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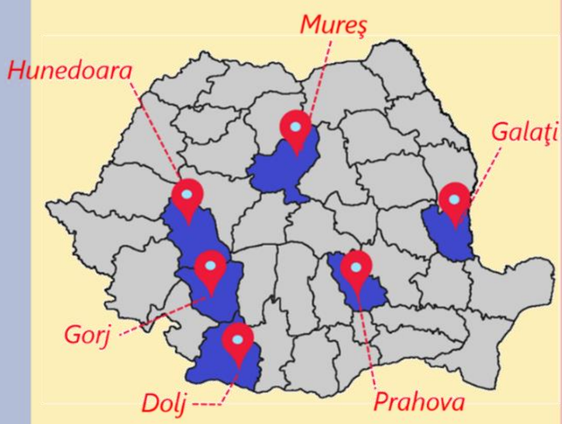

D3. REPORT ON THE TRANSITION PROCESS TOWARDS CLIMATE NEUTRALITY FOR ROMANIA (FINAL)

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ABBREVIATIONS

AF	Family Associations / *Asociație familială*
AMECO	Annual macro-economic database of the European Commission
AP	Active Professionals
AR	Autoregressive model
ARIMA	Auto-Regressive Integrated Moving Average
ARIMAX	Auto-Regressive Integrated Moving Average with extra variables
BAT	Best Available Technology
BAU	Business-As-Usual
BIC	Bayesian Information Criterion
BNR	National Bank of Romania / *Banca Națională a României*
BVB	Bucharest Stock Exchange / *Bursa de Valori București*
CAEN	National Classification of Economic Activities / *Clasificarea Activităților din Economia Națională*
CAPEX	Capital Expenditure
CCGT	Combined Cycle Gas Turbines
CCS	Carbon Capture and Storage
CE	Cambridge Econometrics
CE	Energy Complex / *Complex Energetic*
CEDEFOP	European Centre for the Development of Vocational Training
CEE	Central and Eastern Europe
CGE	Computable General Equilibrium models
CO	Companies and other entities
CO2	Carbon Dioxide
CP	Closed Professionals
CTE	Electric Power Station
D	Deliverable
DG	Directorate General
DJ	Dolj County
E3	Energy-Environment-Economy model
E3ME	Dynamic, computer-based, global macroeconomic model
EC	European Commission
EEA	European Economic Area
EEIs	Energy Intensive Industries
EIB	European Investment Bank
ETS	Emissions Trading System
EU	European Union
EUR	Euro
EU-27	European Union Member States – United Kingdom
EU-28	European Union Member States
EV	Electric Vehicle
FEC	Final Energy Consumption
FOM103D	Indicator for Civil employment population by activity of national economy
FOM104F	Indicator for Average number of employees by activity of national economy
FTT	Future Technology Transformations
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GJ	Gorj County
GL	Galați County
GNI	Gross National Income
GVA	Gross Value Added
GW	Gigawatts
HD	Hunedoara County
ICE	Internal Combustion Engine
ICT	Information and Communication Technologies
IEA	International Energy Agency

