, an additional 2,676 from the district of Haskovo, and 1,336 from the district of Yambol.[88] By far the most affected municipality at the time of the Census was Sliven's Nova Zagora (1,324 commuters to Radnevo), followed by Simeonovgrad (Haskovo) and the Municipality of Yambol. Nearly 80 percent of all daily labor migration flows concentrated towards the municipalities of Galabovo (1.9k) and Radnevo (3.1k) which shows the drawing power of the companies of the "Maritsa Iztok" energy complex. In view of the existing wage disparities between Stara Zagora and its neighboring districts, daily labor migration plays the role of a natural cohesion process that is by definition supportive of household income levels in neighboring districts.

About one in four workers in the four main enterprises in the Maritsa East Complex reside in the neighboring regions of Haskovo, Sliven and Yambol.[89] These workers often commute from municipalities located close to Maritsa East with poorly diversified economies: Nova Zagora (8 percent of the total workforce) located in Sliven district; Topolovgrad (3 percent), Harmanli (2 percent), and Simeonovgrad (2 percent) located in Haskovo district; Elhovo (1 percent) and Tundzha (1 percent), located in Yambol district. In addition, a few additional employees of the complex commute from larger urban centers: Yambol (4 percent), Haskovo (1 percent), Dimitrovgrad (1 percent) and Sliven (1 percent). These estimates are roughly in line with the analysis carried out by PWC among the energy and mining companies located in Stara Zagora

[87] Maritsa East Mines EAD, and the three largest power plants (TPP Maritsa East 2, TPP Contour Global Maritsa East 3 and TPP AES Galabovo).

[88] These estimates cover the entire population of commuters, which goes beyond those employed in the Maritsa East Complex, discussed in the following paragraph.

[89] Non-Paper on the Geographical Coverage of the Necessary Support from the Just Transition Fund (JTF) in Bulgaria (GoB, 2021).

district: they estimate that 1,500 workers commute from Haskovo district (or 13 percent of the workforce employed in the mines and power plants), and additional 900 travel from Sliven (or 8 percent), and 600 from Yambol district (or 5 percent).

5.2.2.5 Impact of the transition and preparedness of the eight districts

In all districts under study, the transition towards a low-carbon economy will affect jobs directly and indirectly, ranging from 2 to 12 percent of total employment. However, contrary to the mining and extractive sectors, the sectors affected by the green transition are not expected to shut down entirely. Three main impacts are expected: (i) some of the jobs destroyed in an industry will be in occupations replicated in growing industries in the same country, offering job openings in which workers from shrinking industries can potentially find employment; (ii) net new jobs will be created that require relevant skills and adapted formal training for potential labor market entrants; (iii) some jobs will be lost without vacancies opening in the same occupations in different industries.

Employment transition pathways of the workforce is likely to involve adaptations of existing occupations, and the creation of new "green" occupations. The decarbonization pathways identified in the main manufacturing industries will entail the substitution of fossil energy with carbon-neutral fuels, improvements in energy, and more efficient recycling schemes. As a consequence, it is expected that the high GHG-emitting factories will need both: retraining and upskilling of the existing workforce, as well as the creation of new occupations. The existing workforce will need to acquire skills related to reduction of environmental impacts, including resource-efficient business practices (e.g. insulation, energy efficiency). The transition may involve the creation of new occupations related to reducing environmental impact (e.g. pollution control officers, energy auditors), and to the design and production of new products and systems (e.g. product designers, production engineers).[90]

This shift in occupational skill needs will require a complex set of policy measures to ensure a fair and inclusive transition. This will be particularly needed for lower-skilled workers, as most employment growth has happened in the recent past in sectors relying on higher-skilled labor, such as ICT, business and financial services[91]. Efficient administration of active labor market policies and income support programs will be critical to cushion the impact of the transition: targeted reskilling and upskilling, active labor market programs (ALMPs), career guidance, and measures to facilitate workers' social protection will need to adress the needs of those most at-risk of losing from the decarbonization process. These will require long-term commitment to regional and community development, as well as institutional coordination between the employment agency, the educational system, social welfare, and the private sector. The most successful efforts to mitigate the social labor impacts of the coal transition have included direct dialogue between key stakeholders: different levels of government, the private sector, trade unions, Non-governmental organizations (NGOs) and community service organizations (CSOs).[92]

For commuting miners, the timeline and nature of the transition is likely to be both, faster and more severe, than for the workforce employed in other high GHG-emitting

[90] ILO, 2018. "Skills for Green Jobs."

[91] World Bank, 2015. "Bulgaria's Potential for Sustainable Growth and Shared Prosperity : Systematic Country Diagnostic." The World Bank. Washington DC.

[92] *Cunningham, W., and A. Schmillen, 2021. "The Coal Transition : Mitigating Social and Labor Impacts." Social Protection and Jobs Discussion Paper No. 2105. World Bank, Washington, DC.*

factories. First, mines and power plants are at the frontline of the transition towards a low-carbon economy, as most mines are mandated to close down. As a consequence, miners will be dismissed and they will have to find opportunities elsewhere. Second, miners display both, lower educational levels (most of them graduated from lower-secondary school at most), and high level of specialization within their position. The tasks that they performed were mostly learned on-the-job, and the most senior workers display more rigid skills-sets with limited transferability to other segments of the labor market. Finally, employees of mining conglomerates have high levels of benefits: higher wages than the district average holding constant education and experience of the workers, better social benefits (in-kind and in-cash) and stronger union protection. Employment transition pathways are hence more limited, and more likely to lead to lower standards of living.

Local labor market and social assistance agencies will continue to face structural challenges, which may have little to do with decarbonization. Active labor market programs and other employment-related services are already underfunded and under-utilized.[93] Bulgaria's ALMPs and employment-related services are struggling to reach disadvantaged groups, and existing programs and instruments are not tailored to the specificities of the transition out of coal, [94][95] when 88 percent of the beneficiaries, or 283 thousand recipients, continue to use solid fuel. Finally, local labor market and social welfare agencies have little flexibility in decision prioritization and budget allocation: they implement national policies, designed centrally for the entire country. Recent experience with European Social Funds (ESF) accessed through the national budget support, and the quick reaction to the COVID-19 pandemic may however point to their capacity to increase their portfolio of programs and work with larger pools of beneficiaries.

Local employment and welfare offices will need to adjust their current offer and develop training options, including life-long learning (needs of firms affected by the transition, readiness and willingness of workers at-risk of losing their job to retrain, most appropriate labor market programs to cushion the impact of the transition, timeline of transition, etc). At 0.57 percent of GDP,[96] Bulgaria's expenditures on labor market programs are among the lowest in the EU, and cover mostly unemployment benefits (74 percent): training programs account for 6.7 percent of total budget only, and record low activation results (3.3 registered jobseekers are activated through training programs, as compared to 12.6 and 12.8 in Portugal and Finland respectively).[97] In addition, there are few partnerships between employers and public training institutions, and there are few incentives for life-long learning (LLL) and vocational training providers to set and achieve learning outcome targets. [98]

In the same context, district educational infrastructure should be adapted to future economic diversification and transition. The World Bank and UNESCO Institute of Statistics' learning poverty indicator demonstrate deterioration of the foundational reading skill of 10-year-old students. Similarly, the performance of Bulgarian students, measured in PISA scores in reading, math and sciences deteriorated over the last 14 years, and is combined with sustainably high level of underachieving students and low and steadily declining level of high-achievers. PISA 2018 results suggest that almost half of Bulgarian 15-year-old students are functionally illiterate.

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[93] World Bank, 2015. "Bulgaria's Potential for Sustainable Growth and Shared Prosperity : Systematic Country Diagnostic." The World Bank. Washington DC.

[94] https://mlsp.government.bg/uploads/1/net-effect-final-report-en1.pdf

[95] Statement made during several meetings with Social Assistance Agency repersentatives in the summer of 2021.

[96] Labour market policy - Expenditure and participants - Data 2018 (2020), table 2.1.3, European Commission, Directorate-General for Employment Social Affairs and Inclusion, Directorate A: Employment and Social Governance https://ec.europa.eu/social/main.jsp?pager.offset=0&advSearchKey=Expenditure+and+participants&mode=advancedSubmit&catId=1307&doc_submit=&policyArea=0&policyAreaSub=0&country=0&year=0#navItem-latestDocuments

[97] Ibid, table 3.3.4.

[98] Regional employment programs represent only 15 percent of National Employment Plan budget.

VET students, who represent more than half of the students in secondary education, perform consistently worse that the students in profiled schools in all PISA assessment domains. Some 74 percent of all low-performing Bulgarian students are VET students. In fact, almost two-thirds of the 15-year-old VET students are functionally illiterate according to the PISA 2018. This represents significant challenges in terms of adequacy of the future workforce with technical vocational education to support industrial transformation and transition to more technology-intensive jobs.

Recent VET graduates in Bulgaria face poorer employment opportunities than their peers in the EU, rising concerns about VET competitive advantage on the labor market. In 2020, 62.7 percent of VET graduates in Bulgaria were employed 1–3 years after graduation, compared to 73.5 percent in the EU.[99] However, there is insufficient data to make reliable conclusions whether the poor employment outcome of recent graduates is related to inadequate labor market relevance of VET programs and curricula, insufficient quality of VET provision, skills shortages, easy access to tertiary education, inter-EU labor mobility, etc. At the same time, there are growing concerns about the labor market relevance of tertiary education programs, especially in the light of the rapid expansion of higher education programs offered: in 2020, only half of graduates from the last five years were employed on job positions requiring tertiary education.[100] In addition, a dearth of life-long learning opportunities is a persistent source of concern, as it suggests very limited upskilling and reskilling potential and insufficient workforce skill development: only 1.6 percent of adult population aged 25-64 years were involved in LLL activities in 2020 (Eurostat, *trng_lfse_01)*, considerably below the strategic goal of 5 percent adult participation in LLL until 2020.

Upgrading the skills of the affected workforce will be crucial to enhance productivity and employment and thus improve living standards. With fewer workers to generate income in the future, it will be even more important that workers of all ages and ethnic groups have the cognitive, socio-emotional, and technical skills to improve their productivity at their current job or move to more productive jobs and sectors. A greater supply of skilled labor is likely to attract investments in more productive sectors with higher value added and thereby raise aggregate economic growth and help achieve external convergence. The high negative correlation in Bulgaria between educational attainment and poverty, labor force inactivity, and social exclusion demonstrates clearly that policies to improve education and skills development, especially for the bottom 40 percent of the population, can have a significant impact on reducing poverty and enhancing shared prosperity (World Bank, 2015).

However, Bulgaria lacks reliable district-level data and statistics, which could be used for analysing and anticipating (i) the specific local demand for labor and skills; (ii) local availability of skills and (iii) existing labor market shortages and skill mismatches in the different districts. Currently, there are no consistent efforts focusing on developing a systematic process of skills anticipation and matching on regional level. The Ministry of Labor and Social Policy developed a system for short-term and long-term forecasting of employers' demand for labor force with specific qualifications, based on (i) quantitative forecasting model and (ii) employers' surveys conducted by the Employment Agency. However, these forecasts are mainly applicable to the planning of active labor market policy measures on the national level and do not offer reliable information for labor market shortages and skills mismatches on district level. As a result, there is no reliable mechanism allowing the local stakeholders to consistently incorporate specific skills-related information in their skills anticipation efforts and upskilling/reskilling activities.

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[99] Eurostat (EDAT_LFSE_24).

[100] Source: Bulgarian University Rating System.

If districts fail to create the basics of a just transition roadmap, the decarbonization process risks fueling further migration of the most qualified workers, leading in turn to decreased public revenues and deterioration of public infrastructure. While outmigration and relocation may be coping strategies for individuals, affected communities may suffer negative ripple effects, such as increasing unemployment rates, economic stagnation, a decrease in public revenue and a degradation of public spaces and property values.[101] Buffering the impact of demography and economic change on future levels of public expenditure on education, pensions and health will be crucial.

Finally, rising energy prices will have an impact on the wellbeing of households, especially the energy poor. Moving away from coal as a source of electricity and heat will require adaptation of the future energy system, which may not be affordable to all households necessitating it, especially older households relying on small pensions. In addition, most of the recipients of the energy benefit program incur higher shares of energy expenses in their monthly expenditure, and will be disproportionally impacted by the transition if energy prices go up. The transition towards a low-carbon economy will hence require (i) an adequate policy to adapt private dwellings to the new energy system, and (ii) adequate social transfers to buffer the impact of rising energy prices on the poorest households.

5.3 The environmental impacts of the transition

5.3.1 Methodology

The main environmental impact of the transition to a climate-neutral economy is the reduction in GHG emissions. Despite the conducted surveys and interviews, the collected data does not allow for a robust estimation of district-level GHG reductions. Therefore, the assessment of the environmental impacts to a carbon-neutral economy are qualitative.

The assessment considers the following aspects:

- GHG reduction potential: the assessment identifies potential industries/sectors with high GHG reduction potential based on collected information about the level of GHG emissions and fuels used102. Information on GHG emissions was collected from enterprises' and waste depots' annual environmental reports, as well as were estimated, in the case of public transport, following the methodology described in Section 2.4. Information on fuel used in enterprises was also obtained from the companies' annual environmental reports.

- Impacts on other environmental aspects such as air, water and soil quality: the assessment considers possible effects on other environmental aspects based on literature review of studies in this area.

- Health impacts: the improvement or worsening of environmental aspects have an impact on health. Therefore, the assessment considers (qualitatively due to lack of specific data) the potential health impacts of the transition to a climate-neutral economy based on literature review.

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[101] C. Martinez-Fernandez, N. Kubo, A. Noya and T. Weyman, 2012. "Demographic Change and Local Development: Shrinkage, Regeneration and Social Dynamics," OECD, Paris.

[102] Detailed information was presented in the District Profiles.

5.3.2. Overall Findings

The environmental focus of decarbonization pathways for the carbon-intensive industries include the following general types of activities:

- Switching from fossil fuels to lower-carbon fuels.
- Improved processes' energy efficiency and system optimization.
- Materials' recycling.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

The activities outlined above have the largest potential to reduce GHG emissions in carbon-intensive industries. The following table103 summarizes the potential environmental impacts from the main decarbonization measures in the carbon-intensive industries.

Table 14. Potential environmental impacts from decarbonizing the carbon-intensive industries

Decarbonization Activities	Potential impacts on				
	Air	**Water**	**Resource efficiency/Waste generation**	**Soil, land use, biodiversity**	**Indirect impacts**
Switching from fossil fuels to electricity	**Positive impacts locally, overall impact depends on the fuel mix** The electrification of the energy-intensive processes eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.	**No impact expected**	**Positive/neutral impact** If coal is replaced, the amount of waste ash is reduced.	**No impact expected**	**Fuel dependent** Dependent on the fuels used to generate electricity.

[103] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen)	**Mainly positive impacts (fuel dependent)** Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	**Fuel dependent** Substantial amounts of water are needed for hydrogen production through electrolysis	**Fuel dependent** On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	**Potential negative impacts** In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	**Potential negative impacts** Additional need for transportation and transport infrastructure.
Switching from fossil fuels to renewable energy (except biomass)	**Positive impact** Use of renewable energy does not lead to emissions to air.	**Mainly positive impact** Overall, reduced risk of water pollution. There is a potential risk of eutrophication in case of	**Potential positive and negative impacts** Negative impacts from the need of additional infrastructure and waste treatment of certain	**Fuel dependent** Deployment of renewable energy sources might lead to land change effects, including from	**Fuel dependent**

		hydropower generation.	renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	
Material recycling	**Depends on process** If no additional energy input (coming from polluting fuels) is required in order to recycle the material, then the impact is positive.	**Depends on process** If no additional water is needed for material recycling, then the impact is positive.	**Positive impact** Improves resource efficiency and reduces waste.	**Positive impact** Reduced extraction of virgin materials.	
Improved energy efficiency and system optimization	**Positive impacts** Positive impacts from reduced emissions to air.	**No impact expected**	**Positive impacts** Reduced demand for machinery and consumables.	**Dependent on specifics**	**Dependent on specifics**
Carbon Capture and Storage/Utilization (CCS/U)	**Positive impact** CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	**Negative impact** CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	**Negative impact** Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	**Negative impact** Potential increase in toxicity. Potential trace metal soil contamination.	**Negative impact** Potential impacts on land's geological structure.

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[104]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils.

Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution. In addition, optimizing processess and material recycling in industry, as well as increasing the level of municipal solid waste recycling will lead to improved resource efficiency and reduced waste generation.

There are possibilities for potential negative impacts, especially on soil, land use and biodiversity, from some decarbonization measures such expansion of biomass feedstock for energy purposes, large-scale ground-based solar, carbon capture and storage/utilization or the need for additional infrastructure for some alternative energy sources (e.g. hydrogen). Most of those potential negative impacts, however, can be minimized or fully eliminated with proper planning and management.

[104] https://www.who.int/health-topics/air-pollution#tab=tab_3

6 WHAT ARE THE OPPORTUNITIES?

6.1 Approach to identifying diversification potential

6.1.1 Context

The JTF regulation [105] requires 'the economic diversification potential and development opportunities', related to the impacted economic activities and industrial sectors, to be explicitly presented (outlined and justified) in the TJTPs. The requirement is introduced in section 2.1. 'Assessment of economic, social and territorial impact of the transition' of the template of TJTP, and is contextually related to the alleviation of the potential negative socio-economic impacts on the two types of affected sectors (declining and transforming).

To that end, the methodology of identifying the diversification potential of the district economies is based on the understanding that **the goal of economic diversification in the context of the TJTPs is to mitigate the potential negative employment impact of the decarbonization**. In that context and considering also the specific goal and very limied scope of the TJTPs interventions, the WB team focused its efforts in identifying the potential of the various sectors in the district economy to grow and ultimately generate alternative new jobs, rather than at developing a strategic and holistic district diversification plan. Having in mind that, it should be noted that in the short- and medium term horizon of the TJTPs job generation could be achieved mainly through the support for existing, successful and high-potential, low-carbon businesses.

In line with above considerations, the underlying assumption on which the methodology for identifying diversification opportunities is based, is that **in all districts there exist already established successful businesses, whose development potential, including to generate new jobs,** that could materialize through targeted support.

6.1.2 Sectors with job generation capabilities: emerging vs. expanding sectors

Industrial transition studies distinguish two types of sectors, providing opportunities for workers from shrinking industries to move to[106]: i) **expanding,** and ii) **emerging sectors.** In the short term economic diversification ensuring generation of new jobs could be achieved mainly through the expansion of established existing businesses, called '**expanding sectors'**. In the context of the TJTPs these would be non-carbon intensive or green businesses, demonstrating a past growth trajectory and growth potential. It is always easier and less risky to support an already established business with a successful history to expand and generate new jobs, as compared to emerging industries with no track record and related high level of development uncertainty, in particular uncertainly related to job generation in the short and medium term.

[105] Cf. Annex II of the JTF Regulation.

[106] OECD (2019), Regions in Industrial Transition: Policies for People and Places, OECD Publishing, Paris, *https://doi.org/10.1787/c76ec2a1-en, p. 121*

By contrast to established industries with growth potential, emerging sectors are industries that are in the early stages of development. The product, service or technology that the emerging industry is formed around may not be widely known by many consumers, and therefore may not have an operating ecosystem, the business generates minimal revenue, the supply chain is underdeveloped, and the public is unfamiliar with the new product, i.e. there is a lack of a consumer base. Emerging industries and services nowadays are broadly understood as entirely new industrial sectors driven by applications of new technologies or other radical innovations or existing economic activities that undergo renewal and transformation, evolving and upgrading and/or merging into new industries.

Emerging high growth small firms have traditionally have been recognized as the main providers of new jobs in advanced economies. While it is generally true that emerging sectors could expand the job market by creating jobs for displaced workers, there are two reasons to focus on existing businesses with growth potential rather than on ''emerging sectors', in terms of job generation expectations.

The ***first reason*** is related to **high level of uncertainty related to the development of those sectors**. If the emerging industry becomes profitable, it can continue to grow and expand; however, there is a lot of uncertainty about that happening. Start-up firms are typically at a high risk and rate of failure even when their technologies are ultimately commercial winners. Thus relying on the job generation potential of those sectors in the short or medium term to mitigate potential negative employment impacts of the decarbonization process could be quite risky, as the future development of those emerging industries is rather uncertain.

The ***second reason*** is that **the generalized concept that emerging high growth firms are the main providers of new jobs been strongly challenged,** initially by economic author David Birch[107] and more recently by a research[108], carried out in the USA in 2008 by the Small Business Administration of the US Federal Government. The latter research established that the firms, which had both grown commercially and had been responsible for the major creation of new jobs (called "high-impact firms"), did not meet the 'standard' assumption that such companies were mostly newly-formed (e.g. emerging) and in high-tech sectors:

- High impact firms were found to be on average 25 years old, though they were younger than the majority of low impact firms
- They existed in a wide range of sectors and were not limited to high-technology industries
- They had a wide geographical distribution and were not limited to metropolitan areas.

Those conceptual findings have been further supported by a later study[109], focused on business growth in China and India.

The finding that high impact firms came from all sectors strongly supports the importance of 'traditional sectors' in regional economic development. If the average

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[107] Birch, David L. Job creation in America: How our smallest companies put the most people to work. New York, Free Press, London, Collier Macmillan, 1987.

[108] Acs, Parsons and Tracey. High Impact Firms: Gazelles Revisited. Small Business Administration, Washington DC, 2008.

[109] Michael J. Ferrantino, Megha Mukim, Alison Pearson, Nathanael Snow. Gazelles and Gazillas in China and India. U.S. International Trade Commission Working Paper, 2012.

age of high impact firms is 25 years, a large number must develop within well-established sectors. Maybe growth is sparked off by a market or technical innovation in an existing business, or as a result of external factors affecting the business- or perhaps there is a change in management, possibly as one generation takes over from another. The age profile of many high impact firms suggests that "emerging sectors and industries" must in many cases develop within already established businesses. It would be wrong to suggest that new growth must mean new firms. Indeed, growth through new firms may be the exception – we know that start-up firms are at a high risk of failure even when their technologies are ultimately commercial winners.

Therefore, in the context of TJTPs the search for diversification opportunities should disregard the distinction between existing (traditional) and emerging sectors in the district economy, as it is not a decisive factor for their job generation potential. The diversification opportunities should be identified within all economic sectors with growth potential within the district economies, which could expand their operations in the district and generate new jobs. To the extent that emerging industries would be identified to have such a growth potential, they could be supported, inter alia, to unlock their development potential through targeted support, addressing their main development barriers, namely support for R&D and innovation, for raising customer awareness about their product, for developing their sustainable supply/value chain, and cluster formation and development, as relevant[110].

6.1.3 Methodology for screening of diversification opportunities

The identification of diversification opportunities for the district economy has been carried out in two stages: i) identification of the sectors of the district economy with a growth potential [111], and ii) matching, where possible, the identified sectors towards new product opportunities at international markets, i.e. export diversification opportunities for the Bulgarian economy, established under internationally recognised diversification models.

The team developed a growth potential screening methodology based on the conceptual findings on firms growth, described above, adapted to the different dimensions of the analysis. The researchers who made the conceptual findings on firms' growth, defined ''high impact firms' ("gazelles") with reference to revenue or/and employment growth: *"establishments with at least 20% sales growth over an interval, starting from a base-year revenue of at least $100,000"* (David Birch: 1995); "*an enterprise with sales that doubled over the most recent four-year period and an employment growth quantifier of two or more over the same period*" (Zoltan Acs, William Parsons and Spencer Tracy: 2008); *"firms that double their real sales during a four-year period"* (Michael J. Ferrantino, Megha Mukim, Alison Pearson, Nathanael Snow: 2012). However, while those conceptual definitions refer to firms and are derived through an analysis of company datasets, the task of the team was to identify i) growing sectors, by ii) using sectoral business statistics at district (NUTS 3) level. **This necessitated accomodating the conceptual findings on growing firms for use to identify sectors with growth potential at granular territorial level**.

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[110] Those aspects will be coverd in the next deliveravles under the RAS, related to the developent needs and opportunities, and related operations to support the just transition.

[111] Considering the growth potential as a proxy for, and acceptable approximation of, the diversification potential,

On the grounds of the two defining dimensions of firms' growth, **a customised growth screening algorithm was developed,** using a combination of two indicators to capture the growth potential of economic sectors: i) employment and ii) productivity (labour productivity). The two indicators were measured at 2-digit NACE Rev. 2 sectoral level, in their static (level/size) and dynamic (rate of change) values, as the measurement scales were arranged in three ranges (low-medium-high), both for the static and the dynamic values. The ranging brackets of static values of the two indicators were established based on an qualitative analysis of the district sectoral data. In particular, the labour productivity ranges were set in relation to the median labour productivity of the district economy, as the range of 1 ÷ 1,2 times the median productivity was chosen as the 'medium' range. The static employment ranges were established in relation to the share of sectoral employment in percent of the total employment in the district economy (non-financial sector), as the 'medium range' was empirically set to cover the sectors accounting for 1 % to 5 % of the total employment in the district economy.

The ranging brackets of dynamic values of the two indicators (i.e. their rate of growth) were set relative to the national GDP real growth rate for the period 2015-2019. Under the NSI data[112], the GDP real growth rate for the 2015-2019 period at 2015-prices was 15%. The range of 15% to 30 % (one to two times the rate of growth of national GDP) was established as the medium range.

The algoritm resulted in a screening matrix with 9 classification groups (quadrants) of sectors[113], presented in Table 15 below.

Table 15. Screening matrix for growth & diversification potential of districts

	Dynamic value: Growth Rate 2015-2019 (GR)		
Static values: Sectoral Employment & Labour Productivity	**Low** GR ≤ 15%	**Medium** 15% < GR ≤ 30%	**High** GR > 30%
Small **Sectoral Employment (SE)** **SE ≤ 1% of total employment of the district economy (non-financial enterprises)** **Sectoral Labour Productivity (SLP)** **SLP ≤ median labor productivity of the district economy (MLP)**	"Mice"		Small, rapidly growing sectors[114] ("Gazelles" =emerging sectors for diversification)
Medium **Sectoral Employment** **1% < SE ≤ 5% of total employment of the district economy** **Sectoral Labor productivity** **MLP ≤ SLP ≥ MLP *1.2**			Medium, fast-growing sectors, ("Stallions")

[112] https://infostat.nsi.bg/infostat/pages/reports/result.jsf?x_2=1169

[113] Following the approach of David Birch and other authors, the most prominent groups of sectors are given animal names, denoting their size and speed (of change). "Mice" refers to sectors that are small and slow (i.e. sectors that start from a low base, and grow slowly), while "elephants" refers to sectors that are large and slow (i.e. sectors that start from a large base and grow slowly). The fast growing sectors are split here in three groups, capturing the full spectrum of sizes: "gazelles" refers to sectors that are small and fast (i.e. sectors that start from a small base but grow rapidly); "gazillas" are sectors that are large and fast (i.e. sectors that start from a large base and also grow rapidly, in other words - gazelles the size of Godzilla); 'stallions" (a category added to the 'growth beastiary' by the present survey) denote the mid-size fast growing sectors, lying in-between the small and large ones.

[114] 'Gazelles'

Large **Sectoral Employment** **SE > 5% of total employment of the district economy** **Sectoral Labor productivity** **SLP > MLP *1.2**	"Elephants"		Large, rapidly growing sectors[115] ("Gazillas")

The three fast-growth quadrants in the right column of the matrix, i.e. the rapidly growing sectors of the three 'size groups', are assumed to be the sectors providing diversification opportunities for the district economy. These three groups are: i) small and fast sectors (i.e. sectors that start from a small base but grow rapidly), ii) mid-size fast growing sectors, and iii) large and fast sectors (i.e. sectors that start from a large base and also grow rapidly).

Using available structural business statistics data at district (NUTS 3) level for 5-year period 2015-2019, the 2-digit sectors of the district economy were screened and classified into the 9 sector groups.[116]

At next stage, the identified sectors with growth potential were matched against the export diversification recommendations for Bulgaria of the Atlas of Economic Complexity[117]**.** The Atlas is a practical methodology of identifying available export diversification opportunites for any country worldwide, developed by a prominent group of Harvard economists. This method assumes that the availability of experience ('production knowledge') in one type of production allows an easy transition, i.e. diversification to another type of production, on the grounds of the similarity of assets and skills required for both. Based on the country export history, the Atlas generates 'new product opportunities', i.e. product export diversification recommendations for countries. The recommended diversification sectors are ranked by 3 criteria – a) proximity ('nearby distance')[118] to existing production (export) capabilities, b) product complexity[119] and c) opportunity gain[120]. Export analyzes and diversification recommendations under this method are available on the Atlas' dedicated website, including for Bulgaria.

The matching of the rapidly developing sectors towards the Atlas of Economic Complexity recommendations for Bulgaria enabled the team to **complement the growth potential screening with concrete export-related product groups (and granular economic sectors) within the identified rapidly developing sectors, recommended for the export diversification the district economy**.[121]

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[115] Gazelle, the size of 'Godzilla'.

[116] It shoul be noted that in a very limited number of cases the 2-digit sectoral data at district level was not available, due to the confidentiality restrictions applicable to the NSI sectoral dataset. The sectors to which these confidentiallity restictions applied were therefore not covered by the growth & diversification potential screening of those districts.

[117] https://atlas.cid.harvard.edu/.

[118] The country's ability to enter in to a new product, measured from 0 to 1 in 0,1 increments. A 'nearby' product (closer to 0) requires related capabilities to existing products, offering a greater likelihood of success

[119] Measures the amount of diversity of knowhow required to make a product. The more diverse know-how needed, the higher competitive advantage (and related wages).

[120] Measures the opportunity for future diversification in entering a product, by opening new links to complex products. The higher opportunity gains, the more preferred diversification choice.

[121] It should be noted that the Atlas is constructed on the basis of country export data, and is aimed to promote export diversification, related to (physical) products. This export focus of the Atlas limits the scope of diversification screening carried out to internationally traded (physical) products only. The diversification screening under the Atlas does not, therefore, cover the full spectrum of identified growing sectors, such as the service sectors, but also the indusrial sectors

6.2 Overall Findings

Following the above described approach, **between 9 to 19 rapidly growing sectors, providing opportunities for growth and generation of new jobs, were identified in various districts.** The number of identified sectors per district are presented in the table below (the figures in brackets show the number of firms belonging to each group of sectors, as of 2019).

Table 16. Number of sectors (and firms) providing growth and diversification potential, per district

Type of sector	Burgas	Gabrovo	Haskovo	Lovech	Sliven	Targovishte	Varna	Yambol
Small, rapidly growing sectors	**9** *(682)*	**7** *(329)*	**5** *(264)*	**6** *(128)*	**6** *(116)*	**7** *(117)*	**11** *(826)*	**12** *(218)*
Medium, rapidly growing sectors	**3** *(1 135)*	**7** *(663)*	**5** *(1 191)*	**6** *(901)*	**7** *(598)*		**5** *(2 132)*	**3** *(440)*
Large, rapidly growing sectors	**2** *(11 241)*	**1** *(92)*			**2** *(2 519)*	**2** *(1 314)*	**3** *(11 177)*	**2** *(1 799)*
Total	**14** *(13 058)*	**15** *(1 084)*	**10** *(1 455)*	**12** *(1 029)*	**15** *(3 233)*	**9** *(1 431)*	**19** *(14 135)*	**17** *(2 457)*

The identified sectors belong mostly to the manufacturing industry, but various service and other sectors are also available among those.

In terms of knowledge intensity[122], the identified **manufacturing industry** sectors with diversification potental belong mostly to the *low technology* and *medium-low technology* sectors, but *medium-high technology* sectors with growth potential were also identified in some districts (e.g. *Manufacture of machinery and equipment n.e.c.* in Burgas, Tragovishte, Lovech and Sliven districts; *Manufactire of motor vehicles, traileer and semi-trailers* in Sliven district). A *hight-tech* manufacturing sector, namely *Manufacture of computer, electronic and optical products,* was identified as an emerging, rapidly developing sector with a diversification potential in three districts (Gabrovo, Sliven and Varna).

The identified **service sectors** with diversification potental are related mostly to trade (retail and wholsale trade), which are dynamically growing in the last decade, as usually these fall in the group of large rapidly developing sectors in the districts. Being an inherent part of the toursit industry, *Food and beverage service* sectors naturally provide growth and diversification potential for the Black Sea coast districts of Burgas and Varna as large rapidly developing sectors there, but also to a number of other districts, as Haskovo, Lovech, Sliven and Yambol, where this sector belongs to the group of medium-sized fastly developing sectors. It is worth mentioning that prominent high-

which by the the specifics of their products are exclusively or predominantly focused on domestic consumption, i.e. are not export-related (such as civil engineering/construction, local food & beverage industries, fishing & aquaculture (fresh products for local consumption), forestry & logging (used as feedstock for local woodprocessing industries), etc). In spite of that limited scope, the economic complexity screening under the Atlas provides a valuable granular information on the export diversification opportunities for the district economy.

[122] Cf. the Eurostat classification of high-tech industry and knowledge-intensive services https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an8.pdf

tech knowledge intensive sectors, as *Computer programming, consultancy and related activities* and/or *Information service activities* were identified as emerging sectors with a diversification potential for a number of districts (Burgas, Yambol, Gabrovo, Haskovo and other), as in Varna *Computer programming, consultancy and related activities* is s a medium-sized rapidly developing sector.

The identified sectors with growth and diversification potential could serve as a starting point to develop targeted business support operations in relevant TJTPs at the next stages of the RAS implementation, where the support could be further prioritized as per the national SME and innovation policies.

7 HOW DO WE GET THERE?

This section presents the methodology and key results of an opinion survey on decarbonization. The opinion survey was conducted with affected carbon-intensive businesses and with the affected municipalities.

7.1 Methodological notes

The survey of the opinions and attitudes of enterprises regarding the decarbonization process was conducted in June and July 2021 in the eight districts: Burgas, Varna, Targovishte, Sliven, Yambol, Gabrovo, Lovech and Haskovo.

The objectives of the survey were twofold:

- To assess reliably and comprehensively the possible economic and social impacts of industrial decarbonization in the eight carbon-intensive districts, and;
- To study the awareness, opinion and the attitude towards the decarbonization process of the enterprises expected to be directly affected by that process, and their readiness to act accordingly.

In addition to the specific financial and economic data from the enterprises, the study collected primary information about the level of knowledge of decarbonization policies, the attitudes and expectations with respect to those policies, the development barriers and the investment intentions of the directly affected companies and the implementation of the partnership principle in decarbonization policy formulation and implementation through an opinion survey among the management of the target enterprises.

The **primary target group** of the study was the carbon-intensive industrial enterprises included in the EU Emissions Trading Scheme (ETS) / BG National GHG Emissions Trading Register or involved in coal mining, which companies are regarded directly affected by the decarbonization process. In order to produce a more representative picture of the industrial decarbonization and its potential impacts, a **secondary target group** of companies was also included in the survey. This target group comprises of industrial companies, which operate a large or medium-sized combustion installation and possess an integrated environmental permit or are included in the Register of Middle-sized Combustion Installations.

The survey covers all companies from those two registers except:

- companies from the agrarian sector (primary production and processing of vegetable and animal products). Justification: i) these are not recognized as carbon-intensive sectors; ii) those sectors are not fundable under the CPR funds, in particular by the JTF and are therefore outside the scope of the TJTPs
- companies with combustion installations fired by biomass or natural gas. Justification: *sustainable biomass* is considered a carbon-neutral fuel; due to its lower CO_2-emission factor, *natural gas* is expected to be a ‘transitional fuel’ within the next 1 or 2 decades on the road to full carbon-neutrality in 2050. Note: Companies belonging to sectors generally

recognized as carbon-intensive, e.g. ceramics, lime, pulp & paper, textiles, are covered by the survey regardless of the fuel used.

Thus the survey is an exhaustive study of all industrial companies (sectors B – E) which have even a minor contribution to the carbon intensity of the economy (included in the ETS and/or operating a fossil-fuel combustion installation of nominal capacity ≥ 1MW except those fired by natural gas).

The methods used to collect information are summarised below:

- Desk research, through which the necessary secondary information will be collected and analyzed. Public and specialized sources of information and databases for the sector will be used. This analysis would require district (NUTS 3) data at class (4-digit code) sectoral dis-aggregation under NACE Rev. 2. The companies in the sample are mostly medium and large, which does not allow the collection of data from the NSI because of the confidentiality of the sectoral statistical data. This method will be used for analysis of general economic information and comparative analysis at regional and national level. A survey was distributed among all enterprises belonging to the primary and secondary target groups of businesses directly affected by the decarbonization process. Under this method primary information on revenues, costs, exports, investments, innovations, labor resources, energy consumption, emissions, waste, value chain, incl. data on partner companies (suppliers and customers) of enterprises will be collected through a specific questionnaire. This way, up-to-date and accurate information on the financial and economic situation of enterprises, the status of their human resources, energy and environment-related aspects (fuel systems, cogeneration, waste and environmental protection measures, etc.) was collected. The economic and social data obtained was used to quantify the expected broad socio-economic impact of the potential industrial decarbonization in the target districts.

- Standardized face-to-face interview. The method allows collecting in-depth qualitative information from the management of target enterprises, related to their attitudes, expectations and constrains, as well as their personal expert assessments of the decarbonization process and its impacts. The interviews were conducted by a qualified team of interviewers and due to the pandemic situation, was conducted online through an internet-based video-conferencing platform. Информацията беше събрана чрез специално разработен въпросник, съдържащ 25 въпроса.

- A literature review and analysis of content from the survey / interviews. This part of the report presents the results of task 2 - Qualitative survey of the opinion of the managers of the surveyed enterprises regarding the decarbonization process.

7.2 Key results

Out of a total of 31 companies included in the interview list, 2 non-working companies were identified, 10 interviews were done, one of which concerned two companies with the same owner. In two of the interviews in the districts of Burgas and Varna, the companies surveyed requested a broader conversation with the team, where they shared in detail their attitudes, plans and views regarding decarbonization. In the town of Gabrovo and Yambol, none of the invited enterprises wanted to participate in the interview.

Table 17. Allocation of interviews by district

DISTRICT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Burgas	2	20.0	20.0	20.0
	Haskovo	1	10.0	10.0	30.0
	Lovech	1	10.0	10.0	40.0
	Sliven	1	10.0	10.0	50.0
	Targovishte	3	30.0	30.0	80.0
	Varna	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

The refusals to participate in the interview were justified by lack of time, sensitivity of the shared information (mainly in the financial part), lack of interest in the topic, lack of knowledge about the issue and lack of information about the decarbonization process.

The small number of interviews does not allow a full statistical analysis, therefore the results will be presented in absolute values and expert opinions within the topics covered by the questionnaire:

- Awareness, information channels and assessment of the quality of information regarding decarbonization, incl. assessment of the nationally representative business organizations, as an information and consulting channel;
- General attitudes towards the decarbonization process and attitudes for participation in the formation and implementation of process-related policies.
- Attitudes regarding the impact of decarbonization on business, the positive and negative social consequences, expectations for business development;
- Applicability of basic technological strategies for decarbonization in the industry, readiness for transition to low carbon production, investment plans, guidelines for green development, obstacles and factors for successful decarbonization;
- Attitudes towards state support for decarbonization - financing, regulatory framework, information, infrastructure.

7.2.1 Awareness and information channels

The level of awareness regarding decarbonization plays a significant role in shaping the attitude of business to the process, policies, state commitments and future development plans.

Table 18. Assessment of personal awareness regarding decarbonization

Awareness self-assessment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Completely aware	1	10.0	10.0	10.0
	Large extend	3	30.0	30.0	40.0
	Small extend	6	60.0	60.0	100.0
	Total	10	100.0	100.0	

Data on the self-assessment of the level of personal awareness regarding decarbonization show that in only one case, the respondent assessed himself as "fully informed". **The majority of the answers are in the "small degree" category.** Respondents' knowledge in terms of content can be assessed as specific and comprehensive, according to the answers of representatives of the chemical and cement industries, which demonstrate knowledge of the political process, possible solutions and strategies in the industry, the main problems and opportunities.

In the glass, textile and ceramic industries, the knowledge about decarbonization is mainly related to the price of emissions and emission allowances and their impact on the cost of production. One of the respondents summed up their viewpoint as:

"We are very poorly informed about the specifics of the Green Deal and how it will affect our business. In our business we use natural gas to melt the glass and it has carbon dioxide, and this process will be affected by decarbonization. But we don't know exactly what technologies we can use. "

Table 19. Preferred sources of information on the decarbonization process and the Green Deal

$Sources Frequencies*				
		Responses		Percent of Cases
		N	Percent	
Type[a]	Seminars	2	8.3%	20.0%
	Printed media	1	4.2%	10.0%
	TV/Radio	5	20.8%	50.0%
	Associations	3	12.5%	30.0%
	Partners/colleagues	3	12.5%	30.0%
	State serv	4	16.7%	40.0%
	Internet	6	25.0%	60.0%
Total		24	100.0%	240.0%

Note: *more than one answer is allowed

The data from the distribution regarding the preferred sources of information about the decarbonization process and the EGD clearly define **the Internet as a preferred information source, followed by television / radio and government institutions.**

The assessment of the quality of the information received from the respondents about the decarbonization and the EGD is made by assessing four basic characteristics - accessibility, comprehensibility, sufficiency, timeliness.

Table 20. Evaluation of the quality of information

Information available	Completely	1
	Large extent	2
	Small extent	4
	No	3
Information understandable	Completely	0
	Large extent	4
	Small extent	3
	No	3
Information sufficient	Completely	0
	Large extent	2
	Small extent	4
	No	4
Information up to date	Completely	2
	Large extent	4
	Small extent	1
	No	3

The availability of information is poorly assessed, with responses cumulative in the "small" and "not at all" categories. With the "intelligibility" indicator, again the accumulation of answers is in the negative part of the scale, as there is no answer "completely". With the indicator "sufficiency", the picture is identical - accumulation in the negative part of the scale and lack of a definite positive answer. Only the indicator "topicality" has a positive assessment - the answers accumulate in the positive part of the scale. The majority of the interviewed companies are members of business organizations - 8 out of 10 respondents. **Their satisfaction with the information on decarbonization they receive from business organizations is relatively low - more than half of the respondents express dissatisfaction or a small degree of satisfaction.**

Table 21. Quality of information provided by business organizations

Information quality – Business organizations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	completely	1	10.0	12.5	12.5
	to a large extent	2	20.0	25.0	37.5
	to a small extent	3	30.0	37.5	75.0
	dissatisfied	2	20.0	25.0	100.0
	Total	8	80.0	100.0	
Missing	System	2	20.0		
Total		10	100.0		

7.2.2 Attitudes towards the decarbonization and the policy making process

To establish the general attitude of the respondents towards decarbonization, a question was asked, registering their attitude, by agreeing or disagreeing with polar statements concerning the impact of decarbonization on various aspects of life and the economy.

Table 22. Decarbonization – general statements

Transforming to a low-carbon economy is the only way to save the planet	completely	4
	to a large extent	1
	to a small extent	4
	disagree	1
Achieving carbon neutrality in the economy is an expensive process with dubious results.	completely	4
	to a large extent	3
	to a small extent	1
	disagree	2
The decarbonization of the European economy is a serious threat to its competitiveness.	completely	7
	to a large extent	3
	to a small extent	0
	disagree	0
The process of achieving carbon neutrality is an opportunity to modernize and increase the	completely	5
	to a large extent	2
	to a small extent	3

competitiveness of enterprises and the economy as a whole	disagree	0
Carbon neutrality is fully achievable by 2050	completely	0
	to a large extent	3
	to a small extent	3
	disagree	4
Carbon neutrality will benefit everyone	completely	5
	to a large extent	3
	to a small extent	1
	disagree	1

At first glance, the contradictory answers to the statements show that on the one hand the importance of the transition to a low-carbon economy is fully understood by respondents, but on the other hand, they are aware of the cost, speed and socio-economic impacts of the process.

Attitudes and self-assessment of the available experience and capacity for business participation in the formation and implementation of decarbonization policies are an important factor influencing the effective implementation of the partnership principle in the process of programming, implementation and evaluation of these policies.

Table 23. Attitudes towards participation in decarbonization policies

Policy Participation Frequencies				
		Responses		Percent of Cases
		N	Percent	
Categories	National policy development	2	7.1%	20.0%
	National policy consult	4	14.3%	40.0%
	Regional decarb plans consult	7	25.0%	70.0%
	Measures formulation	7	25.0%	70.0%
	Beneficiary	6	21.4%	60.0%
	Monitoring/evaluation	1	3.6%	10.0%
	N/A	1	3.6%	10.0%
Total		28	100.0%	280.0%

Note: *more than one answer is allowed

There is a clear desire and opportunity to participate in the formulation of policies and measures at the regional level, as well as in the role of beneficiaries. So far, most of the business development policies in Bulgaria are developed and managed centrally at the national level. In this regard is the experience of the respondents, who are mostly structure-determining industries not only at regional but also at national level, which justifies their desire to participate in the formation and consultation processes of national decarbonization policies.

7.2.3 Attitudes and expectations on the impact of decarbonization on business

Expectations for the effects of decarbonization on individual businesses are at the heart of business responses and assessments of policies and measures related to a fair transition to a low-carbon economy.

Table 24. Expected effect of decarbonization on business

Effect of decarbonization on business					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Some positive effect	2	20.0	20.0	20.0
	Some negative effect	3	30.0	30.0	50.0
	Negative effect	5	50.0	50.0	100.0
	Total	10	100.0	100.0	

The majority of respondents expect categorically negative and rather negative effects on business, and the most common arguments for this assessment are the expected loss of competitiveness due to the necessary large investments, lack of sufficiently developed and applicable production technologies.

"Non-EU-based industries should not add investment, unlike us. This loses competitiveness. "

In practice, in all surveyed enterprises, the managers share that the production technologies, outside the combustion processes, are at the highest level and there are no highly innovative technological solutions that would have a real impact on the level of carbon emissions.

"Refineries are technologically on top of possible efficiency"

This is especially true in the chemical and oil industries. The attitude is to seek a solution by changing the fuel base, optimizing combustion processes and energy efficiency. None of the companies surveyed believes that the decarbonization process will have a definite positive effect on their business.

The expectations of the business for the potential negative effects on their activity as a result of the decarbonization are based mainly on the cost of the transition and the impact and on the competitiveness of the enterprises.

Table 25. Negative expectations

Potential Negative Effects				
		Responses		Percent of Cases
		N	Percent	
Potential_negative_effects [a]	Unemployment	6	11.3%	60.0%
	Migration	6	11.3%	60.0%
	Living standards	7	13.2%	70.0%
	shrinking activity	10	18.9%	100.0%
	loss of markets	10	18.9%	100.0%
	increasing the cost of production.	10	18.9%	100.0%
	increasing staff requirements	4	7.5%	40.0%
Total		53	100.0%	530.0%
a. Dichotomy group tabulated at value 1.				

Note: *more than one answer is allowed

All interviewees indicated expectations for contraction, loss of markets and increase in production costs. These effects are in a direct functional connection with each other and are logically connected by the respondents as well. The ranking is followed by a decrease in the living standards of the population, an increase in unemployment and depopulation of the region.

The positive effects indicated by the respondents as a result of decarbonization are mainly based on the expectation that the obligation to switch to low carbon production will stimulate production, organizational and marketing innovations.

Table 26. Positive effects

Positive Effects Frequencies				
		Responses		Percent of Cases
		N	Percent	
Postitve_effects[a]	Innovation will be stimulated	10	19.6%	100.0%
	More efficient production	7	13.7%	70.0%
	Modernization of the sector	8	15.7%	80.0%
	New export opportunities	4	7.8%	40.0%
	International cooperation	7	13.7%	70.0%
	A healthier lifestyle	9	17.6%	90.0%
	Increasing staff requirements	3	5.9%	30.0%
	Sustainable jobs	2	3.9%	20.0%
	Better products	1	2.0%	10.0%
Total		51	100.0%	510.0%

a. Dichotomy group tabulated at value 1.