IGCC	Integrated Gasification Combined Cycle
IMF	International Monetary Fund
INS	National Institute of Statistics / *Institutul Național de Statistică*
IRENA	International Renewable Energy Agency
IT&C	Information Technology and Communication
JRC	Joint Research Center
JTF	Just Transition Fund
JTM	Just Transition Mechanism
JTP	Just Transition Plan
LCOE	Levelized Cost of Energy
LULUCF	Land Use, Land-Use Change and Forestry
MEIP	Ministry of European Investments and Projects / *Ministerul Investițiilor și Proiectelor Europene*
MKBT	Make Better
MS	Mureș County
MW	Megawatts
NACE	Statistical Classification of Economic Activities in the European Community
NCS	National Strategy for Competitiveness
NECP	National Energy and Climate Plan
NGEU	Next Generation EU
NGO	Non-Governmental Organisation
NIS	National Institute of Statistics
NP	New Professionals registered
NRPP	National Recovery and Resilience Plan
NUTS	Nomenclature des Unités Territoriales Statistiques
OEC	Oltenia Energy Complex
OECD	Organisation for Economic Co-operation and Development
ONRC	National Trade Registry / *Oficiul Național al Registrului Comerțului*
OP	Operational Programme
OPJT	Operational Programme Just Transition
PFA	Authorized Physical Person / *Persoană Fizică Autorizată*
PG	Power Generation
PH	Prahova County
PM10	Particulate Matter
PNIESC	National Energy and Climate Plan / *Planul Național Integrat în domeniul Energiei și Schimbărilor Climatice*
POP105A	Indicator for resident population
PRIMES	EU Energy System Model
PV	Photovoltaic
PVC	Polyvinyl chloride
RDAs	Regional Development Agencies
RES	Renewable Energy Sources
RES-E	Renewable Energy Sources in the electricity sector
RES-H&C	Renewable Energy Sources in the heating and cooling sector
RES-T	Renewable Energy Sources in the transportation sector
RO	Romania
RO41	NUTS code South-West Oltenia Region / *Sud-Vest Oltenia*
RO42	NUTS code West Region / *Vest*
RO125	NUTS code Mureș County
RO224	NUTS code Galați County
RO316	NUTS code Prahova County
RO411	NUTS code Dolj County
RO412	NUTS code Gorj County
RO423	NUTS code Hunedoara County
RON	Romanian currency
RR	Response Rate
SBA	Small Business Act
SE	Self-Employed
SEE	South-East Europe
SME	Small and Medium Enterprises

SOM103A	Indicator for unemployment rate
SRSS	Structural Reform Support Service
STEM	Science, Technology, Engineering and Mathematics
SURE	Support to mitigate Unemployment Risks in an Emergency
SW	South-West
TEMPO	Time series database
TFEU	Treaty on the Functioning of the European Union
TJTP	Territorial Just Transition Plan
TW	Terawatts
UN	United Nations
WAM	With Additional Measures
WEM	With Existing Measures
WEO	World energy Outlook
WWF	World Wide Fund for Nature

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EXECUTIVE SUMMARY

To reach its climate targets, Romania needs to reduce mining, close or replace coal-based power plants, and modernise or close carbon-intensive industries. The transition process to climate neutrality is expected to particularly affect communities with carbon-intensive industries, low-productivity, a risk of increasing unemployment, poverty, and deepening of the already high regional disparities **in the Hunedoara, Gorj, Dolj, Galați, Mureş and Prahova regions**. These are the eligible territories in Romania that are expected to benefit from the European Commission's (Commission) measures under the Just Transition Mechanism.

This draft report outlines **the transition process at the national level towards a climate-neutral economy, including the timeline for key transition steps and an assessment of the status and impacts for the most affected territories** (Deliverable 3). This report has been prepared within the project managed by DG REFORM supporting the Government of Romania (Ministry of European Investments and Projects– MEIP) in the preparation of Territorial Just Transition Plans (TJTP) in Romania. This deliverable starts with a review of the main socio-economic and environmental parameters and challenges of the country followed by an analysis of Romania´s progress towards climate neutrality. Subsequently a description and analysis of the key transition steps towards a climate-neutral economy is being provided. Based on these findings, the report treats the impact on the national level and the territorial level of the six regions, including other regions where applicable. It concludes with preliminary recommendations for identified investment needs at the national and territorial levels.

The evolution of Romania's main economic parameters reflect progress that has been impacted by the coronavirus outbreak. Gross domestic product (GDP) per capita rose from 30% of the EU average in 1995 to 69% in 2019. However, due to the Covid-19 pandemic, the economy contracted by 3.9% in 2020, driven by the weakening of external demand from Europe and pandemic-related restrictions. The unemployment level increased during 2020 due to the pandemic and is expected to reach 6.2% in 2021. Romania's economy is concentrated on some 500,000 SMEs as they contribute 52.7% of the country´s added value and provide 65.8% of employment (approximately 4 million jobs). An estimated 70,000 new jobs were created by SMEs between 2019 and 2020. Several policy weaknesses regarding small businesses, especially access to finance, hamper the sector's further development. The government deficit has also risen dramatically, driven by the Covid-19 crisis and old-age pension increases, from 4.3% in 2019 to 10.3% of GDP in 2020. The deficit is far beyond the 3% of the EU`s Stability and Growth Pact threshold.