Note: *more than one answer is allowed

The majority of respondents expect that decarbonization will stimulate innovation in the sector, followed by an expectation for a healthier lifestyle. These top expectations are followed by positive expectations for modernization of production in the sector, increase of production efficiency and improved opportunities for international cooperation. The positive effects in terms of staffing requirements and sustainable jobs are relatively poorly mentioned. With regard to business development forecasts in the context of decarbonization, it is difficult to draw a definite conclusion. The answers are evenly distributed in the two end categories - "will expand" and "will shrink".

7.2.4 Opinions on strategies for decarbonization, readiness for transition and factors for successful decarbonization

Numerous industrial studies concentrate on four main technological strategies to reduce the carbon intensity of industry:

- Increasing resource efficiency (increasing the productivity of materials, raw materials and energy used, including replacing materials and energy with low-carbon ones)
- Reducing material and energy consumption by increasing material recycling (circular economy, industrial symbiosis)
- Implementation of new production processes with low carbon emissions, incl. electrification of production processes for which fossil fuels are used
- Use of capture and storage technologies or use of carbon emissions

Table 27. Applicability of decarbonization strategies

Resource efficiency	**Compl. applicable**	**4**
	to a large extent	4
	to a small extent	2
	Compl.inapplicable	0
Circular economy	Compl. applicable	4
	to a large extent	2
	to a small extent	3
	Compl.inapplicable	1
New production processes	Compl. applicable	3
	to a large extent	4
	to a small extent	1
	Compl.inapplicable	2
Carbon capturing	Compl. applicable	4
	to a large extent	0
	to a small extent	3
	Compl.inapplicable	**2**

According to the management, each of the strategies can be applied in the surveyed enterprises. In most cases, these strategies can be used in combination. According to the results, the emphasis is on increasing resource efficiency, followed by the introduction of new production processes and the use of recycled materials (circular economy). The capture and storage of carbon emissions is mentioned last, and there are shared opinions that there is still not enough well-developed technology and appropriate infrastructure for this purpose.

> *"The technology for carbon capture and storage must be economically justified and subsidized under European programs. A key element is the country's strategy for conserving carbon emissions. "*

Table 28. Readiness of the companies for transition to low carbon production

Technological readiness	**completely**	**2**
	to a large extent	4
	to a small extent	1
	not prepared	3
Financial readiness	completely	0
	to a large extent	3
	to a small extent	3
	not prepared	3
Human Resources	completely	2
	to a large extent	2
	to a small extent	4
	not prepared	1
Marketing	completely	1
	to a large extent	2
	to a small extent	3
	not prepared	1

In most cases, enterprises demonstrate a high degree of technological readiness, with two indicating full readiness and four being largely ready. In terms of financial readiness, no company declares full readiness, which is related to the still unclear framework for financing decarbonization processes, as well as uncertainty regarding the regulatory framework, specific business requirements and their price.

The main obstacles that companies expect to face in the transition to low-carbon production are summarized in Table 29.

Table 29. Barriers to decarbonization

$decarbonization_barriers Frequencies				
		Responses		Percent of Cases
		N	Percent	
Decarbonization_barriers[a]	Lack of info	1	3.3%	10.0%

	Lack of technol	3	10.0%	30.0%
	Large investments	7	23.3%	70.0%
	Lack of invest financing	5	16.7%	50.0%
	Product compet	3	10.0%	30.0%
	Legal frame	5	16.7%	50.0%
	Carbon leakage	6	20.0%	60.0%
Total		30	100.0%	300.0%

Note: *more than one answer is allowed

As the most significant obstacle to decarbonization, companies point to the large amount of investment required in the first place. In second place is the problem of "carbon leakage", which is present in almost all interviews. One responded summed up this concern by saying:

> *"This risk (carbon leakage) must be minimized. Funding policies are needed; transparency, predictability of the process and legal framework. In the presence of these prerequisites - the effect will be positive, given that cement remains a major product for the construction industry."*

Problems with investment financing and the legal framework for decarbonization were also noted.

The factors that companies indicate as important for a successful transition are shown in Table 30.

Table 30. Success Factors

Success factors Frequencies				
		Responses		Percent of Cases
		N	Percent	
$Success_factors[a]	ready-to-implement technological solutions	10	12.0%	100.0%
	adequate investment financing	10	12.0%	100.0%
	state support	10	12.0%	100.0%
	reorganization of the value chains	8	9.6%	80.0%
	access to raw materials and appropriate energy	10	12.0%	100.0%
	adequate planning	8	9.6%	80.0%
	raising public awareness	10	12.0%	100.0%
	consumer demand for low-carbon products	7	8.4%	70.0%
	corporate responsibility	10	12.0%	100.0%
Total		83	100.0%	830.0%
a. Dichotomy group tabulated at value 1.				

Note: *more than one answer is allowed

Almost all of the factors listed in the questionnaire are mentioned by companies as important for successful decarbonization: availability of ready-made technological solutions, adequate financing, state support, access to raw materials and energy, forming a positive attitude towards decarbonization, increasing corporate responsibility. Factors such as: reorganization of value chains to cover the whole life cycle of products, participation in the planning and management of negative social effects and stimulation of consumer demand for low-carbon products are less mentioned.

7.2.5 Attitudes towards the directions of state support for decarbonization

State support for decarbonization is cited as a key factor in the success of the process by all companies that participated in the interview. The opinions of the companies on the directions of the state's efforts are important for the orientation of the policies and the adequate programming of the support measures.

Table 31. Areas of state support

State_support Frequencies				
		Responses		Percent of Cases
		N	Percent	
State_support[a]	Information	1	3.4%	10.0%
	consultations	2	6.9%	20.0%
	legal framework	7	24.1%	70.0%
	Support for clean energy	9	31.0%	90.0%
	financial support	10	34.5%	100.0%
Total		29	100.0%	290.0%

Note: *more than one answer is allowed

The companies participating in the interview rely to the greatest extent on financial support for investments in technological modernization and new technologies for low-carbon production process by the state. Next is to provide support to the energy sector to ensure industry access to clean and cheap energy. Thirdly, the need to create a regulatory framework to stimulate the transition to a low-carbon economy that takes into account both the specific needs of producers and consumers is highlighted.

The specific areas of the first financial support are shown in Table 32.

Table 32. Areas of financial support

Financial_support_directions Frequencies				
		Responses		Percent of Cases
		N	Percent	
Financial_support_directions[a]	Investments in SME sector	3	10.3%	30.0%
	Support for start-ups	1	3.4%	10.0%
	Support for R&D	5	17.2%	50.0%
	Investments in clean energy	9	31.0%	90.0%
	Investments in clean transport	1	3.4%	10.0%
	Investments in District heating networks	2	6.9%	20.0%
	Investments in circular economy	7	24.1%	70.0%

	Investments in HR	1	3.4%	10.0%
Total		29	100.0%	290.0%
a. Group				

Note: *more than one answer is allowed

The interviewed companies point out financial support, investments in the introduction of technologies and infrastructure for clean energy, reduction of greenhouse gases, energy efficiency and renewable energy as crucial. This is followed by investments to improve the circular economy through waste reduction, resource efficiency, reuse, repair and recycling. Third in importance, companies point to investment in research and innovation and the promotion of technology transfer.

8 CONCLUSIONS

The SSMs described in Part I of this report outline the most important elements of the 'ecosystems' of economic sectors affected by the transition, focusing on four identified key carbon-intensive economic activities (sectors): i) manufacturing industry, ii) energy sector, including buildings, iii) public transport sector, and iv) waste sector. The focus of the SSMs is on industrial and energy companies, which will be mostly affected by the decarbonization, and other stakeholders which are eligible for financing under Just Transition Fund. Within each of these sectors, several subsectors and industries were identified within the eight districts having a high level of carbon intensity. These include: production of cement, lime, ceramics, glass, iron and steel, oil refining, ammonia fertilizer and soda ash, as well as some other sectors where one or more enterprises are reporting high CO2 emisions due to combustion of fossil fuels.

The decarbonization pathways outline recommendable sector-specific actions to be implemented by the carbon-intensive economic sectors, in order to reduce CO2 emissions and achieve the goal of zero-emissions, i.e. becoming climate-neutral, by 2050. The focus of the decarbonization pathways is on technology improvements and changes needed to decarbonise relevant manufacturing processes, however they cover also the infrastructural, financial, regulatory, behavioral and other types of changes inter-linked with the technology ones. The general approach applied suggests that decarbonizing the carbon-intensive industrial sectors is considered to be technically and economically feasible through one or more of the following generic pathways:

- reducing materials and energy use (including through circular business models);
- increasing the productivity of materials and energy use and/or substitution with low-carbon feedstock;
- decarbonizing required production processes, and;
- CCS/U technologies applied to continued fossil fuel use and for bioenergy (and other uses of bio-feedstocks).

The generic decarbonization pathways, in particular the ones for the manufacturing industry, have been also reviewed *in the context of the existing technologies and present state-of-art ones*. It has been established that in terms of technological readiness the electrification of the heating processes appears to be closest to industrial application in most of the examined cases while the other available options are still at a pilot/demonstration level (e.g. use of hydrogen, biomass, CCS/U). However even in these cases which are still at a pilot level there is also a high demand for development of additional infrastructure and the capital and the operational expenditures expected there are significant, especially where Hydrogen or CCS/U shall be used in the future. In that context any company-specific decarbonization strategy will be determined by a number of sector- and company-specific circumstances, the company-specific decarbonization strategy will most probably be a mix of the generic setoral decarbonization pathways, tailor-made to produce the optimal effect for that individual company.

With regard to **assesssing the scope of potential socio-economic impacts** at district level, the report applies **a qualitative impact assesssment approach**. Due to the numerous uncertainties (technological, regulatory, financial, time, etc.), related to the scope, depth and timeline of decarbonization process at sectoral and company level, **sector-specific milestones of the decarbonization cannot be reliably predicted and the economic impacts cannot be quantified**, which renders a quantitative impact assessment impossible. For that reason the economic impact assessment approach, applied by the report, is a **qualitative assessment, based on on the assumption of a hypothetical 'worst-case scenario'**, i.e. a potential discontinuation of the activity of the businesses affected by the decarbonization. As already noted several times throughout the teport, this scenario is not a speculation or prediction that the affected carbon-intensive industries will cease to operate as a result of the decarbonization process, but a methodological hypothesis enabling a qualitative assessment

In terms of economic impacts at sectoral level, the report finds out that **manufacturing industry is the sector which will be most strongly impacted** by the decarbonization in the eight districts, due to the prevailance of industrial manufacturers among the GHG emitters in those districts. The decarbonization of the industrial sector is expected to affect directly the carbon-intensive industries in the districts, as well as a number of sectors in their supply chains which wil be indirectly affected. Depending on the size and structure of district economies, in some districts the potential cummulative impacts will spill over to sectors, providing a significant share of the output, added value, employment and salary income of the district economy (e.g. Targovishte, Gabrovo, etc.). In larger district economies (e.g. Varna and Burgas) the scope of the economic impacts is limited, however the number of potentially affected jobs is still essential. The Input-Output analysis of the inter-sectoral relations within the district economies confirmed the broad magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses.

Decarbonization within the energy sector is expected to lead to decentralization of energy production and a correlated increase of the economic activity at district level. For **buildings and the construction sector**, there is also expected increase of economic activities and number of employees due to activities for building renovation, on-site installation of renewable energy sources, and construction of nearly-zero energy buildings. In the **public transport sector**, no major impacts on the economic performance of the sector, or on employment, are forecasted, since the main function of the transport sector will remain the same. However, decarbonization measures might support new employment opportunities such as in the development and maintenance of charging infrastructure for electric and hydrogen vehicles, e-mobility, walking and cycling, and shared mobility model. Finally, the analysis shows that decarbonizing the **waste sector** will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. It might be expected that more sophisticated waste management, treatment and utilization could actually generate jobs – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis.

The analysis of social impacts shows that the transition towards a low-carbon economy will affect jobs directly and indirectly, ranging from 2 to 12 percent of total employment. However, contrary to the mining and extractive sectors, the sectors affected by the green transition are not expected to shut down entirely. Three main impacts are expected: (i) some of the jobs destroyed in an industry will be in occupations replicated in growing industries in the same country, offering job openings in which workers from shrinking industries can potentially find employment; (ii) net new jobs will be created that require relevant skills and adapted formal training for potential labor market entrants; (iii) some jobs will be lost without vacancies opening in the same occupations in different industries. The social sector analysis also found that manufacturing represents the largest share of employment, that workers face large skills mismatches, especially for lower skilled jobs, and that three districts have a large share of commuters to Stara Zagora, working at the Maritsa East mining complex. Finally, moving away from coal as a source of electricity and heat will require adaptation of the future energy system, which may not be affordable to all households necessitating it, especially older households relying on small pensions. These social factors will need to be carefully considered when designing specific decarbonization pathways for each district.

The environmental impacts are mostly expected to be positive. The analysis indicates that reducing GHG emissions will have several positive environmental effects, including better air quality, which has subsequent positive effects on public health. Environmental decarbonization pathways focus on the following activities: (1) switching from fossil fuels to lower-carbon fuels, (2) improved energy efficiency and system optimization for cleaner production processes, (3) materials' recycling, and (4) Carbon Capture and Storage (CCS) or Utilization (CCU). These activities have the largest potential to reduce GHG emissions in carbon-intensive industries.The environmental focus of decarbonization pathways for the carbon-intensive industries follow the already discussed general rputes to decarbonization:

- Switching from fossil fuels to lower-carbon fuels.
- Improved processes' energy efficiency and system optimization.
- Materials' recycling.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

Finally, results from the opinion survey indicates a clear desire from enterprises operating in carbon intensive sectors to participate in the formulation of policies and decisions which may affect them. The interviewed companies point out financial support, investments in the introduction of technologies and infrastructure for clean energy, reduction of greenhouse gases, energy efficiency and renewable energy as crucial. This is followed by investments to improve the circular economy through waste reduction, resource efficiency, reuse, repair and recycling. Third , companies point to investment in research and innovation and the promotion of technology transfer.

District decarbonization pathways (DPPs) are described in Part II of this report.

ANNEXES

Annex 1: Methodology

The following Annex provides full methodological details for the identification of carbon-intensive (sub)sectors and carbon-intensive companies within each sector.

Scope and methodology: Manufacturing Industry

Top-down approach: The UNFCCC and the EU ETS reporting frameworks, as well as numerous international and EU industrial studies, recognise the following subsectors from the manufacturing industry as being the most carbon-intensive and therefore subject to transformation as a result of the decarbonization of economy: (1) Cement; (2) Iron & Steel; (3) Plastics; (4) Chemicals (ammonia & nitric acid, soda ash); (5) Ceramics; (6) Glass; (7) Lime; (8) Non-ferrous metals & alloys; (9) Oil Refining; and (10) Pulp & Paper. Other industrial (sub)sectors also generate GHG emissions, but those have a very small share in the total GHG emissions compared to the above sectors, and could therefore be left out of the carbon-intensity analysis. The above-mentioned carbon-intensive industrial (sub)sectors were used as a reference framework to identify carbon-intensive sectors in the district economy, expected to be affected by the decarbonization.

Bottom-Up Approach: **The top-down analysis was complemented by a bottom-up enterprise survey.** This survey identified carbon-intensive companies in the district that are expected to be directly impacted by the transition, and studed the expected changes as a result of the transition, in particular the potential technological, economic and labour impacts expected by those companies.

The directly affected companies have been identified based on their CO_2 intensity. All carbon-intensive companies in the 8 districts, which are directly affected by the decarbonization process, have been identified exhaustively[123], using data obtained from various industrial emission registers, namely i) the EU Emissions Trading scheme (ETS) and the ii) national emission registers, covering large combustion plants (capacity >50 MW) under the Industrial Emissions Directive (IED)[124] and of medium combustion plants[125] (capacity 1÷50 MW) under the Medium Combustion Plants Directive (MCPD)[126]. The affected companies fall under two groups:

1. The first group comprises companies operating an industrial installation covered by the EU ETS under Directive 2003/87/EC127. The verified annual reports of those companies have been used to study their GHG emissions. Importantly, structured interviews were conducted with these companies, which provided an additional layer of comprehensive data and knowledge.

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[123] Applying also certain exclusion criteria.

[124] Directive (EU) 2010/75 on industrial emissions.

[125] http://pdbase.government.bg/sgi/RegisterSGI.html

[126] Directive (EU) 2015/2193 on the limitation of emissions of certain pollutants into the air from MCPs

[127] http://eea.government.bg/bg/r-r/r-te/verifitsirani-dokladi-21/dokladi-1r

2. The second group of surveyed enterprises includes non-ETS companies, operating a combustion installation with a capacity ≥ 1MW [128]. The Register of Companies with an Integrated Environmental Permit[129] and the Register of Medium-sized Combustion Plants[130] have been used as sources of information for those companies. Thus all companies operating a combustion plant with a capacity ≥ 1MW have been included in the second group, except:

    - businesses from the agrarian sector (primary production and/or processing of vegetable and animal products). The reason for their exclusion is that this sector is not fundable under the CPR[131] funds, in particular by the JTF, and is therefore outside of the scope of the TJTPs

    - businesses, operating a combustion installation fired by biomass or natural gas. That exclusion has been made on the grounds that sustainable biomass is considered a carbon-neutral fuel, while natural gas due to its lower CO2-emission factor is expected to be a 'transitional fuel' within the next 1 or 2 decades on the road to full carbon-neutrality of the EU economy in 2050. Notwithstanding that, companies belonging to sectors generally recognized as carbon-intensive, e.g. ceramics, lime, pulp, paper & print, textiles, etc. have been included in this group regardless of the fuel used by their combustion plants.

With this scope and coverage the carbon-intensity survey can be considered an exhaustive study of all industrial companies which have a non-negligible direct contribution to the carbon intensity of the district economy. The industrial sectors, to which the companies included in the survey belonged, were identified as carbon-intensive sectors. These sectors are presented in Table 33 below.

Table 33. List of the carbon-intensive industrial sectors in the 8 districts, identified by the industrial survey

№	Sector	NACE Rev. 2 code
	Carbon-intensive industrial sectors[132]	
	Coke & refined petroleum products	
1	Manufacture of refined petroleum products	19.20
	Basic chemicals, fertilizers and nitrogen compounds, plastics in primary form	
2	Manufacture of other inorganic basic chemicals	20.13

[128] It should be noted that under Annex I to Directive *combustion installations with a total Rated thermal input exceeding 20 MW* is in principle covered by the EU ETS, unless a specific exclusion applies (e.g. installations for the incineration of hazardous or municipal waste or "small installations" with annual GHG emissions less than 25,000 t. CO_2 eq.).

[129] Covering companies operating a large combustion installation, i.e. one with a capacity ≥ 50MW.

[130] Covering combustion installations with capacity of 1MW to 50MW.

[131] Common Provisions Regulation, i.e. REGULATION (EU) 2021/1060 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 June 2021 laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, the Just Transition Fund and the European Maritime, Fisheries and Aquaculture Fund and financial rules for those and for the Asylum, Migration and Integration Fund, the Internal Security Fund and the Instrument for Financial Support for Border Management and Visa Policy.

[132] Recognized as such under the UNFCCC and EU ETS regulatory framework and EU industry studies.

3	Manufacture of fertilisers and nitrogen compounds	20.15
	Glass	
4	Manufacture of flat glass	23.11
5	Manufacture of hollow glass	23.13
	Ceramics	
6	Manufacture of clay building materials	23.3
7	Manufacture of other porcelain and ceramic products	23.4
	Cement & lime	
8	Manufacture of cement	23.51
9	Manufacture of lime and plaster	23.52
	Iron & steel	
10	Manufacture of basic iron and steel and of ferro-alloys	24.10
	Non-ferrous metals & alloys	
11	Aluminium production	24.42
12	Lead, zinc and tin production	24.43
	Non carbon-intensive sectors*	
13	Preparation and spinning of textile fibres	13.10
14	Manufacture of veneer sheets and wood-based panels	16.21
15	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	17.21
16	Manufacture of pharmaceutical preparations	21.20
17	Manufacture of other plastic products	22.29
18	Treatment and coating of metals	25.61

*Note: Some companies belong to non carbon-intensive sectors, as listed above. However, these sectors would be affected by the industrial transition, as at least one companies within the sector will be subject to transformation aimed at GHG reduction under the existing and forthcoming EU climate law. In the context of the TJTPs, these sectors are treated as the rest of the carbon-intensive sectors, which is the reason they have also been included in the list of CO2-intensive sectors.

The carbon-intensity analysis of the manufacturing industry was structured to cover the complete value chain of the identified carbon-intensive companies. That is, both1) the carbon-intensive companies themselves, which will be *directly* affected by the decarbonization, as well as 2) the companies within the value/supply chain of the latter, both upstream (feedstock and energy supply chain) and downstream (distribution, use and product EOL [133]). The value/supply chain companies will be *indirectly* affected by the transition of the relevant carbon-intensive company. The *directly* and *indirectly* affected industries are decribed in details in the Sector System Maps (SSMs) of the CO2-intensive industries, developed for each district later in this report.

Declining and Transforming Sectors: The template of the TJTPs (Annex II of the JTF Regulation) distinguishes two groups of sectors with respect to the expected impact of

[133] End-of-life.

decarbonization on them: declining and transforming. Declining sectors are those, which are expected to cease or significantly scale down their activities related to the transition, while transforming sectors are those expected to undergo a transformation of their activities, processes and outputs.

The existing EU legislation does not explicitly list the declining sectors, however based on the EC Green Deal Investment Plan Communication[134] and the preamble of the JTF Regulation[135] it can be concluded that those sectors are related to, coal & lignite mining, production of peat and extraction of oil shale, and related energy production.

No active coal or lignite mining operations, production of peat and extraction of oil shale were identified in the 8 districts, i.e. all carbon-intensive industrial companies in the eight districts belong to transforming sectors, i.e. sectors which are expected to undergo a transformation of their activities, processes and outputs.

Scope and methodology: Energy Sector

In 2019, the energy sector in Bulgaria was the major source of emissions, responsible for 58.7% of the emissions from fuel combustion[136]. Energy industries include public electricity and heat production, petroleum refining and manufacture of solid fuels, and 'other'. In the context of the TJTPs, the energy sector is expected to undergo a transformation of its activity and is considered as a transforming sector.

The energy sector in the districts was developed mainly in the 1990s and is considered GHG-intensive due to the large share of local lignite in electricity production, although RES in Bulgaria has increased in recent years. For the period 1990-2004-2019, greenhouse gas emission intensity of electricity generation changed respectively from 597 to 537 and 424 gCO2e/kWh, which is much higher than EU-27 average (255 gCO2e/kWh in 2019)[137]. The number of generating companies representing at least 95% of the national net electricity generation in Bulgaria increased from 14 in 2004 to 159 in 2019[138] as a result of penetration of RES technologies. The share of energy from RES in Bulgaria increased from 9.93% in 2004 to 21.56% in 2019[139] and is one of the main indicators for decarbonization of the sector.

This analysis is based on data from EU ETS reports and national emission inventory. Gas and electricity distribution networks are also covered, as well as district heating companies. In terms of methodology, a bottom-up approach was applied to identify concrete needs of the affected companies through energy survey. An energy survey was sent to all 62 municipalities in the eight districts and was followed up by interviews with the district centers. Results from the survey were

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134 Cf. COM(2020) 21final, sections 4.3.4, and 6..1 .

135 Cf. recital 2 thereof.

136 National Inventory Report 2021: Greenhouse Gas Emissions in Bulgaria 1988-2019. Available at: https://unfccc.int/documents/273453

137 Source European Environment Agency https://www.eea.europa.eu/data-and-maps/indicators/overview-of-the-electricity-production-3/assessment-1

138 Source of data Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Number_of_generating_companies_representing_at_least_95%25_of_the_national_net_electricity_generation,_2003-2019_v3.png

139 Source of data Eurostat https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_REN__custom_938915/bookmark/table?lang=en,en&bookmarkId=b365f4d1-44b0-4d52-aee8-a78770914695)

summarized for the development of the decarbonization pathway for each district. The specific objectives of the survey were, to evaluate the current state and readiness for implementation of energy efficiency and RES project in street lighting and building stock, and to identify other incentives, including public private partnership, for involvement other stakeholders in the process of decarbonization at municipal level

Carbon-intensive energy production plants were identified in Haskovo, Sliven, Burgas, Varna and Gabrovo districts. Possible decarbonization pathways are developed for district heating and electricity production companies. For electricity and gas transmitting and distribution analysis of the new needs and pathways to cover theme will be also proposed. For the purposes of TJTPs, the energy sector includes companies in the whole sector of SECTION D — ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY (NACE Rev.2 Code) as they have a role in the decarbonization process. However, only those which need to apply decarbonization strategies or to invest in meeting the needs of decarbonized economy are directly affected: codes 35.11 (excluding RES producers), 35.12, 35.13, 35.21, 35.22, 35.30.

Table 34. NACE Rev.2 Codes for electricity, gas, steam and air conditioning supply sector

SECTION D — ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY

Division	Group	Class		NACE Rev. 2 Code
35	Electricity, gas, steam and air conditioning supply			
	35.1	Electric power generation, transmission and distribution		
		35.11	Production of electricity	3510*
		35.12	Transmission of electricity	3510*
		35.13	Distribution of electricity	3510*
		35.14	Trade of electricity	3510*
	35.2	Manufacture of gas; distribution of gaseous fuels through mains		
		35.21	Manufacture of gas	3520*
		35.22	Distribution of gaseous fuels through mains	3520*
		35.23	Trade of gas through mains	3520*
	35.3	Steam and air conditioning supply		
		35.30	Steam and air conditioning supply	3530

Scope and methodology: Buildings

Buildings in the EU are responsible for 40% of our energy consumption and 36% of greenhouse gas emissions, which mainly stem from construction, usage, renovation and demolition[140]**.** In 2019, the direct emissions from fuel combustion in buildings in commercial/institutional and residential sectors in Bulgaria was 3.14% ofthe total GHGs emissions

[140] https://ec.europa.eu/info/news/focus-energy-efficiency-buildings-2020-feb-17_en

according to the National Inventory Report 2021 [141]. The emissions are due to the combustion of coal, oil products, natural gas and biomass. The high emission factor of electricity used in buildings – 424 gCO2e/kWh (2019) have to be also taken into consideration for the role of buildings in decarbonization process and achieving the ambitious goal of carbon-neutrality by 2050, set out in the European Green Deal.

The Energy Performance of Buildings Directive requires all new buildings from 2021 (public buildings from 2019) to be nearly zero-energy buildings (NZEB). The definition of NZEB for Bulgaria stands for a building that cumulatively satisfies the following conditions: a) the building's energy consumption, expressed as primary energy, corresponds to energy performance Class A for that type of building; b) at least 55% of the energy used (supplied) for heating, cooling, ventilation, domestic hot water and lighting is energy from renewable sources produced in the building or in its close surroundings. Estimates show that by 2050 only about 15% of the buildings stock will consist of constructed in the period 2021-2050 buildings, the remaining 85% will be buildings constructed before that periods. For the existing buildings the requirement in the national legislation is that in case of renovation, they should reach at least energy class C.

The social impact of the energy consumption in buildings is related to "energy poverty". Unfortunately there is no national definition in the Bulgarian legislation and monitoring system for energy poverty and only the concept of "vulnerable consumers" is used. The Energy Act defines the term "vulnerable consumers" as "household customers in whose property, supplied with electricity, live persons who for reasons of old age, health or income are exposed to the risk of social exclusion about the supply and consumption of electricity and who benefit from social assistance measures to ensure the necessary electricity supplies". According to the National Energy and Climate Plan, the mechanism for the protection of energy vulnerable customers in the process of liberalisation of the electricity market aims to ensure a minimum quantity of electricity, other than heating needs. The "vulnerable consumers" definition has been developed by the Ministry of Labour and Social Policy, the Ministry of Energy, and the Energy and Water Regulation Commission and includes a wide range of categories: persons over 70 years of age, living alone whose sole source of income is their pensions up to the poverty threshold for the respective year, persons with 90% or more limitation of workability and who need additional help, families with children with disabilities who rely on additional help, and persons and families who already receive targeted aid for heating according to the law on social welfare.

For heating season 2020-2021 about 284,000 households have received support for the energy bills (with 31,000 more than in the previous season). The amount paid was 500 BGN/household (about 250 EUR/households) for the whole heating season. 245,200 households received aid for heating with solid fuels (wood logs and coal), 29,800 declared heating with electricity, 5,100 with district heating and 400 with natural gas [142] .

Energy efficient renovation of buildings is a holistic process and creates numerous co-benefits. There are estimates for the economic, social (including health and energy poverty) and environmental benefits from the implementation of the Long-term Strategy for Renovation of National Building Fund of Residential and Non-residential Buildings untill 2050) at national level.

[141] National Inventory Report 2021: Greenhouse Gas Emissions in Bulgaria 1988-2019. Available at: https://unfccc.int/documents/273453

[142] https://asp.government.bg/bg/novini-i-akcenti-asp/blizo-284-000-semeystva-sa-poluchili-pomosht-za-otoplenie-prez-zimata - Bulgarian Agency for Social Assistance

The lack of territorial (at NUTS3 level) targets and roadmaps make it difficult estimations of benefits from renovation for the eight districts.

For the purposes of impact assessment of decarbonization process in building sector, the following indicators at district level could be used:

- Average annual specific final energy consumption in residential and in administrative buildings, kWh/m2a
- Expected CO_2 equivalent savings per year
- New buildings constructed
- Number of vulnerable consumers receiving energy aid

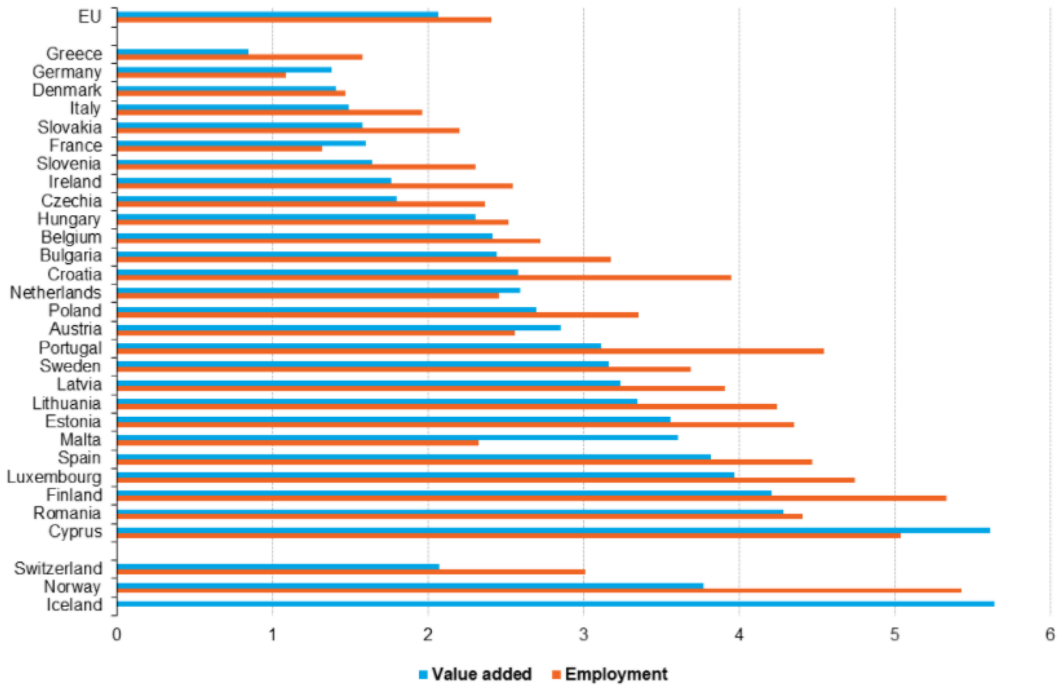
Common results indicators in REGULATION (EU) 2021/1056 for establishing the Just Transition Fund includes:

- Annual primary energy consumption (of which: dwellings, public buildings, enterprises, other)
- RCR 29 – Estimated greenhouse gas emissions

In terms of importance of construction of buildings sector, Bulgaria is in the middle with 3.2% employment and 2.4% added value share in the total non-financial business economy.

Figure 21. Relative importance of construction of buildings (NACE Division 41), 2018
(% share of value added and employment in the non-financial business economy total)

Relative importance of Construction of buildings (NACE Division 41), EU, 2018 *(% share of value added and employment in the non-financial business economy total)*



Source: Eurostat (sbs_na_con_r2)

Although there are no statistical data available for the building construction sector from the National Statistical Institute, data for the overall construction sector (Sector F) could be also used for evaluating impact. Such data could include the number of enterprises, the number of person employed and revenues.

<u>**Scope and methodology: Public Transport Sector**</u>

The transport sector was responsible for around 18% of the total GHG emissions in Bulgaria in 2019. Furthermore, within the transport sector, road transport is responsible for 98% of the total CO_2 emissions from transport in 2019[143]. Therefore, the focus of the current analysis will be placed on road transport as the most important contributor to GHG emissions from the Transport sector.

Bulgaria's National Inventory Report (NIR) categorises several types of motor vehicles for road transport. These include motorcycles, passenger vehicles (cars), light duty vehicles (LDV), heavy duty vehicles (HDV), including buses. The analysis focused on public transport buses[144] as support for smart and sustainable local mobility is the only eligible measure under the JTF. Private passenger transport and freight transport, albeit contributing to GHG emissions, are outside of the scope of the current analysis not only because of the limited eligibility of transport measures under the JTF, but also because these types of transport are not managed on regional and/or municipal level. Private passenger and freight transport are largely influenced by national policies and regulations, as well as private individuals' and companies' decisions. Furthermore, improving the attractiveness and sustainability of public transport, implementing

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[143] National Inventory Report 2021: Greenhouse Gas Emissions in Bulgaria 1988-2019. Available at: https://unfccc.int/documents/273453

[144] The analysis considers trolleybuses, where applicable.

transport demand management measures, improving walking and cycling infrastructure will also reduce the need of private passenger vehicle use and improve local mobility.

The carbon intensity of the Public Transport sector was assessed for the main district city in each district as those cities have the most developed public transport networks. In addition, assessment of the carbon-intensity of Public Transport was also made for the industrial cities of Devnya and Dimitrovgrad. Annual CO2 emissions of public transport were calculated based on the provided data by the municipalities, as requested through a survey, on the fuel consumption of the different vehicles in the public transport fleet for the years 2019[145] and/or 2020 (depending on which year data was provided for), presented in Figure 22 and Figure 23.

Figure 22. Annual diesel consumption of public transport buses, in litres, 2020

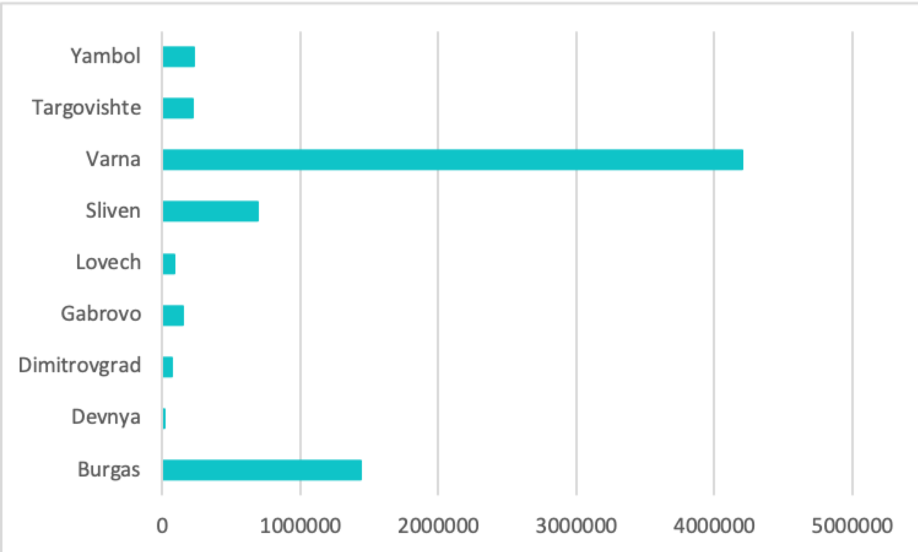
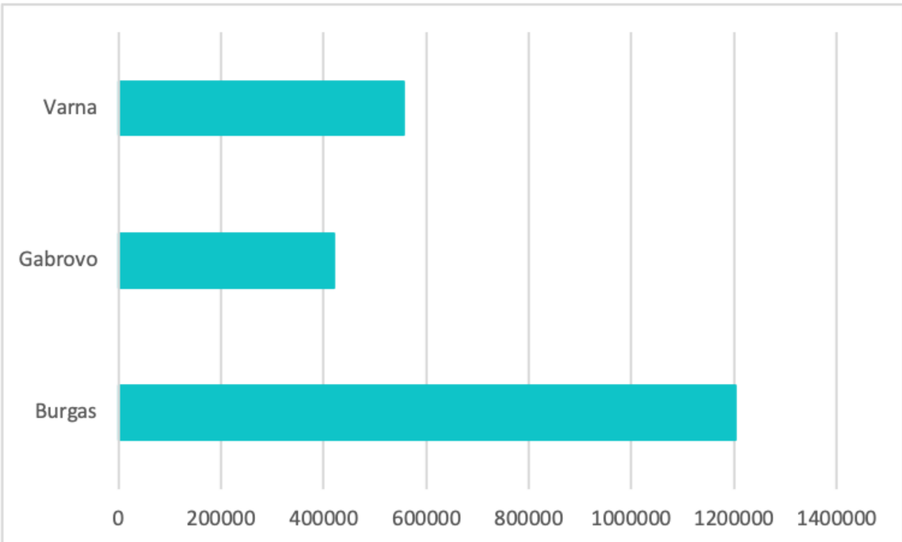


Figure 23. Annual CNG consumption by public transport buses, in kg, 2020



145 Burgas and Varna municipality provided data for only 2019.

Fuel consumption calculations (liters for diesel, kilograms for CNG[146]) were then transformed to energy units (TJ) using conversions from European Commission's reports[147]. The fuel consumption of public transport in TJ was then multiplied by the country-specific emission factors for the different fuels as reported in Bulgaria's latest National Inventory Report (NIR)[148]submitted under UNFCCC. Thus, the equation for calculating annual CO_2 emissions from public transport in the surveyed municipalities is presented below in Table 35.

Table 35. Emission factors used in the CO_2 emission calculations

Fuel source	CO2 Emission factor (t/TJ)
Diesel	75.10
CNG	56.05

Box 7. Equation for calculating annual CO2 emissions from public transport

$E_{a,j} = FC_{a,j} \times EF_j$

where

$E_{a,j}$ = annual emissions of public transport vehicles using fuel j

$FC_{a,j}$ = annual fuel consumption of fuel j, in TJ

EF_j = emission factor of fuel j, in t/TJ

The total CO_2 emissions of public transport in a given municipality is the sum of the emissions of all vehicles and fuels used – namely, diesel and CNG.

Based on the calculated total CO_2 emissions, CO_2 emissions per passenger kilometre were estimated using data from the municipal surveys, as well as CO_2 emissions per passenger were estimated using data that municipalities provided in the survey. In addition, the national average CO_2 emissions per passenger kilometre of urban buses was estimated for benchmarking purposes. The estimation was based on the reported CO_2 emission data on heavy-duty vehicles (HDV), which includes buses, in Bulgaria's NIR 2021, reporting 2019 emissions. The emissions of urban buses in the total HDV emissions were estimated by applying a factor of 0.1312 corresponding to the share of urban buses' mileage in the total national HDV mileage as included in the COPERT model that calculates transport emissions.

The results of the CO2 emission estimations for the surveyed municipalities are presented in Table 36.

Table 36. Estimated CO_2 emissions of public transport in the surveyed municipalities

Municipality	Total CO_2 emissions of public transport, t	CO_2 emissions per passenger km, kg	CO_2 emissions per passenger, kg
Burgas	6 879.9	0.96	0.32
Devnya	45.7	0.49	2.06

[146] Trolleybuses using electricity were not included in the CO_2 emission analyses as the emissions from electricity generation occur at the point of generation.

[147] European Commission, 2017. Study on the Implementation of Article 7(3) of the "Directive on the Deployment of Alternative Fuels Infrastructure" – Fuel Price Comparison. Available at: ttps://ec.europa.eu/transport/sites/default/files/2017-01-fuel-price-comparison.pdf

[148] Bulgaria. 2021 National Inventory Report. Available at: https://unfccc.int/documents/273453

Dimitrovgrad	177.2	0.42	0.55
Gabrovo	1 449.1	0.83	0.54
Haskovo*			
Lovech	238	1.13	1.73
Sliven	1 868.9	1.10	0.62
Varna	12 733.7	1.19	0.38
Targovishte	591.3	0.95	1.01
Yambol	622.9	0.65	0.32
National	27 8656.3	1.16	-

Note: *Haskovo municipality is in the process of replacing all 11 diesel buses with electric buses in the second half of 2021. In essence, the electrification of public transport in Haskovo will eliminate direct CO_2 emissions from public transport. Therefore, emissions were not estimated for Haskovo municipality as the estimations will not reflect the actual situation in public transport in the very near term and might lead to misleading conclusions.

The biggest municipalities of Varna and Burgas have the largest CO_2 emissions from public transport. Varna is also the only municipality where CO_2 emissions per passenger kilometre are higher than the national average. In terms of CO_2 emissions per public transport passenger, the smallest municipality in the sample – Devnya had the highest emissions per capita, followed by Lovech.

Scope and methodology: Waste Sector

The waste sector was responsible for 5.6% of the total GHG emissions in 2019 in Bulgaria. The main GHG emitted from the Waste sector is methane (CH4). Solid waste disposal accounted for 86% of the total reported CH4 emissions from the Waste sector in Bulgaria in 2019.

The analysis focuses on municipal solid waste (MSW) management since solid waste disposal is the main source of GHG from the Waste sector. In addition, MSW is managed locally (by each municipality, as well as by regional associations[149]). The activities that the JTF will support are also in line with waste management practices that can be influenced by local authorities. The following activities in the Waste sector are eligible for support from the JTF: enhancing circular economy, waste prevention & reduction, resource efficiency, reuse, repair, and recycling.

- GHG emissions from the Waste sector were obtained from the database of integrated environmental permits (IEP) of the Executive Environmental Agency[150]. Waste depots have an obligation to obtain an IEP and therefore, report GHG emissions annually. Other waste-related statistics and information were also analyzed to come up with a robust assesment. This included:

- Data on household waste generation and recycling at district level, obtained from the National Statistical Institute.

[149] Regional Associations for Waste Management (RAWM) are legal associations defined in Bulgaria's Waste Management Act. The official seat of the RAWM is the municipality on which territory is the land where the waste depot is located.

[150] http://eea.government.bg/bg/r-r/r-kpkz/godishni-dokladi-14/index

- Suggested improvement of waste management infrastructure per relevant Regional Association for Waste Management (RAWM), obtained from the National Waste Management Plan 2021-2028.
- Exisiting and planned waste collection, utilization, recycling, reuse and repair activities. Information was provided via questionnaires sent to all municipalities in the eight distrcits, as well as interviews with the main municipality in each district.
- Waste utlization and information about industrial symbiosis, obtained by questionnaires sent to the main industrial enterprises in each district.

PART II

1 BURGAS

1.1 Carbon-intensive sectors to be impacted by decarbonization[151]

1.1.1 SSM

The economy of Burgas district is one of the largest regional economies in the country. In 2019, the gross domestic product (GDP) of the district was BGN 5,507 million at current prices, i.e. 4,6% of the national GDP, which ranked 4th after the districts in Bulgaria after Sofia-city, Plovdiv and Varna districts. In 2019 GDP per capita was BGN 13,437, which ranked the district 7th in the country. At A3 aggregation level, in 2019 the largest share in the gross value added (GVA) of Burgas district belonged to services (71%), followed by industry (25%) and agriculture (4%). This structure of the regional GVA is very close to the structure of the GVA for the country.

Foreign direct investment (FDI) in the non-financial sector in Burgas district in 2019 amounted to EUR 2,137 mln at current prices, which is 8.4% of the total FDI in the country and ranked the district 2nd in the country after Sofia-city. In 2019, the biggest share of FDI was in industry, followed by FDI in trade activities, repair of automobiles and motorcycles, transport, warehousing and posting services, hotels and restaurants.

Manufacturing industry

The structure of the manufacturing industry in the district is presented in Table 37 below.

Table 37. Manufacturing Industry in Burgas district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C. Manufacturing industry	**20525**		**754392**	
C10 Manufacture of food products	3300	16.08%	57152	7.58%
C11 Manufacture of beverages	1138	5.54%	37606	4.98%
C12 Manufacture of tobacco products	0	0.00%	0	0.00%
C13 Manufacture of textiles	105	0.51%	2483	0.33%
14 Manufacture of wearing apparel	2155	10.50%	23788	3.15%
C15 Manufacture of leather and related products	17	0.08%	249	0.03%
C16 Timber, articles of wood and cork, unfurnished	681	3.32%	..	..
C17 Paper, cardboard and paper and paperboard products	88	0.43%	1797	0.24%
C18 Printing and reproduction of recorded media	278	1.35%	7680	1.02%
C19 Coke and refined petroleum products	..	..	..	..

[151] As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C20 Chemicals	409	1.99%	9603	1.27%
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	..	..	..	..
C22 Manufacture of rubber and plastic products	715	3.48%	14866	1.97%
C23 Products from other non-metallic mineral raw materials	828	4.03%	20428	2.71%
C24 Base metals	830	4.04%	32091	4.25%
C25 Metal products, except machinery and equipment	958	4.67%	20776	2.75%
C26 Manufacture of computer, electronic and optical product	73	0.36%	5711	0.76%
C27 Electrical equipment	498	2.43%	10989	1.46%
C28 Machinery and equipment, general and special purpose	408	1.99%	14037	1.86%
C29 Manufacture of motor vehicles, trailers and semi-trailers	4102	19.99%	87944	11.66%
C30 Manufacture of other transport equipment	..	..	28578	3.79%
C31 Manufacture of furniture	586	2.86%	6941	0.92%
C32 Other manufacturing	303	1.48%	3822	0.51%
C33 Repair and installation services of machinery and equipment	1013	4.94%	38237	5.07%
.. Confidential data				

Source: NSI Structural Business Statistics, 2019

As seen from the Manufacturing Industry structure, the main sub-sectors of the Manufacturing Industry are the food and beverage industries, apparel industry, chemical and oil refining industry, electronics, manufacture of motor vehicles, trailers and other transport equipment, as well as logging and wood processing (for some municipalities). Most industries are present in the district, as some of them are unique or of specific importance for the country, such as dark and light petroleum products, chemical fibers, plastics and other chemical products; shipbuilding, ventilation and purification equipment, freight wagon building, fish processing industry, etc.

It should be noted that the economy of city of Burgas is heavily dependent on the largest refinery in the Balkans, Lukoil Neftochim Burgas AD. As of 2019 the plant employed 1,377 people and another over 3,000 people are engaged in ancillary production and services. In addition to being one of the largest employers in the region, the company also operates the Rosenets oil port and subcontracts a large number of local companies as service providers for various auxiliary activities.

Of crucial structural importance for the district economy is also the transportation and storage sector. Burgas is a strategically important logistics hub not only for Bulgaria, but also for the EU. One of the largest ports on the Black Sea coast is located in Burgas, as well as an international airport with a cargo terminal, direct access to international road and railway infrastructure. Trakia highway and the 1st class international roads E87 and E773 run through Burgas. The city of Burgas is a logistical point of the Pan-European Transport Corridor №8, which provides a direct connection between the shores of the Adriatic and Black Seas and the beginning of the trans-European TRACECA corridor, which connects the Black and Adriatic Seas.

Industrial sectors affected by the decarbonization

The directly affected sectors in Burgas district were identified on the basis of a field survey of all carbon-intensive companies in the district[152]. The data for the directly affected 4-digit sectors from the manufacturing industry is presented in Table 38 below.

Table 38. Directly affected industrial sectors in Burgas district

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies (number)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Profit (BGN '000)	Investm. in tangible long-term assets (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	23.52 Manufacture of lime and plaster	1	4 118	1 308	121	249	57	864
2	23.63 Manufacture of ready-mixed concrete	1	14 005	3 563	117	0	110	1 390
3	16.21 Manufacture of veneer sheets and wood-based panels	1	202 125	202 927	0	0	434	10 656
4	24.10 Manufacture of basic iron and steel and of ferro-alloys	1	434 364	82 407	3 715	0	484	13 774
5	19.20 Manufacture of refined petroleum products	1	6 372 206	271 714	0	80 810	1 336	60 933

Source: Enterprise survey implementd by the team

The following indirectly affected sectors in the district have been identified, based on a value chain survey with a limited scope[153]:

Table 39. Indirectly affected industrial sectors in Burgas district

Sectors included in the supply chain of directly affected sector	**19.20**	**Manufacture of refined petroleum products**

[152] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify the CO_2-intensive companies.

[153] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district, which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN '000)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	43. Specialised construction activities	1	10 070	10 070	579	53	1 649
2	80. Security and investigation activities	1	10 588	0	231	32	6 063
3	42. Civil engineering	1	10 981	10 981	716	240	7 068
4	33. Repair and installation of machinery and equipment	1	10 565	10 565	75	178	6 803
5	45. Wholesale and retail trade and repair of motor vehicles and motorcycles	2	32 373	14 504	385	418	9 304
6	74. Other professional activities	1	4 844	4 978	84	128	3 762

Source: Enterprise survey implementd by the team

Energy sector and Buildings

The electricity network in Burgas on high voltage is well developed and ensures a generally reliable supply of electricity for industry and households. The main power supply substation is substation Burgas 400/110 kV, which is connected to Maritsa-Iztok 2 (in Stara Zagora district) and substation Varna (in Varna district). There are substations 110/20 kV in each of the 13 municipalities in Burgas, as well as six substations in Burgas city with total capacity 446.5 MVA. Electricity distribution is provided by the company EVN Bulgaria Elektrosnabdiavane EAD which operates the network and substations 20 kV/0.4 kW. There is one industrial co-generation unit, Lukoil Neftohim AD, which uses natural gas as its main fuel and also refinery gas, as well as 181 solar power plants with about 85.6 MW installed capacity, 25 wind farms with 15.9 MW capacity, and one hydropower plant at 1.3 MW.

There is one district heating utility company in Burgas. This is Toplofikacia Burgas EAD with thermal capacity 390 MWt and electrical capacity 18 MWe. In 2019, the realized heat energy was 123,110 MWh and the electricity supplied to the network was 104,426 MWh.

Natural gas supply and distribution networks are available for the city of Burgas and the town of Karnobat. One large company, Overgas Mreji AD, has a license for gas distribution in the city. There is also a gas company (Kameno Gas EOOD) licensed to operate in the municipality of Kameno.

The utility companies operating in the district are presented in Table 40:

Table 40. Energy operators in Burgas district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)

EVN Bulgaria Elektrosnabdiavane EAD	Electricity distribution (20kV/380V)
Toplofikacia Burgas EAD	Heat and electricity production and distribution of heat energy
Overgas Mreji AD	Natural gas distribution in Burgas municipality
Kameno Gas EOOD	Natural gas distribution in Kameno municipality

In 2020, there are also 207 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (181) and 25 are wind plants, as shown in Table 41:

Table 41. Installed capacity and energy production by type of RES in Burgas district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Wind	25	15.875000	20 773.397600
Solar energy	181	85.551417	111 611.399148
Hydro	1	1.300000	3 062.190000
Total	207	102.726417	135 446.986748

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

As noted in the methodology section above, in order to define the impact of decarbonization to the utility companies, an energy survey was conducted in mid 2021.

Table 42. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for a new substation and connecting lines for 43 mln.EUR and about 6 mln.EUR for new transformers.
EVN Bulgaria Elektrosnabdiavane EAD	Answer was not received
Toplofikacia Burgas EAD	Answer was not received
Overgas Mreji AD	Answer was not received
Kameno Gas EOOD	Not significant changes in the next years expected

Source: Enterprise survey implemented by the team

Using standard technology and database from Joint Research Center of EU commission [154] 1 kWp installed PV capacity in Burgas will produce 1324.51 kWh per year and will save 562 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available. In 2020, there was a request for connection of 9 new PV plants with total capacity 329 MW and 1 wind

[154] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

farm with capacity 120MW to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network.

Economic data for companies registered in Burgas in sector D Electricity, gas, steam and air conditioning supply are summarized in Table 43.

Table 43. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019
Number of enterprises	133	129	118
Number of persons employed	370	374	321
Revenues, thousands BGN	116112	111868	79805

Source: NSI

There is a slight decrease of the number of enterprises and the other economic indicators for the sector in the period 2017-2019.

Indicators to be monitored:

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh
- GHGs emissions savings, t/y

Housing in Burgas consists of 29,1749 dwellings, with 68,760 dwellings situated in the cities and 68,760 in the villages[155] .There are 269 buildings from the district with energy efficiency certificates. The average current energy consumption is 171,185 kWh/m2 and it is expected to be reduced after renovation to 85,30 kWh/m2. Expected annual energy savings are estimated at 129850675,8 kWh/a and CO_2 savings- 60676,8463 t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as untill June 2021 the renovated buildings were 205 in Burgas, 9 in Karnobat, 8 in Pomorie, 6 in Sredets,6 in Aitos and 2 in Nesebar [156].

The municipalities in district Burgas have energy efficiency and RES programmes as Nesebar, Aitos and Ruen have also approved Plan for Integrated Development. In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

[155] https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

[156] https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

- Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;
- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.
- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.
- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Burgas for 3-year period are presented in the following table:

Table 44. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%
Number of enterprises	1830	1773	1729	-5.52
Number of persons employed	11805	11745	11813	0.07
Revenues, thousands BGN	1215847	1299779	1277299	5.05

Source: NSI

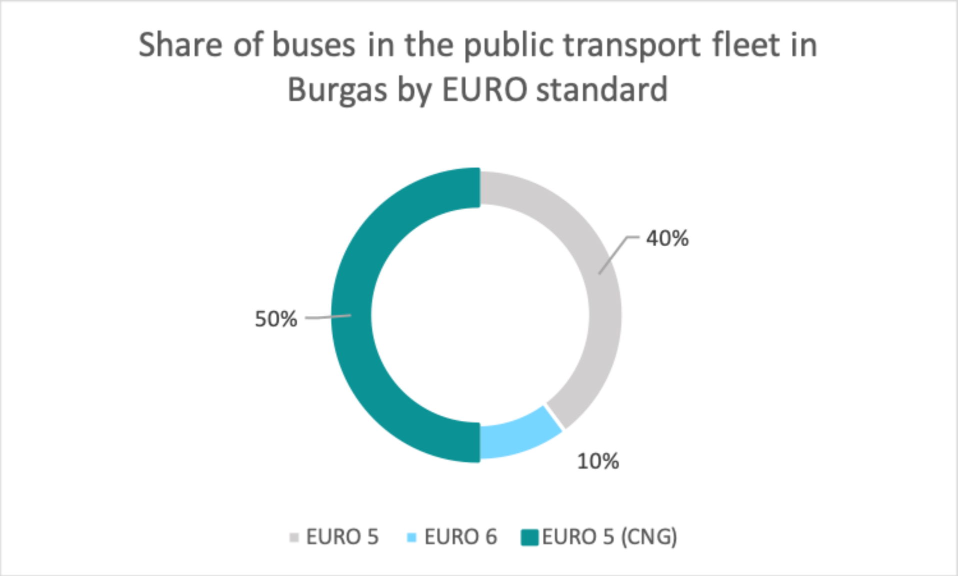
There are no significant changes in the sector in the period 2017-2019.

Public Transport Sector

Burgas municipality is the main municipality in the Burgas district and is the main city with developed public transport network in the district. The municipal enterprise Transport is responsible for the control of the local public transport network's functioning. The actual public transport service in Burgas municipality is provided by the municipality-owned company Burgasbus.

There are both buses and trolleybuses operating in the public transport network of Burgas municipality. Half of the buses operating the public transport network in the municipality are diesel buses and the other half are EURO 5 CNG buses. The majority of the diesel buses are EURO 5 and there are a few EURO 6 buses – see Figure 24 below.

Figure 24. Share of buses in the public transport fleet in Burgas by EURO standard in 2019



Source: World Bank Municipal survey, 2021

In 2019, the total mileage of public transport buses (buses and trolleybuses combined) was 7 752 491 km with total diesel consumption of 1 437 537.8 liters and total CNG consumption of 1 202 817.2 kg, which emitted an estimated 6 878.9 tonnes of CO_2. The emission rate of 0.96 kg CO_2/passenger km was lower than the calculated national average of 1.16 kg CO_2/passenger km. Table 45 below summarizes the current profile of public transport in Burgas.

Table 45. Current profile of public transport in Burgas

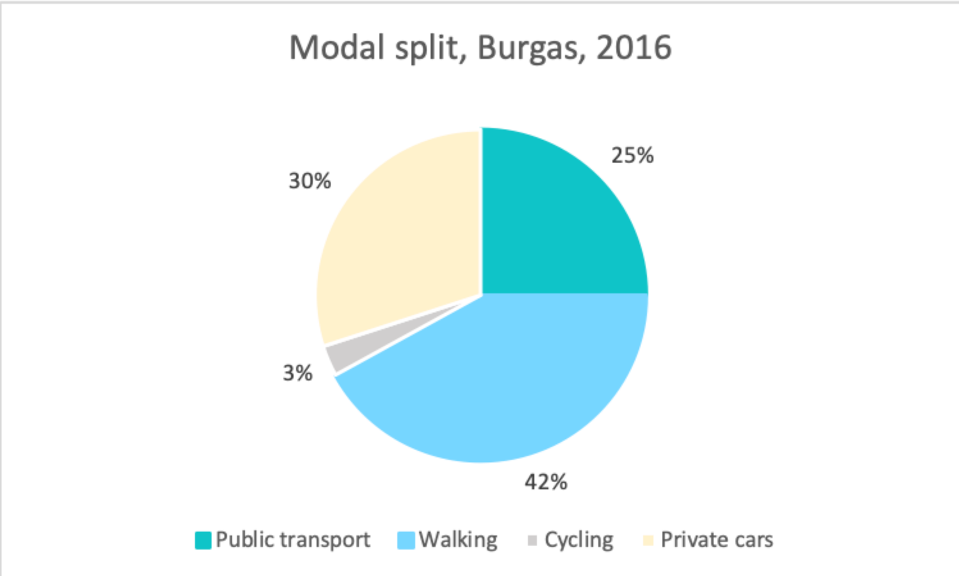
Item	Description
Type of vehicles in public transport network	Buses (diesel and CNG) Trolleybuses
Number of public transport passengers (2019)	Buses: 19 937 000 Trolleybuses: 1 284 000
Total annual consumption of diesel for buses in the public transport network, in liters (2019)	1 437 537.8
Total annual consumption of CNG for buses in the public transport network, in kg (2019)	1 202 817.2

Total annual consumption of electricity for trolleybuses in the public transport network, in MWh (2019)	1 214.9
Total annual mileage of public transport buses, in km (2019)	7 183 754.1
Total annual mileage of public transport trolleybuses, in km (2019)	568 737.3
Total estimated CO2 emissions from public transport, in t (2019)	6 879.9
Total estimated CO2 emissions per passenger km of public transport, in kg (2019)	0.96

Source: World Bank, Municipal survey, 2021

The latest modal split that Burgas municipality provided dates from 2016. In 2016 walking had the highest share of trips in the city (42%), followed by private vehicles (30%) and public transport (25%) - see Figure 25 below.

Figure 25. Modal split, Burgas, 2016



Source: World Bank Municipal survey, 2021

A questionnaire was sent to Burgas municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport development. Some of the key plans and initiatives are summarized below:

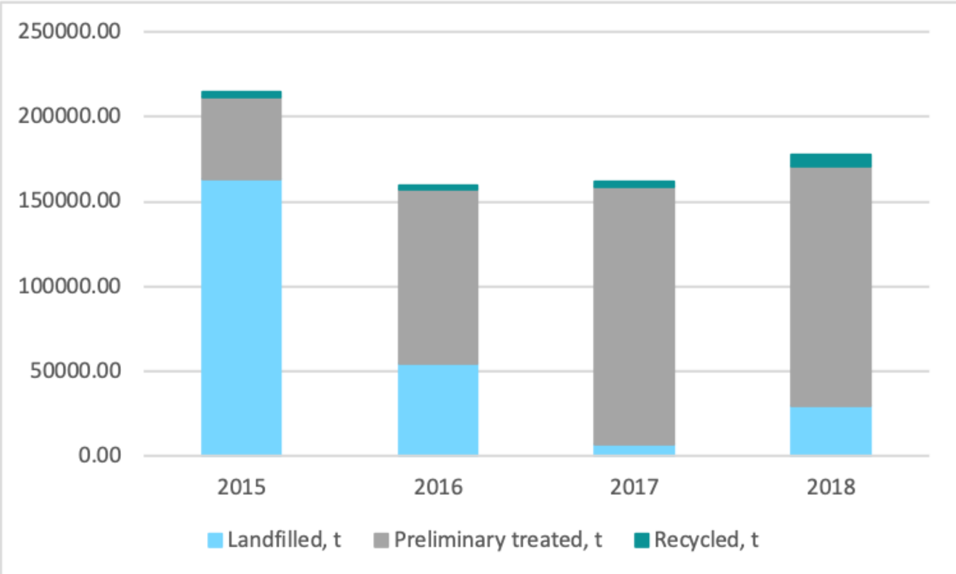
- Burgas municipality plans to terminate the use of fossil fuels in public transport by 2030.
- Burgas municipality has adopted a Sustainable mobility plan.
- Burgas municipality plans to significantly expand the e-charging infrastructure – 56 charging stations for electric buses, five municipal and ten private charging stations for electric vehicles by 2021.
- By September 2022 Burgas municipality should have 56 new electric buses.
- Burgas municipality plans to expand the existing public transport network to integrate new industrial and residential areas.

- Burgas municipality is not planning the introduction of a Low Emission Zone at this stage.
- There are 60 km of bicycle lanes in Burgas municipality. In addition, there is a municipal bicycle-sharing system that in 2020 had 10 000 users.
- As for digitalization of public transport, Burgas municipality already publishes public transport timetables online and has a public transport app and e-ticketing system.

Waste Sector

There are three Regional Associations for Waste Management (RAWM) in Burgas district – RAWM Burgas, RAWM Sozopol and RAWM Malko Tarnovo. All households in the district are served by municipal waste collection systems. The share of population covered by recycling infrasrtucture range between 50% (Sozopol) to 95% (Burgas) for the municipalities in the district that answered the waste survey Nevertheless, data from the National Statistics Institute shows that in 2018 only 4% of all generated household waste was recycled, see Figure 26 below.

Figure 26. Generated and recycled municipal household waste in Burgas district, 2015-2018,



Source: NSI, 2019.

There are two regional waste depots in Burgas district that serve all municipalities in the region and that are managed by the respective Regional Associations for Waste Management (RAWM). The GHG emissions from the depots in 2019 are presented in Table 46. The two regional waste depots in Burgas district contribute relatively little to CO_2 emissions, but are important sources of CH_4 emissions. The remaining landfill capacity of the waste depots in Burgas district is reported to be 226 082.60 m3.

Table 46. GHG emissions of waste depots in Burgas district

Waste depots	CO2 emissions, t	CH4 emissions, t
Regional waste depot municipality of Malko Tarnovo; RAWM Malko Tarnovo	217.6	108.2

Regional waste depot municipaliites of Kameno, Burgas, Aytos, Karnobat, Nessebar, Pomorie, Ruen, Sredets, Sungurlare; RAWM Burgas	21.7	10.8
Source: Executive Environmental Agency		

The latest draft of the National Waste Management Plan 2021-2028 recommends a number of potential improvements to the existing waste management system in Burgas region. The Malko Tarnovo RAWM is in the indicative list for construction of additional modules for stabilization of the biodegradable fraction in the waste separation installations and for installations for treatment of biodegradable waste. RAWM Sozopol also needs to establish installations for treatment of biodegradable waste. On the other hand, RAWM Burgas is in the indicative list for additional capacity and infrastructure at the waste depot. As far as existing infrastructure for collection, recycling, utilization and re-use of waste is concerned, there is a clear difference between bigger and smaller municipalities. Burgas municipality has established collection for most waste streams with the notable exception of biodegradable waste from households, whereas other municipalities in the district do not have much of a waste collection infrastructure, apart from the main recyclable waste (glass, paper, metals, plastics).

In terms of planned activities according to particular waste management practices, all municipalities that answered the survey mentioned that they are planning to expand the recycling infrastructure. Burgas municipality also has plans for prevention/reduction of waste. Some examples of industrial symbiosis are found in Burgas district. Companies from the district were contacted to participate in an industry survey that included questions on waste utilization and industrial symbiosis, among other questions, see Box 8 below.

Box 8. Industrial Symbiosis in Burgas District

One of the surveyed companies that participated in the Industry survey from Burgas district was the largest oil refinery in Bulgaria and the main GHG emitter in Burgas district – Lukoil.

Lukoil has an ambitious program to green its operations. The program also includes some industrial symbiosis measures. The company has a project for plastic waste depolymerization. The material obtained following the plastic waste depolymerization will then be used as a feedstock for the polypropylene unit, which is estimated to save 58 kt of CO_2 per year.

Source: World Bank Industry Survey, 2021

1.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Burgas district:

1. Oil-refining (petroleum) sector
2. Lime industry

3. Ceramics industry
4. Iron and steeel industry
5. Manufacture of wood-based panels (the gereral decarbonization pathwas for non-carbon-intensive industries)

Energy sector and buildings

Decarbonization measures for energy sector in Burgas includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

Burgas municipality has pledged that it will eliminate the use of fossil fuels in public transport by 2030. The municipality is already in the process of purchasing 56 electric buses. Thus, additional efforts could be focused on encouraging sustainable local mobility. According to the latest modal split in 2016, private cars still accounted for 30% of all trips in Burgas municipality. Burgas municipality has a rather extensive network of bicycle lanes, compared to other Bulgarian cities. Moreover, there is a municipal bicycle-sharing system. Therefore, an option to reduce the use of private vehicles is to make walking and cycling even more attractive at the expense of driving a car. This can be achieved by transport management measures such as incentives for walking and cycling and disincentives for using a private vehicle (e.g. parking fees, restrictions on parking/access, etc).

Waste

There is potential for moving up in the waste management hierarchy in Burgas district. For instance, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Burgas municipality (the main municipality in the district) could improve collection and treatment of green and biodegradable waste form households, whereas the smaller municipalities in the district could improve collection and treatment of other waste streams, outside of the glass, paper, metals and plastics streams. Moreover, two of the three Regional Associations for Waste Management (RAWM) in Burgas district are in the indicative list for constructing installations for treatment of biodegradable waste as per the latest National Waste Management Plan 2021-2028. According to Bulgaria's NECP projections, improved treatment of biodegradable waste is the primary measure to reduce GHG emissions from the waste sector.

Burgas district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

1.2 The impact of the transition to a climate-neutral economy

1.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to **directly estimate** the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, employment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 47 below.

Table 47. Assessment of the economic impact of industrial decarbonization in Burgas disrict

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy[157] (BGN '000)	Share of affected companies (%)
Number of companies (number)	5	30 974	0.02%
Turnover (BGN '000)	6 976 621	18 324 387	38.07%
Production value (BGN '000)	7 026 818	14 670 851	47.90%
Value added at factor cost (BGN '000)	561 919	3 211 221	17.50%
Profit (BGN '000)	3 953	1 129 756	0.35%

157 All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies

Investments in tangible long-term assets (BGN ‘000)	81 059	9 814 586	0.83%
Number of employees (number)	2 421	96 155	2.52%
Wages and salaries BGN ‘000)	87617	1217911	7.19%
Indirectly affected businesses (limited scope of the supply chain coverage)			
Economic indicator	Total value for all indirectly affected companies (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	7	30 974	0.02%
Turnover (BGN ‘000)	77 713	18 324 387	0.42%
Production value (BGN ‘000)	79 421	14 670 851	0.54%
Value added at factor cost (BGN ‘000)	51 098	3 211 221	1.59%
Profit (BGN ‘000)	2 070	1 129 756	0.18%
Investments in tangible long-term assets (BGN ‘000)	N/A	9 814 586	N/A
Number of employees (number)	1 049	96 155	1.09%
Wages and salaries BGN ‘000)	34649	1217911	2.84%
Cummulative impact (directly and indirectly affected businesses[158])			
Economic indicator	Total value for all affected companies from the district (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	12	30 974	0.04%
Turnover (BGN ‘000)	7 054 334	18 324 387	38.50%
Production value (BGN ‘000)	7 106 239	14 670 851	48.44%
Value added at factor cost (BGN ‘000)	613 017	3 211 221	19.09%
Profit (BGN ‘000)	6 023	1 129 756	0.53%
Investments in tangible long-term assets (BGN ‘000)	N/A	9 814 586	N/A
Number of employees (number)	3 470	96 155	3.61%
Wages and salaries BGN ‘000)	122 266	1217911	10.04%

[158] Limited supply chain coverage.

Source: Enterprise survey implemented by the team

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the four 2-digit sectors in the district, which will be directly affected by the industrial decarbonization, sector **C24** is a **key sector** and sector **C16** has a **strong backward linkage** to the district economy. Both (types of) sectors are important for the district economy in terms of indirect employment impacts.

Table 48. Key sectors[159] and sectors with backward linkages[160] in Burgas district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C16	Backward Linkages (BW)	12	2.59
C24	Key sector (K)	6	2.97

On the basis of relevant Type I employment multipliers, it was established that in the worst-case scenario for **sector C24** a total of 1,437 jobs could be lost, which included 484 the initial job losses in the identified directly affected businesses, and 953 job losses in their supply chain. **For sector C16** in the worst-case scenario a total 1125 jobs could be lost, which included 434 initial jobs of the identified directly affected companies, and 691 jobs in their supply chains. It was thus established on the grounds of the employment multipliers, that the **total impact of the decarbonization of those two sectors** could be the loss of 2,562 jobs in the district, including 918 jobs in the directly affected industries and 1,644 jobs in their supply chains in the district.

Summary

The subsectors of manufacturing of: veneer sheets and wood-based panels, refined petroleum products, lime and plaster, ready-mixed concrete, and basic iron and steel and of ferro-alloys, to which the five identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The five affected businesses generate about 48% of the output, 17% of the value added at factor cost, as well as 2,5% of the employment and 7,2% of the wages & salaries of the district economy.

It was established under a supply chain survey with a limited scope that the **indirect impacts** of the industrial decarbonization spill over to a variety of sectors in the district, ranging from repair & installation and construction to a variety of service sectors, such as trade & repair of motor vehicles, civil engineering, security services, and other professional services. The identified indirectly impacted businesses account together for 0.5% of the output, 1.6% of the value added, 1% of the employment and 2.8% of the wages and salaries generated by the district economy.

[159] Sectors with strong forward and backward linkages to other sectors in the district economy.

[160] Sectors with strong backward linkages to other sectors in the district economy.

It was thus estimated under the *survey method* that the decarbonization of the district economy will **cumulatively affect industrial subsectors** providing 48 % of the output, 19% of the added value, 3.6% of the employment and 10% of the wages and salaries of the non-financial sector of the district economy.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the carbon-intensive industries in the district could result in the hypothetical loss of 4,065 jobs in the district, this including 2421 jobs in the directly affected industries and 1,644 jobs in the supply chains of two major CO_2-intensive sectors in the district.

Energy sector and buildings

In 2019 there were 118 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a total of 321 employees. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 49. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[161]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	118	30974	0.38
Number of employees (number)	321	121323	0.26
Wages and salaries (BGN '000)	4063	1217911	0.33

Source: Enterprise survey implemented by the team

Although sector represents less than 0.5% of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well represented in the district.

Table 50. Economic indicators for sector F Construction in 2019

[161] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Economic indicator	Value for all companies from the sector	Impact on the district economy[162]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	1729	30974	5.58
Number of employees (number)	11813	121323	8.76
Wages and salaries (BGN '000)	127992	1217911	10.51

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term as the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics** (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies.

[162] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Burgas district in 2018 was just 4%, whereas 80% was preliminary treated and 16% landfilled. Therefore, it might be expected that more sophisticated **waste management, treatment and utilization_that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

1.2.2 The social impacts of the transition

Burgas is an attractive migration destination, especially among older age groups. The district experiences positive net migration, but population projections from NSI predict a decline to about 353 thousand in 2050. Many immigrants arrive from abroad and anecdotal evidence suggests a significant share of them are foreigners (especially Russians). Burgas has a positive migration balance with the rest of the country and only loses population to other leading districts such as Sofia, Plovdiv and Varna. On the other hand, most of the people who leave the district are aged 10-29: the recent decline of the district's appeal for some of the younger age groups can be attributed to the decreasing significant of the local universities. Age-dependency ratios remain relatively low.

Table 51. Key labor and social indicators, Burgas

	Burgas	Bulgaria	EU-27
Population			
Dependency ratio	55.6	55.5	54.9
Old-age dependency ratio	31.5	33.2	31.4
Net migration	851		
abroad	442		
of 20-39 y.o.	-254		
Labor			
Employment rate	64.6	68.5	67.7
Unemployment rate	4.9	5.2	7.2
Share of manufacturing in total employment	15	22	
Share of 25-54 in employment	76	76	
Share of job openings for high-skilled labor	11		
Skills			
Share of employed with tertiary education	25	31	
Jobseekers/vacancies ratio (low-skilled)	12		
Share of TVET in IT-related curricula	15		
Social inclusion			
Poverty	29.0	23.8	

Number of energy beneficiaries	10,015	283,680	
Share of energy beneficiaries using fossil fuel	86	88	
Labor impact			
Share of workers in carbon-intensive sectors	3		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

Burgas' workforce is skewed towards prime-aged, middle-skilled workers, employed in a diversified economy. One in three workers has an upper-secondary education, which corresponds to the high share of service sector employment in activities that typically require low-to-medium skill levels such as trade and tourism. The share of the employed with tertiary education is 7 percentage point lower than the national average, at 25 percent, pointing out to the declining attractiveness of local universities has resulted in a significant contraction of the number of students in the district in the last decade and there are no signs that the trend is about to be reversed.

Lower-skilled workers are those facing the highest difficulties in finding job opportunities. Demand for skills via the employment agency services is concentrated in the medium- and low-skills spectrum: the majority of job openings require medium skills sets (66 percent), while 23 percent require a low level of skills. The most sizeable mismatch between demand and supply of skills appears in the segment of low skillsets, with the number of job seekers with low skill levels 12 times the job opportunities requiring the same level of skills.[163] The relative difficulty of low- and medium-skilled workers and women engaged in the tourism sector was highlighted by the sharp rise in unemployment as a result of the COVID-19 pandemic.[164] The education system is gearing up for a greener and more digital future: while the largest specialization remains "hotels, restaurants and caterings" (reflecting the importance of tourism sector on the local labor market), around 29 percent of VET students are enrolled in technical and engineering professional areas, or IT specializations.

However, TVET doesn't seem to provide a considerable competitive advantage on the local labor market. A recent VET graduate tracking study in Burgas shows that VET graduates enter the local labor market relatively quickly (3.5 months after graduation on average). At the same time, only a small share of them manages to find a job in the targeted professional area during their first year on the labor market, even when considering the broadest possible matching range. The highest levels of occupational matching were found in Forestry (20 percent of graduates were employed in the same professional area), Chemical Products and Technologies (16 percent of graduates), Electrical and Power Engineering (17 percent of graduates) and Hotels, Restaurants and Catering (14 percent of graduates). Occupational matching in professional areas typically associated with greener industries (computer sciences, electronics, environment protection, etc.) is insignificant during the first year after transition from education to the labor market. It is not clear to what extent are those poor skills activation outcomes linked to (i) inadequacy of the structure

163 For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

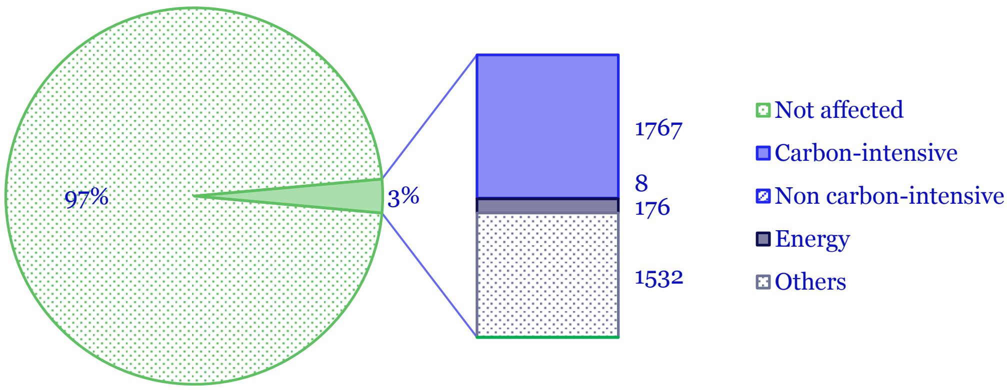
164 Employment dropped sharply to a 5-year low of 65 percent in 2020 as a result of the COVID-crisis, affecting mainly female labor market participation. Despite the lower share of the workforce (46%) the decline in female employment explains nearly 60 percent of all jobs lost in 2020. Women also account for nearly two-thirds of the increase of the inactive population relative to 2019. Falling labor force participation is the main reason why the district once again recorded a lower than the average unemployment rate in 2020, despite the sharper drop of employment during the year of the COVID-19 pandemic.

and local labor market relevance of VET, (ii) insufficient quality of VET provision or (iii) of existing skills mismatches.

The structure of the economy of Burgas is rather balanced. Wholesale and retail trade, manufacturing and the hospitality industry all account for about 15 percent of total employment, followed by construction (9 percent) and transportation and storage (8 percent). The share of employment in tourism (14 percent) is by far the highest among the 8 districts under review. Despite the relatively low share of manufacturing employment, the significance of the sector to the local economy in terms of investment, GVA and wages cannot be overstated.

Burgas' should be able to cope relatively well with the consequences of decarbonization over the medium-term. The analysis of the local business fabric identified six industrial companies with verified emissions under the ETS as being among the directly affected by the planned decarbonization. These companies are engaged in the production of refined petroleum products, cast iron and steel, wood paneling, lime production, as well as heat and power generation. One of them is the largest refinery in the Balkans, Lukoil Neftochim Burgas AD which is also one of the leading employers in the entire region. Most of these companies are located in the municipality of Burgas, but one of the larger employers is located in Sredets, alongside some of the potentially impacted SMEs in the district.

Figure 27. Employment in affected sectors, including value chain (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019).

About 2.4 thousand workers are employed in carbon-intensive industries, and an additional 1 thousand are employed in subcontractors. The latter are mostly SMEs in civil engineering, trade, repair and installation of machinery and other activities that are part of potentially vulnerable up-stream and down-stream supply chains. Estimating the indirect impact of the transition to carbon neutrality on the local socio-economic environment is hindered by the limitations of the available data. The living standard of the local population is broadly comparable to the country average, even if income disparities have increased somewhat faster than the average in recent years.

In addition, Burgas is one of the country's leading economic centers and also neighbors other carbon-intensive districts such as Sliven and Yambol, both of which face more severe direct risks with regard to the planned decarbonization's impact on employment. This may result in the intensification of daily or permanent labor migration flows towards the district, especially as far as workers in manufacturing are concerned. Such a scenario could provide further impetus to the gradually increasing importance of the service sector in terms of generating employment opportunities. The potential excess labor supply in the manufacturing sector may pose a challenge for local (re)qualification practices and the education system[165] as a whole.

Labor market disturbances may have large immediate impacts. The relative share of the population living below the poverty line rose sharply from 20 to 29 percent between 2018 and 2019, reflecting unfavorable labor market dynamics. As a consequence, labor market disturbances and other potential socio-economic effects of decarbonization, such as rising energy prices, may thus have a disproportionally strong effect on some of the more vulnerable municipalities and social groups in the district.

1.2.3 The environmental impacts of the transition

The largest GHG emitter in Burgas district operates in the oil refining industry. Other important GHG emitters in Burgas district operate in the iron and steel industry, as well as lime and ceramincs industries. In addition, some of the enterprises in the lime sector, as well as in the ceramics sector still use coal. The focus of decarbonization pathways for the carbon-intensive industries in Burgas district include the following main activities:

- Switching from fossil fuels to lower-carbon fuels.
- Improved processes' energy efficiency and system optimization.
- Materials' recycling.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

The measures outlined above have the largest potential to reduce GHG emissions in Burgas district. Table 52[166] summarizes the potential environmental impacts from the main decarbonization measures in the carbon-intensive industries in Burgas district.

Table 52. Potential environmental impacts from decarbonizing the carbon-intensive industries in Burgas district

Decarbonization Pathway	Potential impacts on				
	Air	**Water**	**Resource efficiency/Waste generation**	**Soil, land use, biodiversity**	**Indirect impacts**
Switching from fossil fuels to electricity Relevant for:	Positive impacts locally, overall impact depends on the fuel mix	No impact expected	Positive/neutral impact If coal is replaced, the	No impact expected	Fuel dependent Dependent on the fuels used

[165] These include secondary, continuing and higher education, as well as both academic and vocational education and training (VET). Additionally, as of May 2021, there are 29 licensed centers for vocational training providing continuous vocational training for adults. About half of the secondary students in Burgas were enrolled in vocational tracks during the last decade.

[166] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Oil refining Lime Ceramics Iron and steel	The electrification of the energy-intensive processes eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.		amount of waste ash is reduced.		to generate electricity.
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen) Relevant for: Oil refining Lime Ceramics Iron and steel	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	Potential negative impacts Additional need for transportation and transport infrastructure.
Switching from fossil fuels to renewable energy (except biomass)	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly positive impact	Potential positive and negative impacts	Fuel dependent Deployment of renewable	Fuel dependent

Relevant for: Oil refining Lime Ceramics Iron and steel		Overall, reduced risk of water pollution. There is a potential risk of eutrophication in case of hydropower generation.	Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	
Material recycling Relevant for: Iron and steel	Depends on process If no additional energy input (coming from polluting fuels) is required in order to recycle the material, then the impact is positive.	Depends on process If no additional water is needed for material recycling, then the impact is positive.	Positive impact Improves resource efficiency and reduces waste.	Positive impact Reduced extraction of virgin materials.	
Improved energy efficiency and system optimization Relevant for: Oil refining Lime Ceramics Iron and steel	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics
Carbon Capture and Storage/Utilization (CCS/U) Relevant for: Oil refining Lime Ceramics	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[167]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils. Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

1.3 Economic diversification potential and related development opportunities

Following the diversification screening methodology, rapidly growing sectors providing diversification opportunities for the district economy were identified. In addition, detailed lists of new products recommended for export diversification in some of those sectors were compiled. The identified sectors, proving diversification opportunities, were split into three groups:

- small and rapidly growing sectors, i.e. sectors that start from a small base but grow rapidly,
- mid-size fast growing sectors, and
- large and rapidly growing sectors, i.e. sectors that start from a large base and also grow rapidly.

The small, but rapidly growing sectors can be regarded as **emerging sectors with growth potential**, which are expected to positively affect the structure of the district economy. The mid-size and large fast developing sectors, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

1.3.1 Small and rapidly growing sectors

These are sectors that start from a small base but grow rapidly. **The common features of each of these emerging sectors are:**

- within the 2015-2019 period the sector accounted for *1% or less of total employment of the district economy* (non-financial enterprises)
- within the 2015-2019 period the labour productivity of the sector was less or equal to the median labour productivity of the district economy

[167] https://www.who.int/health-topics/air-pollution#tab=tab_3

- within the 2015-2019 period the employment and the productivity of the sector *grew by more than 30% compared to the baseline year*, i.e. *more than twice the rate of growth of the national GDP* for the same period.

Nine small, but rapidly growing sectors. providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 53. Small and Rapidly Growing Sectors for Burgas District

№	**Sector** (NACE Rev.2 code and name)	**Product export diversification opportunities within the sector**[168]
1	02. Fishing and aquaculture	N/A[169]
2	63. Information service activities	N/R[170]
3	25. Manufacture of fabricated metal products, except machinery and equipment	Padlocks and locks; clasps and frames with clasps incorporating locks, flexible tubes (HS codes 8301, 8307)
4	31. Manufacture of furniture	N/A
5	28. Manufacture of machinery and equipment n.e.c.	Tractors, locomotive parts, floating structures, Railway or tramway track fixtures and fittings (HS codes 8701, 8607, 8608, 8907)
6	17. Manufacture of paper and paper products	N/A
7	13. Manufacture of textiles	Woven or sintetic fibres, textile, yarn (HS codes 5514, 5811, 5606, 6308)
8	33. Repair and installation of machinery and equipment	N/A
9	61. Telecommunications	N/R

1.3.2 Mid-size and rapidly growing sectors

These are sectors that start from a medium (middle-size) base and grow rapidly. **The common features of each of these sectors are:**

- within the 2015-2019 period the sector accounted for *1% to 5% of total employment of the district economy* (non-financial enterprises)
- within the 2015-2019 period the labour productivity of the sector was in the range of 1 ÷ 1,2 times the median labour productivity of the district economy

[168] Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

[169] Not Available.

[170] Not Relevant.

- within the 2015-2019 period the employment and the productivity of the sector *grew by more than 30% compared to the baseline year*, i.e. *more that twice the rate of growth of the national GDP* for the same period.

Three mid-size rapidly growing sectors. providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 54. Mid-size rapidly growing sectors for Burgas District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	41. Construction of buildings	N/R
2	11. Manufacture of beverages	N/A
3	52. Warehousing and support activities for transportation	N/R

1.3.3 Large and rapidly growing sectors

These are sectors that start from a large base and grow rapidly. **The common features of each of these sectors are:**

- within the 2015-2019 period the sector accounted for *more than 5% of total employment of the district economy* (non-financial enterprises)
- within the 2015-2019 period the labour productivity of the sector exceeded at least 1,2 times the median labour productivity of the district economy
- within the 2015-2019 period the employment and the productivity of the sector *grew by more than 30% compared to the baseline year*, i.e. *more that twice the rate of growth of the national GDP* for the same period.

Two large and rapidly growing sectors. providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 55. Large and rapidly growing sectors for Burgas District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	56. Food and beverage service activities	N/A
2	47. Retail trade, except of motor vehicles and motorcycles	N/R

Thus a total of 14 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

2 VARNA

2.1 Carbon-intensive sectors to be impacted by decarbonization171

2.1.1 SSM

The economy of Varna district is one of the largest regional economies in the country. In 2019 the gross domestic product (GDP) generated in the district equaled to BGN 7,689 million at current prices, which was 6.4% of the country's GDP and ranked the district 3rd among the Bulgarian districts after Sofia-City and Plovdiv. In 2019 GDP per capita was BGN 16,340, which again ranked the district 3rd in the country. At A3 aggregation level, in 2019 the largest share in the gross value added (GVA) of Varna district belonged to services (73%), followed by industry (25%) and agriculture (3%). This structure of the regional GVA is very close to the structure of the GVA of the country.

Foreign direct investment (FDI) in the non-financial sector in Varna district in 2019 amounted to EUR 1748.7 million at current prices. This ranked the district 4th in the country (after Sofia-city, Burgas and Plovdiv). In 2019 the largest value of FDI was in manufacturing industry – EUR 893.1 million, followed by FDI in trade, repair of motor vehicles and motorcycles, transport, storage and post offices, hotels and restaurants - EUR 276.5 million, real estate operations - EUR 244.1 million and professional activities and research; administrative and support service activities - EUR 157.9 million.

Manufacturing industry

The structure of the Manufacturing Industry in the district is presented in Table 56 below.

Table 56. Manufacturing Industry in Varna district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C. Manufacturing industry	22 126		907 343	
C10 Manufacture of food products	3 443	15,6%	55 650	6,1%
C11 Manufacture of beverages	178	0,8%	2 896	0,3%
C12 Manufacture of tobacco products	0	0,0%	0	0,0%
C13 Manufacture of textiles	121	0,5%	1 303	0,1%
C 14 Manufacture of wearing apparel	1 887	8,5%	22 158	2,4%
C15 Manufacture of leather and related products	74	0,3%	1 227	0,1%
C16 Timber, articles of wood and cork, unfurnished	263	1,2%	3 466	0,4%

[171] As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C17 Paper, cardboard and paper and paperboard products	766	3,5%	29 476	3,2%
C18 Printing and reproduction of recorded media	460	2,1%	11 777	1,3%
C19 Coke and refined petroleum products	0	0,0%	0	0,0%
C20 Chemicals	2 205	10,0%	346 210	38,2%
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	..	0	..	0
C22 Manufacture of rubber and plastic products	1 537	6,9%	54 184	6,0%
C23 Products from other non-metallic mineral raw materials	985	4,5%	72 899	8,0%
C24 Base metals	47	0,2%	2 430	0,3%
C25 Metal products, except machinery and equipment	2 400	10,8%	62 791	6,9%
C26 Manufacture of computer, electronic and optical product	300	1,4%	7 224	0,8%
C27 Electrical equipment	826	3,7%	21 468	2,4%
C28 Machinery and equipment, general and special purpose	396	1,8%	11 790	1,3%
C29 Manufacture of motor vehicles, trailers and semi-trailers	26	0,1%	100	0,0%
C30 Manufacture of other transport equipment	..	0	..	0
C31 Manufacture of furniture	746	3,4%	8 797	1,0%
C32 Other manufacturing	534	2,4%	10 468	1,2%
C33 Repair and installation services of machinery and equipment	4 466	20,2%	154 411	17,0%
.. Confidential data				

Source: NSI Structural Business Statistics, 2019

As seen from the Manufacturing Industry structure, the main industrial activities in the district include chemical industry, cement industry, sanitary ceramics, glass industry, food industry, shipbuilding, machine building and metalworking, textiles and wearing apparel.

In the industrial zone of Varna and Provadia there are about 100 enterprises in the field of machine building, ship repairing, internal combustion engines, telecommunications, shipping, medical equipment, household goods, textiles and metallurgy. The chemical industry is concentrated in Devnya. The Devnya Chemical Complex alone provides 16% of the national chemistry production. Other productions developed on the territory of Devnya include production of soda, fertilizers, heat energy, construction materials, sugar and other products, concentrated in Devnya municipality. About 50% of the sales of the largest soda factory in Bulgaria and Europe are for clients from in the glass industry, about 15% are for manufacturers of detergents and cleaners, and the rest is distributed between the chemical industry and metallurgy, silicates and glass fibres. A leading producer of nitrogen fertilizers in Southeast Europe and a leader in the production of phosphorus fertilizers on the Balkan Peninsula operates on the territory of the Region. The geographical location, product range and production capacity position the fertilizer plant as a supplier to the Bulgarian and regional markets of the Balkans, Central and Eastern Europe and also on the international market in Western Europe, the Middle East, North and South America. Production, processing, sale of cement, clinker, dry mixes, paints, plasters, sands, micronized and other fractions of limestone, hydraulic binders and concrete products are also concentrated in Varna Region, as well as a significant part of electronic, glass, porcelain, faience, clothing and footwear industries.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[172].

The data for the directly affected 4-digit sectors from the manufacturing industry is presented in Table 57 below.

Table 57. Directly affected industrial sectors in Varna district

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Profit	Investm. in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN '000)	(BGN '000)	(BGN '000)	(BGN '000)	(number)	(BGN '000)
1	23.51 Manufacture of cement	1	124 222	52 334	16 459	8 982	218	7 065
2	20.13 Manufacture of other inorganic basic chemicals	1	440 893	246 205	115 392	42 799	486	20 170
3	20.15 Manufacture of fertilisers and nitrogen compounds	1	460 936	142 031	60 299	N/A	701	16 548

Source: Enterprise survey implementd by the team

The following indirectly affected sectors in Varna district have been identified, based on a value chain survey with a limited scope[173]:

Table 58. Indirectly affected industrial sectors in Varna district

Sectors included in the supply chain of directly affected sector				20.13	Manufacture of other basic inorganic chemicals		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN '000)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	46. Wholesale trade, except of motor vehicles and motorcycles	3	89 808	92 291	7 763	231	2 534

[172] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify CO_2-intensive companies.

[173] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

2	49. Land transport and transport via pipelines	1	16 245	16 245	11 888	228	4 384
3	08. Other mining and quarrying	1	12 390	12 367	8 025	45	2 277
4	81. Building maintenance and landscaping activities	3	16 997	16 997	15 389	153	2 752
5	33. Repair and installation of machinery and equipment	2	2 424	2 424	2 371	50	613
6	27. Manufacture of electrical equipment	1	2 622	2 622	1 596	34	819
7	80. Security and investigation activities	1	4 138	4 138	3 937	276	2 810
8	25. Manufacture of fabricated metal products, except machinery and equipment	1	1 017	1 017	909	32	497
9	45. Wholesale and retail trade and repair of motor vehicles and motorcycles	1	1 388	1 388	1 177	36	523
10	43. Specialized construction activities	1	497	497	467	16	114
11	41. Construction of buildings	1	290	290	290	10	54
12	72. Research and development	1	1 069	1 069	957	12	0
13	38. Waste collection, treatment and disposal activities; materials recovery	1	178	178	127	0	1
14	39. Remediation activities and other waste management services	1	320	320	319	5	0
15	52. Warehousing and support activities for transportation	3	13 064	13 064	3 934	42	1 201
Sectors included in the supply chain of directly affected sector				**23.51**	**Manufacture of cement**		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN ‘000)	Production value (BGN ‘000)	Value added at factor cost (BGN ‘000)	Number of employees (number)	Wages and salaries (BGN ‘000)
1	46. Wholesale trade, except of motor vehicles and motorcycles	1	10 679	13 159	4 550	224	2 095
Sectors included in the supply chain of directly affected sector				**23.11**	**Production of flat glass**		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN ‘000)	Production value (BGN ‘000)	Value added at factor cost (BGN ‘000)	Number of employees (number)	Wages and salaries (BGN ‘000)
1	46. Wholesale trade, except of motor vehicles and motorcycles	1	77 436	77 447	1 539	3	121
2	52. Warehousing and support activities for transportation	3	13 064	13 064	3 934	42	1 201

Sectors included in the supply chain of directly affected sector				**19.20**	**Manufacture of refined petroleum products**		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN '000)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	46. Wholesale trade, except of motor vehicles and motorcycles	1	1 693	1 685	1 674	4	318

Source: Enterprise survey implementd by the team

Energy Sector and Buildings

The energy infrastructure network of Varna district is well developed and ensures a generally reliable supply of electricity for industry and households. However, some electricity distribution network equipment is old and requires repairs. Key energy infrastructure in Varna includes the Varna Thermal Power Plant (the largest thermal power plant in Bulgaria, at 6x210 kW5), two co-generation plants (Veolia Energy Varna and Solvey Sodi) and 49 renewable energy power, three system electricity substations, 11 regional substations and 240 kilometers of supply power lines.

The utility companies operating in the district are presented in Table 59.

Table 59. Energy operators in Varna district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
ELEKTRORAZPREDELENIE SEVER AD	Electricity distribution (20kV/380V)
ARESGAS EAD	Natural gas distribution in Varna municipality
PRIMAGAS AD	Natural gas distribution in Varna municipality

There are also 49 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (46) and 2 are wind plants, as shown in Table 60:

Table 60. Installed capacity and energy production by type of RES in Varna district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Solar energy	46	11.702290	14 165.345
Wind energy	2	60.450000	121 514.834
Water energy	1	1.183000	445.562
Total	49	73.335290	136 125.741

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, an energy survey was conducted in mid 2021.