Romania has the highest at-risk of poverty rate (after social transfers) in the EU (23.8%), which is way above the 2019 EU-27 average of 16.5%. This means that approximately 4.8 million Romanians live at risk of poverty, which exceeds the entire populations of Latvia and Lithuania, the two other countries in top three poorest EU countries. These poverty challenges are further compounded by population prospects, where Romania is among the countries with the sharpest trends of demographic decline in the world, determined both by negative natural growth rates as well as emigration. Shrinking demographics is associated with regional disparities throughout the country.

According to the National Strategy for Competitiveness, the economic sectors with competitive potential include: tourism and ecotourism, textiles and leather, wood and furniture, creative industries, automotive and components, information and communication technology, food and beverage processing, health and pharmaceuticals, energy and environmental management, bio-economy (agriculture, forestry, fisheries, and aqua-culture), biopharmaceuticals and biotechnology. **However, the Romanian labour market is facing quantitative and qualitative constraints**, which hampers the development of these potential poles of competitiveness. Labour force participation is one of the lowest in the EU (overall rate of 68.8% and 60.2% for women in 2017), resulting from the weak participation of women and lower-educated people in the formal labour market, while the aging population and emigration further negatively affect labour quantity.

As outlined in the European Semester Report, one of Romania's key challenges is to combine its increasing economic prosperity with environmental sustainability. Although Romania has some of the lowest greenhouse gas emissions (GHG) per person in the EU, it also has some of the highest rates of carbon intensity. In 2017, Romania's resource productivity ratio (i.e. how efficiently the economy uses material resources to produce wealth) was the lowest in the EU. GHG emissions from the energy supply sector have been steadily declining but, despite a higher than EU average share of renewables in overall energy consumption (24.5%), GHG emissions from the energy sector were still at 66% in 2020. Energy is also the main air-polluting sector, followed by metal, the intensive rearing of poultry and pigs and waste management. Romania is on track to meet its 2020 climate targets but will miss its 2030 targets with current policies. Although increased, the proposed 2030 Renewable Energy Share (RES) target of 30.7% is still below the country's potential cost-effective development of RES and below the collective EU target of 34%. In the absence of more ambitious climate change policies, Romania is expected to lose 8-10% of its GDP due to climate change effects by 2100[1].

The planning towards climate neutrality is less ambitious than what is economically feasible in Romania. In the final version of its National Energy and Climate Plan (NECP), Romania's 2030 targets are, according to the Commission, less ambitious than what is economically feasible, except for the emissions target of non-ETS emissions, set at -2% from reference year 2005. All targets in the NECP use 2005 as the reference year, while the European Green Deal targets use 1990 as the reference year. As a result, comparable assessments are difficult to make. According to the NECP, two determinants of decarbonisation are considered. The first metric is GHG emissions and removals, through decarbonisation in the energy, industrial and waste management sector, as well as based on secondary determinants. The second decarbonisation metric is determined by the promotion of RES. Romania also has an updated National Strategy for Climate Change and Low Carbon Economic Growth for 2016-2030 and a National Energy Strategy, but it is unclear to what extent they guide current policy making since they also exhibit significant differences from the NECP. Still, it is worth noticing the former strategy indicates that the GHG reduction measures should be related to energy efficiency since they have a high abatement potential (about 30% of the required reduction by 2050) and low (mostly negative) costs - taking into account a time horizon until 2050.

Neither the NECP, nor any of the other national strategy and policy documents (adopted or in draft stage) we revised envisage a target date for climate neutrality or coal phase-out. According to the NECP, together with gas, coal is expected to represent about 20% of the installed capacity in 2030; hydro power will comprise about 30% installed capacity, while wind and solar will each have a 20% share. The remaining energy mix will include insignificant installed capacities of biomass and oil. The NECP also includes estimated data on primary energy production by energy source by 2035, which is based on the PRIMES 2016 scenario. According to this data, with current policies and measures, coal is expected to cover 12% of primary energy production in 2030. In the NECP forecast, the ETS price is significantly undervalued, which means the NECP scenarios will be revised in terms of the forecasted energy mix when the national transposition of relevant EU legislation will be finalised. In contrast to the original version of the NECP, the final version contains some estimates of investment needs (EUR 150 bn. for the 2021-2030 period). However, it is not clear how the investments are to be distributed by sector, with calculations only available for a limited number of sectors (e.g. buildings). We believe the overall investments are likely overestimated by at least 10%-20% in both scenarios, due to the erroneous assumptions for solar and wind prices. The Just Transition Process does not yet have a clearly defined and officially adopted governance mechanism, as mentioned in our earlier reports. The NECP also lacks a governance mechanism.