Table 61. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for a new substation and connecting lines for 43 mln.EUR and about 6 mln.EUR for new transformers.
ELEKTRORAZPREDELENIE SEVER AD	Not significant changes in the next years expected
ARESGAS EAD	Not significant changes in the next years expected
PRIMAGAS AD	Not significant changes in the next years expected

Source: Enterprise survey implemented by the team

In 2020 there is a request for connection of five new PV plants with total capacity 310,5 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [174] 1 kWp installed PV capacity in Varna will produce 1315.71 kWh per year and will save 558 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Varna in sector D Electricity, gas, steam and air conditioning supply are summarized in Table 62:

Table 62. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019
Number of enterprises	64	65	70
Number of persons employed	2148	2256	2337
Revenues, thousands BGN	1406201	1092693	1087249

Source: NSI

There is increase of the number of enterprises and employed persons for the sector in the period 2017-2019.

Indicators to be monitored:

[174] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh
- GHGs emissions savings, t/y

Housing in district Varna consists of 266,328 dwellings with 217,159 of the dwellings situated in the cities and 49,169 in the villages [175]. There are 83 buildings from the district with energy efficiency certificate. The average current energy consumption is 185,98 and it is expected to be reduced after renovation to 83,23 kWh/m2. Expected annual energy savings are estimated at 25324833,94 kWh/a and CO2 savings- 10559,577 t/a.

Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme. In June 2021 the renovated buildings were 41 in Varna, 6 in Provadia, 4 in Aksakovo, 3 in Beloslav, 2 in Dolni Chiflik and 2 in Vulchi dol [176]. The municipalities in district Varna have energy efficiency and RES programmes as Vetrino and Provadia have also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

Activities on structural reconstruction /strengthening/ overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;

- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;
- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.
- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.

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[175] https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

[176] https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Varna for 3-year period are presented in Table 63.

Table 63. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%
Number of enterprises	1997	2040	2055	2.90
Number of persons employed	13999	14750	14691	4.94
Revenues, thousands BGN	1348841	1838161	1809185	34.13

Source: NSI

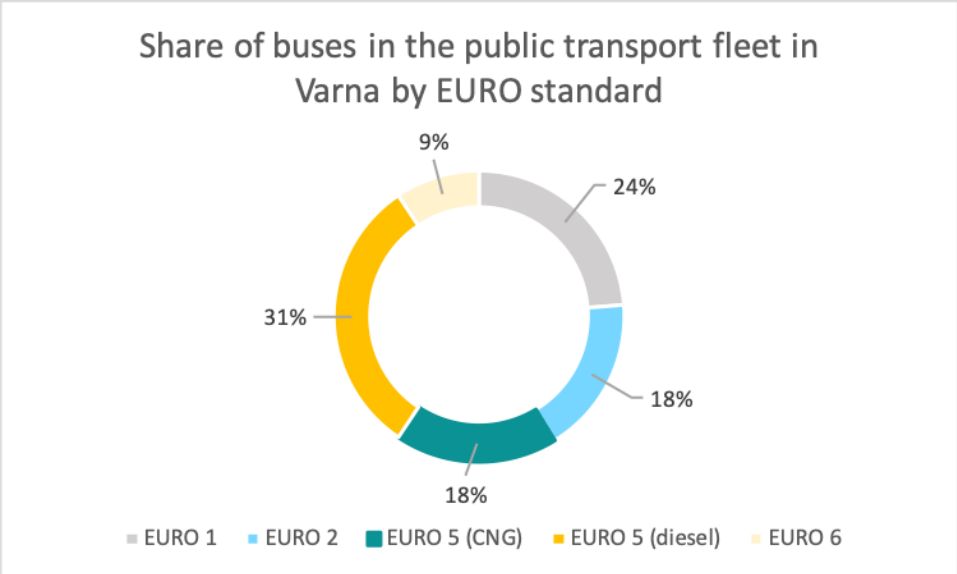
The increase of revenue is 34.13% due to the increased economic activities.

Public Transport Sector

Varna municipality is the main municipality in the Varna district and is the main city with developed public transport network in the district. The municipal enterprise Public Transport is responsible for providing the public transport service in Varna municipality.

There are both buses and trolleybuses operating in the public transport network of Varna municipality. Almost one third of the buses operating the public transport network in the municipality are EURO 5 diesel buses. Nevertheless, there is a significant number of EURO 1 and EURO 2 buses still in use in the public transport network – see Figure 28 below.

Figure 28. Share of buses in the public transport fleet in Varna by EURO standard in 2019



Source: World Bank Municipal survey, 2021

In 2019, the total mileage of public transport buses (buses and trolleybuses combined) was 12 075 412 km with total diesel consumption of 4 198 661 liters and total CNG consumption of 555 424 kg, which emitted an estimated 12 733.7 tonnes of CO_2. The emission rate of 1.19 kg CO_2/passenger km was higher than the calculated national average of 1.16 kg CO_2/passenger km. Table 64 below summarizes the current profile of public transport in Varna.

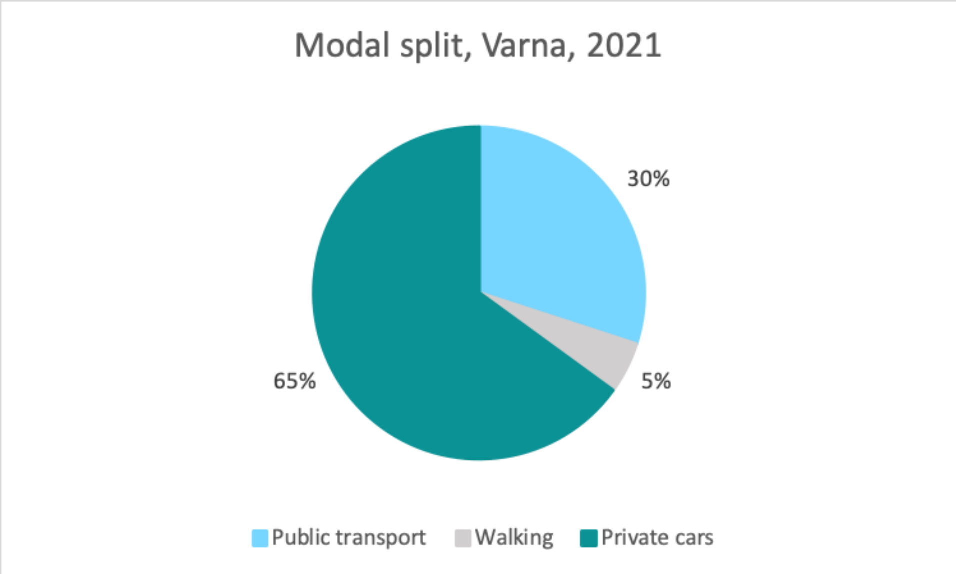
Table 64. Current profile of public transport in Varna

Item	Description
Type of vehicles in public transport network	Buses (diesel and CNG) Trolleybuses
Number of public transport passengers (2019)	Buses: 29 305 000 Trolleybuses: 4 145 000
Total annual consumption of diesel for buses in the public transport network, in liters (2019)	4 198 661
Total annual consumption of CNG for buses in the public transport network, in kg (2019)	555 424
Total annual consumption of electricity for trolleybuses in the public transport network, in MWh (2019)	3 062.9
Total annual mileage of public transport buses, in km (2019)	10 743 034
Total annual mileage of public transport trolleybuses, in km (2019)	1 332 378
Total estimated CO2 emissions from public transport, in t (2019)	12 733.7
Total estimated CO2 emissions per passenger km of public transport, in kg (2019)	1.19

Source: World Bank Municipal survey, 2021

The latest modal split data that Varna municipality provided is for 2021. According to this study, the majority of trips in Varna are executed by private vehicles (65%), followed by public transport (30%), whereas walking and cycling accounted for just 5% of all trips - see Figure 29 below.

Figure 29. Modal split, Varna, 2021



Source: World Bank Municipal survey, 2021

A questionnaire was sent to Varna municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport development. Some of the key plans and initiatives are summarized below:

- Varna municipality has adopted a Sustainable mobility plan. The main goal of the plan is to improve attractiveness of public transport and increase the share of walking and cycling.There are 34 km of bicycle lanes in Varna municipality. Moreover, the municipality has developed an application to encourage walking and cycling through the City Walk project;
- Varna municipality already has 31 charging stations for electric vehicles and is planning to expand the charging infrastructure for electric buses and cars with 62 charging stations – 60 slow charging and 2 fast charging ones;
- Varna municipality plans to purchase 60 electric buses, and plans to create a bus rapid transit system. The municipality is also considering the introduction of a Low Emission Zone through congestion charging, and;
- Varna municipality is planning to improve digitalization of public transport in terms of providing information online, developing a public transport application and providing WiFi on public transport vehicles.

In addition to Varna municipality, information was obtained for the public transport network of Devnya municipality – an industrial center within Varna district. The public transport network in Devnya is run by a private company following a tendering procedure by the municipality. The public transport network in Devnya is rather small, which is to be expected given the small size of the municipality. Two EURO 3 buses serve the public transport network in Devnya. Details about the current state of public transport in Devnya is provided in Table 65 below.

Table 65. Current profile of public transport in Devnya

Item	Description

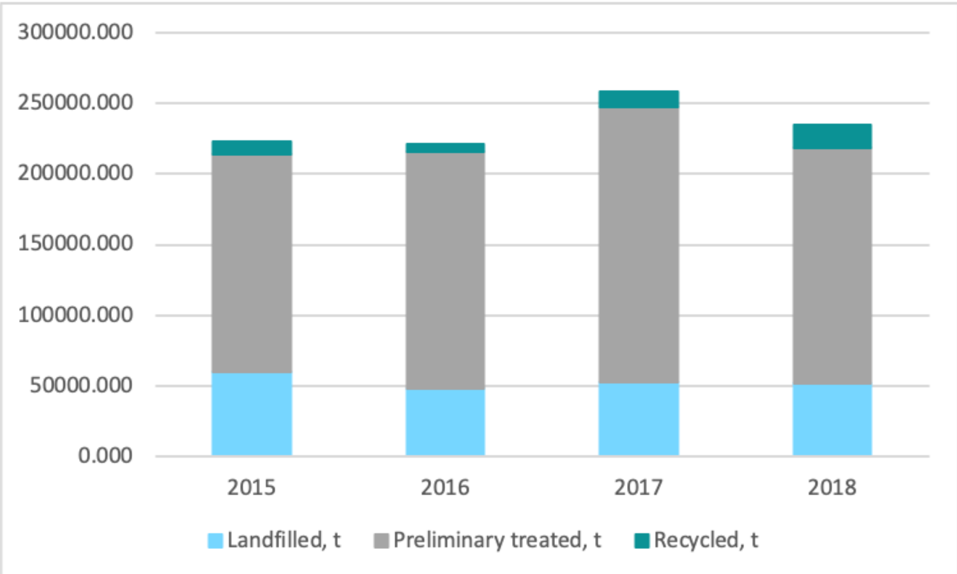
Type of vehicles in public transport network	Buses
Number of public transport passengers (2020)	22 190
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	16 900
Total annual mileage of public transport buses, in km (2020)	93 890
Total estimated CO2 emissions from public transport, in t (2020)	45.7
Total estimated CO2 emissions per passenger km of public transport, in kg (2020)	0.49

Source: World Bank Municipal survey, 2021

Waste Sector

There are two Regional Associations for Waste Management (RAWM) in Varna district – RAWM Varna and RAWM Provadia. All households in Varna district are served by municipal waste collection systems. The amount of generated waste in the district is in general growing in the period 205-2018. The amount of recycled municipal waste is also generally growing, but in 2018 it represented a mere 7% of all generated municipal waste - see Figure 30 below.

Figure 30. Generated and recycled municipal household waste in Varna district, 2015-2018, t



Source: National Statistical Institute, 2019

There are two regional waste depots in Varna district that serve all municipalities in the region and that are managed by the respective Regional Associations for Waste Management (RAWM). The GHG emissions from the RAWM Varna waste depot in 2019 are presented in the table below. The remaining landfill capacity of the waste depots in Varna district is reported to be 260450.30 m^3.

Table 66. GHG emissions of waste depots in Varna district

Waste depots	CO2 emissions, t	CH4 emissions, t

Regional waste depot municipalities of Varna, Aksakovo and Beloslav (RAWM Varna)	8.9	4.4
Source: Executive Environmental Agency		

The latest draft of the National Waste Management Plan 2021-2028 recommends some potential improvements to the existing waste management system in Varna district. The Provadia RAWM is in the indicative list for construction of installations for treatment of biodegradable waste. As far as existing infrastructure for collection, recycling, utilization and re-use of waste is concerned, Byala municipality reports no coverage of population by recycling infrastructure, while the other municipalities that answered the waste survey (Avren, Devnya and Varna) reports 100% or nearly 100% coverage. Most municipalities that answered the waste survey report limited initiatives in collecting and treating waste streams different than from the main recyclable waste products (glass, paper, metals, plastics). Varna municipality has plans to collect green waste from parks, biodegradable waste from households and construction waste. In terms of planned activities according to particular waste management practices, all municipalities that answered the survey mentioned that they are planning to expand the recycling infrastructure.

Some examples of industrial symbiosis are found in Varna district. Companies from the district were contacted to participate in an industry survey that included questions on waste utilization and industrial symbiosis, among other questions. One example is highlighted in the box below:

Box 9. Industrial symbiosis in Varna district

The multitude of industries located in the Devnya industrial zone provide ample opportunities for industrial symbiosis. An example for industrial symbiosis comes from two companies in this industrial zone.

Agropolihim produces fertilizers, whereas Alifos produces feed phosphates. Alifos buys phosphoric acid used to manufacture fertilizers from Agropolihim. Alifos applies a process to purify the phosphoric acid which can then be used in the production of feed phosphates.

Source: denskatt, 2019[177]

2.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Varna district:

- Cement industry
- Soda ash industry
- Ammonia fertiliser industry

[177] https://www.bia-bg.com/uploads/files/Projects/Combined%20Report_SWAN_denkstatt_190430.pdf

Energy sector and buildings

Decarbonization measures for energy sector in Varna includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

Varna municipality is considering the implementation of a Low Emission Zone through a congestion charge which can reduce transport demand, especially in terms of using private cars. In addition, such a measure provides an incentive for shifting to lower-carbon transport modes such as using public transport, walking and cycling.

With regards to reducing the GHG emissions from public tranposrt, the focus should be to replace the existing EURO 1 and EURO 2 buses, which are the oldest and most inefficient buses in Varna's public transport fleet. Varna municipality is planning to purchase 60 electric buses which will significantly reduce GHG emissions of public transport. Currently, estimated CO_2 emissions per passenger kilometer in Varna are slightly higher than the estimated national average. Thus, replacing the oldest buses with electric buses in the public transport fleet would reduce the carbon intensity of public transport that could bring it below the national average.

Waste

There is potential for moving up in the waste management hierarchy in Varna district. For instance, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Varma municipality (the main municipality in the district) could improve collection and treatment of green and biodegradable waste form households, as well as construction waste. The smaller municipalities in the district could improve collection and treatment of other waste streams, outside of the glass, paper, metals and plastics streams.

Varna district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach. In addition, an Industrial symbiosis plan or initiative could be launched in Devnya industrial zone as it is home to a number of industries which can potentially benefit from industrial symbiosis.

2.2 The impact of the transition to a climate-neutral economy

2.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to **directly estimate** the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 67 below.

Table 67. Assessment of the economic impact of industrial decarbonization in Varna district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy[178] (BGN '000)	Share of affected companies (%)
Number of companies (number)	3	33 529	0.01%
Turnover (BGN '000)	1 027 958	17 726 815	5.80%
Production value (BGN '000)	1 026 051	10 939 422	9.38%
Value added at factor cost (BGN '000)	440 570	4 400 250	10.01%
Profit (BGN '000)	192 150	1 773 014	10.84%
Investments in tangible long-term assets (BGN '000)	51 781	8 330 148	0.62%
Number of employees (number)	1 405	124 082	1.13%
Wages and salaries BGN '000)	43 783	1 835 974	2.38%
Indirectly affected businesses (limited scope of the supply chain coverage)			
Economic indicator	Total value for all indirectly affected	Impact on the district economy	

[178] All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organisations and bodies.

	companies (BGN '000)	Value for the whole district economy (BGN '000)	Share of affected companies (%)
Number of companies (number)	28	33 529	0.08%
Turnover (BGN '000)	265 319	17 726 815	1.50%
Production value (BGN '000)	270 262	10 939 422	2.47%
Value added at factor cost (BGN '000)	70 846	4 400 250	1.61%
Profit (BGN '000)	18 533	1 773 014	1.05%
Investments in tangible long-term assets (BGN '000)	N/A	8 330 148	N/A
Number of employees (number)	1 443	124 082	1.16%
Wages and salaries BGN '000)	22 314	1 835 974	1.22%
Cummulative impact (directly and indirectly affected businesses[179])			
Economic indicator	Total value for all affected companies from the district (BGN '000)	Impact on the district economy	
		Value for the whole district economy (BGN '000)	Share of affected companies (%)
Number of companies (number)	31	33 529	0.09%
Turnover (BGN '000)	1 293 277	17 726 815	7.30%
Production value (BGN '000)	1 296 313	10 939 422	11.85%
Value added at factor cost (BGN '000)	511 416	4 400 250	11.62%
Profit (BGN '000)	210 683	1 773 014	11.88%
Investments in tangible long-term assets (BGN '000)	51 781	8 330 148	0.62%
Number of employees (number)	2 848	124 082	2.30%
Wages and salaries BGN '000)	66 097	1 835 974	3.60%

Source: Enterprise survey implemented by the team

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the two 2-digit sectors in the district, which will be directly affected by the industrial decarbonization, sector **C20** is a **key sector** and sector **C23** has a **strong**

[179] Llimited supply chain coverage.

backward linkage to the district economy. Both (types of) sectors are important for the district economy in terms of indirect employment impacts.

Table 68. Key sectors[180] and sectors with backward linkages[181] in Varna district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C20	Key sector (BW)	8	4.02
C23	Backward linkages (K)	11	2.22

On the basis of relevant Type I employment multipliers, it was established that in the worst-case scenario for **sector C20** a total of 4,772 jobs could be lost, which included 1187 initial job losses in the identified directly affected businesses, and 3,585 job losses in their supply chain. **For sector C23** in the worst-case scenario a total 483 jobs could be lost, which include 218 initial jobs of the identified directly affected companies, and 265 jobs in their supply chains. It was thus established on the grounds of the employment multipliers, that the **total impact of the decarbonization of those two major sectors** on the district economy could be the loss of 5,255 jobs, including 1,405 jobs in the directly affected industries and 3,850 jobs in their supply chains in the district.

Summary

The subsectors of 20.13 Manufacture of other inorganic basic chemicals, 20.15 Manufacture of fertilisers and nitrogen compounds and 23.51 Manufacture of cement, to which the three identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The three affected businesses generate 10% of the output and of the value added at factor cost, as well as 1,1% of the employment and 2.3% of the wages and salaries, of the district economy.

It was established under a supply chain survey with a limited scope that the **indirect impacts** of the industrial decarbonization spill over to 15 subsectors, varying from mining & quarrying to manufacturing and repair & installation of equipment, and to a variety of service sectors, such as wholesale trade, transport & logistics, security services, remediation & waste management, construction, etc. The identified indirectly impacted businesses account together for 2,47% of the output, 1.6% of the value added and 1.2% of the employment and of the wages & salaries generated by the district economy.

It was thus estimated under the *survey method* that the decarbonization of the district economy will **cumulatively affect industrial subsectors** providing 12 % of the output and of the added value, 2.3% of the employment and 3.6% of the wages & salaries of the non-financial sector of the district economy.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the carbon-intensive industries in the district could result in the hypothetical

[180] Sectors with strong forward and backward linkages to other sectors in the district economy.

[181] Sectors with strong backward linkages to other sectors in the district economy.

loss of 5,255 jobs, this including 1,405 jobs in the directly affected industries and 3,850 jobs in the supply chains of two major CO_2-intensive sectors in the district.

Energy sector and buildings

In 2019 there were 70 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a toal of 2337 employees. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 69. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[182]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	70	33529	0.21
Number of employees (number)	2337	151472	1.54
Wages and salaries (BGN '000)	48174	1835974	2.62

Source: Enterprise survey implemented by the team

Although sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well presented in the district.

Table 70. Economic indicators for sector F Construction in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[183]	
		Value for the whole district economy	Share of affected companies (%)

[182] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

[183] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Number of companies (number)	2055	33529	6.13
Number of employees (number)	14691	151472	9.70
Wages and salaries (BGN '000)	168878	1835974	9.20

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term as the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics** (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Varna district in 2018 was just 7%, whereas 71% was preliminary treated and 22% landfilled. Therefore, it might be expected that more sophisticated **waste management, treatment and utilization_that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

2.2.2 The social impacts of the transition

Varna is the leading economic center in Northern Bulgaria which makes it an attractive migration destination, especially among younger age groups. The district experiences positive net migration, but population projections from NSI predict a decline of 419 thousand people by 2050: migration inflows are insufficient to offset the declining number of live births. Younger age groups (0-19 years old) formed the bulk of immigration, most of which came from the rest of the country, especially the neighboring districts of Dobrich and Shumen. Conversely, outmigration flows to Sofia were quite substantial. Age dependency ratios are below the national average.

Table 71. Key labor and social indicators, Varna

	Varna	Bulgaria	EU-27
Population			
Dependency ratio	52.9	55.5	54.9
Old-age dependency ratio	29.7	33.2	31.4
Net migration	339		
abroad	6		
of 20-39 y.o.	151		
Labor			
Employment rate	70.2	68.5	67.7
Unemployment rate	2.2	5.2	7.2
Share of manufacturing in total employment	13	22	
Share of 25-54 in employment	81	76	
Share of job openings for high-skilled labor	13		
Skills			
Share of employed with tertiary education	27	31	
Jobseekers/vacancies ratio (low-skilled)	6		
Share of TVET in IT-related curricula	15		
Social inclusion			
Poverty	24.0	23.8	
Number of energy beneficiaries	12,327	283,680	
Share of energy beneficiaries using fossil fuel	77	88	
Labor impact			
Share of workers in carbon-intensive sectors	2		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

Varna is thus a younger district, with a more educated workforce, better educational system and economic opportunities. Over one in three workers is less than

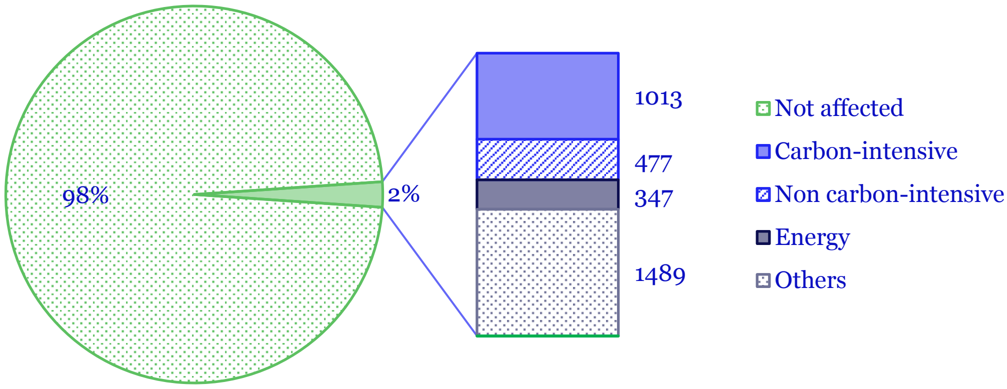
34 years old, as compared to 1 in 4 at the national level; and only one in three workers didn't graduate from upper-secondary school, as compared to 45 percent at the national level. The local labor market has also traditionally displayed higher wage levels and low unemployment rates: the unemployment rate remained consistently lower than the country average ever since 2015 except for 2017. At 75 percent, Varna also boasted the highest labor force replacement ratio (15-19/60-64-year-olds) in the country, compared to a national average of 66 percent, suggesting that the anticipated negative consequences of the demographic crisis on the local labor force are not as clearly pronounced as in other districts.

The distribution of employment reflects the dominating role of service sector activities in local labor markets. Wholesale and retail trade, manufacturing, and accommodation and food service activities play a key role in the district economy (respectively 19, 13 and 10 percent). In addition, the district reports a relatively high share of employment in higher value-added service sector activities (10 percent) such as ICT, financial and insurance activities, real estate activities and professional, scientific and technical activities.

All workers are facing difficulties in finding job opportunities. Demand for skills is concentrated in the medium- and low-skills spectrum: two thirds of all job offers registered with the national employment agency require medium skills sets, while an additional 20 percent require low levels of skills. Persistent imbalances between supply and demand of are observed in all skill segments. Although the number of job seekers with low and medium skillsets is gradually decreasing in the recent years, registered number of unemployed with low level of skills is still more than six times higher than the job opportunities requiring the same level of skills.[184] Very few job openings requiring high level of skills have been registered in the employment agency, while the number of registered highly skilled unemployed remains stable at above 2000 individuals. The education system is gearing up for a greener and more digital future: while the largest specialization remains "hotels, restaurants and caterings" (reflecting the importance of tourism sector on the local labor market), around 25 percent of VET students are enrolled in technical and engineering professional areas, and an additional 9 percent enrolled in IT areas.

Figure 31. Employment in affected sectors, including value chain (share, then total numbers)

184 For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019).

Varna could be only moderately affected by the implementation of the EU Green Deal. This is primarily due to its comparatively large and diversified economy in which 73 percent of the Gross Value Added (GVA) is generated by the service sector. Chemical and cement production, heat generation, and gas production and distribution are the main industrial sectors that will be directly affected by decarbonization. These "transforming sectors" in the context of the EU Green Deal host eight leading companies with verified emissions under the ETS, among which large chemical, fertilizer and cement manufacturers, the subsidiary of a leading natural gas producer and distributor, a district heating company and two thermal power plants.

An estimated 3.3 thousand workers, or 2 percent of the total workforce, is employed in carbon-intensive industries and subcontractors. About 1.8 thousand workers are employed directly in carbon-intensive industries, and an additional 1.4 workers are employed by subcontractors of the largest GHG emitters. Due to its regional economic significance, Varna is one of the districts whose economy stands to be among the most affected in terms of the up-stream and down-stream impact of decarbonization. These are mostly in wholesale trade and land transport, but also mining, construction, building maintenance, manufacture, repair and installation of machinery and equipment, warehousing and security.

However, the labor-induced impact of the transition to carbon neutrality could have a disproportionate effect on some of the municipalities. This is particularly true for the municipality of Devnya, which provides 74 percent of the directly affected employment. The Devnya Chemical Complex located in the municipality provides 16 percent of the national chemistry production. The municipality also has manufacturing companies engaged in the production of soda ash, fertilizers, heat energy, construction materials, sugar and other products. Among the largest companies located in Devnya municipality, there is an even split between workers with upper-secondary and higher education. Over 70 percent of the workforce is aged 35-54 years – i.e. in prime working age. More than half of the workers have been with their respective companies for more than 10 years and wages are overwhelmingly higher than the district average. While most of the workforce commutes daily from the Municipality of Varna, the companies also employ workers from other municipalities such as Aksakovo (World Bank Industry Survey, 2021).

The district labor market is vibrant enough to accommodate a potential excess of workers resulting from the restructuring or suspension of activities of companies in the transforming sectors. The local education system offers a variety of higher education and training opportunities, including both academic and vocational education and training (VET). In addition to 103 general schools in Varna, there are 19 VET schools, 2 arts and sports schools, 3 VET colleges and 6 universities. About half of the secondary students in Varna are enrolled in vocational tracks. As of May 2021, there are 73 licensed centers for vocational training providing continuous vocational training for some 8,000 adults annually. More than 80 percent of these adult trainees graduated with partial qualifications.

Finally, the social impact of the transition may be channeled through rising energy prices. Some 13 percent of the population of the district still uses wood as heating fuel, and another 5 percent uses the services of the district's largest heating utility company which falls within the scope of the transforming activities. But the population of the district is relatively well-positioned to face some of the potential indirect impacts of decarbonization, with a relatively low share of the population living in poverty in 2019 (24 percent).

2.2.3 The environmental impacts of the transition

The largest GHG emitters in Varna district operate in the industries of soda ash production, cement manufacturing and ammonia production. In addition, enterprises in the soda ash produciton and in cement manufacturing still use coal. The focus of decarbonization pathways for the carbon-intensive industries in Varna district include the following main activities:

- Switching from fossil fuels to lower-carbon fuels.
- Improved processes' energy efficiency and system optimization.
- Materials' recycling.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

The measures outlined above have the largest potential to reduce GHG emissions in Varna district. Table 72[185] summarizes the potential environmental impacts from the main decarbonization measures in the carbon-intensive industries in Varna district.

Table 72. Potential environmental impacts from decarbonizing the carbon-intensive industries in Varna district

Decarbonization Pathway	Potential impacts on				
	Air	Water	Resource efficiency/Waste generation	Soil, land use, biodiversity	Indirect impacts
Switching from fossil fuels to electricity Relevant for: Soda ash Cement	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.

[185] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Ammonia	processes (e.g. cement kilns, heat input in the production of ammonia) eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.				
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen) Relevant for: Soda ash Cement Ammonia	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	Potential negative impacts Additional need for transportation and transport infrastructure.

Switching from fossil fuels to renewable energy (except biomass) Relevant for: Soda ash Cement Ammonia	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly positive impact Overall, reduced risk of water pollution. There is a potential risk of eutrophication in case of hydropower generation.	Potential positive and negative impacts Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	Fuel dependent Deployment of renewable energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	Fuel dependent
Material recycling Relevant for: Cement	Depends on process If no additional energy input (coming from polluting fuels) is required in order to recycle the material, then the impact is positive.	Depends on process If no additional water is needed for material recycling, then the impact is positive.	Positive impact Improves resource efficiency and reduces waste.	Positive impact Reduced extraction of virgin materials.	
Improved energy efficiency and system optimization Relevant for: Soda ash Cement	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics
Carbon Capture and Storage/Utilization (CCS/U) Relevant for: Soda ash Cement Ammonia	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO186. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils. Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

2.3 Economic diversification potential and related development opportunities

Following the diversification screening methodology, rapidly growing sectors providing diversification opportunities for the district economy, have been identified, as detailed lists of new products recommened for export diversification of some of those sectors have additionally been provided.

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

2.3.1 Small and rapidly growing sectors

Eleven small, but rapidly growing sectors. providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 73. Small and Rapidly Growing Sectors for Varna District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[187]
1	03. Fishing and aquaculture	N/A[188]
2	02. Forestry and logging	N/R[189]

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[186] https://www.who.int/health-topics/air-pollution#tab=tab_3

[187] Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

[188] Not Available.

[189] Not Relevant.

3	63. Information service activities	N/R
4	11. Manufacture of beverages	N/A
5	26. Manufacture of computer, electronic and optical products	Resistors, clippers, lamps, sound equipment (HS codes 8533, 8510, 8513, 8519)
6	17. Manufacture of paper and paper products	N/A
7	32. Other manufacturing	N/A
8	08. Other mining and quarrying	N/R
9	18. Printing and reproduction of recorded media	N/A
10	58. Publishing activities	N/R
11	38. Waste collection, treatment and disposal activities; materials recovery	N/R

2.3.2 Mid-size and rapidly growing sectors

Five mid-size rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 74. Mid-size rapidly growing sectors for Varna District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	55. Accommodation	N/R
2	62. Computer programming, consultancy and related activities	N/R
3	25. Manufacture of fabricated metal products, except machinery and equipment	Padlocks and locks; clasps and frames with clasps incorporating locks, flexible tubes (HS codes 8301, 8307)
4	33. Repair and installation of machinery and equipment	N/A
5	52. Warehousing and support activities for transportation	N/R

2.3.3 Large and rapidly growing sectors

Three large and rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 75. Large and rapidly growing sectors for Varna District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector

1	56. Food and beverage service activities	N/A
2	47. Retail trade, except of motor vehicles and motorcycles	N/R
3	46. Wholesale trade, except of motor vehicles and motorcycles	N/R

Thus a total of 19 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

3 TARGOVISHTE

3.1 Carbon-intensive sectors to be impacted by decarbonization[190]

3.1.1 SSM

The economy of Targovishte district is characterized by a lower degree of economic development compared to the national average. In 2019, the gross domestic product (GDP) produced in the district was worth BGN 1 165 million at current prices, which represents about 1% of the value of the indicator for the country as a whole. This ranked the district 23rd among the 28 districts in Bulgaria under this indicator. In 2019 GDP per capita was BGN 10,470, which ranked the district 12th of the 28 districts in the country. At A3 aggregation level, in 2019 the largest share in the gross value added (GVA) of the district had the sector of services (56%), followed by industry (32.6%) and agriculture (11.4%). Compared to the average structure of GVA of the country, Targovishte district has a lower share of services on the account of a higher GVA share of industry and significantly higher in GVA of agriculture. The gross domestic product per capita (BGN 10,470) and average salary in the district (BGN 12,035) are significantly lower than the national averages, but still the district is among the most developed in North Bulgaria.

In **2019 Foreign Direct Investment (FDI) in the non-financial sector in Targovishte district amounted to EUR 304.9 million at current prices, ranking 13th in the country.** Targovishte has a share of 1.2 % of the total FDI for the country and 9.5% for the North-East region. Almost all of FDI (97.3%) was in the manufacturing industry and 1.6% in the transportation & storage sector. The major part of the FDI in manufacturing industry amounting to EUR 240.7 was in sector Manufacture of glass and glass products.

Manufacturing industry

The structure of the Manufacturing Industry in the district is presented in Table 76 below.

Table 76. Sector C. Manufacturing Industry in Targovishte district, 2019

Sector	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C Manufacturing industry	8 820		233 769	
C10 Manufacture of food products	1 437	16,29%	39 611	16,94%
C11 Manufacture of beverages	238	2,70%	..	..
C12 Manufacture of tobacco products	0	0,00%	0	0,00%
C13 Manufacture of textiles	62	0,70%	..	..
14 Manufacture of wearing apparel	1 120	12,70%	11 957	5,11%

[190] As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C15 Manufacture of leather and related products	..	..	..	..
C16 Timber, articles of wood and cork, unfurnished	155	1,76%	2 571	1,10%
C17 Paper, cardboard and paper and paperboard products	..	..	..	..
C18 Printing and reproduction of recorded media	22	0,25%	303	0,13%
C19 Coke and refined petroleum products	0	0,00%	0	0,00%
C20 Chemicals	..	..	..	..
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	0	0,00%	0	0,00%
C22 Manufacture of rubber and plastic products	208	2,36%	3 367	1,44%
C23 Products from other non-metallic mineral raw materials	3 202	36,30%	138 027	59,04%
C24 Base metals	106	1,20%	2 872	1,23%
C25 Metal products, except machinery and equipment	734	8,32%	13 036	5,58%
C26 Manufacture of computer, electronic and optical product	9	0,10%	..	..
C27 Electrical equipment	254	2,88%	2 154	0,92%
C28 Machinery and equipment, general and special purpose	74	0,84%	2 056	0,88%
C29 Manufacture of motor vehicles, trailers and semi0trailers	..	..	..	..
C30 Manufacture of other transport equipment	0	0,00%	0	0,00%
C31 Manufacture of furniture	..	..	..	..
C32 Other manufacturing	43	0,49%	378	0,16%
C33 Repair and installation services of machinery and equipment	116	1,32%	2 055	0,88%
.. Confidential data				

Source: NSI Structural Business Statistics, 2019

As seen from the table, the most important industrial sectors in the district economy is C23 Manufacture of other non-metallic mineral products and C25 Manufacture of fabricated metal products, except machinery and equipment. The former sector is related to the production of glass. Targovishte district is a leading center for glass production in Southeast Europe with two largest companies from that sector operating in the district. This sector employs about 3,200 people which is about 36% of the employment of the manufacturing industry, and its production amounts to BGN 518 mln which is 28% of that of the district's total.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[191].

The data for each directly affected 4-digit industrial sectors is presented in Table 77 below.

Table 77. Directly affected industrial sectors in Targovishte district

[191] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify CO_2-intensive companies.

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Profit	Investments in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN ‘000)	(BGN ‘000)	(BGN ‘000)	(BGN ‘000)	(number)	(BGN ‘000)
1	23.11 Manufacture of flat glass	1	210 910	46 568	-2 736	75 741	596	10 687
2	23.13 Manufacture of hollow glass	1	202 431	111 738	1 985	6 762	1 718	26 928
3	23.32 Manufacture of bricks, tiles and construction products, in baked clay	1	983	379	-65	24	36	348

Source: Enterprise survey implementd by the team

The following indirectly affected sectors in Targovishte district have been identified, based on a value chain survey with a limited scope[192].

Table 78. Indirectly affected industrial sectors in Targovishte district

Sectors in Targovishte district included in the supply chain of directly affected sector		**23.11 Manufacture of flat glass**					
No	**Sector (2-digit NACE Rev. 2 code)**	**Indicators (2019 data)**					
		Affected companies (number)	Production value (BGN ‘000)	Value added at factor cost (BGN ‘000)	Profit (BGN ‘000)	Number of employees (number)	Wages and salaries (BGN ‘000)
1	46. Wholesale trade, except of motor vehicles and motorcycles	2	8 206	1 710	604	30	590
2	49. Land transport and transport via pipelines	1	22 721	5 372	2 334	89	2 568

[192] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district, which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

3	52. Warehousing and support activities for transportation	1	27 040	12 580	8 290	129	3 175
4	23. Manufacture of other non-metallic mineral products	1	199	105	16	3	34

Source: Enterprise survey implementd by the team

Energy Sector and Buildings

District Targovishte has a well-developed electricity infrastructure with 4 substations 110/20kV and 251 806 kVA installed capacity. There is no district heating or small heating plants with district heating network.

The utility companies operating in the district are presented in Table 79:

Table 79. Energy operators in Targovishte district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
ELEKTRORAZPREDELENIE SEVER AD	Electricity distribution (20kV/380V)
ARESGAS EAD	Natural gas distribution in Targovishte
Overgas Mreji AD	Natural gas distribution in Popovo

To the end of 2020, there are also 67 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (64), 2 are wind and there is one biogas plant, as shown in Table 80.

Table 80. Installed capacity and energy production by type of RES in Targovishte district

Type RES	Electricity Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Solar energy	64	3.268020	3 630.661000
Wind energy	2	1.250000	1 186.107000
Biogas	1	0.850000	7 214.292000
Total	67	5.368020	12 031.060000

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, an energy survey was conducted in mid 2021.

Table 81. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for new transformers, about 4 mln.EUR.
ELEKTRORAZPREDELENIE SEVER AD	Not specified
ARESGAS EAD	Changes in the number of jobs are not expected Other impact was not specified
Overgas Mreji AD	Answer was not received

Source: Enterprise survey implemented by the team

In 2020 there is a request for connection of 1 new PV plant with capacity 36 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [193] 1 kWp installed capacity in Targovishte will produce 1250.77 kWh per year and will save 530 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). Impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Targovishte in sector D Electricity, gas, steam and air conditioning supply are summarized in the following table:

Table 82. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019	Change,%
Number of enterprises	24	25	22	-8.33
Number of persons employed	23	26	26	13.04
Revenues, thousands BGN	1626	1893	na	-

Source: NSI

There are no major changes in the number of economic indicators for the sector in the period 2017-2019.

Indicators to be monitored:

[193] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh
- GHGs emissions savings, t/y

Housing in Targovishte consist of 43,700 residential buildings. 96.5% of the dwellings are private. 27.5% of the buildings are situated in the cities and 72.5% in the villages. The highest share is of the buildings constructed in the period 1946 - 1960 - 30.2%, and the lowest of these constructed from 2011 г. - 0.5% [194]. There are 67 buildings from the district with energy efficiency certificate (until 04.2021). The average current energy consumption is 293,58 and it is expected to be reduced after renovation to 93,76 kWh/m2a. Expected annual energy savings are estimated at 30312879,34 kWh/a and CO2 savings- 5791,779 t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as untill June 2021 the renovated buildings were 18 in Targovishte, 2 in Omurtag and 13 in Popovo [195]. There is one building with co-generation unit, this is the hospital „MBAL – Targovishte“ AD. The installed electrical capacity is 0,104 MWe, it is operating on natural gas and has efficiency 88,06%.

In 2020 21.2% of people in district Targovishte suffer from difficulties to heat their homes [196]. For heating season 2019-2020 6 584 households from the district have received social aid for heating their homes as the majority is for heating with solid fuels (wood logs and coal) [197]. The municipalities in District Targovishte have energy efficiency and RES programmes as Omurtag and Popovo have also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

- Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.

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194 https://www.nsi.bg/tsb/wp-content/uploads/2021/07/24_GFond_2020_trgv.pdf , source NSI

195 https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

196 https://www.nsi.bg/tsb/wp-content/uploads/2021/06/20_SILC_2020_trgv.pdf data from NSI

197 https://shumenonline.bg/2020/10/08/6-751-%D0%B7%D0%B0%D1%8F%D0%B2%D0%BB%D0%B5%D0%BD%D0%B8%D1%8F-%D0%B7%D0%B0-%D0%B5%D0%BD%D0%B5%D1%80%D0%B3%D0%B8%D0%B9%D0%BD%D0%B8-%D0%BF%D0%BE%D0%BC%D0%BE%D1%89%D0%B8-%D0%B2-%D1%82%D1%8A%D1%80%D0%B3/

- Others as ensuring access for disabled people, safety requirements etc.

The expected impactsare:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;

- Social: Providing additional employment; Establishing traditions in the management of multi-family residential buildings; Increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.

- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.

- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Targovishte for 3-year period are presented in the following table:

Table 83. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019	Change,%
Number of enterprises	121	130	154	27.27
Number of persons employed	1791	1980	2255	25.91
Revenues, thousands BGN	122123	182280	308825	152.88

Source: NSI

There is an increase in all indicators due to increase in the economic activities in the sector. The increase in the number of employed persons is 25.91% and in revenues – 152.88%.

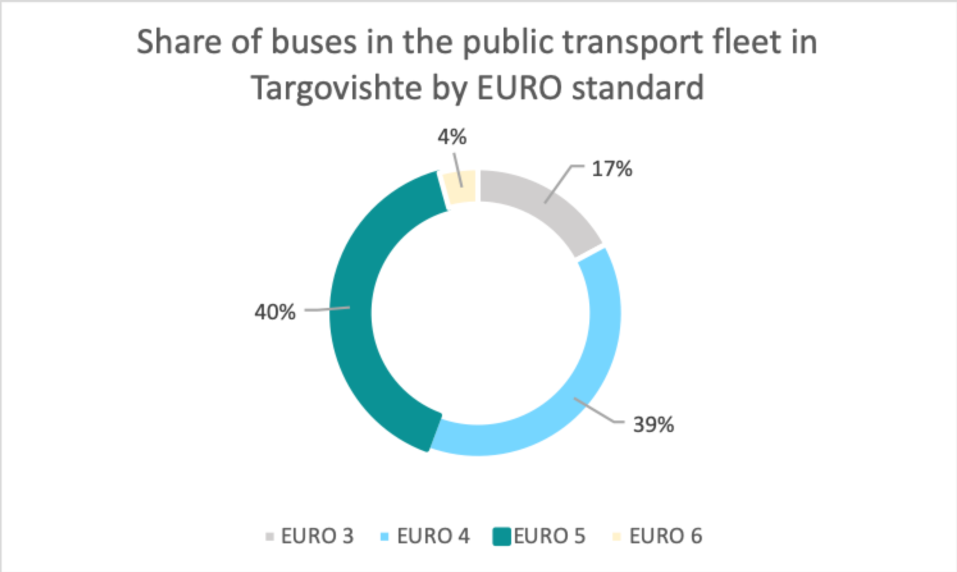
Public Transport Sector

Targovishte municipality is the main municipality in the Targovishte district and is the main city with developed public transport network in the district. The Spatial planning, environment and transport Directorate of the municipality is responsible for managing the local public transport. The municipality conducts a public tender to select the operator of the public transport network.

There are five public transport routes in the city of Targovishte. All public transport in the municipality is run by diesel buses. The majority of buses are EURO 4 and EURO 5 buses. EURO

5 buses account for 40% of the public transport fleet, whereas EURO 4 buses – for 39%. The remaining buses are EURO 3 (17%) and EURO 6 (4%) – see Figure 32 below.

Figure 32. Share of buses in the public transport fleet in Targovishte by EURO standard in 2020



Source: World Bank Municipal survey, 2021

In 2020 the mileage of public transport buses was 624 978 km with total diesel consumption of 218 700 liters which emitted an estimated 591 tonnes of CO_2. The emission rate of 0.95 kg CO_2/passenger km was lower than the calculated national average of 1.16 kg CO_2/passenger km. Table 84 below summarizes the current profile of public transport in Targovishte.

Table 84. Current profile of public transport in Targovishte

Item	Description
Type of vehicles in public transport network	Buses (diesel)
Number of public transport passengers (2020)	587 057
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	218 700
Total annual mileage of public transport buses, in km (2020)	624 978
Total estimated CO2 emissions from public transport, in t (2020)	591
Total estimated CO2 emissions per passenger km of public transport, in kg (2020)	0.95

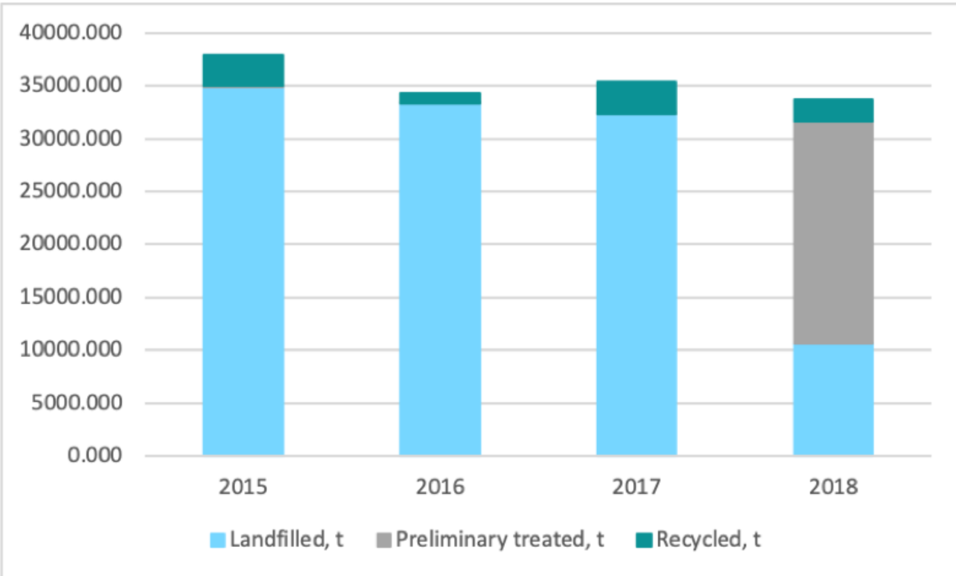
Source: World Bank Municipal survey, 2021

A questionnaire was sent to Targovishte municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport development. As a result of those, it can be concluded that Targovishte municipality is not planning expansion of the charging infrastructure, definitive commitment to phasing-out of fossil fuels in public transport or introduction of a Low Emissions Zone. With regards to other aspects of smart and sustainable local mobility, there are no electric and/or hydrogen charging stations in Targovishte. There are 6 km of bike lanes that cover approximately 8% of the municipality's territory. As far as digitalization of public transport is concerned, the municipality provides online information about public transport routes and timetables.

Waste Sector

There are two Regional Associations for Waste Management (RAWM) in Targovishte district – RAWM Targovishte and RAWM Omurtag. All households in the district are served by municipal waste collection systems. In addition, 68% of households in Targovishte were covered by recycling infrastructure. The municipality of Opaka that also submitted answers to the waste questionnaire reports 100% coverage of the population in terms of recycling infrastructure. Nevertheless, data from the National Statistics Institute shows that in 2018 still over 30% of all generated household waste was landfilled, see Figure 33 below.

Figure 33. Generated and recycled municipal household waste in Targovishte district, 2015-2018, t



Source: National Statistical Institute, 2019

There are two regional waste depots in Targovishte district that serve all municipalities in the district region and that are managed by the respective RAWMs. The GHG emissions from one of the depots in 2019 were reported in its Integrated Environmental Permit annual report and are presented in Table 85. The remaining landfill capacity of the waste depots in Targovishte district is reported to be 585 m^3.

Table 85. GHG emissions of waste depots in Targovishte district

Waste depots	CO_2 emissions, t	CH_4 emissions, t
Regional waste depot - municipalities of Omurtag, Varbitsa, Kotel (RAWM Omurtag)	1760	875.5

Source: Executive Environmental Agency

The latest draft of the National Waste Management Plan 2021-2028[198] recommends a number of potential improvements to the existing waste management system in Targovishte district. Both RAWMs in Targovishte district are in the indicative list for construction of installations for treatment of biodegradable waste and for additional capacity and infrastructure at landfills. As far as existing infrastructure for collection, recycling, utilization and re-use of waste is concerned, Targovishte municipality has established green waste collection from municipal parks and is planning collection of biodegradable waste from households and other types of waste such as batteries, e-waste, tyres, hazardous waste, as well as collection and potential utilization of construction waste. In terms of planned activities according to particular waste management practices, Targovishte municipality has some plans for prevention and reduction of waste generation, re-use of waste and increasing the share of recycling infrastructure.

Some examples of industrial symbiosis are found in Targovishte district. Companies from the district were contacted to participate in an industry survey that included questions on waste utilization and industrial symbiosis, among other questions, see Box 10 below.

Box 10. Industrial symbiosis in glass production in Targovishte district

One of the surveyed companies that participated in the Industry survey from Targovishte district was the glass manufacturer Trakia Glass. Trakia Glass performs both internal and external waste utilization.

The glass shards that are left after production of the different types of glass are re-used in the flat glass production process. A certain percentage of glass shards are added to the mix that is melted and from which flat glass is produced. The share of glass shards in the production mix for flat glass can vary between 5% and 20%.

In addition, Trakia Glass recycles glass shards from other manufacturers that are also used as raw materials in the process of flat glass production.

Source: World Bank Industry survey, 2021

3.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Targovishte district:

- Glass industry
- Ceramics industry

Energy sector and buildings

Decarbonization measures for energy sector in Targovishte includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site

[198] Available at: https://www.moew.government.bg/static/media/ups/tiny/%D0%A3%D0%9E%D0%9E%D0%9F/%D0%9D%D0%9F%D0%A3%D0%9E-2021-2028/NPUO_2021-2028.pdf. Reviewed on August 20, 2021.

- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

A clear decarbonization measure for public transport in Targovishte is to replace diesel buses with electric or hydrogen buses. Nevetheless, 40% of the diesel bus fleet in Targovishte consists of relativelty new EURO 5 buses, which means that realistically replacement of those buses will not happen in the immediate future, but rather in the medium term. Thus, the focus of bus replacement might be the EURO 3 and EURO 4 buses in the public transport fleet.

There is potential for short term measures to encourage sustainable and smart urban mobility in Targovishte. For instance, incentives for walking and cycling could be provided by establishing adequate infrastructure, coupled with some transport demand management measures such as increase in parking fees and/or stricter parking regulation and/or measures regarding reduced private vehicles' access to certain areas of the municipality. Municipal charging infrastructure for electric vehicles could also be developed to serve as an institutional guidance for the direction that urban mobility is moving to.

Waste

There is significant potential for moving up in the waste management hierarchy in Targovishte district. For instance, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Targovishte municipality (the main municipality in the district) could improve collection and treatment of green and biodegradable waste, as well as other waste streams such as textile waste and old furniture. Smaller municipalities[199] in Targovishte district seem to have limited collection of waste streams such as: green, biodegradable, construction, electronic wastes and tyres, among others. Moreover, both Regional Associations for Waste Management (RAWM) in Targovishte district are in the indicative list for constructing installations for treatment of biodegradable waste as per the latest National Waste Management Plan 2021-2028. According to Bulgaria's NECP projections, improved treatment of biodegradable waste is the primary measure to reduce GHG emissions from the waste sector.

Targovishte district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

[199] Apart from Targovishte municipality, only Opaka municipality answered the waste questionnaire.

3.2 The impact of the transition to a climate-neutral economy

3.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to directly estimate the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 86 below.

Table 86. Assessment of the economic impact of industrial decarbonization in Targovisjte district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy[200] (BGN '000)	Share of affected companies (%)
Number of companies (number)	3	4 133	0.07%
Turnover (BGN '000)	429 291	2 625 354	16.35%
Production value (BGN '000)	414 324	1 826 701	22.68%
Value added at factor cost (BGN '000)	134 590	603 333	22.31%
Profit (BGN '000)	-816	162 155	N/R
Investments in tangible long-term assets (BGN '000)	82 527	1 367 467	6.04%
Number of employees (number)	2 350	21 407	10.98%
Wages and salaries BGN '000)	37 963	273 219	13.89%
Indirectly affected businesses (limited scope of the supply chain coverage)			

[200] All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organisations and bodies.

<table>
<tr><td rowspan="2">Economic indicator</td><td rowspan="2">Total value for all indirectly affected companies (BGN ‘000)</td><td colspan="2">Impact on the district economy</td></tr>
<tr><td>Value for the whole district economy (BGN ‘000)</td><td>Share of affected companies (%)</td></tr>
<tr><td>Number of companies (number)</td><td>5</td><td>4 133</td><td>0.12%</td></tr>
<tr><td>Turnover (BGN ‘000)</td><td>55 436</td><td>2 625 354</td><td>2.11%</td></tr>
<tr><td>Production value (BGN ‘000)</td><td>58 166</td><td>1 826 701</td><td>3.18%</td></tr>
<tr><td>Value added at factor cost (BGN ‘000)</td><td>19 767</td><td>603 333</td><td>3.28%</td></tr>
<tr><td>Profit (BGN ‘000)</td><td>11 244</td><td>162 155</td><td>6.93%</td></tr>
<tr><td>Investments in tangible long-term assets (BGN ‘000)</td><td>0</td><td>1 367 467</td><td>0.00%</td></tr>
<tr><td>Number of employees (number)</td><td>251</td><td>21 407</td><td>1.17%</td></tr>
<tr><td>Wages and salaries BGN ‘000)</td><td>6 367</td><td>273 219</td><td>2.33%</td></tr>
<tr><td colspan="4">Cummulative impact (directly and indirectly affected businesses[201])</td></tr>
<tr><td rowspan="2">Economic indicator</td><td rowspan="2">Total value for all affected companies from the district (BGN ‘000)</td><td colspan="2">Impact on the district economy</td></tr>
<tr><td>Value for the whole district economy (BGN ‘000)</td><td>Share of affected companies (%)</td></tr>
<tr><td>Number of companies (number)</td><td>8</td><td>4 133</td><td>0.19%</td></tr>
<tr><td>Turnover (BGN ‘000)</td><td>484 727</td><td>2 625 354</td><td>18.46%</td></tr>
<tr><td>Production value (BGN ‘000)</td><td>472 490</td><td>1 826 701</td><td>25.87%</td></tr>
<tr><td>Value added at factor cost (BGN ‘000)</td><td>154 357</td><td>603 333</td><td>25.58%</td></tr>
<tr><td>Profit (BGN ‘000)</td><td>10 428</td><td>162 155</td><td>6.43%</td></tr>
<tr><td>Investments in tangible long-term assets (BGN ‘000)</td><td>82 527</td><td>1 367 467</td><td>6.04%</td></tr>
<tr><td>Number of employees (number)</td><td>2 601</td><td>21 407</td><td>12.15%</td></tr>
<tr><td>Wages and salaries BGN ‘000)</td><td>44 330</td><td>273 219</td><td>16.23%</td></tr>
</table>

Source: Enterprise survey implemented by the team

[201] Limited supply chain coverage.

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the 3 directly affected industrial subsectors, **none is a key one** for the district or **has strong backward linkages** to other sectors in the district economy, i.e. none of these CO2-intensive sectors is important for the district in terms of indirect employment impacts. Therefore, the decarbonization of those three CO_2-intensive industrial subsectors in a worst-case scenario could result in the hypothetical loss of 2,350 jobs in the directly affected industries, but no loss of jobs in their supply chain within the district are expected.

Summary

The subsectors of 23.11 Manufacture of flat glass, 23.13 Manufacture of hollow glass and 23.32 Manufacture of bricks, tiles and construction products, in baked clay, to which the three identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The 3 affected businesses generate together about 23% of the output, 22% of the value added at factor cost, as well as app. 11% of the employment and 14% of the wages & salaries of the non-financial sector of the district economy.

It was established under a supply chain survey with a limited scope that the **indirect impacts** of the industrial decarbonization spill over to a variety of sectors in the district, ranging from wholesale trade to transportation and logistics, namely sectors 46. Wholesale trade, except of motor vehicles and motorcycles, 49. Land transport and transport via pipelines and 52. Warehousing and support activities for transportation), as well as other companies in sector 23 Manufacture of other non-metallic mineral products. The identified indirectly impacted businesses account together for 3% of the output and of the value added, 1,1% of the employment and 2,3% of the wages & salaries generated by the district economy.

It was thus estimated under the *survey method* that the decarbonization of the district economy will **cumulatively affect industrial subsectors** providing 26 % of the output, 30% of the added value, 12% of the employment and 16% of the wages & salaries of the non-financial sector of the district economy.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the three CO_2-intensive industrial subsectors in a worst-case scenario could result in the hypothetical loss of 2,350 jobs in the directly affected industries, but no loss of jobs in their supply chain within the district were to be expected.

Energy sector and buildings

In 2019 there were only 22 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a toal of 26 employees. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 87. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[202]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	22	4133	0.53
Number of employees (number)	26	24915	0.10
Wages and salaries (BGN '000)	142	273219	0.05

Source: Enterprise survey implemented by the team

Although sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well presented in the district.

Table 88. Economic indicators for sector F Construction in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[203]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	154	4133	3.73
Number of employees (number)	2151	24915	8.63
Wages and salaries (BGN '000)	35643	273219	13.05

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;

[202] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

[203] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term as the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics** (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Targovishte district in 2018 was just 6%, whereas 62% was preliminary treated and 32% landfilled. Therefore, it might be expected that **more sophisticated waste management, treatment and utilization that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

3.2.2 The social impacts of the transition

Targovishte is an aging district, and misses prime-age workers who have left elsewhere to find better economic opportunities. With 109,000 people in 2020, it is one of the smallest out of Bulgaria's 28 districts, ranking 26th in terms of population size. NSI's baseline projections show that the district population will decline steeply by 19 percent to about 85 thousand people by 2050. At 24.6 percent, poverty rates are lightly above the country average: according to local authorities, low-skilled and low-educated workers, the long-term unemployed, people who live in remote areas, and Roma families concentrated in the municipalities of Targovishte, Antonovo and Omurtag are the most vulnerable populations.

Table 89. Key labor and social indicators, Targovishte

	Targovishte	Bulgaria	EU-27
Population			
Dependency ratio	56.4	55.5	54.9
Old-age dependency ratio	33.8	33.2	31.4
Net migration	303		
abroad	394		
20-39 y.o.	-103		
Labor			
Employment rate	56.5	68.5	67.7
Unemployment rate	10.8	5.2	7.2
Share of manufacturing in total employment	31	22	
Share of 25-54 in employment	77	76	
Share of job openings for high-skilled labor	6		
Skills			
Share of employed with tertiary education	9	31	
Jobseekers/vacancies ratio (low-skilled)	13		
Share of TVET in IT-related curricula	31		
Social inclusion			
Poverty	24.6	23.8	
Number of energy beneficiaries	7,121	283,680	
Share of energy beneficiaries using fossil fuel	93	88	
Labor impact			
Share of workers in carbon-intensive sectors	9		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

The effects of ageing are compounded by rapid outmigration (mostly abroad). Net outmigration accounts for 19 percent of the decline of the population in the period 2015-2019.[204] It is most visible in the age groups 30-44, but it also reflects the departure of younger people, mainly abroad and towards the nearby district of Varna. Even so, Targovishte is not experiencing the worst negative demographic trends of the country, and dependency ratios remain on par with the country average, suggesting that it is losing its younger and more educated workforce, at a slower rate than other districts under study.

Targovishte's labor market is traditionally one of the worst-performing in the country with low employment rates and a reliance on traditional sectors. Employment are consistently 10 percentage points below the national average since 2013. Manufacturing continues to be the leading economic activity in the district, employing one third of all workers in 2019. Employment in construction and agriculture is also one of the highest in the carbon-intensive districts, at 8 percent of the total workforce for each sector (NSI, 2019).

[204] Net migration turned positive in 2019 after a neutral 2018 because of increased arrivals from abroad. These likely include a significant share of returnees.

The educational structure of Targovishte's workforce is among the least favorable in the country. Workers with at-most lower-secondary education account for 26 percent of all employment, which is the second-highest share observed in the eight carbon-intensive districts after Sliven (28 percent). Targovishte the district with the lowest share of high-skilled workers out of the eight districts under review: vocational education form by far the largest group (44 percent), while only 19 percent of all employed have tertiary education. In addition, Targovishte displays the lowest share of female labor market participation out of the 8 carbon-intensive districts with Sliven (NSI, 2019).

These lower-skilled workers are already those facing the highest difficulties in finding job opportunities. During the period 2016-2018, the demand for low-skilled labor prevailed, with half of registered job openings requiring low level of skills, which partially reflects the relative importance of the agricultural sector in the district. Demand for high-order skills (at least through the employment agency) has remained negligible. The potential loss of relatively high paying jobs may also have broader implications for the socio-economic environment in the region. The most sizeable mismatch between the supply and demand of skills appears in the segment of low skillsets, where registered jobseekers exceed by 13 times the number of registered vacancies.[205] Adequate medium and high skills may also be difficult to find, as some of the biggest foreign investors often hire mid- and high-skill workers outside of the district, according to local authorities (Employment Agency, 2019)[206].

Targovishte is a leading center for glass production in Southeast Europe – an industry that is expected to be directly affected by decarbonization. The two large glass factories in the district are among the three largest industrial GHG emitters in the district. They employ some 2,300 workers, accounting for about 27 percent of the employed under labor contract of the manufacturing industry and 8.4 percent of the district's total employment in 2019. Among the potentially affected by the transition are also several SMEs engaged in the production of building materials (including ceramics), basic iron and steel products as well as micro-firms dealing with steam and air conditioning supply. The combined number of their workforce is estimated at about 120 people. Additionally, the World Bank's industrial firm survey identified firms employing a total of 251 workers that may be among the affected due to the anticipated disruption of supply chains, primarily regarding firms from the Burgas region.

An estimated total number of about 2.5 thousand workers, or 9 percent of the district workforce, could potentially be affected by the decarbonization process. The two large glass factories in the district are the largest industrial GHG emitters in the district: they employ some 2.3 thousand workers, or about one third of total manufacturing employment. The bulk of these two firms' workers are low-educated prime-age workers, with some seniority within the companies[207] (World Bank Industry Survey, 2021). In addition, around 150 workers are employed by SMEs related to carbon-intensive sectors of activity, mostly manufacturing bricks, tiles, ceramics products and basic iron (NSI and Lakorda,

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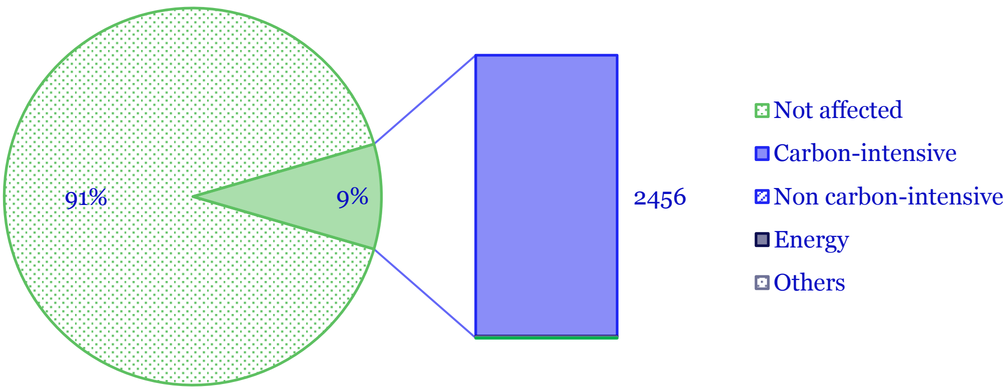
[205] For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

[206]

[207] Two-thirds of the workers are between 35 and 54 year-olds; more than half have been with the company for more than 6 years.

2019).[208] However, and contrary to the mining and extractive sectors, the sectors affected by the green transition in Targovishte will not shut down entirely.

Figure 34. Employment in affected sectors (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019).

The affected workforce is mainly made of low-educated prime-age workers, with seniority in large companies. Affected workers are concentrated in three very large companies: about two-thirds of the workers of two of the largest affected companies in the district are prime-age workers (35- to 54-year-olds), more than half of the workers have been with the company for more than 6 years, and about one-third of these workers receive a monthly gross wage below or equal to the district average (BGN 1,003 in 2019), while another third receive up to 1.5 times the district average (World Bank Industry Survey, 2021).

Beyond the carbon-intensive companies, the transition risks fueling further migration of qualified workers if Targovishte fails to attract investments. While most of the affected workforce is made up of blue-collar workers, the largest firms also employ highly qualified specialists with tertiary education, whose reservation wages are high (they currently earn more than 1.5 times the district average). In the absence of retraining and upskilling options, or positions similar to the ones they currently hold in other industries, in terms of both, wages and skills, this highly educated workforce may reverse the recent favorable migration trend, and contribute to a deterioration of the district's socio-economic outlook.

Finally, the social impact of the transition may be channeled through rising energy prices. One in five households incurs difficulties to heat their homes (NSI, 2020)[209]. The Social Welfare covers 7,121 households through the energy subsidy benefit, most of which (93 percent) are using solid fuels as a source of heating (wood or coal).

3.2.3 The environmental impacts of the transition

The largest emitters of GHG in Targovishte district operate in the glass and ceramics industries. In addition, some of the enterprises in those sectors still use coal. The focus of

[208] These estimates include the third largest GHG emitter identified in the industry section.

[209]

decarbonization pathways for the glass and ceramics industries include the following main activities:

- Switching from fossil fuels to lower-carbon fuels.
- Improved processes' energy efficiency and system optimization.
- Materials' recycling.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

The measures outlined above have the largest potential to reduce GHG emissions in Targovishte district. Table 90 [210] summarizes the potential environmental impacts from the main decarbonization measures in the glass and ceramics industries.

Table 90. Potential environmental impacts from decarbonizing the carbon-intensive industries in Targovishte district

Decarbonization Pathway	Potential impacts on				
	Air	**Water**	**Resource efficiency/Waste generation**	**Soil, land use, biodiversity**	**Indirect impacts**
Switching from fossil fuels to electricity Relevant for: Glass Ceramics	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive processes such as cement and ceramic kilns eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen)	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion	Fuel dependent Substantial amounts of water are needed for hydrogen	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the	Potential negative impacts In the case of biomass and hydrogen,	Potential negative impacts Additional need for transportation

[210] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Relevant for: Glass Ceramics	of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	production through electrolysis	other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	and transport infrastructure.
Switching from fossil fuels to renewable energy (except biomass) Relevant for: Glass Ceramics	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly neutral impact There is a potential risk of eutrophication in case of hydropower generation.	Potential positive and negative impacts Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	Fuel dependent Deployment of renewable energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	Fuel dependent
Material recycling Relevant for: Glass	Depends on process If no additional energy input (coming from polluting fuels) is required in order to recycle the material, then the impact is positive.	Depends on process If no additional water is needed for material recycling, then	Positive impact Improves resource efficiency and reduces waste.	Positive impact Reduced extraction of virgin materials.	

		the impact is positive.			
Improved energy efficiency and system optimization Relevant for: Glass Ceramics	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics
Carbon Capture and Storage/Utilization (CCS/U) Relevant for: Ceramics	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[211]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils. Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

3.3 Economic diversification potential and related development opportunities

Following the diversification screening methodology, rapidly growing sectors providing diversification opportunities for the district economy, have been identified, as detailed lists of new

[211] https://www.who.int/health-topics/air-pollution#tab=tab_3

products recommened for export diversification in some of those sectors have additionally been provided.

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

3.3.1 Small and rapidly growing sectors

Seven small, but rapidly growing sectors providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 91. Small and Rapidly Growing Sectors for Targovishte District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[212]
1	55. Accomodation	N/R[213]
2	02. Forestry and logging	N/A[214]
3	28. Manufacture of machinery and equipment n.e.c.	Tractors, locomotive parts, floating structures, railway or tramway track fixtures and fittings
4	16. Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	N/A
5	18. Printing and reproduction of recorded media	N/A
6	33. Repair and installation of machinery and equipment	N/A
7	52. Warehousing and support activities for transportation	N/R

212 Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

213 Not Relevant.

214 Not Available.

3.3.2 Mid-size and rapidly growing sectors

No mid-size and rapidly growing sectors providing good opportunities for growth and diversification of the district economy were identified in Targovishte district.

3.3.3 Large and rapidly growing sectors

Two large and rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 92. Large and rapidly growing sectors for Targovishte District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	14. Manufacture of wearing apparel	N/A
2	47. Retail trade, except of motor vehicles and motorcycles	N/R

Thus a total of 9 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

4 LOVECH

4.1 Carbon-intensive sectors to be impacted by decarbonization[215]

4.1.1 SSM

In 2019, the gross domestic product (GDP) produced in Lovech district amounted to BGN 1,272 million at current prices, which represents 1% of the total production in the country. In 2019 GDP per capita was BGN 10,284, which ranked the district 15th of the 28 districts in the country. At A3 aggregation level, in 2019 the largest share in the gross value added (GVA) of Lovech district belongs to services (60%), followed by industry (31%) and agriculture (9%). It should be noted that within that structure of the district economy the services sector has a smaller share compared to the national average, which is due to the relatively higher weight of industry and agriculture in the district economy.

The foreign direct investment (FDI) in non-financial enterprises in the district in 2019 amounted to EUR 147.1 mln. This accounted for 0.6% of the FDI in the country and 23.6% of the FDI of North-West region, ranking the district 17th in the country and 2nd in the North-West region. The largest share of investments is in manufacturing industry, with a share of about 92%.

Manufacturing industry

The structure of the Manufacturing Industry in the district is presented in Table 93 below.

Table 93. Manufacturing Industry in Lovech district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C Manufacturing industry	**13 189**		**323 986**	
C10 Manufacture of food products	2 470	18,73%	56 965	17,58%
C11 Manufacture of beverages	179	1,36%	3 768	1,16%
C12 Manufacture of tobacco products	0	0,00%	0	0,00%
C13 Manufacture of textiles	1 809	13,72%	..	..
C14 Manufacture of wearing apparel	558	4,23%	6 287	1,94%
C15 Manufacture of leather and related products	141	1,07%	1 148	0,35%
C16 Timber, articles of wood and cork, unfurnished	1 335	10,12%	15 635	4,83%
C17 Paper, cardboard and paper and paperboard products	89	0,67%	..	..
C18 Printing and reproduction of recorded media	68	0,52%	..	..

[215] As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C19 Coke and refined petroleum products	0	0,00%	0	0,00%
C20 Chemicals	217	1,65%	675	0,21%
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	..	..	..	..
C22 Manufacture of rubber and plastic products	303	2,30%	6 017	1,86%
C23 Products from other non-metallic mineral raw materials	675	5,12%	56 222	17,35%
C24 Base metals	..	..	..	..
C25 Metal products, except machinery and equipment	467	3,54%	11 477	3,54%
C26 Manufacture of computer, electronic and optical product	..	..	..	..
C27 Electrical equipment	477	3,62%	6 179	1,91%
C28 Machinery and equipment, general and special purpose	586	4,44%	15 557	4,80%
C29 Manufacture of motor vehicles, trailers and semi0trailers	..	..	..	..
C30 Manufacture of other transport equipment	84	0,64%	1 861	0,57%
C31 Manufacture of furniture	1 972	14,95%	33 013	10,19%
C32 Other manufacturing	965	7,32%	..	..
C33 Repair and installation services of machinery and equipment	172	1,30%	3 820	1,18%
				.. Confidential data

Source: NSI Structural Business Statistics, 2019

Although a portion of the sectoral NSI data is confidential, still an approximate assessment on the role of various industrial sectors in the district economy could be made, as far as the companies belonging to those sectors are well known. Leading sectors within the Manufacturing Industry for the district are the production of machines and equipment with general and special purpose, woodworking industry, manufacturing of paper and cardboard, production of pharmaceutical products and cement.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[216].

The data for each directly affected 4-digit sector is presented in Table 94 below.

Table 94. Directly affected industrial sectors in Lovech district

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Investm. in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN ‘000)	(BGN ‘000)	(BGN ‘000)	(number)	(BGN ‘000)

[216] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify the CO_2-intensive companies.

1	23.51 Manufacture of cement	1	94 884	30 701	6 189	262	7 790
2	21.20 Manufacture of pharmaceutical preparations	1	47 954	46 684	N/A	262	625
3	23.32 Manufacture of bricks, tiles and construction products, in baked clay	1	55 963	46 912	N/A	102	3 753
4	23.42 Manufacture of alluminium	1	36	34	0	0	0
5	16.21 Manufacture of veneer sheets and wood-based panels	1	35 016	7 536	N/A	497	5 896
6	20.30 Manufacture of paints, varnishes and similar coatings, printing ink and mastics	1	2 097	428	N/A	27	165
7	17.21 Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	1	10 113	11 817	N/A	139	815

Source: Enterprise survey implementd by the team

The following indirectly affected sectors in the district have been identified, based on a value chain survey with a limited scope[217].

Table 95. Indirectly affected industrial sectors in Lovech district

Sectors included in the supply chain of directly affected sector				23.51	Manufacture of cement		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN '000)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	49.Land transport and transport via pipelines	3	6 147	1 414	529	0	45

Source: Enterprise survey implementd by the team

Energy Sector and Buildings

The energy infrastructure network of Lovech district is well developed and ensures a generally reliable supply of electricity for industry and households. Key energy infrastructure in Lovech includes the main substations Balkan and Pleven 1 (220/110/20 kV), as well as substations in each of the eight municipalities - their number depends on the industry developed (e.g. 2 substations in Troyan and 3 in Lovech). There are no large power plants in Lovech district.

[217] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district, which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

Three companies have licenses for gas distribution in Lovech district. These are ARESGAS EAD, Konsortuim Troyan Gas AD and Overgas Mreji AD. The network is well developed in Lovech and Lukovit. The gas distribution network covers 3.39% of the total number of households. There is no district heating network in Lovech.

The utility companies operating in the district are presented in Table 96:

Table 96. Energy operators in Lovech district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
CEZ Razpredelenie Bulgaria AD	Electricity distribution (20kV/380V)
ARESGAS EAD	Natural gas distribution in Lukovit municipality
Konsortuim Troyan Gas AD	Natural gas distribution in Troyan municipality
Overgas Mreji AD	Natural gas distribution in Lovech municipality

To the end of 2020 there are also 74 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (53) and 20 are hydropower plants, as shown in Table 97.

Table 97. Installed capacity and energy production by type of RES in Lovech district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Water energy	20	15.695	47 445.968
Solar energy	53	27.971	36 462.8880
Wind energy	1	2.720	2 582.531
Total	74	46.386	86 491.387

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, an energy survey was conducted in mid 2021.

Table 98. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff

	Investments are needed for new transformers, about 4 mln.EUR.
CEZ Razpredelenie Bulgaria AD	Answer was not received
ARESGAS EAD	Not significant changes in the next years expected
Konsortuim Troyan Gas AD	Answer was not received
Overgas Mreji AD	Answer was not received

Source: Enterprise survey implemented by the team

In 2020, there is a request for connection of 2 new PV plants with total capacity 114,9 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [218] 1 kWp installed PV capacity in Lovech will produce 1237.22 kWh per year and will save 525 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Lovech in sector D Electricity, gas, steam and air conditioning supply are summarized in the following table:

Table 99. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019
Number of enterprises	28	28	25
Number of persons employed	..	85	..
Revenues, thousands BGN	5665	..	..

Source: NSI, missing data are confidential

There are no major changes in the number of economic indicators for the sector in the period 2017-2019.

Indicators to be monitored:

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh

[218] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

- GHGs emissions savings, t/y

Housing in district Lovech consists of 94,973 dwellings with 47,234 of the dwellings situated in the cities and 47,739 in the villages [219]. There are 62 buildings from the district with energy efficiency certificate (until 04.2021). The average current energy consumption is 229 and it is expected to be reduced after renovation to 86 kWh/m2. Expected annual energy savings are estimated at 29052400,35 kWh/a and CO2 savings- 6875,7501 t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as untill June 2021 the renovated buildings were 15 in Lovech, 10 in Teteven, 5 in Troyan and 3 in Lukovit [220]. In district Lovech 7152 households have received energy aid for the heating season 2019-2020.

The municipalities in district Lovech have energy efficiency and RES programmes as Letnitsa and Lovech have also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures include:

- Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;
- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.
- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.
- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors,

[219] https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

[220] https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Lovech for 3-year period are presented in the following table:

Table 100. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%
Number of enterprises	151	163	164	8.61
Number of persons employed	828	872	884	6.76
Revenues, thousands BGN	46927	90986	71322	51.98

Source: NSI

Public Transport Sector

Lovech municipality is the main municipality in the Lovech district and is the main city with developed public transport network in the district. The Technical infrastructure and environment Directorate of the municipality is responsible for managing the local public transport. The municipality conducts a public tender to select the operator of the public transport network. There are five public transport routes in the city of Lovech. All public transport in the municipality is run by diesel buses – namely, 15 EURO 2 buses. In 2020 the mileage of public transport buses was 211 527 km with total diesel consumption of 88 034 liters which emitted an estimated 238 tonnes of CO_2. The emission rate of 1.13 kg CO_2/passenger km was slightly lower than the calculated national average of 1.16 kg CO_2/passenger km. Table 101 below summarizes the current profile of public transport in Lovech.

Table 101. Current profile of public transport in Lovech

Item	Description
Type of vehicles in public transport network	Buses
Number of public transport passengers (2020)	137 420
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	88 034
Total annual mileage of public transport buses, in km (2020)	211 527
Total estimated CO2 emissions from public transport, in t (2020)	238
Total estimated CO2 emissions per passenger km of public transport, in kg (2020)	1.13

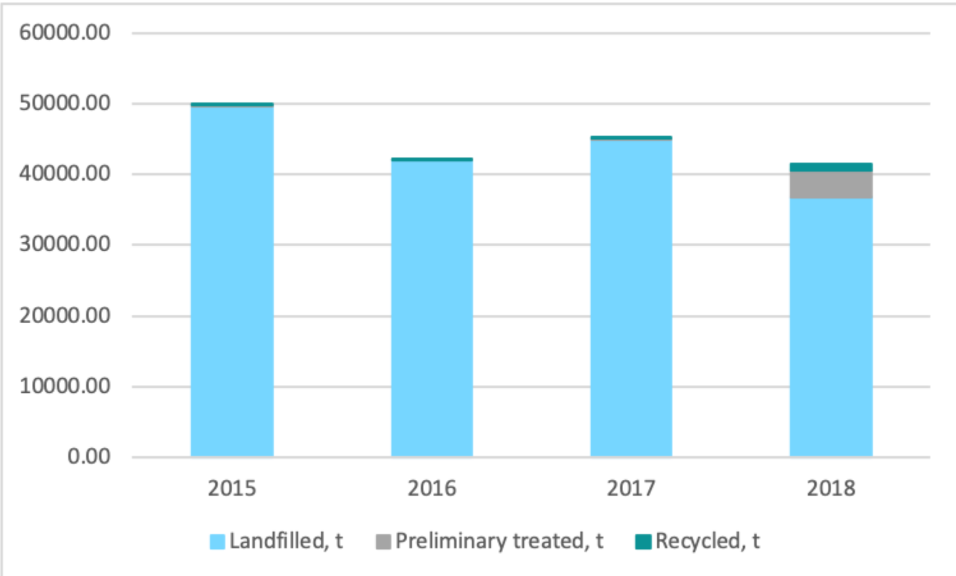
Source: World Bank Municipal survey, 2021

A questionnaire was sent to Lovech municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport development. It appears that Lovech municipality has no specific strategic plans related to decarbonization of the public transport sector and/or the development of sustainable and smart mobility.

Waste Sector

There are three Regional Associations for Waste Management (RAWM) in Lovech district – RAWM Lovech, RAWM Troyan and RAWM Lukovit. All households in Lovech district were served by municipal waste collection systems in 2018. There is a somewhat slightly declining trend in household waste generation. The share of recycled municipal waste, however, was a mere 2% of all generated municipal waste in 2018 – see Figure 35 below.

Figure 35. Generated and recycled municipal household waste in Lovech district, 2015-2018, t



Source: National Statistical Institute, 2019

There are three regional waste depots in Lovech district that serve all municipalities in the region and that are managed by the respective Regional Associations for Waste Management (RAWM). The three depots report relatively high GHG emissions in 2019 (see Table 102 below) when compared to depots from other districts. The remaining landfill capacity of the waste depots in Lovech district is reported to be 1106649.69.36 m[3].

Table 102. GHG emissions of the waste depots in Lovech district in 2019

Waste depots	CO2 emissions, t	CH4 emissions, t
Regional waste depot Lukovit (RAWM Lukovit)	3794	1887
Regional waste depot - municipaliites of Lovech, Letnitsa and Ugurchin (RAWM Lovech)	3185	1584
Regional waste depot Troyan and Apriltsi (RAWM Troyan)	1204.5	599
Source: Executive Environmental Agency		

The latest draft of the National Waste Management Plan 2021-2028 recommends a number of potential improvements to the existing waste management system in Lovech district. RAWM Lovech and RAWM Lukovit are in the indicative list for construction of installations for preliminary treatment of waste and for construction of installations for treatment of biodegradable waste. RAWM Troyan is also in the indicative list for construction of installations for treatment of biodegradable waste. As far as existing infrastructure for collection, recycling, utilization and re-use of waste is concerned, the share of population covered by recycling infrastructure in the municipalities that answered the waste survey varies betweeen 40% in Apriltsi to 100% in Lovech, Troyan and Letnitsa. Green waste collection from municipal parks and construction waste appear to be the waste streams for which most municipalities have some plans to tackle, whereas collection of biodegradable waste seems to be problematic for most municipalities. In terms of planned activities according to particular waste management practices, all municipalities that answered the survey mentioned that they are planning to expand the recycling infrastructure. Apriltsi and Teteven municipalities also mentioned that they had plans for re-use of waste.

An enterprise in Lovech district participates in industrial symbiosis, see Box 11 below.

Box 11. Industrial symbiosis in cement production

Zlatna Panega, located in Lovech district, is one of the largest cement plants in Bulgaria. Together with the other large cement factories in Bulgaria – Holcim and Devnya Cement, Zlatna Panega obtains a by-product in copper production.

The copper producer Aurubis produces iron silicate as a by-product of copper extraction. Iron silicate is a raw material for the production of cement clinker, which is used by the cement factories in Bulgaria.

Source: denkstatt, 2019[221]

4.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Lovech district:

- Cement industry
- Ceramics industry
- Non-ferrous metals industry
- The gereral decarbonization pathwas for non-carbon-intensive industries (related to sectors: manufacture of wood-based panels, pharmaceuticals; manufacture of paints, varnishes and similar coatings; manufacture of corrugated cardboard)

Energy sector and buildings

Decarbonization measures for energy sector in Lovech includes:

[221] https://www.bia-bg.com/uploads/files/Projects/Combined%20Report_SWAN_denkstatt_190430.pdf

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

A clear decarbonization measure for public transport in Lovech is to replace diesel buses with electric or hydrogen buses. All buses that run the public transport network are rather old EURO 2 buses. Therefore, the municipality could have a requirement for higher EURO category buses and/or electric buses in tendering the public transport routes.

The lack of specific feedback in the sent questionnaire, as well as during the follow-up interview does not allow for a proper assessment of public transport and sustainable urban mobility plans in Lovech. It can be assumed that there is potential for short term measures to encourage sustainable and smart urban mobility in Lovech. For instance, incentives for walking and cycling could be provided by establishing adequate infrastructure, coupled with some transport demand management measures such as increase in parking fees and/or stricter parking regulation and/or measures regarding reduced private vehicles' access to certain areas of the municipality. Municipal charging infrastructure for electric vehicles could also be developed to serve as an institutional guidance for the direction that urban mobility is moving to.

Waste

There is significant potential for moving up in the waste management hierarchy in Lovech district. Namely, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Lovech municipality (the main municipality in the district) could improve collection and treatment of green waste, biodegradable waste and construction waste.

All three Regional Associations for Waste Management (RAWM) in Lovech district are in the indicative list for constructing installations for treatment of biodegradable waste as per the latest National Waste Management Plan 2021-2028. According to Bulgaria's NECP projections, improved treatment of biodegradable waste is the primary measure to reduce GHG emissions from the waste sector. Moreover, RAWM Lovech and RAWM Lukovit are in the indicative list for construction of an installation for preliminary treatment of waste.

Lovech district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

4.2 The impact of the transition to a climate-neutral economy

4.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to directly estimate the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 103 below.

Table 103. Assessment of the economic impact of industrial decarbonization in Lovech district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy[222] (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	7	5 639	0.12%
Turnover (BGN ‘000)	250 096	2 447 697	10.22%
Production value (BGN ‘000)	246 063	1 814 387	13.56%
Value added at factor cost (BGN ‘000)	144 112	594 659	24.23%
Profit (BGN ‘000)	15 687	186 382	8.42%
Investments in tangible long-term assets (BGN ‘000)	6 189	1 398 476	0.44%
Number of employees (number)	1 289	23 949	5.38%
Wages and salaries BGN ‘000)	19 044	270 147	7.05%

[222] All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organisations and bodies.

Indirectly affected businesses (limited scope of the supply chain coverage)			
Economic indicator	Total value for all indirectly affected companies (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	3	5 639	0.05%
Turnover (BGN ‘000)	6 147	2 447 697	0.25%
Production value (BGN ‘000)	6 147	1 814 387	0.34%
Value added at factor cost (BGN ‘000)	1 414	594 659	0.24%
Profit (BGN ‘000)	529	186 382	0.28%
Investments in tangible long-term assets (BGN ‘000)	N/A	1 398 476	N/A
Number of employees (number)	45	23 949	0.19%
Wages and salaries BGN ‘000)	321	270 147	0.12%
Cummulative impact (directly and indirectly affected businesses[223])			
Economic indicator	Total value for all affected companies from the district (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	10	5 639	0.18%
Turnover (BGN ‘000)	256 243	2 447 697	10.47%
Production value (BGN ‘000)	252 210	1 814 387	13.90%
Value added at factor cost (BGN ‘000)	145 526	594 659	24.47%
Profit (BGN ‘000)	16 216	186 382	8.70%
Investments in tangible long-term assets (BGN ‘000)	N/A	1 398 476	N/A
Number of employees (number)	1 334	23 949	5.57%
Wages and salaries BGN ‘000)	19 365	270 147	7.17%

Source: Enterprise survey implemented by the team

[223] Limited supply chain coverage.

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the six directly affected 2-digit sectors, **C17** is a **key sector** and **C16** has a **strong backward linkage** to the district economy. Both (types of) sectors are important for the district economy in terms of indirect employment impacts.

Table 104. Key sectors[224] and sectors with backward linkages[225] in Lovech district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C16	Backward linkages (BW)	37	1.94
C17	Key sector (K)	28	1.85

On the basis of relevant Type I employment multipliers, it was established that in the worst-case scenario for **sector C16** a total of 963 jobs could be lost in the district, which included 497 initial job losses in the identified directly affected industry, and 466 job losses in its supply chain in the district. **For sector C17** in the worst-case scenario a total 256 jobs could be lost, which include 139 initial jobs of the identified directly affected companies, and 117 jobs in their supply chains in the district. It was thus established on the grounds of the employment multipliers, that the **total impact of the decarbonization of those two sectors** on the district economy could be the loss of 1,219 jobs, including 636 jobs in the directly affected industries and 583 jobs in their supply chains in the district.

Summary

The subsectors of manufacturing of veneer sheets and wood-based panels, corrugated paper and paperboard and of containers of paper and paperboard, paints, varnishes and similar coatings, printing ink and mastics, pharmaceutical preparations, bricks, tiles and construction products, in baked clay, aluminium and cement, to which the seven identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The seven affected businesses generate about 14% of the output, 24% of the value added at factor cost, as well as 5.4% of the employment and 7% of the wages & salaries of the district economy.

It was established under a supply chain survey with a limited scope that **the identified indirectly impacted businesses** account together for approximately 0.3% of the output and of the value added, as well as 0.1% of the employment and of the wages & salaries generated by the district economy.

It was thus estimated under the *survey method* that the decarbonization of the district economy will **cumulatively affect industrial subsectors** providing 14% of the output, 35% of the added

[224] Sectors with strong forward and backward linkages to other sectors in the district economy.

[225] Sectors with strong backward linkages to other sectors in the district economy.

value, 5.6% of the employment and 7% of the wages & salaries of the non-financial sector of the district economy.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the carbon-intensive industries in the district could result in the hypothetical loss of 1,872 jobs, this including 1,289 jobs in the directly affected industries and 583 jobs in the supply chains of two major CO_2-intensive sectors in the district.

Energy sector and buildings

In 2019 there were only 25 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a total of 70 employees. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 105. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[226]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	25	5639	0.44
Number of employees (number)	70	28514	0.25
Wages and salaries (BGN '000)	1357	270147	0.50

Source: Enterprise survey implemented by the team

Although the sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well represented in the district.

Table 106. Economic indicators for sector F Construction in 2019

Economic indicator		Impact on the district economy[227]

[226] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

[227] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

	Value for all companies from the sector	Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	164	5639	2.91
Number of employees (number)	884	28514	3.10
Wages and salaries (BGN ‘000)	9042	270147	3.35

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials’ producers, etc.;

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term. This is because the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term, one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics** (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials’ and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Lovech district in 2018 was just 2%, whereas 9% was preliminary treated and 89% landfilled. Therefore, it might be expected that **more sophisticated waste management, treatment and utilization that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

4.2.2 The social impacts of the transition

Lovech is the only one of the eight districts under review which belongs to the EU's poorest NUTS-2 region: Northwestern Bulgaria. The population is projected to decline from 122.6 thousand in 2020 to 84.1 thousand in 2050, with a rate of decline almost two times faster than the country average and the fourth most significant overall. The age structure of the population is unfavorable and has been significantly impacted by negative migration trends, as it is primarily people aged 10-29 that choose to leave the district. Unfavorable migration and natural increase trends have resulted in a marked worsening of the ag- dependency ratios over the last two decades.

Table 107. Key labor and social indicators, Lovech

	Lovech	Bulgaria	EU-27
Population			
Dependency ratio	68.2	55.5	54.9
Old-age dependency ratio	45.6	33.2	31.4
Net migration	-714		
abroad	-406		
of 20-39 y.o.	-249		
Labor			
Employment rate	64.1	68.5	67.7
Unemployment rate	4.7	5.2	7.2
Share of manufacturing in total employment	41	22	
Share of 25-54 in employment	75	76	
Share of job openings for high-skilled labor	13		
Skills			
Share of employed with tertiary education	22	31	
Jobseekers/vacancies ratio (low-skilled)	13		
Share of TVET in IT-related curricula	6		
Social inclusion			
Poverty		23.8	
Number of energy beneficiaries	8,862	283,680	
Share of energy beneficiaries using fossil fuel	94	88	
Labor impact			
Share of workers in carbon-intensive sectors	5		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

The local labor market has traditionally underperformed, but recent trends have been overwhelmingly positive, largely due to foreign direct investments (FDIs) in manufacturing. While most labor market indicators remain less favorable than the country averages, the gaps have narrowed markedly. Employment rates in the district are at a record high of 67 percent in 2019, due to large-scale FDI in the automotive industry. This also pushed the unemployment rate down to a long-term low of 6.6 percent, reversing the increase registered in the period 2016-2018.

The industrial sector plays an important (and growing) part in the local economy. Manufacturing accounts for 41 percent of total employment, followed by wholesale and retail trade (13 percent) and education (8 percent). Additional investments are in the pipeline: one foreign company announced a EUR 140 million investment in the automotive industry, and a new e-vehicle factory, which will produce about 30 thousand cars annually, is scheduled to start operating in 2024. It is too early to say whether the new investments will contribute to a structural shift in employment patterns and migration trends, but the low impact of the pandemic indicates a sustainable and resilient labor market.

However, the manufacturing sector, which is dominant in Lovech, is facing shortages of individuals with upper-secondary vocational education. The relative share of the population with upper-secondary vocational education was just 33 percent in 2019, when the relative share of the manufacturing sector is 41 percent. The gap is filled with workers with upper-secondary general education, who account for 37 percent of the total workforce. On the other hand, there are relatively few workers in Lovech with less than upper-secondary education.

Only 1 TVET student in 4 is enrolled in technical engineering or ICT curricula, which is not aligned with the raising demand for technical and engineering skills in the district. The local TVET provision involves delivery of training programs in 23 professional areas, but most TVET students are still opting for "Hotels, restaurants and catering," concentrating 28 percent of all TVET students in the district. The other most popular TVET concentrations are "Motor vehicles, ships and aircrafts" and "Forestry" (respectively 11 and 8 percent). Lifelong learning through continuous vocational training is underutilized: less than 1,000 adults graduate each year, mostly with partial qualifications.

Labor force participation is relatively more favorable for women and less favorable for men than in the rest of the country. Female labor force participation is relatively higher in Lovech, due to the presence of garment factories. On the other hand, at 67 percent, male employment rates are markedly lower than the national average of 74 percent (2019).

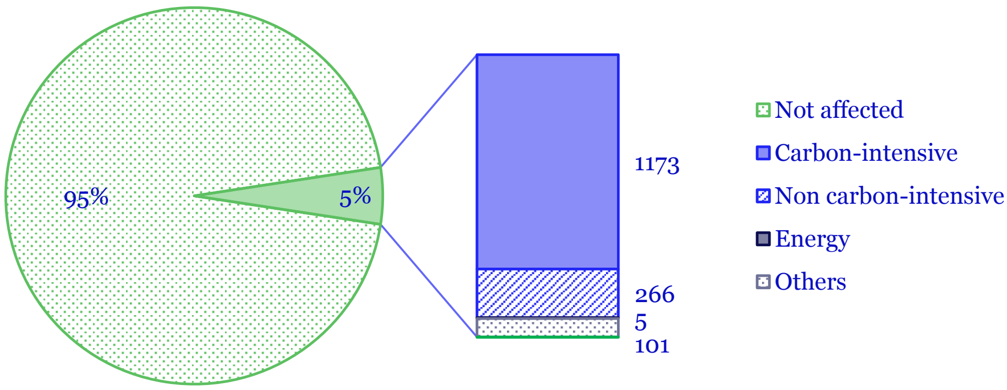
The most sizeable skills mismatch[228] between supply and demand is concentrated in the segment of the low skillsets. Demand for skills via the Public Employment Services (PES) is concentrated in the medium- and low-skills spectrum, which means that affected

[228] For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

workers with higher education may find it difficult to find corresponding employment opportunities. The majority of job openings (68 percent in 2019) required medium skills sets, while 19 percent required a low level of skills. The number of jobseekers with low skills level is 29 times higher than the number of registered job vacancies requiring the same level of skills. Although the number of available job vacancies requiring medium level of skills is considerably higher than those in the other two segments, there are indications for persisting imbalances between the supply and demand of medium skills as well.

The transition to climate neutrality will affect a number of leading local companies engaged with the manufacture of ceramics, cement, building materials, veneer sheets and wood-based panels. Lovech is home to 4 companies employing over 100 workers each: the largest company employs about 600 workers in wood processing, followed by just under 270 workers in a pharmaceutical company, 250 in a large cement factory (one of the largest in Bulgaria), and 140 in cardboard processing. A number of smaller companies operating mainly in the manufacture of ceramics may also have to undergo a transformation of their activities, processes and output in order to meet decarbonization goals.

Figure 36. Employment in affected sectors (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019).