After mapping the key transition steps outlined in the NECP, we have conducted a more in-depth review and recommended a revised timeline. By compiling various documents, modelling results and stakeholder interviews, Section 3.4 of the report recommends a timeline for the transition at the national level and demonstrates its feasibility by drawing on best practice models from other countries, with a focus on the Czech Republic and Slovakia. The key lesson from Slovakia's case is that while broad assessments of coal's viability in future power systems can be performed by the central government and provided to the local communities, the main direction of action to deliver a coal phase-out needs to be shaped by the local communities. Romania is in a significantly better position than the Czech Republic to deliver a just and accelerated coal phase-out by 2030 despite the issue currently not being given prominence on the public agenda. The coal commission of Romania needs to be created as soon as possible, ideally by the end of 2021, with first recommendations drafted by mid-2022. Additionally, Romania needs a timeline of closures for its 4.6 GW fleet of coal by 2030. As the Czech Republic model suggests, this can be done by 2030 and involves increased renewable energy deployment targets, both onshore wind and solar, and increasingly offshore wind as well.

The results of the transition impacts at the national and NUTS3 levels were identified by running two scenarios based on the E3ME model (Cambridge Econometrics): one scenario follows the NECP closely while the second scenario follows a more ambitious plan in accordance with the Green Deal (GD). In the modelling, two sensitivity analyses were conducted: one with a forced

[1] https://ec.europa.eu/info/sites/info/files/2020-european_semester_country-report-romania_en.pdf; page 63

coal phase-out by 2030 and another one with adjusted LCOE assumptions based on discussions during the Steering Committee. A notable aspect is that the indicators in the baseline scenario, follow a purely market-driven logic, which, due to the decreasing costs of renewables and increasing ETS price, leads to a faster decarbonisation process than the NECP scenario. At the national level, both the NECP and Green Deal scenarios reach the goal of a 44% emissions reduction compared to 2005. The NECP scenario reaches a 46% reduction by 2030, while the more ambitious Green Deal scenario reaches a 72% reduction by 2030. The accelerated coal phase-out sensitivity introduced in the modelling shows that a net positive GDP difference from the baseline can be achieved; employment results also show positive effects of early phase-out. GDP impacts are relatively small throughout the period (between -0.2% and +0.4%) in the NECP scenario. The GD scenario yields a long-term positive impact of about 1.9% by 2030. The coal phase-out sensitivity analysis produces positive impacts throughout the period, largely driven by additional energy investments (compared to both the baseline and the other scenarios). Employment, however, does not follow the same path. Employment is adversely impacted in both scenarios: it is about -0.2% compared to the baseline by 2030. Both scenarios show increases in construction and manufacturing employment, but these gains fail to offset losses in the energy and public services sectors. The sensitivity analysis shows slightly better results, with employment at -0.2% compared to the baseline by 2030.

A regional (NUTS3) analysis for the six affected regions and industries, including the estimated impact of the energy transition, has been performed and is detailed in section 5. The analysis led to the following preliminary results:

- **In Prahova,** the region's geographic position and demographic size advantages helped offset what has been a very difficult industrial restructuring process the end of the 1990s/early 2000s. The county contributes 3.8% to the national GDP, with a local GDP of RON 36,566.8 m (EUR 7,858 m). Of the six JTP counties analysed, Prahova has the largest demographic and economic base. The county's economy – and its county seat city in particular – has long been tied to the industries of oil refinery and the production of equipment for the oil industry. Industrial employment decreased by 11.1% from 2008 to 2019, a loss of 10,100 jobs. Nevertheless, Prahova still ranks among the most industrialised counties of Romania: 28.6% of local jobs are in the industrial sector compared to 22.3% nationally. That is why the modelling results in Prahova show differences from the national trends. Both the NECP and GD scenarios have negative impacts on GVA (EUR 120-330 million in the long-term; EUR 230-520 million in the medium-term). Employment impacts are similar to the national trends (higher losses in GD, lower in NECP). A strong negative impact in the GD scenario is related to gas-based power generation being severely reduced from 2025 onwards as ETS prices and the prices of other technologies (especially renewables) decrease the demand for gas-based technologies. The impact on the energy and utilities sector is about 4 times higher in GVA terms (negative EUR 470 million/EUR 110 million compared to baseline) and about 10 times higher in employment terms (negative 2,000 jobs/200 jobs compared to baseline) in the GD scenario compared to the NECP.