An estimated number of 1.5 thousand workers are employed in carbon-intensive sectors. This represents 5 percent of the district's total employment and 12 percent of manufacturing employment. About 76 percent of the potentially affected workers are employed in economic activities that are deemed carbon-intensive, while an additional 17 percent are in non-carbon intensive industries, which may still be affected by the transition due to the nature of their production activities. But the actual impact may be more pronounced due to the disturbance of upstream and downstream supply chains.

While the direct impact on employment will not be as clearly pronounced as in other districts, the local labor market may continue to struggle with the absorption of the excess labor force in the medium term. In addition, regional labor markets in Northeast Bulgaria are not dynamic enough to offer alternatives to permanent migration or labor market exodus. The relative isolation of the district results in rather low daily labor migration flows, primarily towards Sofia (capital) and Pleven, according to the 2011

Census. While daily migration is likely to have intensified during the last decade (especially towards Sofia and its surrounding industrial zones such as Bozhurishte), the main labor market indicators do not suggest any significant improvement in this regard. This means that affected workers may have increased incentives to leave the district permanently, generating additional long-term socio-economic costs from the green transition.

Future job opportunities in the district will likely require different skillsets than those of affected workers. A great deal may thus depend on the capacity and efficiency of the local education and life-long learning systems. Some shifts are already taking place to accommodate the need for trained professionals in some economic activities. The share of secondary students enrolled in vocational tracks is gradually increasing, reaching 54 percent in 2020/2021 school year.

The broader socio-economic consequences of the EU Green Deal are harder to estimate due to existing data constraints. Lovech's poverty rates are 4 percentage points below national average, and women are les at-risk of poverty than men, reflecting their higher-than-average labor force participation. But the low level of socio-economic development of the district leaves it vulnerable to increases in energy prices. Approximately 8,600 households receive the energy subsidy, 8,300 of which us solid fuel (mostly wood).

4.2.3. The environmental impacts of the transition

The largest emitters of GHG in Lovech district operate in the cement and ceramics industries. In addition, the enterprise in the cement industry still uses coal. The focus of decarbonization pathways for the cement and ceramics industries include the following main activities:

- Switching from fossil fuels to lower-carbon fuels.
- Improved processes' energy efficiency and system optimization.
- Materials' recycling.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

The measures outlined above have the largest potential to reduce GHG emissions in Lovech district. Table 108[229] summarizes the potential environmental impacts from the main decarbonization measures in the glass and ceramics industries.

Table 108. Potential environmental impacts from decarbonizing the carbon-intensive industries in Lovech district

Decarbonization Pathway	Potential impacts on				
	Air	Water	Resource efficiency/Waste generation	Soil, land use, biodiversity	Indirect impacts

[229] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Switching from fossil fuels to electricity Relevant for: Cement Ceramics	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive processes of glass melting and ceramic kilns eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen) Relevant for: Cement Ceramics	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels.	Potential negative impacts Additional need for transportation and transport infrastructure.

				The emissions from biomass combustion also contribute to eutrophication.	
Switching from fossil fuels to renewable energy (except biomass) Relevant for: Cement Ceramics	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly neutral impact There is a potential risk of eutrophication in case of hydropower generation.	Potential positive and negative impacts Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	Fuel dependent Deployment of renewable energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	Fuel dependent
Material recycling Relevant for: Cement	Depends on process If no additional energy input (coming from polluting fuels) is required in order to recycle the material, then the impact is positive.	Depends on process If no additional water is needed for material recycling, then the impact is positive.	Positive impact Improves resource efficiency and reduces waste.	Positive impact Reduced extraction of virgin materials.	
Improved energy efficiency and system optimization Relevant for: Cement Ceramics	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics
Carbon Capture and Storage/Utilization (CCS/U) Relevant for: Cement Ceramics	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[230]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils.

Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

4.3 Economic diversification potential and related development opportunities

Following the diversification screening methodology, rapidly growing sectors providing diversification opportunities for the district economy, have been identified, as detailed lists of new products recommened for export diversification of some of those sectors have additionally been provided.

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

4.3.1 Small, rapidly growing sectors

Six small, but rapidly growing sectors providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 109. Small and Rapidly Growing Sectors for Lovech District

[230] https://www.who.int/health-topics/air-pollution#tab=tab_3

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[231]
1	42. Civil engineering	N/R[232]
2	11. Manufacture of beverages	N/A[233]
3	22. Manufacture of rubber and plastic products	Plastic plates, sheets etc.(HS codes 3920, 3925)
4	53. Postal and courier activities	N/R
5	33. Repair and installation of machinery and equipment	N/A
6	52. Warehousing and support activities for transportation	N/R

4.3.2 Mid-size and rapidly growing sectors

Six mid-size, rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 110. Mid-size rapidly growing sectors for Lovech District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	55. Accommodation	N/R
2	41. Construction of buildings	N/R
3	56. Food and beverage service activities	N/A
4	25. Manufacture of fabricated metal products, except machinery and equipment	Padlocks and locks; clasps and frames with clasps incorporating locks, flexible tubes (HS codes 8301, 8307)
5	28. Manufacture of machinery and equipment n.e.c.	Tractors, locomotive parts, floating structures, Railway or tramway track fixtures and fittings (HS codes 8701, 8607, 8608, 8907)
6	46. Wholesale trade, except of motor vehicles and motorcycles	N/R

4.3.3 Large rapidly growing sectors

No **large and rapidly growing sectors** providing strong opportunities for growth and diversification of the district economy, have been identified

231 Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

232 Not Relevant.

233 Not Available.

Thus a total of 12 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

5 GABROVO

5.1 Carbon-intensive sectors to be impacted by decarbonization234

5.1.1 SSM

The gross domestic product (GDP) of Gabrovo district in 2019 amounted to 1.553 mln BGN at current prices. The share of GDP of the district is 1.3% of the national GDP, which ranks the district 16th among the Bulgarian districts. In 2019 GDP per capita was BGN 14,444, which ranked the district 6th in the country. At A3 aggregation level, in 2019 the biggest share in the gross value added (GVA) formation of Gabrovo district belonged to services sector with 51%, followed by industry with 45% and agriculture by 4%. Gabrovo ranks 5th in the country in GVA created by the industry. As seen from its GVA structure, Gabrovo district is one of the most industrialized districts in Bulgaria. The municipalities of Gabrovo and Sevlievo have the highest share in the manufacturing industry.

In Gabrovo district, the foreign direct investment (FDI) in the non-financial sector as of 2019 amounted to EUR 340.9 million. The largest was the value of foreign direct investments in the industry from about 90% of all FDIs in the region. Next in volume of FDIs was the services sector (trade, repair of cars and motorcycles, transport, warehousing and posts, accommodation and food services) with a little over 4% of all foreign investments.

Manufacturing industry

The structure of manufacturing industry in the district is presented in Table 111 below.

Table 111. Manufacturing Industry in Gabrovo district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C. Manufacturing industry	**19 120**		**536 798**	
C10 Manufacture of food products	1 565	8,19%	36 348	6,77%
C11 Manufacture of beverages	8	0,04%	66	0,01%
C12 Manufacture of tobacco products	0	0,00%	0	0,00%
C13 Manufacture of textiles	430	2,25%	12 676	2,36%
14 Manufacture of wearing apparel	2 656	13,89%	53 192	9,91%
C15 Manufacture of leather and related products	359	1,88%	6 993	1,30%
C16 Timber, articles of wood and cork, unfurnished	242	1,27%	3 010	0,56%
C17 Paper, cardboard and paper and paperboard products	110	0,58%	2 272	0,42%

234 As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C18 Printing and reproduction of recorded media	125	0,65%	4 776	0,89%
C19 Coke and refined petroleum products	0	0,00%	0	0,00%
C20 Chemicals	221	1,16%	3 421	0,64%
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	0	0,00%	0	0,00%
C22 Manufacture of rubber and plastic products	2 204	11,53%	74 930	13,96%
C23 Products from other non-metallic mineral raw materials	157	0,82%	4 720	0,88%
C24 Base metals	507	2,65%	12 325	2,30%
C25 Metal products, except machinery and equipment	2 565	13,42%	79 549	14,82%
C26 Manufacture of computer, electronic and optical product	68	0,36%	1 334	0,25%
C27 Electrical equipment	746	3,90%	27 611	5,14%
C28 Machinery and equipment, general and special purpose	5 095	26,65%	169 517	31,58%
C29 Manufacture of motor vehicles, trailers and semi-trailers	..	..	..	..
C30 Manufacture of other transport equipment	..	..	..	..
C31 Manufacture of furniture	1 549	8,10%	35 115	6,54%
C32 Other manufacturing	194	1,01%	2 776	0,52%
C33 Repair and installation services of machinery and equipment	163	0,85%	5 323	0,99%
				.. Confidential data

Source: NSI Structural Business Statistics, 2019

As seen from the Manufacturing Industry structure, the leading industrial sectors by share in the value added at factor cost in Gabrovo districts are production of general and special purpose machinery and equipment (32%), production of rubber and plastic products (14%), manufacturing of textiles and wearing apparel (13%), furniture manufacture (6.5%), etc. The industry structure demonstrates a very strong positions of the mechanical engineering industries.

In addition to the traditional industrial sectors for Gabrovo, such as mechanical engineering (lifting devices, instruments), production of sanitary fittings, textile, knitted, leather and footwear industries, which shape its industrial profile, some new economic activities are also gaining momentum in the district, such as production of porcelain-ware products, cosmetic products, packaging with application in a number of industries, etc.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[235].

The data for each directly affected 4-digit economic sector is presented in Table 112 below.

Table 112. Directly affected industrial sectors in Gabrovo district

[235] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify CO_2-intensive companies.

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Profit	Investm. in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN '000)	(BGN '000)	(BGN '000)	(BGN '000)	(number)	(BGN '000)
1	23.42 Manufacture of ceramic sanitary fixtures	1	433 290	424 395	1 399	N/A	3 250	71 321
2	22.23 Manufacture of builders' ware of plastic	1	177 601	69 760	9 986	N/A	1 167	20 260
3	28.14 Manufacture of other taps and valves	1	4 809	2 056	30	N/A	139	4 998

Source: Enterprise survey implementd by the team

No indirectly affected sectors have been identified in the district under the implemented supply chain survey with a scope limited to 4 major companies, directly affected by the decarbonization.

Energy Sector and Buildings

District Gabrovo has a well-developed electricity infrastructure with 4 substations for transformation 110/20 kV located in each of the municipalities: Gabrovo, Dryanovo, Triavna and Sevlievo as the total capacity reach 832 MW. Electricity network consist of 244 km air powerlines 220 and 110kV as some of the substations have double connection for security of the supply. There is one district heating company "Toplofikacia – Gabrovo" EAD which provides heat energy to about 4000 clients, mainly households in city of Gabrovo. District heating company operate biomass and natural gas co-generation units with 6 MWe capacity.

The utility companies operating in the district are presented in Table 113:

Table 113. Energy operators in Gabrovo district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
ELEKTRORAZPREDELENIE SEVER AD	Electricity distribution (20kV/380V)
"Toplofikacia – Gabrovo" EAD	District heating production and distribution
"SEVLIEVOGAS-2000" AD	Natural gas distribution in Sevlievo municipality
"CITYGAS BULGARIA" EAD	Natural gas distribution in Gabrovo

To the end of 2020 there are also 43 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (33), 10 are hydropower plants, as shown in Table 114.

Table 114. Installed capacity and energy production by type of RES in Gabrovo district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Water energy	10	5.820000	11 520.493000
Solar energy	33	2.275950	2 589.451000
Total	43	8.095950	14 109.944000

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, energy survey was held in the mid of 2021.

Table 115. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for new transformers, about 4 mln.EUR.
ELEKTRORAZPREDELENIE SEVER AD	Not specified
"Toplofikacia – Gabrovo" EAD	Answer was not received
"SEVLIEVOGAS-2000" AD	Answer was not received
"CITYGAS BULGARIA" EAD	Answer was not received

Source: Enterprise survey implemented by the team

In 2020 there is a request for connection of 1 new PV plant with capacity 1 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [236] 1 kWp installed PV capacity in Gabrovo will produce 1193.38 kWh per year and will save 506 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Gabrovo in sector D Electricity, gas, steam and air conditioning supply are summarized in the following table:

Table 116. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

[236] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

Indicator	2017	2018	2019
Number of enterprises	24	23	23
Number of persons employed	..	..	107
Revenues, thousands BGN	121690	..	..

Source: NSI, missing data are confidential

There are no major changes in the number of economic indicators for the sector in the period 2017-2019.

Indicators to be monitored:

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh
- GHGs emissions savings, t/y

Housing in District Gabrovo consists of 79,995 dwellings with 53,372 of the dwellings situated in the cities and 26,623 in the villages [237]. There are 59 buildings from the district with energy efficiency certificate (until 04.2021). The average current energy consumption is 212 and it is expected to be reduced after renovation to 92 kWh/m2. Expected annual energy savings are estimated at 34898880,77kWh/a and CO_2 savings- 8076,768 t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as untill June 2021 the renovated buildings were 37 in Gabrovo, 9 in Sevlievo and 4 in Tryavna [238].

The municipalities in District Gabrovo have energy efficiency and RES programmes as Dryanovo and Tryavna have also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

1. Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
2. Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)

[237] https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

[238] https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

3. Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.

4. Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;

- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.

- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.

- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Gabrovo for 3-year period are presented in the following table:

Table 117. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%
Number of enterprises	232	235	244	5.17
Number of persons employed	1419	1360	1412	-0.49
Revenues, thousands BGN	121690	129452	139363	14.52

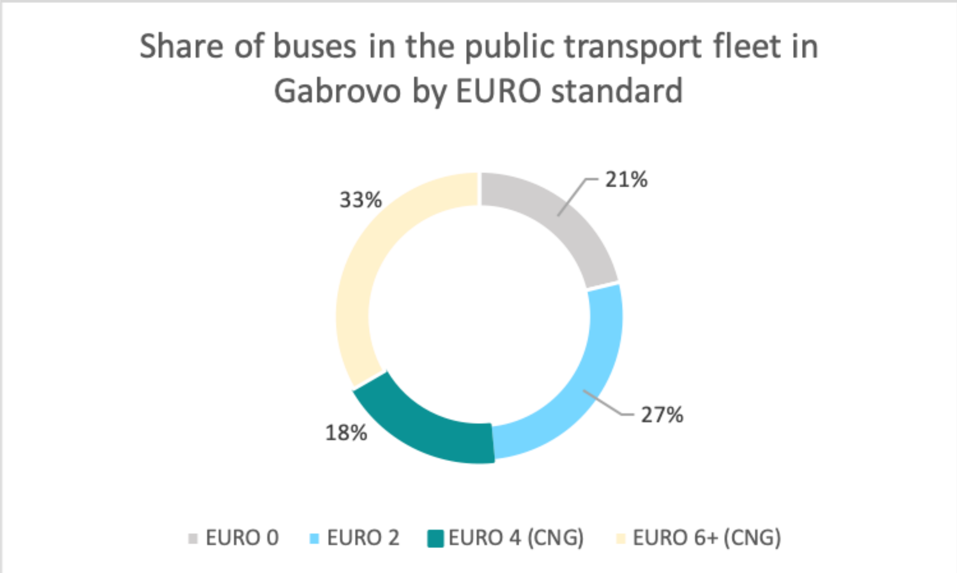
Source: NSI

There are no significant changes in the sector in the period 2017-2019. The increase of revenue is 14.52% due to the increased economic activities.

Public Transport Sector

Gabrovo municipality is the main municipality in the Gabrovo district and is the main city with developed public transport network in the district. The local public transport is managed by a municipal transport enterprise. The public transport in Gabrovo municipality is run by diesel and CNG buses. One third of the buses are EURO 6+ CNG buses, while only the older buses (EURO 0 and EURO 2) are diesel buses – see Figure 37 below.

Figure 37. Share of buses in the public transport fleet in Gabrovo by EURO standard in 2020



Source: World Bank Municipal survey, 2021

In 2020 the mileage of public transport buses was 1 752 000 km with total diesel consumption of 149 400 liters and total CNG consumption of 420 000 kg. The estimated CO_2 emissions from public transport were which emitted an estimated 1 449.1 tonnes of CO_2. The emission rate of 0.83 kg CO_2/passenger km was lower than the calculated national average of 1.16 kg CO_2/passenger km. Table 118 below summarizes the current profile of public transport in Gabrovo.

Table 118. Current profile of public transport in Gabrovo

Item	Description
Type of vehicles in public transport network	Buses (diesel and CNG)
Number of public transport passengers (2020)	2 682 000
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	149 400
Total annual consumption of CNG for buses in the public transport network, in kg (2020)	420 000
Total annual mileage of public transport buses, in km (2020)	1 752 000
Total estimated CO_2 emissions from public transport, in t (2020)	1 449.1
Total estimated CO_2 emissions per passenger km of public transport, in kg (2020)	0.83

Source: World Bank Municipal survey, 2021

A questionnaire was sent to Gabrovo municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport development. The following conclusions were made from the questionnaires and the interviews:

- Gabrovo municipality is already investing in electric buses – 3 electric buses were added to the public transport fleet in 2021.

- There are four charging stations for electric buses and four charging stations for electric passenger vehicles. In addition, Gabrovo is planning to add seven more charging stations for electric passenger vehicles.

- Bicycle lanes cover less than 1% of the municipal's territory. The municipality plans to significantly expand the bicycle lanes' network.

- A sustainable urban mobility plan is expected to be adopted in 2021.

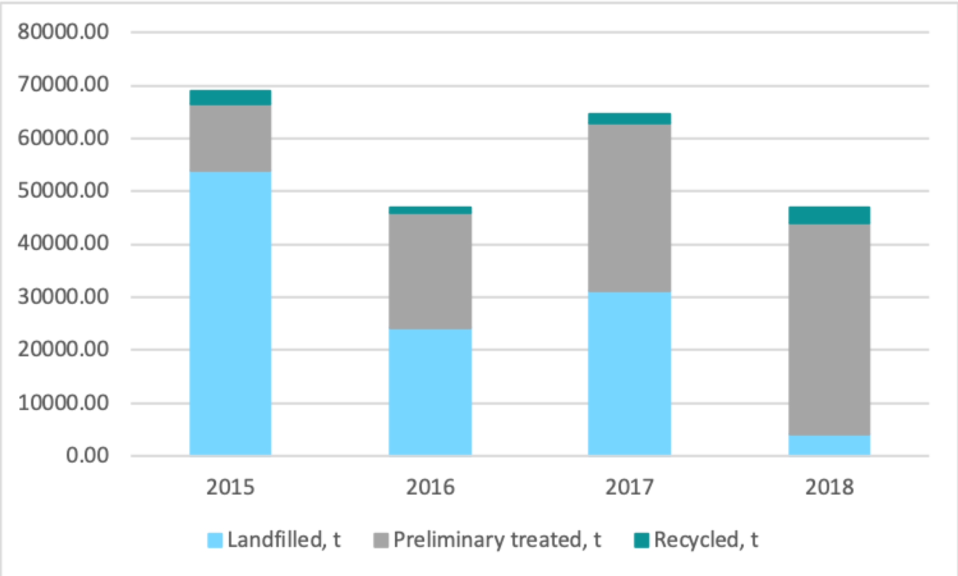
- There is partial digitalization of public transport – there is an online real-time information system about timetables, as well as a public transport mobile app.

- Gabrovo municipality is planning to terminate the use of fossil fuels in public transport. No timeline for the phase-out of fossil fuel use is given.

Waste Sector

There are two Regional Associations for Waste Management (RAWM) in Gabrovo district – RAWM Gabrovo and RAWM Sevlievo. Nearly 100% of households in the district are served by municipal waste collection systems. In addition, all households in Gabrovo municipality were covered by recycling infrastructure. Data from the National Statistics Institute shows that in 2018 9% of all generated household waste was landfilled. However, the share of recycled waste was also low – 6% of the generated waste was recycled in 2018 – see Figure 38 below.

Figure 38. Generated and recycled municipal household waste in Gabrovo district, 2015-2018, t



Source: National Statistical Institute, 2019

There are two regional waste depots in Gabrovo district that serve all municipalities in the region and that are managed by the respective Regional Associations for Waste Management (RAWM). The GHG emissions from the depots in 2019 are presented in Table 119 below. It can be noted that the Regional waste depot of Gabrovo and Tryavna has relatively high GHG emissions. The remaining landfill capacity of the waste depots in Gabrovo district is reported to be 967270.54 m^3.

Table 119. GHG emissions of the waste depots in Gabrovo district

Waste depots	CO_2 emissions, t	CH_4 emissions, t
Regional waste depot Gabrovo and Tryavna; RAWM Gabrovo	3369	1675.4
Regional waste depot Sevlievo, Suhindol and Dryanovo; RAWM Sevlievo	140	64
Source: Executive Environmental Agency		

The latest draft of the National Waste Management Plan 2021-2028 recommends a number of potential improvements to the existing waste management system in Gabrovo district. The Gabrovo RAWM is in the indicative list for construction of installations for preliminary treatment of waste and for installations for treatment of biodegradable waste. RAWM Sevlievo also needs to establish installations for treatment of biodegradable waste.Gabrovo municipality has a rather developed recycling infrastructure. In addition to the recycling containers for paper and cardboard, glass, metals and plastics, Gabrovo municipality has containers for biodegradable household waste, textile waste, e-waste, batteries, hazardous waste from households, bulk waste. Nearly 12% of the households in Gabrovo municipality are provided with containers for composting.

Planned waste management activities in Gabrovo municipality include:

- Expanding the household composting infrastructure in order to cover additional 300 households and prevent the generation of 80 tonnes of waste. The timeline for this activity is until 2027.
- Expanding textile waste collection by providing 40 more containers for collecting textile waste. The timeline for this activity is until 2024.
- Establishing a facility for collection and repair of old furniture as stipulated in the National Waste Management Plan 2021-2028.
- Purchasing a municipal waste separation installation.
- Purchasing a bioreactive installation for aerobic treatment of biodegradable waste that will be added to the existing composting installation. The timeline for this activity is until 2027.

5.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Gabrovo district:

- Ceramics industry
- The gereral decarbonization pathwas for non-carbon-intensive industries (related to available such sectors: manufacture of plastics (secondary production) and manufacture of machinery and equipment)

Energy sector and buildings

Decarbonization measures for energy sector in Gabrovo includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

A clear decarbonization measure for public transport in Gabrovo is to replace the remaining diesel buses with electric or hydrogen buses. More than half of the bus fleet in Gabrovo consists of relativelty new CNG buses, which means that realistically replacement of those buses will not happen in the immediate future, but rather in the medium term.

Gabrovo municipality is already investing in or planning to implement measures for sustainable and smart local mobility such as developing the e-charging vehicle infrastructure and improving the digitalization of public transport. Incentives for walking and cycling could be strengthened by establishing adequate infrastructure, coupled with some transport demand management measures such as increase in parking fees and/or stricter parking regulation and/or measures regarding reduced private vehicles' access to certain areas of the municipality. A timeline for the declared phase-out of fossil fuels from public transport could also be provided in a strategic document – perhaps in the sustainable urban mobility plan.

Waste

There is significant potential for moving up in the waste management hierarchy in Gabrovo district. Namely, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Gabrovo municipality (the main municipality in the district) could improve collection and treatment of green waste from households, as well as biodegradable waste from the commercial sector. The municipality is already planning the expansion of the household composting infrastructure, as well as the textile waste collection infrastructure. Gabrovo municipality is also planning establishing a reuse and repair facility for old furniture.

Both Regional Associations for Waste Management (RAWM) in Gabrovo district are in the indicative list for constructing installations for treatment of biodegradable waste as per the latest National Waste Management Plan 2021-2028. According to

Bulgaria's NECP projections, improved treatment of biodegradable waste is the primary measure to reduce GHG emissions from the waste sector. Moreover, the Gabrovo RAWM is in the indicative list for construction of an installation for preliminary treatment of waste. Gabrovo district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

5.2 The impact of the transition to a climate-neutral economy

5.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to **directly estimate** the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 120 below.

Table 120. Assessment of the economic impact of industrial decarbonization in Gabrovo district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy[239] (BGN '000)	Share of affected companies (%)
Number of companies (number)	3	6 024	0,05%
Turnover (BGN '000)	610 324	3 517 241	17,35%
Production value (BGN '000)	615 700	2 644 935	23,28%
Value added at factor cost (BGN '000)	496 211	911 407	54,44%
Profit (BGN '000)	11 415	217 904	5,24%
Investments in tangible long-term assets (BGN '000)	0	1 204 184	0,00%

[239] All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organisations and bodies.

Number of employees (number)	4 556	32 591	13,98%
Wages and salaries BGN ‘000)	96 579	453 097	21,32%
Cummulative impact (directly and indirectly affected businesses[240])			
Economic indicator	Total value for all affected companies from the district (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	3	6 024	0,05%
Turnover (BGN ‘000)	610 324	3 517 241	17,35%
Production value (BGN ‘000)	615 700	2 644 935	23,28%
Value added at factor cost (BGN ‘000)	496 211	911 407	54,44%
Profit (BGN ‘000)	11 415	217 904	5,24%
Investments in tangible long-term assets (BGN ‘000)	N/A	1 204 184	N/A
Number of employees (number)	4 556	32 591	13,98%
Wages and salaries BGN ‘000)	96 579	453 097	21.32%

Source: Enterprise survey implemented by the team

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the three 2-digit sectors in the district, which will be directly affected by the industrial decarbonization, **sector C22** is a **key sector**, important for the district economy in terms of indirect employment impacts.

Table 121. Key sectors[241] and sectors with backward linkages[242] in Gabrovo district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C22	Key sector	29	3.01

On the basis of the Type I employment multiplier, it was established that in the worst-case scenario for sector C22 a total 3,513 jobs could be lost in the district, which include 1,167 the initial job losses

240 Llimited supply chain coverage.

241 Sectors with strong forward and backward linkages to other sectors in the district economy.

242 Sectors with strong backward linkages to other sectors in the district economy.

of the identified directly affected industry, and 2,346 indirect job losses in its supply chain in the district.

Summary

The sectors of manufacturing of plastic, ceramic sanitary fixtures and other taps and valves, to which the three identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The affected businesses generate 23% of the output and 54% of the value added at factor cost as well as 14 of the employment and 21% of the wages and salaries, of the district economy. As no companies belonging to the surveyed supply chains of the 4 major CO_2 emitters have been identified, the latter figures could be considered as the **cumulative impact of the decarbonization** on all identified directly and indirectly affected businesses in the district.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the carbon-intensive industries in the district could result in the hypothetical loss of 6,902 jobs in the district, this including 4,556 jobs in the directly affected industries and 2,346 jobs in the supply chain of a major CO_2-intensive sector in the district.

Energy sector and buildings

In 2019 there were only 23 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a toal of 107 employees. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 122. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[243]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	23	6024	0.38
Number of employees (number)	107	37701	0.28
Wages and salaries (BGN '000)	1740	453097	0.38

Source: Enterprise survey implemented by the team

243 All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Although sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well presented in the district.

Table 123. Economic indicators for sector F Construction in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[244]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	244	6024	4.05
Number of employees (number)	1412	37701	3.75
Wages and salaries (BGN '000)	12349	453097	2.72

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term. This is because the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel**

[244] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

logistics (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Gabrovo district in 2018 was just 6%, whereas 85% was preliminary treated and 9% landfilled. Therefore, it might be expected that **more sophisticated waste management, treatment and utilization that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

5.2.2 The social impacts of the transition

Gabrovo is one of the Bulgarian districts in which the negative demographic trends are most clearly pronounced. High age dependency ratios, unfavorable migration trends and low birth rates all contribute to a rather bleak demographic outlook. The population is projected to decline by one-third in the period 2020-2050 with only the districts of Vidin and Smolyan projected to record steeper declines.[245] Emigration of the working-age population is leading to sharp deterioration of the district's age dependency ratios, with the second-highest headline age dependency ratio in the country.

Table 124. Key labor and social indicators, Gabrovo

	Gabrovo	Bulgaria	EU-27
Population			
Dependency ratio	68.8	55.5	54.9
Old-age dependency ratio	49.2	33.2	31.4
Net migration	-443		
abroad	-367		
of 20-39 y.o.	-298		
Labor			
Employment rate	67.7	68.5	67.7
Unemployment rate	7.0	5.2	7.2

[245] These are also the three Bulgarian districts whose population is projected to slip below 100 thousand by 2025.

Share of manufacturing in total employment	50	22	
Share of 25-54 in employment	76	76	
Share of job openings for high-skilled labor	9		
Skills			
Share of employed with tertiary education	31	31	
Jobseekers/vacancies ratio (low-skilled)	5		
Share of TVET in IT-related curricula	23		
Social inclusion			
Poverty	12.3	23.8	
Number of energy beneficiaries	4,776	283,680	
Share of energy beneficiaries using fossil fuel	76	88	
Labor impact			
Share of workers in carbon-intensive sectors	12		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

The local labor market is vibrant and has been outperforming the country average in most leading indicators over the course of the last decade. Gabrovo has the highest share of workers with tertiary education among the eight carbon-intensive districts under study, as well as the lowest share of workers with less than lower-secondary education. Half of all workers have completed upper-secondary vocational education, while about 31 percent of the employed graduated with a tertiary degree. The local technical university hosts some 3 thousand students and the district also has 23 general schools, 6 vocational education and training (VET) schools, 9 licensed VET centers as well as arts and sports schools. The high share of the urban population (81 percent) is another factor that favors educational outcomes and facilitates employment possibilities.

Lower-skilled workers are facing the highest difficulties in finding job opportunities. The most sizeable mismatch between demand and supply of skills appears in the segment of medium skillsets – the number of job seekers with medium skill levels remains 5 times higher than the job opportunities requiring the same level of skills.[246] Although the number of job seekers with medium skill levels that had a registration with the Employment Agency is gradually decreasing, it remains 5 times higher than the job openings requiring the same level of skills. These figures are partly explained by the fact that, on average, only 23-25 percent[247] of job vacancies are advertised in the local labor office, while almost all newly unemployed individuals register in order to access unemployment benefits. `

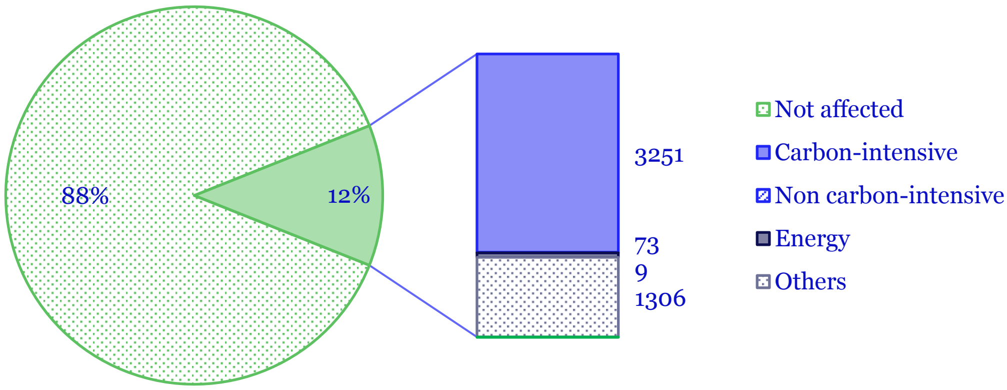
Manufacturing accounts for about 50 percent of the employment in the district. It is followed by economic activities in the service sector, such as wholesale and retail trade (11 percent), healthcare (7 percent), and transportation and storage (6 percent). The impact of the COVID-19 pandemic on local labor markets was somewhat stronger than in most districts, probably due to the significant share of export-oriented manufacturing companies. This

[246] For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

[247] National employment agency informal assessments.

resulted in a sharper contraction of employment and a more marked rise in the unemployment rate in 2020 than the one observed at the national level. However, the changes were also reflective of persistently high economic activity, as the decline of the labor force participation in Gabrovo during the pandemic was markedly softer than in most Bulgarian districts.

Figure 39. Employment in affected sectors (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019).

Gabrovo should be one of the more moderately affected of the carbon-intensive districts in terms of the perceived impact of the Green Transition on employment: 12 percent of the workforce is employed in carbon-intensive sectors**.** The analysis of the local business fabric revealed potential direct impacts only on several companies engaged in the production of ceramics, plastics, and heat and power generation industries in the municipalities of Gabrovo and Sevlievo. Not all of these companies fall directly within the scope of the "transforming sectors" in the context of the EU Green Deal. However, some of them may be viewed as having carbon-intensive production cycles in the context of TJTPs. The workforce directly affected by the transition is concentrated in very few companies: two large companies are engaged in the manufacture of ceramic sanitary fixtures, employing respectively 3.3 and 1.2 thousand workers; and a smaller factory producing alloys from non-ferrous metals (slightly over 100 employees).

The persistently high number of unemployed offering middle level of skills, combined with the availability of high-skilled jobseekers indicates potential hiring difficulties for medium- and high-skilled unemployed in Gabrovo. This also reflects the relative underdevelopment of the service sector. According to the 2020 investment profile of the municipality of Gabrovo[248], the relative share of workers employed in higher value-added activities such as the Information and Communication Technology (ICT) sector and professional activities is respectively three and two times lower than the national average. In addition, wages in the local ICT sector are about two times lower than the country average. While not necessarily surprising in view of the size of the district, this is probably one of the key reasons why highly educated youth prefer to look for employment opportunities elsewhere. The ICT sector however is showing signs of growth potential: according to local authorities, the ICT sector doubled in the last 3-4 years, thanks to the well-developed technical educational infrastructure, relatively lower wages in the sector, and domestic migration of young ICT

[248] Gabrovo Investment Profiles 2020. Invest in Gabrovo: Green, Smart & Innovative, p. 7.

professionals settling along the Gabrovo-Sevlievo motorway, who are mostly employed in the Sevlievo industrial zone.

The indirect impact of the transition is harder to evaluate, also due to the lack of clear timelines with regard to the processes involved. For instance, an important user of coal in Gabrovo district is the Gabrovo district heating plant, which supplies heating energy for about 4 thousand apartments (i.e. about 10 percent of the total population), as well as municipal buildings (including schools, kindergartens and healthcare establishments). While emissions from the district heating plant have declined in recent years (perceivably due to declining demand), its clients may rank among those affected by the transition. The heating plant itself employs 64 workers.

The demographic structure of the local population is one of the main deterrents to economic diversification efforts. Out-migration of young people and the rising average age of domestic workers soften the positive impact of the well performing education system. Up-skilling and requalification efforts are likely to be hindered by these factors, even if the district has some good practices with regard to continuing education. The capacity of the region to adapt to new economic realities is made even more challenging by the fact that the population aged 65 and above forms 29 percent of the population, compared to a national average of 21.6 percent. In this sense, the capacity of much of the local population to deal with some of the anticipated effects of the EU Green Deal, such as rising energy prices, may be directly dependent on the capacity of the social security system and the efficiency of social safety nets.

While Gabrovo benefits from a well-developed educational infrastructure and public services in urban areas, the demographic crisis may threaten the maintenance and existence of these advantages, and contribute to a vicious circle of deterioration of public infrastructure and outmigration. Gabrovo boasted the lowest share of the population living in poverty in 2019 (at just 12.3 percent). [249] High employment rates mean that the relative share of the population at-risk of poverty and social exclusion (AROPE) was also the lowest in the country (22.2 percent). Low income inequalities in the district thus do not tell the full story with regard to the living standard of the population.

Rising energy prices will have an impact on the wellbeing of the local population, especially in view of the large share of retirees. According to local social assistance officials, energy poverty, which will likely worsen during the energy transition, is a major concern, especially for the elderly and those living in remote mountainous areas. Most of the recipients of the energy subsidy program incur higher shares of energy expenses in their monthly expenditure, and will be disproportionally impacted by the transition if energy prices go up. They will also likely need to adapt their homes with the transition out of coal, as they currently mostly use solid fuel for heating. The relative territorial isolation of Gabrovo from the country's key economic centers is another factor that simultaneously drives outmigration and slows down investment flows. The district's long-lasting inability to find a way to tackle key brownfield sites (also in the city of Gabrovo itself) is another issue that has to be resolved in order to facilitate additional investment opportunities.

Although Gabrovo is well known manufacturing region and there are many export-oriented companies, local authorities believe that the region has growth potential in a mix of some traditional and emerging sectors such as agriculture,

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[249] The district poverty line is BGN 4,761, below the country average.

forestry and ecology (water basins and forestry cleaning as well as brown fields revitalization). The aforementioned sectors have potential to give employment to low-skilled and low-educated people who usually suffer from long-term unemployment. Social and health care sectors are also underdeveloped in the light of aging population and insufficient access to services especially in small municipalities and remote areas. Furthermore, the sector of services including ICT has not only growth potential but also could draw in higher added value and paid jobs and could have positive impact on youth out-migration.

5.2.3 The environmental impacts of the transition

The largest GHG emitter in Gabrovo district operate in the bathroom ceramics industry. The focus of decarbonization pathways for the ceramics industry include the following main activities:

Switching from fossil fuels to lower-carbon fuels.

- Improved processes' energy efficiency and system optimization.
- Carbon Capture and Storage (CCS) or Utilization (CCU).

The measures outlined above have the largest potential to reduce GHG emissions in Gabrovo district. Table 125 [250] summarizes the potential environmental impacts from the main decarbonization measures in the ceramics industry.

Table 125. Potential environmental impacts from decarbonizing the carbon-intensive industries in Gabrovo district

Decarbonization Pathway	Potential impacts on				
	Air	**Water**	**Resource efficiency/Waste generation**	**Soil, land use, biodiversity**	**Indirect impacts**
Switching from fossil fuels to electricity	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive processes of ceramic kilns eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.

250 Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

	used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.				
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen)	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	Potential negative impacts Additional need for transportation and transport infrastructure.
Switching from fossil fuels to renewable energy (except biomass)	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly neutral impact There is a potential risk of eutrophication in case of hydropower generation.	Potential positive and negative impacts Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries).	Fuel dependent Deployment of renewable energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are	Fuel dependent

			Positive impacts from improved resource efficiency.	generally lower than in the case of fossil fuels.	
Improved energy efficiency and system optimization	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics
Carbon Capture and Storage/Utilization (CCS/U)	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[251]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils.

Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

5.3 Economic diversification potential and related development opportunities

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with

[251] https://www.who.int/health-topics/air-pollution#tab=tab_3

growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

5.3.1 Small, rapidly growing sectors

Seven small, but rapidly growing sectors providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 126. Small and Rapidly Growing Sectors for Gabrovo District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[252]
1	62. Computer programming, consultancy and related activities	N/R[253]
2	63. Information service activities	N/R
3	26. Manufacture of computer, electronic and optical products	Resistors, clippers, lamps, sound equipment (HS codes 8533, 8510, 8513, 8519)
4	16. Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	N/A[254]
5	58. Publishing activities	N/R
6	33. Repair and installation of machinery and equipment	N/A
7	43. Specialised construction activities	N/R

5.3.2 Mid-size and rapdily growing sectors

Seven mid-size, rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 127. Mid-size rapidly growing sectors for Gabrovo District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	42. Civil engineering	N/R

252 Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

253 Not Relevant.

254 Not Available.

2	41. Construction of buildings	N/R
3	24. Manufacture of basic metals	Alloy steel bars, rods, shapes and sections, tubes and pipes, sheets, magnesium (HS codes 7228, 7305, 7215, 7301, 8104)
4	10. Manufacture of food products	Crustaceans, molluscs and other aquatic invertebrates, prepared or preserved; coffee, cocoa paste; sausages, fermented milk products, fowls, horse meat, egg yolks, cereal meals, vegetable fats (HS codes 1605,0901, 1803, 1601, 0403, 0105, 0408,1103, 0205, 1516)
5	31. Manufacture of furniture	N/A
6	13. Manufacture of textiles	Woven or Sintetic fibres, textile, yarn (HS codes 5514, 5811, 5606, 6308)
7	466. Wholesale trade, except of motor vehicles and motorcycles	N/R

5.3.3 Large and rapidly growing sectors

One large and rapidly growing sector providing strong opportunities for growth and diversification of the district economy, has been identified, namely:

Table 128. Large and rapidly growing sectors for Gabrovo District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	14. Manufacture of wearing apparel	N/A

Thus a total of 15 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

6 SLIVEN

6.1 Carbon-intensive sectors to be impacted by decarbonization255

6.1.1 SSM

In 2019, the gross domestic product (GDP) generated by Sliven district amounted to BGN 1,506 million at current prices, which is 1.3% of GDP of the country. In 2019 GDP per capita was BGN 8,130, which ranked the district 27th of the 28 districts in the country. At A3 aggregation level, in 2019 the services sector held the largest share in the gross value added (GVA) of 64% in Sliven district, followed by industry with 28% share and the agriculture is with the smallest share of 9%. It should be noted that, compared to the structure of GVA of the country, in Sliven district the share of industry and agriculture is relatively high on the account of the share of services.

The foreign direct investment (FDI) in the non-financial sector in Sliven district in 2019 amounted to EUR 159 million, with the largest value of FDI in industry - EUR 134.8 million. In 2019 the costs incurred for acquisition of tangible fixed assets (fixed assets) were BGN 227 million. The largest volume of investments in fixed assets was in the Industry sector - BGN 93.7 million, while Agriculture, forestry and fisheries sector with BGN 53 million was ranking 2nd.

Manufacturing industry

The structure of the Manufacturing Industry in the district is presented in Table 129 below.

Table 129. Manufacturing Industry in Sliven district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C. Manufacturing industry	**11 909**		**267 622**	
C10 Manufacture of food products	3 034	25,48%	68 158	25,47%
C11 Manufacture of beverages	391	3,28%	9 184	3,43%
C12 Manufacture of tobacco products	0	0,00%	0	0,00%
C13 Manufacture of textiles	2 987	25,08%	..	0,00%
14 Manufacture of wearing apparel	634	5,32%	8 088	3,02%
C15 Manufacture of leather and related products	20	0,17%	126	0,05%
C16 Timber, articles of wood and cork, unfurnished	372	3,12%	7 066	2,64%
C17 Paper, cardboard and paper and paperboard products	..	0,00%	..	0,00%

255 As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C18 Printing and reproduction of recorded media	102	0,86%	1 304	0,49%
C19 Coke and refined petroleum products	0	0,00%	0	0,00%
C20 Chemicals	373	3,13%	12 632	4,72%
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	..	0,00%	..	0,00%
C22 Manufacture of rubber and plastic products	214	1,80%	9 573	3,58%
C23 Products from other non-metallic mineral raw materials	203	1,70%	969	0,36%
C24 Base metals	46	0,39%	717	0,27%
C25 Metal products, except machinery and equipment	567	4,76%	11 791	4,41%
C26 Manufacture of computer, electronic and optical product	130	1,09%	5 844	2,18%
C27 Electrical equipment	103	0,86%	1 929	0,72%
C28 Machinery and equipment, general and special purpose	739	6,21%	16 505	6,17%
C29 Manufacture of motor vehicles, trailers and semi-trailers	961	8,07%	13 762	5,14%
C30 Manufacture of other transport equipment	0	0,00%	0	0,00%
C31 Manufacture of furniture	599	5,03%	12 870	4,81%
C32 Other manufacturing	147	1,23%	2 468	0,92%
C33 Repair and installation services of machinery and equipment	136	1,14%	3 552	1,33%
				.. Confidential data

Source: NSI Structural Business Statistics, 2019

The main traditional industrial sectors for Sliven are textiles and wearing apparel, food production and mechanical and metal products.

The leading industrial sectors by share in the value added at factor cost in Sliven districts are production of food and beverages (25%), Machinery and equipment, general and special purpose (6,2%), Manufacturing of motor vehicles, trailers and semi-trailers (5,14%), Chemicals (4,72%), manufacture of furniture (4,81%), manufacturing of textiles and wearing apparel (3%). The processing industry in Sliven district is mostly dominated by enterprises in the food, textile, machine-building and chemical industries. These account for app. 50% of the activity of non-financial enterprises in the district and for 82% share of employment in Manufacturing Industry.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[256].

The data for each directly affected 4-digit industrial sector is presented in Table 130 below.

Table 130. Directly affected industrial sectors in Sliven district

[256] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify the CO_2-intensive companies.

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Profit	Investm. in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN '000)	(BGN '000)	(BGN '000)	(BGN '000)	(number)	(BGN '000)
1	13.10 Preparation and spinning of textile fibres	1	235 316	63 585	0	10 166	2 447	35 937
2	23.32 Manufacture of bricks, tiles and construction products, in baked clay	1	0	0	0	0	0	0

Source: Enterprise survey implementd by the team

No indirectly affected sectors have been identified in the district under the implemented supply chain survey with a scope limited to 4 major companies, directly affected by the decarbonization [257].

Energy sector and buildings

The energy infrastructure network of Sliven district is well developed and ensures a generally reliable supply of electricity for industry and households. There is one large thermal power plant (TPP Sliven), one industrial co-generation unit (TPP Dekotex) with 2 MWe installed capacity, as well as a main power supply substation Tvarditsa 220/110 kV, which is connected to TPP Maritsa-Iztok 2 and substation Gorna Oriahovitsa. There are substations 110/20 kV in each of the four municipalities of the district, as well as five substations in Sliven city. There is one big thermal power plant located in the city of Sliven (TPP Sliven) operated by the company Toplofikacia Sliven EAD and providing district heating and steam. TPP Sliven has a thermal capacity of 493 MWt and electrical capacity of 30 мWe.

Natural gas supply and distribution networks are available for the cities Sliven and Nova Zagora. In Sliven city, the natural gas distribution company Gastreid Sliven EOOD. The company Overgas Mreji AD has a license for gas distribution in the city of Nova Zagora.

The utility companies operating in the district are presented in Table 131:

Table 131. Energy operators in Sliven district

Operator	System

[257] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district, which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
EVN Bulgaria Elektrosnabdiavane EAD	Electricity distribution (20kV/380V)
Toplofikacia Sliven EAD	Heat and electricity production and distribution of heat energy
Overgas Mreji AD	Natural gas distribution in Nova Zagora municipality
Gastreid Sliven EOOD	Natural gas distribution in Sliven municipality

To the end of 2020 there are also 313 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (293) and 14 are wind plants, as shown in Table 132.

Table 132. Installed capacity and energy production by type of RES in Sliven district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Wind	14	14.23	21 061.793
Solar energy	293	92.53	134 799.499
Biogas	1	1.50	11 565.351
Hydroenergy	5	18.28	9 638.492
Total	**313**	**126.54**	**177 065.135**

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, energy survey was conducted in mid 2021.

Table 133. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for new transformers, about 4 mln.EUR.
EVN Bulgaria Elektrosnabdiavane EAD	Answer was not received
Toplofikacia Sliven EAD	Answer was not received
Overgas Mreji AD	Answer was not received

Gastreid Sliven EOOD	Answer was not received

Source: Enterprise survey implemented by the team

In 2020 there is a request for connection of 5 new PV plants with total capacity 131 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [258] 1 kWp installed PV capacity in Sliven will produce 1316.67 kWh per year and will save 558 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Gabrovo in sector D Electricity, gas, steam and air conditioning supply are summarized in the following table:

Table 134. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019
Number of enterprises	88	92	112
Number of persons employed	432	363	475
Revenues, thousands BGN	91764	81981	97308

Source: NSI

There is an increase of the number of enterprises and the other economic indicators for the sector in the period 2017-2019.

In case of fuel change in Toplofikacia Sliven EAD from solid fuels to natural gas, it is expected that about 120 employees currently involved in activities for solid fuel supply will lose their jobs.

Indicators to be monitored:

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh
- GHGs emissions savings, t/y

Housing in district Sliven consists of 93,296 dwellings – 60,538 of the dwellings are

[258] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

situated in the cities and 32,758 in the villages 259. There are 81 buildings from the district with energy efficiency certificate. The average current energy consumption is 180,73 and it is expected to be reduced after renovation to 87,91 kWh/m2. Expected annual energy savings are estimated at 33124886,09 kWh/a and CO2 savings- 11359,0746t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as untill June 2021 the renovated buildings were 51 in Sliven, 11 in Nova Zagora, 2 in Tvarditsa 260.

The municipalities in district Sliven have energy efficiency and RES programmes as Sliven have also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

- Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;
- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.
- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.
- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

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259 https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

260 https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

The economic data for construction sector in district Sliven for 3-year period are presented in the following table:

Table 135. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%
Number of enterprises	260	259	259	-0.38
Number of persons employed	1742	1877	1962	12.63
Revenues, thousands BGN	118473	170532	187344	58.13

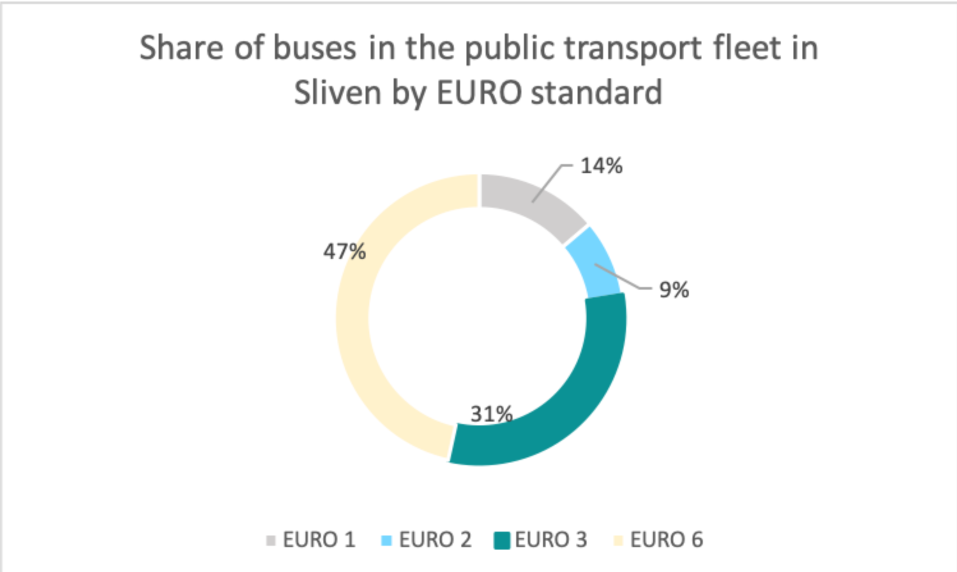
Source: NSI

The increase of revenue is 58.13% due to the increased economic activities.

Public Transport Sector

Sliven municipality is the main municipality in the Sliven district and is the main city with developed public transport network in the district. The municipal enterprise Urban mobility is responsible for managing the public transport service in Sliven municipality. There are both buses and trolleybuses operating in the public transport network of Sliven municipality. Almost half of the buses operating the public transport network in the municipality are EURO 6 diesel buses. Nevertheless, the remaining buses in the public transport fleet are EURO 3 or lower – see Figure 40 below.

Figure 40. Share of buses in the public transport fleet in Sliven by EURO standard in 2020



Source: World Bank Municipal survey, 2021

In 2020 the total mileage of public transport buses (buses and trolleybuses combined) was 1 762 231 km with total diesel consumption of 691 244 liters, which emitted an estimated 1 868.9 tonnes of CO_2. The emission rate of 1.10 kg CO_2/passenger km was lower than the calculated national average of 1.16 kg CO_2/passenger km. The table below summarizes the current profile of public transport in Sliven.

Table 136. Current profile of public transport in Sliven

Item	Description
Type of vehicles in public transport network	Buses Trolleybuses
Number of public transport passengers (2020)	Buses: 2 816 000 Trolleybuses: 179 000
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	691 244
Total annual consumption of electricity for trolleybuses in the public transport network, in MWh (2020)	153
Total annual mileage of public transport buses, in km (2020)	1 697 368
Total annual mileage of public transport trolleybuses, in km (2020)	64 863
Total estimated CO2 emissions from public transport, in t (2020)	1 868.9
Total estimated CO2 emissions per passenger km of public transport, in kg (2020)	1.10

Source: World Bank Municipal survey, 2021

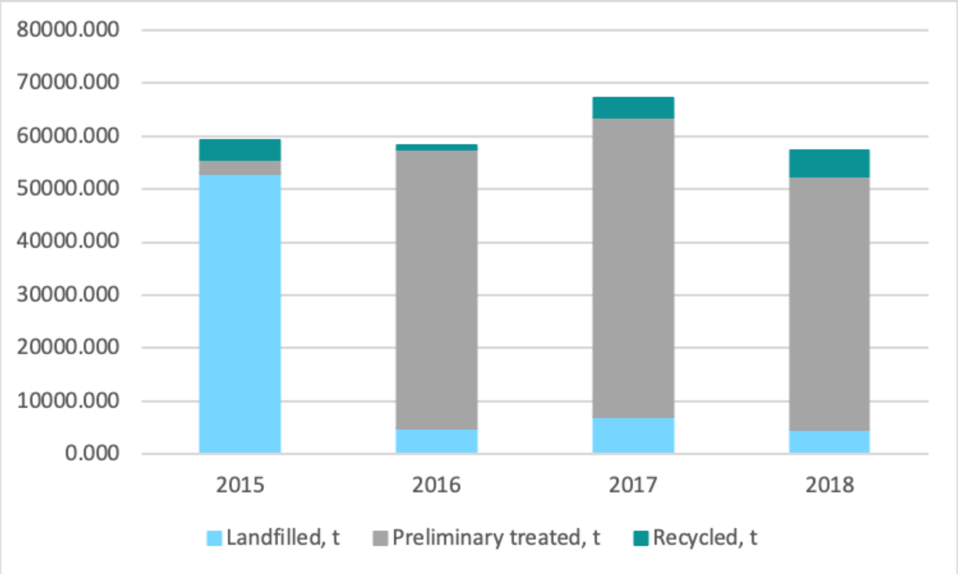
A questionnaire was sent to Sliven municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport and sustainable mobility development. **Some of the key plans and initiatives are summarized below:**

- A Sustainable urban mobility plan is expected to be adopted in 2021.
- Sliven municipality would like to replace all diesel buses, but this might take ten or more years.
- There are 2 km of bicycle lanes in Sliven with 9 km more in planning. The new bicycle lanes will connect different neighborhoods to the city center.
- Sliven municipality is planning the installation of four charging stations for electric cars and 5 charging stations for electric buses.
- Sliven municipality is not planning to implement a Low Emission Zone.

Waste Sector

Sliven district does not have its own waste depot and uses the waste depot in the neighboring Yambol district and therefore, is a member of Regional Association for Waste Management (RAWM) Yambol. Data on waste by district is limited to household waste and currently is available until 2018. All households in Sliven district were served by municipal waste collection systems in 2018. There is a relatively stable trend in household waste generation in Sliven district. The amount of recycled municipal waste has been growing, but in 2018 it represented a mere 9% of all generated municipal waste – see Figure 41 below.

Figure 41. Generated and recycled municipal household waste in Sliven district, 2015-2018, t



Source: National Statistical Institute, 2019

The share of the population in Sliven municipality covered by recycling infrastructure is 83%. Sliven municipality plans to improve collection of textile and other household waste types. According to a conducted interview with representatives of Sliven municipality, the municipality finds it problematic to collect and treat construction waste.

6.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Sliven district:

- Ceramics industry
- The gereral decarbonization pathwas for non-carbon-intensive industries (related to the available sector manufacture/processing of textile)

Energy sector and buildings

Decarbonization measures for energy sector in Sliven includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas

- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

TPP Sliven running on coal could be transfromed to a plant operating on biomass or natural gas.

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

A clear decarbonization measure for public transport in Sliven is to replace diesel buses with electric or hydrogen buses. Nevetheless, 47% of the diesel bus fleet in Sliven consists of new EURO 6 buses, which means that realistically replacement of those buses will not happen in the immediate future, but rather in the medium term. Thus, the focus of bus replacement might be the EURO 1, EURO 2 and EURO 3 buses in the public transport fleet.

There is potential for short term measures to encourage sustainable and smart urban mobility in Sliven. For instance, incentives for walking and cycling could be provided by establishing adequate infrastructure, coupled with some transport demand management measures such as increase in parking fees and/or stricter parking regulation and/or measures regarding reduced private vehicles' access to certain areas of the municipality. Municipal charging infrastructure for electric vehicles could also be further expanded to serve as an institutional guidance for the direction that urban mobility is moving to.

Waste

There is significant potential for moving up in the waste management hierarchy in Sliven district. Namely, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Sliven municipality (the main municipality in the district) could improve collection and treatment of green waste, biodegradable waste and construction waste.

Sliven district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

6.2 The impact of the transition to a climate-neutral economy

6.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to **directly estimate** the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 137 below.

Table 137. Assessment of the economic impact of industrial decarbonization in Sliven district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy[261] (BGN '000)	Share of affected companies (%)
Number of companies (number)	2	7 209	0.03%
Turnover (BGN '000)	234 573	3 056 056	7.68%
Production value (BGN '000)	235 316	2 285 658	10.30%
Value added at factor cost (BGN '000)	63 585	826 837	7.69%
Profit (BGN '000)	0	283 047	0.00%
Investments in tangible long-term assets (BGN '000)	10 166	1 443 852	0.70%
Number of employees (number)	2 447	29 409	8.32%
Wages and salaries BGN '000)	35 937	329 362	10.91%
Cummulative impact (directly and indirectly affected businesses[262])			
Economic indicator	Total value for all affected companies from the district (BGN '000)	Impact on the district economy	
		Value for the whole district economy (BGN '000)	Share of affected companies (%)
Number of companies (number)	2	7 209	0.03%
Turnover (BGN '000)	234 573	3 056 056	7.68%
Production value (BGN '000)	235 316	2 285 658	10.30%
Value added at factor cost (BGN '000)	63 585	826 837	7.69%
Profit (BGN '000)	0	283 047	0.00%
Investments in tangible long-term assets (BGN '000)	10 166	1 443 852	N/A
Number of employees (number)	2 447	29 409	8.32%
Wages and salaries BGN '000)	35 937	329 362	10.91%

Source: Enterprise survey implemented by the team

[261] All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organizations and bodies.

[262] Llimited supply chain coverage.

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the two directly affected 2-digit sectors, **C13-15** are **key sectors**, which are important for the district economy in terms of indirect employment impacts.

Table 138. Key sectors[263] and sectors with backward linkages[264] in Sliven district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C13-15	Key sector (K)	27	2.32

On the basis of the Type I employment multiplier, it was established that in the worst-case scenario for **sector C13-15** a total of 5,667 jobs could be lost in the district, which included 2,447 the initial job losses in the identified directly affected businesses, and 3,220 job losses in their supply chains in the district.

Summary

The subsectors preparation and spinning of textile fibres and manufacture of bricks, tiles and construction products, in baked clay, to which the two identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The 2 affected businesses generate about 10% of the output, 7% of the value added at factor cost, as well as 8,3% of the employment and 11% of the wages & salaries of the district economy. As no companies belonging to the surveyed supply chains of the 4 major CO_2 emitters have been identified, the above figures could be considered as the **cumulative impact of the decarbonization** on all identified directly and indirectly impacted businesses in the district.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the carbon-intensive industries in the district could result in the hypothetical loss of 5,667 jobs in the district, this including 2,447 jobs in the directly affected industries and 3,220 jobs in the supply chain of a major CO_2-intensive sector in the district.

Energy sector and buildings

In 2019 there were only 112 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a total of 475 employees. TPP Sliven will be affected if coal fuel is replaced with natural gas as anout 120 employees will lose their jobs. **However the impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

[263] Sectors with strong forward and backward linkages to other sectors in the district economy.

[264] Sectors with strong backward linkages to other sectors in the district economy.

Table 139. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[265]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	112	7209	1.55
Number of employees (number)	475	36091	1.32
Wages and salaries (BGN '000)	6319	329362	1.92

Source: Enterprise survey implemented by the team

Although the sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well presented in the district.

Table 140. Economic indicators for sector F Construction in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[266]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	259	7209	3.59
Number of employees (number)	1962	36091	5.44
Wages and salaries (BGN '000)	17887	329362	5.43

Source: Enterprise survey implemented by the team

265 All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

266 All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term as the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics** (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Sliven district in 2018 was just 9%, whereas 83% was preliminary treated and 8% landfilled. Therefore, it might be expected that more sophisticated **waste management, treatment and utilization that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

6.2.2 The social impacts of the transition

Sliven displays a relatively young population, marked by higher fertility rates and lower life expectancy. The district records the second largest share of Roma population, 12 percent according to the 2011 Census, which is more than twice the country average. The higher birth rate and lower life expectancy traditionally observed among Roma population have contributed to a relatively favorable age structure, with the most favorable population dynamics projections out of all districts except for Sofia.

Table 141. Key labor and social indicators, Sliven

	Sliven	Bulgaria	EU-27
Population			
Dependency ratio	63.5	55.5	54.9
Old-age dependency ratio	33.2	33.2	31.4
Net migration	-1,836		
abroad	-1,099		
of 20-39 y.o.	-820		
Labor			
Employment rate	65.1	68.5	67.7
Unemployment rate	6.9	5.2	7.2
Share of manufacturing in total employment	30	22	
Share of 25-54 in employment	72	76	
Share of job openings for high-skilled labor	15.4		
Skills			
Share of employed with tertiary education	25	31.3	
Jobseekers/vacancies ratio (low-skilled)	27		
Share of TVET in IT-related curricula	11		
Social inclusion			
Poverty	31.3	23.8	
Number of energy beneficiaries	11,082	283,680	
Share of energy beneficiaries using fossil fuel	94	88	
Labor impact			
Share of workers in carbon-intensive sectors	10		
Number of commuters	941		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

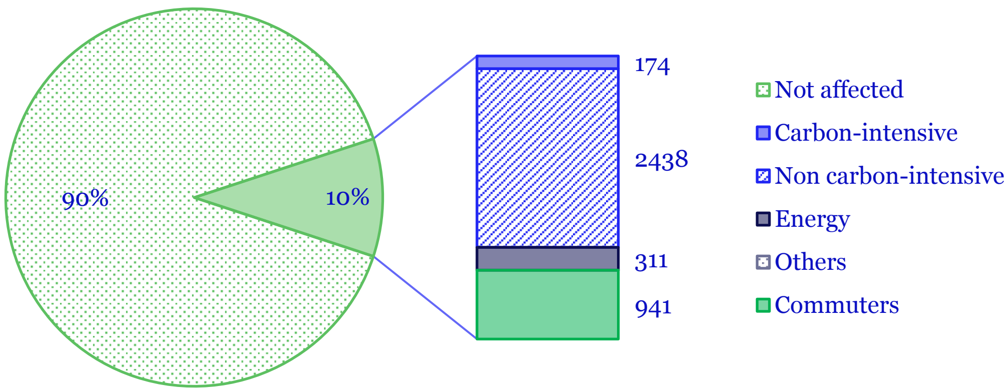
Sliven is losing its population nonetheless, driven by large outmigration flows, mostly out of the country. Net outmigration accounts for a staggering 80 percent of the total decline of the district's population in the last two decades, and the 10-29 age group represents more than half of the negative migration balance since 2015.

Sliven displays comparatively low levels of socio-economic development. Productivity is low, and with 2.6 percent of the country's population, the district contributes to only 1.3 percent of national GDP. Poverty rates are the highest in the country, at 31 percent of the population, that is at 7 percentage points above the national average. Similarly, at 45 percent of the population, the share of the population at-risk of poverty and social exclusion (AROPE), is 50 percent higher than the country average (32 percent). In addition, the district reports a much lower relative share employment in higher value-added service sector activities (3 percent) such as ICT, financial and insurance activities, real estate activities and professional, scientific and technical activities, and manufacturing and agriculture continue to play key roles in the district economy (respectively 31 and 6 percent, as compared to 22 and 3 percent at the national level).

Sliven's labor force participation is low, and its workforce is skewed towards older, lower-skilled workers, in more traditional sectors. Labor force participation rates are among the lowest in the country, at 60 percent of the workable population: this reflects limited labor market opportunities, low female activity rates, high levels of NEET, especially among Roma.[267] The labor market supply is low-skilled: 28 percent the workforce didn't go beyond lower-secondary education, which is 2.5 times above the national average. Female employment remained rather low at 57 percent, compared to a national average of 66 percent. The district registers one of the highest relative shares of repeaters (3.4 percent) and drop-offs (5.7 percent), as well as some of the lowest results at the state matriculation exams.

These lower-skilled workers are already those facing the highest difficulties in finding job opportunities. Although declining in recent years, the number of unemployed with low level of skills is considerably higher than unemployment in medium and high skill segments. The most sizeable mismatch between the supply and demand of skills appears in the segment of low skillsets, registered jobseekers exceed by 27 times the number of registered vacancies. [268] Furthermore, the share of registered job openings requiring higher-order skillsets has declined from 23 to 15 percent between 2016 and 2019, confirming that few higher-skilled positions are available.

Figure 42. Employment in affected sectors (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019), and PWC for commuters.

About three thousand workers are employed by high GHG-emitting companies located in Sliven. Most of them are concentrated in three large companies. The majority of

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[267] Sliven is one of the leading places in terms of child marriages and early childbirths, with Roma girls with Turkish identity, in particular, having the lowest educational status compared to their counterparts in Sliven, Montana and Shumen. UNICEF, 2016. "*Research On the Social Norms Which Prevent Roma Girls from Access to Education.*"

[268] For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

workers (about 2.4 thousand) are engaged in one garnment factory, followed by 305 workers employed by the district heating, and 120 workers employed in the manufacture of iron and steel. In addition, 44 workers are employed in a brick and tiles manufacture, and a small number of microenterprises are involved in the production of electricity.

Including commuters 269 to Stara Zagora, 10 percent of the district total employment is directly employed in carbon-intensive sectors or mining. An additional 941 workers commute from the district of Sliven to Maritsa East Energy Complex, mostly from the municipalities of Nova Zagora and Sliven. For these miners, the timeline and nature of the transition is likely to be both, faster and more severe, than for the workforce employed in other high GHG-emitting factories. The impact of the transition through employment may vary widely across municipalities, and some may be harder hit than others, such as Nova Zagora, where the majority of commuters to the Maritsa East Energy Complex live.

High rates of traditional outmigration and the potential pool of people who will lose their current social-economic status could bring about additional emigration. The intensification of the existing migration trend towards larger and more dynamic economic centers may reinforce a vicious circle of lower access to and quality of public services (education, health, social services) and significant outmigration trends. In particular, in view of the recent past, local authorities fear the intensification of outmigration flow from Nova Zagora: the closure of local mines in the 1990s and the recent stoppage of Tvarditsa complex without preparation nor alleviating measures led to the shrinkage of local settlements.

Finally, the social impact of the transition may be channeled through rising energy prices. Recipients of the energy subsidy are unlikely to be much affected by the energy transition, as most of them use wood for heating. On the other hand, 14,000 district households use the central heating, powered by coal, and would be on the frontline if energy prices go up.[270]

6.2.3 The environmental impacts of the transition

The largest GHG emitter in Sliven district operate in the energy (heat generation) and ceramics industries. Enterprises in those industries still use coal. The focus of decarbonization pathways for the energy and ceramics industries include the following main activities:

Switching from fossil fuels to lower-carbon fuels.

- Improved processes' energy efficiency and system optimization.
- Carbon Capture and Storage (CCS) or Utilization (CCU).

The measures outlined above have the largest potential to reduce GHG emissions in Sliven district. Table 142[271] summarizes the potential environmental impacts from the main decarbonization measures in the carbon-intensive industries.

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[269] The numbers of commuters throughout the text are provided by PWC

[270] Local authorities mentioned that many households are highly sensitive to energy price fluctuations, and households easily disconnect from the grid as a coping mechanism when prices go up.

[271] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Table 142. Potential environmental impacts from decarbonizing the carbon-intensive industries in Sliven district

Decarbonization Pathway	Potential impacts on				
	Air	**Water**	**Resource efficiency/Waste generation**	**Soil, land use, biodiversity**	**Indirect impacts**
Switching from fossil fuels to electricity Relevant for: Ceramics	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive processes of ceramic kilns eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen) Relevant for: Energy Ceramics	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production.	Potential negative impacts Additional need for transportation and transport infrastructure.

				Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	
Switching from fossil fuels to renewable energy (except biomass) Relevant for: Energy Ceramics	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly neutral impact There is a potential risk of eutrophication in case of hydropower generation.	Potential positive and negative impacts Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	Fuel dependent Deployment of renewable energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	Fuel dependent
Improved energy efficiency and system optimization Relevant for: Ceramics	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics
Carbon Capture and Storage/Utilization (CCS/U) Relevant for: Ceramics	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[272]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils.

Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

6.3 Economic diversification potential and related development opportunities

Following the diversification screening methodology, rapidly growing sectors providing diversification opportunities for the district economy, have been identified, as detailed lists of new products recommened for export diversification of some of those sectors have additionally been provided.

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

6.3.1 Small and rapidly growing sectors

Six small, rapidly growing sectors providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 143. Small and Rapidly Growing Sectors for Sliven District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[273]

[272] https://www.who.int/health-topics/air-pollution#tab=tab_3

[273] Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

1	20. Manufacture of chemicals and chemical products	Industrial monocarboxylic fatty acids; acid oils from refining; industrial fatty alcohols (HS codes 3823)
2	26. Manufacture of computer, electronic and optical products	Resistors, clippers, lamps, sound equipment (HS codes 8533, 8510, 8513, 8519)
3	32. Other manufacturing	N/A[274]
4	53. Postal and courier activities	N/R[275]
5	33. Repair and installation of machinery and equipment	N/A
6	61. Telecommunications	N/R

6.3.2 Mid-size and rapdily growing sectors

Seven mid-size rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 144. Mid-size rapidly growing sectors for Sliven District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	42. Civil engineering	
2	56. Food and beverage service activities	
3	31. Manufacture of furniture	
4	28. Manufacture of machinery and equipment n.e.c.	Tractors, locomotive parts, floating structures, Railway or tramway track fixtures and fittings (HS codes 8701, 8607, 8608, 8907)
5	29. Manufacture of motor vehicles, trailers and semi-trailers	
6	14. Manufacture of wearing apparel	
7	16. Manufacture of wood and of products of wood and cork, except furniture;	

6.3.3 Large and rapidly growing sectors

Two large and rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 145. Large and rapidly growing sectors for Sliven District

274 Not Available.

275 Not Relevant.

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	47. Retail trade, except of motor vehicles and motorcycles	N/R
2	46. Wholesale trade, except of motor vehicles and motorcycles	N/R

Thus a total of 15 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

7 YAMBOL

7.1 Carbon-intensive sectors to be impacted by decarbonization276

7.1.1 SSM

In 2019 the gross domestic product (GDP) generated in the district was BGN 1,198 mln at current prices, which represented about 1% of the GDP of the country. This ranked the district 22nd among the 28 districts in Bulgaria. In 2019 GDP per capita was BGN 10,142, which ranked the district 17th in the country. The economy of Yambol district has a lower degree of economic development compared to the national average. At A3 aggregation level, in 2019 the services sector accounted for the largest share in the gross value added (GVA) of the district (58%), followed by industry (30%) and agriculture (12%). Compared to the structure of GVA for the whole country, at Yambol district there is a lower share of services on the account of relatively higher share of GVA in industry and significantly higher in GVA of agriculture. The GDP per capita is significantly lower than the national average.

Foreign direct investments (DFI) in the non-financial sector in Yambol district by 2019 amounted to EUR 41.2 million at current prices, which were 0.2% of FDI for the country and 1.2% within the Southeast region. This ranks the district as one of last in the country in terms of FDI. In 2019 in Yambol district the largest relative share of direct foreign investments belonged to industry, followed by the services sector (trade, repair of motor vehicles and motorcycles, transport, storage and post offices, hotels and restaurants) with a share of 18.3%.

Manufacturing industry

The structure of Manufacturing Industry in the district is presented in Table 146 below.

Table 146. Manufacturing Industry in Yambol district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C. Manufacturing industry	12 351		254 408	
C10 Manufacture of food products	1 387	11,2%	30 551	12,0%
C11 Manufacture of beverages	284	2,3%	7 274	2,9%
C12 Manufacture of tobacco products	0	0,0%	0	0,0%
C13 Manufacture of textiles	139	1,1%	2 559	1,0%
14 Manufacture of wearing apparel	443	3,6%	4 733	1,9%
C15 Manufacture of leather and related products	60	0,5%	570	0,2%
C16 Timber, articles of wood and cork, unfurnished	107	0,9%	1 654	0,7%

276 As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C17 Paper, cardboard and paper and paperboard products	20	0,2%	483	0,2%
C18 Printing and reproduction of recorded media	99	0,8%	1 860	0,7%
C19 Coke and refined petroleum products	0	0,0%	0	0,0%
C20 Chemicals	..	0	..	0
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	..	0	..	0
C22 Manufacture of rubber and plastic products	115	0,9%	1 675	0,7%
C23 Products from other non-metallic mineral raw materials	121	1,0%	3 728	1,5%
C24 Base metals	173	1,4%	..	0
C25 Metal products, except machinery and equipment	455	3,7%	9 272	3,6%
C26 Manufacture of computer, electronic and optical product	..	0	..	0
C27 Electrical equipment	..	0	..	0
C28 Machinery and equipment, general and special purpose	923	7,5%	32 184	12,7%
C29 Manufacture of motor vehicles, trailers and semi-trailers	..	0	..	0
C30 Manufacture of other transport equipment	..	0	..	0
C31 Manufacture of furniture	1 599	12,9%	40 459	15,9%
C32 Other manufacturing	49	0,4%	384	0,2%
C33 Repair and installation services of machinery and equipment	103	0,8%	1 909	0,8%
				.. Confidential data

Source: NSI Structural Business Statistics, 2019

As seen from the structure of Manufacturing Industry, the leading industrial sectors in 2019 were the production of furniture; food products; beverages and tobacco products; machinery and equipment with general and special purposes, which generated respectively 15,9%, 14.9% and 12,7% of the value added in the manufacturing industry in the district. Other industries with a significant share in regional economy was textiles and wearing apparel with a share of app. 3%.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[277]. The data for each directly affected 4-digit sector and their share of the district economy is presented in Table 147 below.

Table 147. Directly affected industrial sectors in Yambol district[278]

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[277] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify the CO_2-intensive companies.

[278] It **should be noted** that in addition to those three industries, a textile company (E.Mirolio EAD) has an establishment in Yambol engaged in textile dying, which is listed as a separate CO_2-emitter in the EU ETS. This establishment is however neither a separate legal entity, nor a financially autonomous branch, but just a local manufacturing unit of that company. The company is registered and headquartered in Sliven, where it operates another establishment also covered by the EU ETS as a separate emitter. The company doesn't maintain separate accounting records for its Yambol establishment, but common accounting records for the whole company, which makes it impossible to review separately the two establishments. To this end, the potential economic impacts from the decarbonization of that textile company, covering both establishments, have been reported in Sliven district where the company is fiscally registered.

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Profit	Investm. in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN '000)	(BGN '000)	(BGN '000)	(BGN '000)	(number)	(BGN '000)
1	28.12 Manufacture of fluid power equipment	1	169 270	151 418	1 176	22 445	1 391	26 126
2	25.62 Metal processing	1	11 787	1 035	441	0	40	428
3	46.73 Wholesale of wood, construction materials and sanitary equipment	1	75 193	3 186	681	0	128	933

Source: Enterprise survey implementd by the team

The following indirectly affected sectors in the district have been identified, based on a value chain survey with a limited scope[279]:

Table 148. Indirectly affected industrial sectors in Gabrovo district

Sectors included in the supply chain of directly affected sector				20.13	Manufacture of other inorganic basic chemicals		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN '000)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	46. Wholesale trade, except of motor vehicles and motorcycles	1	16 036	16 035	2 071	N/A	25

Sectors included in the supply chain of directly affected sector				23.11	Manufacture of flat glass		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN '000)	Production value (BGN '000)	Value added at factor cost (BGN '000)	Number of employees (number)	Wages and salaries (BGN '000)
1	49.Land transport and transport via pipelines	1	17 040	17 040	6 056	2 998	N/A

Source: Enterprise survey implementd by the team

[279] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district, which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

Energy sector and buildings

The energy infrastructure network of Yambol district is well developed and ensures a generally reliable supply of electricity for industry and households. Electricity supply in Yambol district is provided by the national electricity network. There are no large thermal power plants operating in the district – instead, the main power supply substation is substation Maritsa Iztok-2, 400/220/110 kW, located in the neighboring district Stara Zagora, which is connected to the state-owned TPP Maritsa Iztok 2. There are substations 110/20 kV in each of the five municipalities of Yambol district, as well as four substations in Yambol city. There is one industrial co-generation unit TPP Dekotex with 2 MWe installed capacity and efficiency 76.31%. There is no district heating developed in the district.

Natural gas supply and distribution networks are available for the city of Yambol. One large company, Overgas Mreji AD, has a license for gas distribution in the city. There are two gas compressor stations in Yambol district, operated by the state-owned company Bulgartransgaz.

The utility companies operating in the district are presented in Table 149:

Table 149. Energy operators in Yambol district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
BULGARTRANSGAS EAD	Gas transmission system
EVN Bulgaria Elektrosnabdiavane EAD	Electricity distribution (20kV/380V)
Overgas Mreji AD	Natural gas distribution in Yambol

To the end of 2020 there are also 166 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (149) and 14 are wind plants, as shown in Table 150:

Table 150. Installed capacity and energy production by type of RES in Yambol district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Solar energy	149	109.905795	148 844.352070
Wind	14	10.575000	10 340.768200
Biogas	3	2.217000	12 977.944200
Total	**166**	**122.697795**	**172 163.064470**

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, an energy survey was conducted in mid 2021.

Table 151. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for reconstructions of a substation and network, about 26 mln.EUR.
BULGARTRANSGAS EAD	Answer was not received
EVN Bulgaria Elektrosnabdiavane EAD	Answer was not received
Overgas Mreji AD	Answer was not received

Source: Enterprise survey implemented by the team

In 2020 there is a request for connection of 2 new PV plants with total capacity 50 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [280] 1 kWp installed PV capacity in Yambol will produce 1317.81 kWh per year and will save 558 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Gabrovo in sector D Electricity, gas, steam and air conditioning supply are summarized in the following table:

Table 152. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019
Number of enterprises	92	94	86
Number of persons employed	130	113	117
Revenues, thousands BGN	57445	60202	47395

Source: NSI

There is slight decrease of the number of enterprises and the other economic indicators for the sector in the period 2017-2019.

Indicators to be monitored:

[280] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

1 Number of installations using RES for electricity

2 Installed capacity, MW cumulatively

3 Energy produced, MWh

4 GHGs emissions savings, t/y

Housing in district Yambol consists of 71,979 dwellings –43,615 of the dwellings are situated in the cities and 28,364 in the villages [281]. There are 52 buildings from the district with energy efficiency certificate. The average current energy consumption is 169,54 and it is expected to be reduced after renovation to 74.78kWh/m2. Expected annual energy savings are estimated at 18461480.15 kWh/a and CO2 savings- 10205.285 t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as untill June 2021 the renovated buildings were 21 in Yambol, 10 in Elhovo, 5 in Straldzha and 3 in Bolyarovo [282]. The municipalities in district Yambol have energy efficiency and RES programmes as Bolyarovo, Elhovo, Straldzha and Tundzha have also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

- Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;
- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.
- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.

[281] https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

[282] https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Yambol for 3-year period are presented in the following table:

Table 153. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%
Number of enterprises	190	186	202	6.32
Number of persons employed	1692	1603	1628	-3.78
Revenues, thousands BGN	108419	116430	143472	32.33

Source: NSI

The increase of revenue is 32.33% due to the increased economic activities.

Public Transport Sector

Yambol municipality is the main municipality in the Yambol district and is the main city with developed public transport network in the district. The State property and economic activity Directorate of the municipality is responsible for managing the local public transport. The municipality conducts a public tender to select the operator of the public transport network. All public transport in the municipality is run by diesel buses – namely, 20 EURO 4 buses. In 2020 the mileage of public transport buses was 960 000 km with total diesel consumption of 230 400 liters which emitted an estimated 622.9 tonnes of CO_2. The emission rate of 0.65 kg CO_2/passenger km was lower than the calculated national average of 1.16 kg CO_2/passenger km. Table 154 below summarizes the current profile of public transport in Yambol.

Table 154. Current profile of public transport in Yambol

Item	Description
Type of vehicles in public transport network	Buses
Number of public transport passengers (2020)	1 956 000
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	230 400
Total annual mileage of public transport buses, in km (2020)	960 000
Total estimated CO2 emissions from public transport, in t (2020)	622.9
Total estimated CO2 emissions per passenger km of public transport, in kg (2020)	0.65

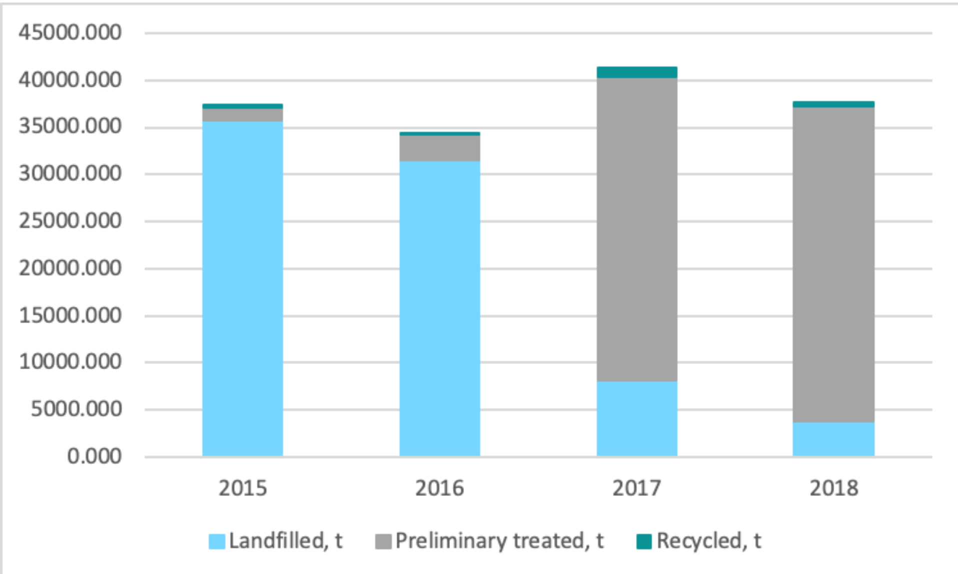
Source: World Bank Municipal survey, 2021

A questionnaire was sent to Yambol municipality, which was followed up by an interview, to understand the strategic plans in terms of public transport development. It is understood that Yambol municipality is in the process of developing a Sustainable urban mobility plan.

Waste Sector

The Regional Association for Waste Management (RAWM) Yambol serves all municipalities in Yambol district, as well as municipalities in the neighboring Sliven district. All households in Yambol district are served by municipal waste collection systems. Household municipal waste generation was relatively stable generated in the period 2015-2018. The amount of recycled municipal waste in the district is insignificant and represented a mere 1% of all generated municipal waste in Yambol district in 2018.

Figure 43. Generated and recycled municipal household waste in Yambol district, 2015-2018, t



Source: National Statistical Institute, 2019

There is one regional waste depot in Yambol district that serve all municipalities in the region (including municipalities from Sliven district) and that is managed by the respective Regional Association for Waste Management (RAWM). The GHG emissions from the depot in 2019 were reported in its IEP annual report and are presented in the following table. The regional waste depot Yambol is an important source of CH_4 emissions and has some contribution to CO2 emissions in the district.

Table 155. GHG emissions of waste depots in Yambol district

Waste depots	CO2 emissions, t	CH4 emissions, t
Regional waste depot - municipalities of Yambol, Nova Zagora, Tundzha, Sliven, Straldzha (RAWM Yambol)	1255	624
Source: Executive Environmental Agency		

The latest draft of the National Waste Management Plan 2021-2028 recommends some potential improvements to the existing waste management system in Yambol district. The Yambol RAWM is in the indicative list for construction of installations for treatment of biodegradable waste and for additional capacity and infrastructure at the landfill. As far as existing infrastructure for collection, recycling, utilization and re-use of waste is concerned, the share of population covered by recycling infrastructure in the municipalities that answered the waste survey varies betweeen 43% in Tundzha to 64% in Yambol. These are relatively small shares compared to other districts. Green waste collection from municipal parks and construction waste appear to be the waste streams for which most municipalities have some plans to tackle, whereas collection of biodegradable waste seems to be problematic for most municipalities that answered the waste survey.

7.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Yambol district:

- The gereral decarbonization pathways for non-carbon-intensive industries (related to the available sectors metal processing and manufacture of machines and equipment)

Energy sector and buildings

Decarbonization measures for energy sector in Yambol includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

All buses in use in public transport in Yambol are EURO 4 buses. In order to decarbonizee public transport, **Yambol municipality needs to replace diesel buses with electric or hydrogen**

buses. The municipality might require the provider of the public transport service to use buses of higher EURO category and/or electric buses.

Yambol municipality is developing a Sustainable urban mobility plan. Therefore, there is potential to include measures to encourage sustainable and smart urban mobility in the municipality. For instance, incentives for walking and cycling could be provided by establishing adequate infrastructure, coupled with some transport demand management measures such as increase in parking fees and/or stricter parking regulation and/or measures regarding reduced private vehicles' access to certain areas of the municipality. Municipal charging infrastructure for electric vehicles could also be further expanded to serve as an institutional guidance for the direction that urban mobility is moving to.

Waste

There is significant potential for moving up in the waste management hierarchy in Yambol district. Namely, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Yambol municipality (the main municipality in the district) could improve collection and treatment of green waste, biodegradable waste and textile waste.

The Regional Associations for Waste Management (RAWM) in Yambol district is in the indicative list for constructing an installation for treatment of biodegradable waste as per the latest National Waste Management Plan 2021-2028. According to Bulgaria's NECP projections, improved treatment of biodegradable waste is the primary measure to reduce GHG emissions from the waste sector. Yambol district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

7.2 The impact of the transition to a climate-neutral economy

7.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to **directly estimate** the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 156 below.

Table 156. Assessment of the economic impact of industrial decarbonization in Yambol district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy[283] (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	3	5 523	0.05%
Turnover (BGN ‘000)	237 569	3 043 134	7.81%
Production value (BGN ‘000)	256 250	1 888 428	13.57%
Value added at factor cost (BGN ‘000)	155 639	673 207	23.12%
Profit (BGN ‘000)	2 298	233 668	0.98%
Investments in tangible long-term assets (BGN ‘000)	22 445	1 180 524	1.90%
Number of employees (number)	1 559	24 984	6.24%
Wages and salaries BGN ‘000)	27 487	299 303	9.18%
Indirectly affected businesses (limited scope of the supply chain coverage)			
Economic indicator	Total value for all indirectly affected companies (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	2	5 523	0.04%
Turnover (BGN ‘000)	33 076	3 043 134	1.09%
Production value (BGN ‘000)	33 075	1 888 428	1.75%
Value added at factor cost (BGN ‘000)	8 127	673 207	1.21%
Profit (BGN ‘000)	4 342	233 668	1.86%
Investments in tangible long-term assets (BGN ‘000)	N/A	1 180 524	N/A
Number of employees (number)	150	24 984	0.60%
Wages and salaries BGN ‘000)	1 822	299 303	0.61%
Cummulative impact (directly and indirectly affected businesses[284])			
Economic indicator	Total value for all affected companies from the district (BGN ‘000)	Impact on the district economy	
		Value for the whole district economy (BGN ‘000)	Share of affected companies (%)
Number of companies (number)	5	5 523	0.09%
Turnover (BGN ‘000)	270 645	3 043 134	8.89%
Production value (BGN ‘000)	289 325	1 888 428	15.32%
Value added at factor cost (BGN ‘000)	163 766	673 207	24.33%
Profit (BGN ‘000)	6 640	233 668	2.84%
Investments in tangible long-term assets (BGN ‘000)	N/A	1 180 524	N/A

[283] All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organisations and bodies.

[284] Limited supply chain coverage.

Number of employees (number)	1 709	24 984	6.84%
Wages and salaries BGN '000)	29 309	299 303	9.79%

Source: Enterprise survey implemented by the team

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the three directly affected 3-digit sectors, none is a key one for the district, while **C28** has a **strong backward linkage** to the district economy and is thus important in terms of indirect employment impacts.

Table 157. Key sectors[285] and sectors with backward linkages[286] in Yambol district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C28	Backward linkages	22	1.70

On the basis of Type I employment multiplier, it was established that in the worst-case scenario for **sector C28** a total of 2,370 jobs could be lost in the district, which included 1,391 initial job losses in the identified directly affected industry, and 979 job losses in its supply chain in the district.

Summary

The subsectors of machining, manufacture of fluid power equipment and wholesale of wood, construction materials and sanitary equipment, to which the three identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The 3 affected businesses generate together about 15% of the output, 24% of the value added at factor cost, as well as app. 7% of the employment and 10% of the wages & salaries of the district economy.

It was established under a supply chain survey with a limited scope that the identified **indirectly impacted** businesses in the district account together for 1.75% of the output, 1.21% of the value added, as well as 0.6% of the employment and of the wages & salaries generated by the district economy.

It was thus estimated under the *survey method* that the decarbonization of the district economy will **cumulatively affect industrial subsectors** providing 15% of the output, 24% of the added value, and app. 7% of the employment and 10% of the wages & salaries of the non-financial sector of the district economy.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts** beyond the scope of directly and indirectly affected businesses, established that the decarbonization

[285] Sectors with strong forward and backward linkages to other sectors in the district economy.

[286] Sectors with strong backward linkages to other sectors in the district economy.

of the carbon-intensive industries in the district could result in the hypothetical loss of 2,410 jobs in the district, this including 1,559 jobs in the directly affected industries and 979 jobs in the supply chains of two major CO_2-intensive sectors in the district.

Energy sector and buildings

In 2019 there were 86 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a toal of 117 employees. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 158. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[287]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	86	5523	1.55
Number of employees (number)	117	29653	0.39
Wages and salaries (BGN '000)	2472	299303	0.83

Source: Enterprise survey implemented by the team

Although the sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well presented in the district.

Table 159. Economic indicators for sector F Construction in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[288]	
		Value for the whole district economy	Share of affected companies (%)

[287] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

[288] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Number of companies (number)	202	5523	3.66
Number of employees (number)	1628	29653	5.49
Wages and salaries (BGN ‘000)	17902	299303	5.98

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials’ producers, etc.;

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term as the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics (refining, transport, distribution) or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials’ and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Yambol district in 2018 was just 1%, whereas 89% was preliminary treated and 10% landfilled. Therefore, it might be expected that **more sophisticated waste management, treatment and utilization that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources’ recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

7.2.2 The social impacts of the transition

Yambol displays higher-than-average population decline, largely due to outmigration: it is an aging district, missing prime-age workers who have left elsewhere to find better economic opportunities. The population of the district is projected to decline from 117 to about 90 thousand between 2020 and 2050 due to both, outmigration and negative rate of natural increase. The effects of ageing are compounded by rapid outmigration (mostly internally to neighboring Plodviv and Burgas). The vast majority of migrants is very young: those aged 0 to 19 account for 44 percent of outmigration. The shrinkage of the working-age population, coupled with rapid population aging, is causing dependency ratios to surge: the age-dependency ratio is 10 percentage points higher than the country average at 65 percent. Unless the demographic and migration trends are halted, Yambol will continue to lose its younger, more educated workforce, leaving behind mostly lower skilled workers and aging households.

Table 160. Key labor and social indicators, Yambol

	Yambol	Bulgaria	EU-27
Population			
Dependency ratio	65.4	55.5	54.9
Old-age dependency ratio	40.0	33.2	31.4
Net migration	-539		
abroad	-192		
of 20-39 y.o.	-239		
Labor			
Employment rate	63.2	68.5	67.7
Unemployment rate	6.5	5.2	7.2
Share of manufacturing in total employment	32	22	
Share of 25-54 in employment	75	76	
Share of job openings for high-skilled labor	20		
Skills			
Share of employed with tertiary education	16	31	
Jobseekers/vacancies ratio (low-skilled)	9		
Share of TVET in IT-related curricula	6		
Social inclusion			
Poverty	22.2	23.8	
Number of energy beneficiaries	4,946	283,680	
Share of energy beneficiaries using fossil fuel	79	88	
Labor impact			
Share of workers in carbon-intensive sectors	8		
Number of commuters	648		

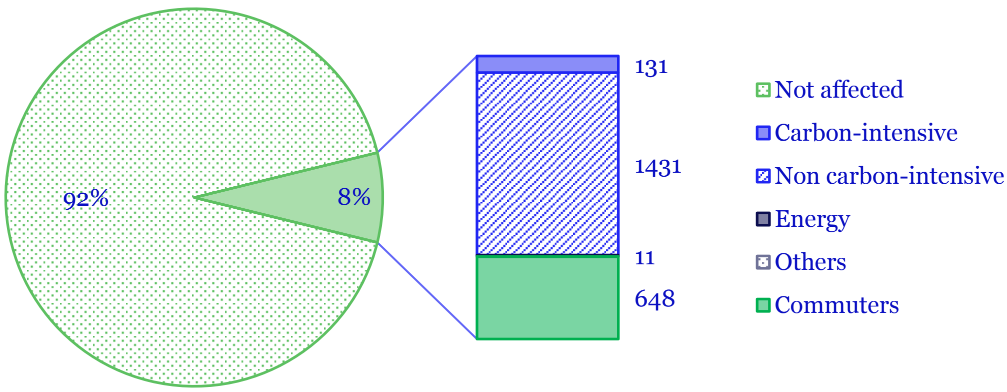
Source: National Statistical Institute (NSI) and Eurostat (latest year available).

Yambol's labor market indicators were relatively good until 2017, but worsened markedly as of 2018. Until 2017, labor force participation rates were higher than the country average, and unemployment rates were lower. But 2018 saw employment rates drop sharply by 5.6 percentage points to a five-year low of 62 percent: 5,300 jobs were lost in 2018 alone, mostly in manufacturing and wholesale trade. In 2019, unemployment rates were still two times higher than the country average, as 6.5 percent, and labor force participation rates were among the lowest at 70 percent. In addition, female participation is significantly lower than the country average, at 57 percent.

Yambol's workforce is skewed towards older, lower-skilled workers, in more traditional sectors. Half of the workforce is 45 years of age or older. Less than one in four workers graduated from university, as compared to 1 in 3 at the national level. The structure of Yambol's workforce highlights the importance of the vocational track: 43 percent of the labor force graduated with a secondary vocational degree, 10 percentage points above the national average, and one in three are enrolled in the lower qualifying track (EQF level 3).

These lower-skilled workers are already those facing the highest difficulties in finding job opportunities: the most sizeable mismatch between the supply and demand of skills appears in the segment of low skillsets, registered jobseekers exceed by 9 times the number of registered vacancies. And there are also indications for persisting high imbalances between the demand and supply of middle and high skills. [289]

Figure 44. Employment in affected sectors (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019), and PWC for commuters.

Around 1.5 thousand workers are employed by high GHG-emitting companies located in Yambol. Most of them are concentrated in three large companies. The majority of workers (1.4 thousand workers) are employed by a factory of surface metal treatment, and over 100 workers employed in the production of ceramics. In addition, 40 workers are

[289] For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

employed in the production of PET granulate, and a small number of microenterprises are involved in the production of electricity, or the manufacture of iron and steel.

Including commuters to Stara Zagora, 8 percent of the district workforce is employed in carbon-intensive or mining sectors. An additional 648 workers commute from the district of Yambol to Maritsa East Energy Complex, mostly from the municipalities of Elhovo, Tundzha, and Yambol. However, the miners represent between 1 and 2 percent of the total population in these three municipalities. But for these miners, the timeline and nature of the transition is likely to be both, faster and more severe, than for the workforce employed in other high GHG-emitting factories.

The impact of the transition through employment may vary widely across municipalities. In the municipalities of Elhovo, Tundzha, and Yambol, where commuters to Maritsa East Energy Complex are located, miners represent between 1 and 2 percent of the total population in these three municipalities. However, discussions with experts from local labor offices highlight that they often represent the only source of income besides pensions and social assistance benefits. The intensification of the existing migration trend towards larger and more dynamic economic centers, especially to Stara Zagora and Burgas, may reinforce a vicious circle of lower access to and quality of public services (education, health, social services) and significant outmigration trends. Already, some municipalities have large shares of inactive populations: Elhovo and Bolnarovo are home to elderly households, who rely entirely on pensions.

Finally, the social impact of the transition may be channeled through rising energy prices. The district's 5,000 recipients of the energy subsidy are unlikely to be much affected by the energy transition, as most of them use wood for heating.[290]

7.2.3 The environmental impacts of the transition

The largest GHG emitter in Yambol district operates in the textiles industries. The focus of decarbonization pathways for the textiles industries include the following main activities:

Switching from fossil fuels to lower-carbon fuels.

- Improved processes' energy efficiency and system optimization.

The measures outlined above have the largest potential to reduce GHG emissions in Yambol district. Table 161 [291] summarizes the potential environmental impacts from the main decarbonization measures in the textile industry.

Table 161. Potential environmental impacts from decarbonizing the textile industry in Yambol district

	Potential impacts on

[290] According to regional social assistance agency experts, most beneficiaries of the energy benefit are rural isolated households and Roma, who burn wood, tires, or textile as a primary source of energy.

[291] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

Decarbonization Pathway	Air	Water	Resource efficiency/Waste generation	Soil, land use, biodiversity	Indirect impacts
Switching from fossil fuels to electricity	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive processes eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen)	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels.	Potential negative impacts Additional need for transportation and transport infrastructure.

				The emissions from biomass combustion also contribute to eutrophication.	
Switching from fossil fuels to renewable energy (except biomass)	Positive impact Use of renewable energy does not lead to emissions to air.	Mainly neutral impact There is a potential risk of eutrophication in case of hydropower generation.	Potential positive and negative impacts Negative impacts from the need of additional infrastructure and waste treatment of certain renewable energy infrastructure (e.g. solar panels, batteries). Positive impacts from improved resource efficiency.	Fuel dependent Deployment of renewable energy sources might lead to land change effects, including from the deployment of additional infrastructure. Nevertheless, depending on the renewable energy source, impacts are generally lower than in the case of fossil fuels.	Fuel dependent
Improved energy efficiency and system optimization	Positive impacts Positive impacts from reduced emissions to air.	No impact expected	Positive impacts Reduced demand for machinery and consumables.	Dependent on specifics	Dependent on specifics

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[292]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils.

Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

[292] https://www.who.int/health-topics/air-pollution#tab=tab_3

7.3 Economic diversification potential and related development opportunities

Following the diversification screening methodology, rapidly growing sectors providing diversification opportunities for the district economy, have been identified, as detailed lists of new products recommened for export diversification of some of those sectors have additionally been provided.

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

7.3.1 Small and rapidly growing sectors

Twelve small, rapidly growing sectors providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 162. Small and Rapidly Growing Sectors for Yambol District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[293]
1	55. Accomodation	N/R[294]
2	62. Computer programming, consultancy and related activities	N/R
3	03. Fishing and aquaculture	N/A[295]
4	63. Information service activities	
5	25. Manufacture of leather and related products	Leather (HS code 4112)
6	17. Manufacture of paper and paper products	N/A
7	22. Manufacture of rubber and plastic products	Plastic plates, sheets etc. (HS codes 3920, 3925)
8	13. Manufacture of textiles	Woven of Sintetic fibres, textile, yarn (HS codes 5514, 5811, 5606, 6308)

[293] Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

[294] Not Relevant.

[295] Not Available.

9	16. Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	N/A
10	33. Repair and installation of machinery and equipment	N/A
11	61. Telecommunications	N/R
12	52. Warehousing and support activities for transportation	N/R

7.3.2 Mid-size and rapdily growing sectors

Three mid-size, rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 163. Mid-size rapidly growing sectors for Yambol District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	56. Food and beverage service activities	N/R
2	31. Manufacture of furniture	N/A
3	14. Manufacture of wearing apparel	N/A

7.3.3 Large and rapidly growing sectors

Two large and rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 164. Large and rapidly growing sectors for Yambol District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	47. Retail trade, except of motor vehicles and motorcycles	N/R
2	46. Wholesale trade, except of motor vehicles and motorcycles	N/R

Thus a total of 17 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

8 HASKOVO

8.1 Carbon-intensive sectors to be impacted by decarbonization296

8.1.1 SSM

According to data of the National Statistical Institute, the gross domestic product (GDP) of Haskovo district in 2019 amounted to 2049 mln BGN at current prices. The share of GDP of the district was 1.71% of the total GDP of the national GDP, which ranked the district 13th among Bulgarian districts. In 2019 GDP per capita was BGN 9,036, which ranked the district 25h of the 28 districts in the country. At A3 aggregation level, in 2019 the biggest share in the gross value added (GVA) formation of Haskovo district was due to the services sector with 66%, followed by industry with 26% and agriculture by 9%. Haskovo region ranks 13th in the country in GVA created by the industry. As seem from its GVA structure, the district is one of the industrialized districts in Bulgaria, i.e. with highest share of industry in the district economy

In Haskovo region, the foreign direct investment (FDI) in the non-financial sector as of 2019 amount to EUR 183,1 million. The largest is the value of foreign direct investments in the industry from about 78% of all FDIs in the region. Next in volume of FDIs is the services sector (trade, repair of cars and motorcycles, transport, warehousing and posts, accommodation and food services) with a little over 16% of all foreign investments.

Manufacturing industry

The structure of the Manufacturing Industry in the district is presented in Table 165 below.

Table 165. Manufacturing Industry in Haskovo district, 2019

Sectors	Persons employed		Value added at factor costs	
	Number	% of total	BGN '000	% of total
C. Manufacturing industry	13 908		285 338	
C10 Manufacture of food products	2 566	18,45%	45 057	15,79%
C11 Manufacture of beverages	1 055	7,59%	52 866	18,53%
C12 Manufacture of tobacco products	0	0,00%	0	0,00%
C13 Manufacture of textiles	684	4,92%	10 603	3,72%
14 Manufacture of wearing apparel	3 989	28,68%	41 284	14,47%
C15 Manufacture of leather and related products	470	3,38%	6 153	2,16%
C16 Timber, articles of wood and cork, unfurnished	85	0,61%	1 475	0,52%
C17 Paper, cardboard and paper and paperboard products	45	0,32%	432	0,15%

296 As mentioned in Part I, Section 3, the level of detail in the sectoral analyses corresponds to the focus of the TJTPs as provided in Article 11 of the JTF Regulation and the eligible activities to be supported outlined in Article 8 of the JTF Regulation. Thus, the main focus points of the analyses are the economic and social impacts from the transition, in particular with regard to impacts on workers and jobs in fossil fuel production and use and the transformation needs of the production processes of industrial facilities with the highest greenhouse gas intensity in the district.

C18 Printing and reproduction of recorded media	51	0,37%	353	0,12%
C19 Coke and refined petroleum products	0	0,00%	0	0,00%
C20 Chemicals	..	0	..	0
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	0	0,00%	0	0,00%
C22 Manufacture of rubber and plastic products	314	2,26%	6 292	2,21%
C23 Products from other non-metallic mineral raw materials	764	5,49%	25 404	8,90%
C24 Base metals	0	0,00%	0	0,00%
C25 Metal products, except machinery and equipment	642	4,62%	13 472	4,72%
C26 Manufacture of computer, electronic and optical product	..	0	..	0
C27 Electrical equipment	255	1,83%	5 584	1,96%
C28 Machinery and equipment, general and special purpose	1 130	8,12%	33 780	11,84%
C29 Manufacture of motor vehicles, trailers and semi-trailers	..	0	..	0
C30 Manufacture of other transport equipment	..	0	..	0
C31 Manufacture of furniture	306	2,20%	3 229	1,13%
C32 Other manufacturing	189	1,36%	2 434	0,85%
C33 Repair and installation services of machinery and equipment	240	1,73%	2 791	0,98%
.. Confidential data				

Source: NSI Structural Business Statistics, 2019

As seen from the structure of Manufacturing Industry, leading sectors from the manufacturing industry for the district were the food & beverage industries which accounted for 34.3% of the value added and 26% of the employment in the manufacturing industry in the district. The next most important industries are textile & wearing apparel production which generated 18.2% of the added value and 33.6% of the employment in the manufacturing industry, as well as the manufacturing of machines and equipment for general and specific, use and production of non-metallic mineral raw materials, which were responsible respectively for 11,84% and 8.9% of the added value by the manufacturing industry in the district.

Industrial sectors affected by the decarbonization

The directly affected sectors were identified on the basis of an exhaustive field survey of all carbon-intensive companies in the district[297].

The data for each directly affected 4-digit economic sector is presented in Table 166 below.

Table 166. Directly affected industrial sectors in Haskovo district

[297] See the methodological notes on the SSMs for the scope of the field survey, incl. the criteria and methods applied to identify the CO_2-intensive companies.

No	Sector (4-digit NACE Rev. 2 code)	Directly affected compa-nies	Production value	Value added at factor cost	Profit	Investm. in tangible long-term assets	Number of employees	Wages and salaries
		(number)	(BGN ‘000)	(BGN ‘000)	(BGN ‘000)	(BGN ‘000)	(number)	(BGN ‘000)
1	20.15 Manufacture of fertilisers and nitrogen compounds	1	255 105	26 571	0	4 591	804	20 025
2	23.32 Manufacture of bricks, tiles and construction products, in baked clay	1	152	165	0	0	8	52

Source: Enterprise survey implementd by the team

The following indirectly affected sectors in the district have been identified, based on a value chain survey with a limited scope[298]:

Table 167. Indirectly affected industrial sectors in Gabrovo district

Sectors included in the supply chain of directly affected sector				23.51	Manufacture of cement		
No	Sector (2-digit NACE Rev. 2 code)	Affected companies (number)	Turnover (BGN ‘000)	Production value (BGN ‘000)	Value added at factor cost (BGN ‘000)	Number of employees (number)	Wages and salaries (BGN ‘000)
1	42. Civil engineering	1	1 901	2 254	1 208	69	548

Source: Enterprise survey implementd by the team

Energy Sector and Buildings

The energy infrastructure network of Haskovo district is well developed and ensures a generally reliable supply of electricity for industry and households. Electricity supply in Haskovo is provided by the national electricity network. The Thermal Powerplant Maritza 3 and Maritza Iztok substation are important parts of the national and district electricity network. The substation has 1030 MW installed capacity, 400/220/110 kV. Substation Uzundjovo 220/110/20/6 kV is the main supply station for the region and has installed capacity of 400 MW. There is a network of 10 regional substations on 110/20 kV, with a total capacity of 584 MW.

[298] The scope of the value chain survey is limited to the companies, included in the supply chains of 4 major companies, directly affected by the decarbonization, namely: Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district, which presented structured data about their major supply chain partners located in the 8 districts, covered by the survey, namely Burgas, Varna, Targovishte, Lovech, Gabrovo, Sliven, Yambol and Haskovo.

Natural gas supply and distribution networks are available for the cities Haskovo and Dimitrovgrad. In both cities, the gas distribution company "Citygas Bulgaria" EAD supplies the natural gas. There is no district heating in the district.

The utility companies operating in the district are presented in Table 168:

Table 168. Energy operators in Haskovo district

Operator	System
Elektroenergien sistemen operator EAD	Electricity transmission system (400/220/110 kV)
EVN Bulgaria Elektrosnabdiavane EAD	Electricity distribution (20kV/380V)
"Citygas Bulgaria" EAD	Natural gas distribution in Haskovo and Dimitrovgrad
Thermal Powerplant Maritza 3	Electricity generation

To the end of 2020 there are also 261 electricity plants producing energy from RES and receiving certificates for origin. Most of them are solar PV (259) and 2 are hydroenergy plants, as shown in Table 169:

Table 169. Installed capacity and energy production by type of RES in Hskovo district

Type RES	Energy Plants (number)	Installed Capacity (MW)	Energy Produced in 2020 (MWh)
Solar energy	259	82.807	109 884.86
Hydroenergy	2	121.010	140 106.491
Total	**261**	203.817	249 991.355

Source: https://portal.seea.government.bg/bg/EnergyByRegionAndRip

In order to define the impact of decarbonization to the utility companies, an energy survey was conducted in mid 2021.

Table 170. Impact assessment of decarbonization to the utility companies

Operator	Impact
Elektroenergien sistemen operator EAD	Changes in the number of jobs are not expected Investments are needed for digitalization and training of the staff Investments are needed for reconstructions of a substation and network, about 34 mln.EUR.
EVN Bulgaria Elektrosnabdiavane EAD	Answer was not received

“Citygas Bulgaria” EAD	Changes are not expected
Thermal Powerplant Maritza 3	Answer was not received

Source: Enterprise survey implemented by the team

In 2020 there is a request for connection of 10 new PV plants with total capacity 1144 MW - to a substation of Elektroenergien sistemen operator EAD. There is no information for the connection to 20 kV network. Using standard technology and database from Joint Research Center of EU commission [299] 1 kWp installed PV capacity in Haskovo will produce 1331.74 kWh per year and will save 565 gCO2e/y (emission factor 424 gCO2e/kWh for 2019). The impact of RES to the decarbonization in terms of GHGs emission savings from replacing electricity from the network have to be estimated annually using the emission factor for the last year available.

Economic data for companies registered in Gabrovo in sector D Electricity, gas, steam and air conditioning supply are summarized in the following table:

Table 171. Economic indicators for sector D Electricity, gas, steam and air conditioning supply

Indicator	2017	2018	2019
Number of enterprises	96	96	91
Number of persons employed	288	305	333
Revenues, thousands BGN	60768	61599	96947

Source: NSI

There is slight decrease of the number of enterprises but increase of the other economic indicators for the sector in the period 2017-2019.

Indicators to be monitored:

- Number of installations using RES for electricity
- Installed capacity, MW cumulatively
- Energy produced, MWh
- GHGs emissions savings, t/y

Housing in district Haskovo consists of 123,645 dwellings -- 82,500 of the dwellings are situated in the cities and 41,145 in the villages [300]. There are 81 buildings from the district with energy efficiency certificate. The average current energy consumption is 166,89 and it

[299] https://re.jrc.ec.europa.eu/pvg_tools/en/#PVP

[300] https://www.nsi.bg/bg/content/3145/%D0%B6%D0%B8%D0%BB%D0%B8%D1%89%D0%B0

is expected to be reduced after renovation to 77,56 kWh/m2. Expected annual energy savings are estimated at 76616218,68 kWh/a and CO2 savings- 27163,351 t/a. Municipalities in the district are active in supporting and implementation energy efficiency measures under Energy Efficiency of Multi-Family Residential Buildings National Programme as until June 2021 the renovated buildings were 110 in Haskovo, 21 in Dimitrovgrad, 13 in Simeonovgrad, 13 in Harmanly, Svilengrad 9, Ivailovgrad 5, Lyubimets 2, Topolovgrad 2 [301]. The municipalities in district Haskovo have energy efficiency and RES programmes as Haskovo has also approved Plan for Integrated Development (until the end of August 2021). In all strategic documents there are measures for energy efficiency and integration of RES in the building stock – municipal and residential buildings, as the main sources of financing are EU and national funds. Measures includes:

- Activities on structural reconstruction /strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Others as ensuring access for disabled people, safety requirements etc.

The expected impacts are:

- Economic: more opportunities to business for economic activity – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;
- Social: Providing additional employment; establishing traditions in the management of multi-family residential buildings; increasing public awareness of the ways for energy efficiency enhancement; improved comfort of living; reduction of energy poverty.
- Environmental: Decrease of pollution during the heating season caused by burning of fossil fuels and biomass in non-efficient stoves.
- Fiscal: Raising the incomes of economic operators from the value chain – from the directly engaged companies external contractors to all companies – subcontractors, and servicing firms lead to increase of tax revenues in the state budget in the form of both direct taxes – corporation tax (profit tax), income tax (paid by all workers and employees) and indirect taxes - value added tax. This applies to also for the revenues in the state budget in the form of social and health insurances for the hired at a certain company.

The economic data for construction sector in district Haskovo for 3-year period are presented in the following table:

Table 172. Economic indicators for construction sector

Indicator	2017	2018	2019	Change,%

[301] https://www.mrrb.bg/bg/energijna-efektivnost/nacionalna-programa-za-ee-na-mnogofamilni-jilistni-sgradi/aktualna-informaciya-za-napreduka-po-programata/

Number of enterprises	384	394	390	1.56
Number of persons employed	2800	2447	2260	-19.29
Revenues, thousands BGN	248492	221696	199877	-19.56

Source: NSI

There is decrease of revenue and number of employees with about 19%.

Public Transport Sector

Haskovo municipality is the main municipality in the Haskovo district and is the main city with developed public transport network in the district. A municipal enterprise is responsible for managing the local public transport. The municipality is in the process of fully electrifying its public transport network. In addition, to the trolleybuses in use in the municipality, Haskovo municipality are purchasing 11 in total electric buses to replace all diesel buses by the end of 2021. Due to this major change in the public transport in Haskovo municipality that will happen rather soon, the current situation of the public transport network is not analyzed.

In addition to Haskovo, the public transport sector of the Dimitrovgrad municipality was analyzed. Dimitrovgrad is an industrial center in Haskovo district. There are five buses that operate the public transport network in Dimitrovgrad district – two EURO 3, two EURO 4 and one EURO 5 bus. In 2020 the mileage of public transport buses was 422 248 km with total diesel consumption of 65 550 liters which emitted an estimated 177.2 tonnes of CO_2. The emission rate of 0.42 kg CO_2/passenger km was lower than the calculated national average of 1.16 kg CO_2/passenger km. Table 173 below summarizes the current profile of public transport in Dimitrovgrad.

Table 173. Current profile of public transport in Dimitrovgrad

Item	Description
Type of vehicles in public transport network	Buses
Number of public transport passengers (2020)	323 000
Total annual consumption of diesel for buses in the public transport network, in liters (2020)	65 550
Total annual mileage of public transport buses, in km (2020)	422 248
Total estimated CO2 emissions from public transport, in t (2020)	177.2
Total estimated CO2 emissions per passenger km of public transport, in kg (2020)	0.42

Source: World Bank Municipal survey, 2021

A questionnaire was sent to both Haskovo and Dimitrovgrad municipalities, which was followed up by an interview, to understand the strategic plans in terms of public transport development. **The key findings are summarized below:**

- Haskovo municipality is on course to fully electrify its public transport by the end of 2021.

- Both Haskovo and Dimitrovgrad municipalities are planning to expand their charging infrasructure for electric vehicles. Haskovo municipality will also expand the charging infrastructure for electric buses with six more stations.

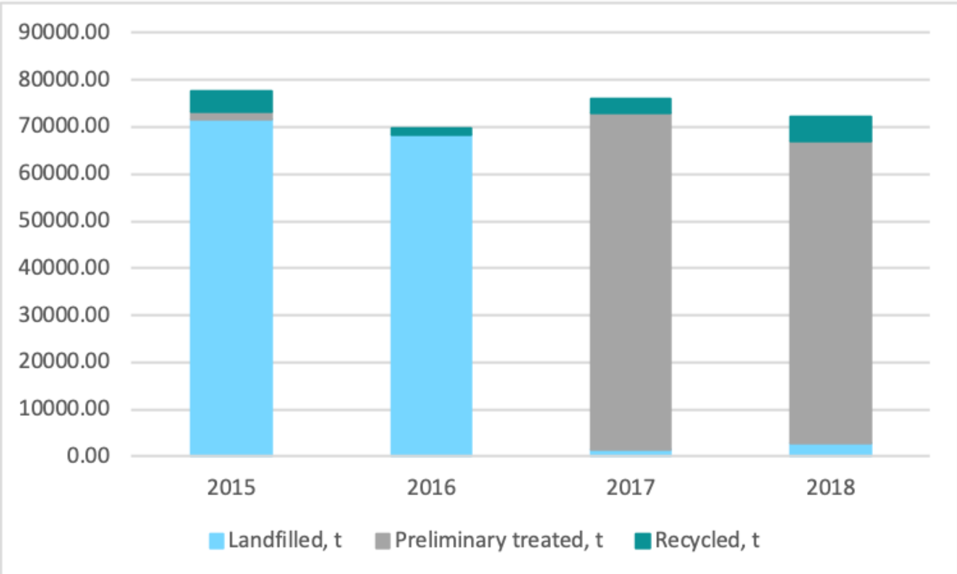
- Dimitrovgrad municipality has adopted a Sustainable urban mobility plan.

- Haskovo municipality plans to restrict access of polluting vehicles to the city center.

Waste Sector

There are two Regional Associations for Waste Management (RAWM) in Haskovo district – RAWM Haskovo and RAWM Harmanli. All households in Haskovo district were served by municipal waste collection systems in 2018. There is a slightly declining trend in household waste generation, whereas the amount of recycled municipal waste has been growing, but in 2018 it represented a mere 7% of all generated municipal waste.

Figure 45. Generated and recycled municipal household waste in Haskovo district, 2015-2018, t



Source: National Statistical Institute, 2019

There are two regional waste depots in Haskovo district that serve all municipalities in the region and that are managed by the respective Regional Associations for Waste Management (RAWM). The GHG emissions from the depots in 2019 are presented in the following table and are insignificant, compared to industrial emissions, for instance. The remaining landfill capacity of the waste depots in Haskovo district is reported to be 426228.36 m^3.

Table 174. GHG emissions of the waste depots in Haskovo district in 2019

Waste depots	CO2 emissions, t	CH4 emissions, t
Regional waste depot - municipalities of Harmanli, Madzharovo, Lyubimets, Topolovgrad, Simeonovgrad, Svilengrad (RAWM Harmanli)	1	0.5
Regional waste depot - municipaliites of Haskovo, Dimitrovgrad, Mineralni bani (RAWM Haskovo)	0.6	0.5

Source: Executive Environmental Agency

The latest draft of the National Waste Management Plan 2021-2028 recommends a number of potential improvements to the existing waste management system in Haskovo district. Both RAWMs are in the indicative list for construction of additional modules for stabilization of the biodegradable fraction in the waste separation installations, installations for treatment of biodegradable waste and additional capacity and infrastructure at landfills. As far as existing infrastructure for collection, recycling, utilization and re-use of waste is concerned, the share of population covered by recycling infrastructure in the municipalities that answered the waste survey varies betweeen 0% in Simeonovgrad and Stambolovo to 87% in Haskovo. Green waste collection from municipal parks and other household waste appear to be the waste streams for which most municipalities have some plans to tackle, whereas collection of biodegradable waste seems to be problematic for most municipalities that answered the waste survey. Most municipalities that answered the waste survey mentioned that they are planning to expand the recycling infrastructure.

8.1.2 Decarbonization pathways for carbon-intensive economic activities

Manufacturing industry

The decarbonization pathways of the following industrial sectors, described in section 3.2.1, are relevant to be implemented by the economy of Haskovo district:

- Ceramics industry
- Ammonia fertilsers industry

Energy sector and buildings

Decarbonization measures for energy sector in Haskovo includes:

- Energy efficiency of energy production and supply
- Use of renewable energy or green hydrogen – generated on-site or off-site
- Energy storage
- Digitalization and energy efficiency in transmittion and distribution of electricity (smart grids) and natural gas
- Phase out of solid fosil fuels and oil products for heating of buildings
- Smart cities including energy planning and digitalization

The only coal TPP Maritsa 3 could be transformed to biomass or gas fired plant.

The generalized pathway for building decarbonization includes implementation of energy efficient measures and use of renewable energy produced in the building or on other site. Measures include the process of urban planning, building design, materials used, construction activities, operation and demolishing of buildings.

Public Transport Sector

Haskovo municipality is on course to fully electrifying its public transport by the end of 2021 and thus, eliminate direct GHG emissions. On the other hand, Dimitrovgrad municipality could make further efforts for use of higher category EURO buses or electric buses.

Both municipalities can provide more incentives for walking and cycling. Haskovo municipality is considering restricting access of polluting vehicles to the city center, which is an option for incentivize more sustainable mobility modes. Other measures include ncrease in parking fees and/or stricter parking regulation. Municipal charging infrastructure for electric vehicles could also be further expanded to serve as an institutional guidance for the direction that urban mobility is moving to.

Waste

There is significant potential for moving up in the waste management hierarchy in Haskovo district. Namely, recycling rates can be increased and consequently, the amount of waste that is landfilled decreased. Haskovo municipality (the main municipality in the district) could improve collection and treatment of biodegradable waste, as well as provide more recycling containers.

Both Regional Associations for Waste Management (RAWM) in Haskovo district are in the indicative list for constructing installations for treatment of biodegradable waste as per the latest National Waste Management Plan 2021-2028. According to Bulgaria's NECP projections, improved treatment of biodegradable waste is the primary measure to reduce GHG emissions from the waste sector. Moreover, RAWM Haskovo and RAWM Harmanli are in the indicative list for construction of installations for stabilization of the biodegradable fraction. Haskovo district or individual municipalities within the district might consider the concept of circular economy in a more strategic way. District/municipal circular economy plans might be adopted as a first step towards implementation of a circular economy approach.

8.2 The impact of the transition to a climate-neutral economy

8.2.1 The economic impacts of the transition

Manufacturing industry

Survey-based assessment (limited scope)

The economic impact assessment under the survey method aims to **directly estimate** the scope of potential effects of the decarbonization on the identified directly and indirectly affected businesses. It measures the potential impacts of the decarbonization in structural dimension, by the share (in %) of the affected industries in the district economy, related to output, added value, eployment, wages and similar structural economic indicators.

The survey-based assessment of the economic impact of industrial decarbonization is presented in Table 175 below.

Table 175. Assessment of the economic impact of industrial decarbonization in Haskovo district

Directly affected businesses (exhaustive coverage)			
Economic indicator	Total value for all directly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy[302] (BGN '000)	Share of affected companies (%)
Number of companies (number)	2	12 080	0.02%
Turnover (BGN '000)	257 184	4 159 594	6.18%
Production value (BGN '000)	255 257	2 888 235	8.84%
Value added at factor cost (BGN '000)	26 736	953 910	2.80%
Profit (BGN '000)	0	331 556	0.00%
Investments in tangible long-term assets (BGN '000)	4 591	1 592 877	0.29%
Number of employees (number)	812	38 491	2.11%
Wages and salaries BGN '000)	20 077	393 780	5.10%
Indirectly affected businesses (limited scope of the supply chain coverage)			
Economic indicator	Total value for all indirectly affected companies (BGN '000)	Impact on the district economy	
		Value for the whole district economy (BGN '000)	Share of affected companies (%)
Number of companies (number)	1	12 080	0.01%
Turnover (BGN '000)	1 901	4 159 594	0.05%
Production value (BGN '000)	2 254	2 888 235	0.08%
Value added at factor cost (BGN '000)	1 208	953 910	0.13%
Profit (BGN '000)	422	331 556	0.13%
Investments in tangible long-term assets (BGN '000)	N/A	1 592 877	N/A
Number of employees (number)	69	38 491	0.18%
Wages and salaries BGN '000)	548	393 780	0.14%
Cummulative impact (directly and indirectly affected businesses[303])			
Economic indicator	Total value for all affected companies from the district (BGN '000)	Impact on the district economy	
		Value for the whole district economy (BGN '000)	Share of affected companies (%)
Number of companies (number)	3	12 080	0.02%
Turnover (BGN '000)	259 085	4 159 594	6.23%

302 All non-financial enterprises in the district, i.e. all NACE Rev. 2 activities, except sectors K. Financial and insurance activities, O. Public administration, T. Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U. Activities of extraterritorial organisations and bodies.

303 Limited supply chain coverage.

Production value (BGN '000)	257 511	2 888 235	8.92%
Value added at factor cost (BGN '000)	27 944	953 910	2.93%
Profit (BGN '000)	422	331 556	0.13%
Investments in tangible long-term assets (BGN '000)	N/A	1 592 877	N/A
Number of employees (number)	881	38 491	2.29%
Wages and salaries BGN '000)	20 625	393 780	5.24%

Source: Enterprise survey implemented by the team

Assessment based on an Input-Output analysis

The broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses was established through modeling of the inter-sectoral relationships within the district economy by an Input-Output analysis.

That analysis established that from the two 2-digit sectors in the district, which will be directly affected by the industrial decarbonization, **sector C20** is a **key sector,** important for the district economy in terms of indirect employment impacts.

Table 176. Key sectors[304] and sectors with backward linkages[305] in Haskovo district, and their employment multipliers

Sector (2-digit NACE Rev. 2 code)	Type of sector(al importance)	Simple Employment Multiplier (SEM)	Type I Employment Multiplier (Type I EM)
C20	Key sector	11	2.75

On the basis of the Type I employment multiplier, it was established that in the worst-case scenario for that sector a total 2,208 jobs could be lost in the district, which include 804 the initial job losses of the identified directly affected businesses, and 1,404 indirect job losses in its supply chain in the district.

Summary

The subsectors of manufacture of fertilisers and nitrogen compounds and manufacture of bricks, tiles and construction products, in baked clay, to which the two identified industrial CO_2 emitters belong, will be **directly affected** by the decarbonization of the industry. The 2 affected businesses generate together about 8% of the output, 2% of the value added at factor cost, as well as app. 2% of the employment and 5% of the wages & salaries of the district economy.

It was established under a supply chain survey with a limited scope[306] that the **indirect impacts** of the industrial decarbonization refer to one particular subsector in the district, which accounts

[304] Sector with strong forward and backward linkages to other sectors in the district economy.

[305] Sectors with strong backward linkages to other sectors in the district economy.

[306] As explained above in section 3.1.1., the supply chain survey covered the value chain only of four CO_2-intensive companies (Solvay Sodi AD, Varna district, Zlatna Panega Cement AD, Lovech district, Trakia Glass EAD, Targovishte district and Lukoil Neftochim Burgas AD, Burgas district.) out of 26 such companies operating in the 8 districts.

for 0,085% of the output, 1,13% of the value added, as well as 0,18% of the employment and 0,14%of the wages & salaries generated by the non-financial sector of the district economy.

It was thus estimated under the *survey method* that the decarbonization of the district economy will **cumulatively affect industrial subsectors** providing 9% of the output, 3% of the added value, and app. 2,3% of the employment and 5,2% of the wages & salaries of the non-financial sector of the district economy.

The *Input-Output analysis*, outlining the **broader magnitude of socio-economic impacts beyond the scope of directly and indirectly affected businesses**, established that the decarbonization of the carbon-intensive industries in the district could result in the hypothetical loss of 2,216 jobs in the district, this including 812 jobs in the directly affected industries and 1,404 jobs in the supply chain of one major CO_2-intensive sector in the district.

Energy sector and buildings

In 2019 there were 91 companies relating to electricity, gas, steam and air conditioning supply registered in the distrct. These had a toal of 333 employees. TPP Maritsa 3 operates with about 50 employees as in case of transformation from coal to natural gas the number of people will remain the same as it is on the minimum for safety operation. **The impact from decarbonizing the energy sector is expected to be largely positive in terms of an increasing number of jobs and increased revenues due to the construction of new RES Plants.**

Table 177. Economic indicators for sector F electricity, gas, steam and air conditioning supply in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[307]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies	91	12080	0.75
Number of employees	333	48763	0.68
Wages and salaries (BGN ‘000)	4469	393780	1.13

Source: Enterprise survey implemented by the team

307 All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Although the sector represents a small share of the economy in the district, it has a potential for development, especialy of SMEs operating and maintaining small and big RES.

Construction sector and activities related to building construction and renovation are well presented in the district.

Table 178. Economic indicators for sector F Construction in 2019

Economic indicator	Value for all companies from the sector	Impact on the district economy[308]	
		Value for the whole district economy	Share of affected companies (%)
Number of companies (number)	390	12080	3.23
Number of employees (number)	2260	48763	4.63
Wages and salaries (BGN '000)	21104	393780	5.36

Source: Enterprise survey implemented by the team

The expected impact from decarbonization of the building sector is overall positive for the local economy in terms of the increasing number of jobs and revenue in the construction sector. This includes more opportunities for business – designers, construction industry, companies for technical and energy efficiency audits, materials' producers, etc.;

Public Transport Sector

No major impacts on the economic performance of the sector or on employment are forecasted in the short to medium term as the function of the public transport service and local mobility will remain the same: moving people and goods from one point to another. In the short to medium term one type of bus (diesel or methane) will be replaced by another type of bus (electric or green hydrogen) that will potentially drive on similar routes. However, new mobility modes (such as e-mobility) and urban planning for green mobility might considerably alter the need and function of public transport in the medium and long term. Moreover, decarbonization measures might support new employment opportunities in relation to e-mobility, walking and cycling, shared or new mobility modes and in the development and maintenance of charging infrastructure for electric and hydrogen vehicles.

Since decarbonization measures lead to reduction in the consumption of fossil fuels for transport, this might have **a potentially negative impact on jobs directly connected with fossil fuel logistics** (refining, transport, distribution) **or to jobs related to the repair and maintenance of vehicles with internal combustion engines** that are expected to be replaced by electric or hydrogen vehicles.

[308] All NACE Rev. 2 activities, except sectors K Financial and insurance activities, O Public administration, T Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U Activities of extraterritorial organisations and bodies.

Waste

Decarbonizing the waste sector will have mainly positive impacts. Enhanced circular economy and improved resource efficiency might generate economic benefits for waste management systems, as well as for private enterprises. Circular economy, resource efficiency and reuse of waste could reduce raw materials' and waste management costs for companies. Alternatively, strict regulation on resource efficiency and reuse of waste materials, if enforced, might be costly to some enterprises in the short term. These effects, however, are highly dependent on the particular context of different economic operators and cannot be generalized on a district level.

The share of municipal solid waste that was recycled in Haskovo district in 2018 was just 7%, whereas 89% was preliminary treated and 4% landfilled. Therefore, it might be expected that more sophisticated **waste management, treatment and utilization that leads to higher amounts of recycled waste and lower landfill rates could actually generate new jobs** – in recycling, resources' recovery, repair, etc. and even lead to the creation of new companies that can facilitate the re-use of waste and the implementation of industrial symbiosis. Nevertheless, the economic impact, as well as the effects on jobs are also highly dependent on the local context and waste management practices pursued.

8.2.2 The social impacts of the transition

Haskovo is an aging district, and misses prime-age workers who have left elsewhere to find better economic opportunities. The population of the district is projected to decline steadily from 225 thousand in 2020 to 171 thousand in 2050. The effects of ageing are compounded by rapid outmigration (mostly internally), especially of younger populations groups (aged 20 to 39). The shrinkage of the working-age population, coupled with rapid population aging, is causing dependency ratios to surge: the age-dependency ratio is 4 percentage points higher than the country average at 60 percent. Unless the demographic and migration trends are halted, Haskovo will continue to lose its younger, more educated workforce, leaving behind mostly lower skilled workers and aging households.

Table 179. Key labor and social indicators, Haskovo

	Haskovo	Bulgaria	EU-27
Population			
Dependency ratio	60.1	55.5	54.9
Old-age dependency ratio	36.9	33.2	31.4
Net migration	-862		
abroad	-544		
of 20-39 y.o.	-477		
Labor			
Employment rate	67.4	68.5	67.7
Unemployment rate	N/A	5.2	7.2
Share of manufacturing in total employment	29	22	
Share of 25-54 in employment	72	76	
Share of job openings for high-skilled labor	9.6		
Skills			

Share of employed with tertiary education	23.4	31.3	
Jobseekers/vacancies ratio (low-skilled)	12		
Share of TVET in IT-related curricula	16		
Social inclusion			
Poverty	17.1	23.8	
Number of energy beneficiaries	9,980	283,680	
Share of energy beneficiaries using fossil fuel	87	88	
Labor impact			
Share of workers in carbon-intensive sectors	5		
Number of commuters	1,471		

Source: National Statistical Institute (NSI) and Eurostat (latest year available).

Haskovo's workforce is skewed towards older, lower-skilled workers, in more traditional sectors. One in five workers is less than 34 years old, as compared to 1 in 4 at the national level; while one in four workers graduated from university, as compared to 1 in 3 at the national level. In addition, the district reports a much lower relative share employment in higher value-added service sector activities (3 percent) such as ICT, financial and insurance activities, real estate activities and professional, scientific and technical activities, and manufacturing continues to play a key role in the district economy (29 percent, as compared to 22 percent at the national level).

These lower-skilled workers are already those facing the highest difficulties in finding job opportunities: the most sizeable mismatch between the supply and demand of skills appears in the segment of low skillsets, registered jobseekers exceed by 12 times the number of registered vacancies.[309] The education system is however trying to gear up for a greener and more digital future: about one third of VET students in Haskovo are enrolled in technical and engineering professional areas, while an additional 10 percent is enrolled in IT curricula.[310] The University of Trakia has also teamed up with trade unions and employer organizations to tackle the transition to a low-carbon economy.

Haskovo has few carbon-intensive industries, but a large number of residents commute to the mining and coal-fueled power plants in the neighboring district of Stara Zagora. Haskovo is one of the least affected of carbon-intensive districts in terms of employment, with less than 2 percent of its workforce currently employed in the affected sector. The number of potentially affected employees is below 900 people, 90 percent of which are employed in one of the largest nitric acid and ammonia production plants in Bulgaria, namely Neochim in Dimitrovgrad. In addition, two small companies producing bricks and tiles, and basic iron and steel employ less than 50 employees, and the rest of the affected population is scattered across 13 companies with up to one employee.

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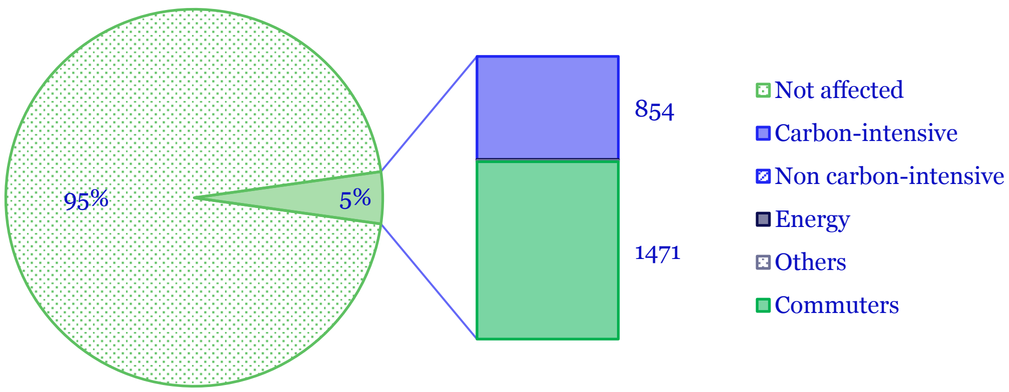
[309] For the purpose of this analysis, Employment agency data are used for (i) registered unemployed by educational level and (ii) registered job vacancies by occupational levels. These data are used as proxies to outline the possible skills mismatch at district level. For estimation of skills supply, three skills levels – high, medium and low – are distinguished corresponding to the ISCED classification. For estimation of skills demand, the same three skills levels are distinguished to each of the vacancies' occupational groups according to the ILO's ISCO-08, thus indicating the skill level required.

[310] Among the other large VET areas are motor vehicles, ships and aircrafts (10 percent of students) and electrical and power engineering (8 percent of students).

Including commuters [311] to Stara Zagora, 5 percent of the district total employment may be directly affected by the transition towards a low-carbon economy. Indeed, Haskovo records the largest total number of commuters to Maritsa East Energy Complex with total of 1,471 commuters, the majority of which is employed in mines mandated to close down.[312] For these miners, the timeline and nature of the transition is likely to be both, faster and more severe, than for the workforce employed in other high GHG-emitting factories.

Figure 46. Employment in affected sectors (share, then total numbers)



Source: Lakorda dataset for sector specific data, National Statistical Institute for total employment (2019), and PWC for commuters.

The share of workers employed in carbon-intensive industries may vary widely across municipalities, to up to 10 percent in Topolovgrad. The labor-induced impact of the transition is likely to affected some municipalities harder: in the municipalities of Harmanli and Topolovgrad, up to respectively 4 and 10 percent of the population may be affected by one household member having to retrain, upskill, or find a new job. [313] These estimates may be even higher if all upstream and downstream supply-chain disruptions are considered.

The district is not new to mass layoffs, and local stakeholders expect that the labor-induced impact of the transition will lead to reinforced outmigration. Local authorities and social partners acknowledge that the region already witnessed mine closures in the municipality of Dimitrovgrad in the mid-1990s, which led to a wave of outmigration. The intensification of the existing migration trend towards larger and more dynamic economic centers may reinforce a vicious circle of lower access to and quality of public services (education, health, social services) and significant outmigration trends.

Finally, and despite the preponderance of the traditional sectors of activities in the employment mix, Haskovo is part of the fastest-growing special economic zone in the country. Haskovo is included in the broader Trakia Economic Zone, centered around Plovdiv. In addition, the geographical proximity between the cities of Haskovo and

[311] The numbers of commuters throughout the text are provided by PWC

[312] The numbers of commuters throughout the text are provided by PWC.

[313] According to th 2011 Census, the average household size in Haskovo is 2.5 persons.

Dimitrovgrad also lays the ground for the joint development of a local economic agglomeration: employers' organizations and trade unions are discussing the establishment of hydrogen cluster, given that Dimitrovgrad is the biggest producer of blue hydrogen in Bulgaria.

8.2.3 The environmental impacts of the transition

The largest GHG emitter in Haskovo district operates in ammonia production. The focus of decarbonization pathways for the ammonia production industry in Haskovo district include the following main activities:

- Switching from fossil fuels to lower-carbon fuels.
- Carbon Capture and Storage (CCS) or Utilization (CCU)

The measures outlined above have the largest potential to reduce GHG emissions in Haskovo district. Table 180 [314] summarizes the potential environmental impacts from the main decarbonization measures in the ammonia production industry in Haskovo district.

Table 180. Potential environmental impacts from decarbonizing the ammonia production industry in Haskovo district

Decarbonization Pathway	Potential impacts on				
	Air	Water	Resource efficiency/Waste generation	Soil, land use, biodiversity	Indirect impacts
Switching from fossil fuels to electricity	Positive impacts locally, overall impact depends on the fuel mix The electrification of the energy-intensive processes (e.g. cement kilns, heat input in the production of ammonia) eliminates the main source of GHG and air pollutant emissions. Locally emissions are substantially reduced. The overall impact on air quality, though, depends on the sources used to generate electricity. If electricity is	No impact expected	Positive/neutral impact If coal is replaced, the amount of waste ash is reduced.	No impact expected	Fuel dependent Dependent on the fuels used to generate electricity.

[314] Adapted from: European Commission – DG Environment, 2021. Wider environmental impacts of industry decarbonization. Available at: https://circabc.europa.eu/sd/a/c027a361-02da-49f4-b187-63f9e429561d/Final_report.pdf

	generated primarily using solid fuels, then emissions at the point of generation might be increased, leading to worsening of air quality at the point of generation.				
Switching from fossil fuels to low-carbon alternatives (biomass, biogas, synthetic fuels, hydrogen)	Mainly positive impacts (fuel dependent) Switching to lower-polluting fuels reduces air pollutant emissions. Nevertheless, combustion of certain fuels (e.g. biomass) leads to emissions of some air pollutants such as CO, PM, VOCs, NOx).	Fuel dependent Substantial amounts of water are needed for hydrogen production through electrolysis	Fuel dependent On one hand, waste products can be utilized to generate biogas. On the other hand, additional infrastructure is needed in the case of hydrogen. In addition, some catalysts used in hydrogen production need to be recycled or properly disposed of.	Potential negative impacts In the case of biomass and hydrogen, direct or indirect land use change effects can be expected – from expansion of biomass feedstock and from the deployment of renewable energy installations for hydrogen production. Nevertheless, depending on the context, net impacts might be lower than in the case of fossil fuels. The emissions from biomass combustion also contribute to eutrophication.	Potential negative impacts Additional need for transportation and transport infrastructure.
Carbon Capture and Storage/Utilization (CCS/U)	Positive impact CCS/U reduces the amount of emissions to air (most notably, SO_2 and NOx). CCS/U equipment increases primary energy demand. Therefore, net effect will depend on how primary energy is generated.	Negative impact CCS/U technologies could lead to: Water eutrophication Additional need for surface water Groundwater contamination	Negative impact Reduction of energy efficiency because of an increase in primary energy consumption Waste slag and ash, as well as spent sorbents are generated. Potential hazardous waste.	Negative impact Potential increase in toxicity. Potential trace metal soil contamination.	Negative impact Potential impacts on land's geological structure.

Source: European Commission, 2021

Measures to promote renewable energy and energy efficiency in the energy and buildings' sectors also contribute to the reduction of emissions to air and have a positive impact on air quality. In addition, measures to electrify public transport and/or encourage walking, cycling and sustainable urban mobility reduce emissions of mainly NOx, which is also an important precursor to secondary PM formation. PM, especially the finer fractions such as $PM_{2.5}$, is the air pollutant of main health concern according to the WHO[315]. On the other hand, increased electrification of public transport will in the long-term increase battery waste, which has to be treated properly in order not to cause contamination of water and soils.

Implementing the outlined decarbonization measures has the potential to lower emissions of air pollutants and thus, provide health benefits from cleaner air. In addition, some of the other measures outlined in the sectoral decarbonization pathways such as improved energy efficiency (and hence, thermal comfort) in buildings, as well as encouraging mobility modes such as walking and cycling also have a positive health impact through improved thermal comfort in buildings and reduced air pollution.

8.3 Economic diversification potential and related development opportunities

The identified sectors, proving diversification opportunities, were split into three groups: i) small and fast sectors, i.e. sectors that start from a small base but grow rapidly, ii) middle-size fast growing sectors, and iii) large and fast sectors, i.e. sectors that start from a large base and also grow rapidly. The **small, but rapidly growing sectors** can be regarded **as emerging sectors** with growth potential, which are expected to positively affect the structure of the district economy. The **mid-size and large fast developing sectors**, to the other end, demonstrate **mature growth and diversification potential** for the district economy, which is particularly important for the generation of job opportunities, needed to mitigate the potential negative employment impacts of the decarbonization of the district economy.

As a result of the implementation of the diversification potential screening, the following sectors, providing opportunities for the diversification of the district economy, were identified.

8.3.1 Small and rapidly growing sectors

Five small, rapidly growing sectors providing promising opportunities for growth and diversification of the district economy, have been identified, namely:

Table 181. Small and Rapidly Growing Sectors for Haskovo District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector[316]
1	62. Computer programming, consultancy and related activities	N/R[317]

[315] https://www.who.int/health-topics/air-pollution#tab=tab_3

[316] Products/product groups, identified under the Atlas of Economic Complexity to provide partucular export diversification opportunities for Bulgaria.

[317] Not Relevant.

2	31. Manufacture of furniture	N/A[318]
3	17. Manufacture of paper and paper products	N/A
4	32. Other manufacturing	N/A
5	52. Warehousing and support activities for transportation	N/R

8.3.2 Mid-size and rapdily growing sectors

Five mid-size rapidly growing sectors providing strong opportunities for growth and diversification of the district economy, have been identified, namely:

Table 182. Mid-size rapidly growing sectors for Haskovo District

№	Sector (NACE Rev.2 code and name)	Product export diversification opportunities within the sector
1	55. Accommodation	N/R
2	56. Food and beverage service activities	N/R
3	11. Manufacture of beverages	N/A
4	25. Manufacture of fabricated metal products, except machinery and equipment	Padlocks and locks; clasps and frames with clasps incorporating locks, flexible tubes (HS codes 8301, 8307)
5	43. Specialised construction activities	N/R

8.3.3 Large and rapidly growing sectors

No **large and rapidly growing sectors** providing strong opportunities for growth and diversification of the district economy, have been identified.

Thus a total of 10 sectors, providing opportunities for growth and diversification of the district economy, have been identified. Specific support measures could be prioritized for those sectors when developing the operations to be funded under the Territorial Just Transition Plan of the district, as appropriate.

[318] Not Available.