- **Galați** is a county located in South-East Romania with a population of 499,650 inhabitants, of which 50% reside in the county seat city (Galați). This centralised demographic feature distinguishes the county from the other JTP counties. Galați lost nearly a quarter of its population (22%) during the post-communist decades, a significantly higher demographic decline compared to the national rate over the same period (15.3%). Galați county contributes 1.8% to the national GDP with a local GDP of RON 16,733.7 m (EUR 3,596 m). Its geographic position and harbour facilities favoured the development of the largest steel production facility in Romania. The local economy also includes, among others, shipbuilding, a growing services sector in the county seat city (based primarily on outsourcing services) as well as a developing intensive agriculture sector. Modelling results for the region show mostly positive impacts for the GD scenario (positive regional GVA – about EUR 66 million compared to the baseline scenario, small employment decrease – around 200 jobs compared to the baseline, strong CO_2 reduction – over 42% compared to the baseline). There are lower levels of GVA (impact is a reduction of about EUR 6 million) in the NECP and employment (around 100 jobs) in both scenarios in the service sectors due to price effects of increased ETS. The NECP has negative GVA impacts in the energy sector (about EUR 18 million), with muted employment losses (less than a 100 jobs), while the GD shows little GVA impacts (compared to the baseline) in the sector, but higher employment losses (about 500 lost jobs). Despite the increase of approximately 5,000 jobs in the public and other services sector, the job losses in agriculture (approximately 5,000 job losses), manufacturing (approximately 3,000 job losses) and construction (approximately 5,000 jobs losses) lead to a total estimated job loss in Galați of some 7,800 jobs, with small differences between scenarios. Nonetheless, GVA is projected to increase in Galați between 2018 and 2030 by approximately EUR 750 million. The increase is even more significant in the GD scenario (approximately EUR 850 million), which is presumably driven by the increase in renewables.

- **Mureș** is a county located in central Romania with a population of 533,064 inhabitants, of which 25% reside in its county seat city (Târgu Mureș). The distinctiveness of Mureș county is marked by natural gas extraction, which generated several of its most developed industrial activities, such as AzoMureș SA, the country's largest nitrogen fertilizers factory and CTE Iernut, a 800MW energy plant based on natural gas and owned by Romgaz SA. Of the JTP counties, Mureș has been least affected by demographic decline and industrial restructuring. While an overall positive GDP impact is observed in the national results of the NECP by 2030, GVA impacts in Mureș are the opposite. GVA is about EUR 30 million lower by 2030 than in the baseline. As in the national results, GVA and employment show opposite results in the GD scenario, while the GVA impact is negative in the NECP scenario. However, after an initial decrease in the early years, the employment effect in the long-term is close to zero. Mureș is expected to lose approximately 1,000 jobs on average in both the baseline and NECP scenarios and slightly more (approximately 1,300 jobs) in the GD scenario. However, the losses are not significantly distributed across sectors. There are high gains in the services sector (approximately 4,800 jobs) and heavy losses in the construction and manufacturing sectors. Nevertheless, these two sectors exhibit net GVA growth, illustrating the phenomenon of "jobless growth". The energy and utilities sector underperforms in terms of GVA contribution in all scenarios and employment (particularly in the GD scenario) due to the lower contribution of natural gas to the energy mix: approximately 2,500 jobs will be lost under the GD scenario in Mureș. In the baseline scenario, emissions decrease by only 30% in 2030 compared to 2018. However, in a GD scenario, with strict emission targets and a significantly lower contribution of natural gas to the electricity production mix, emissions decrease by up to 80%.
- Geographically, **Dolj** is the largest county in the South West Oltenia region and one of the largest in Romania with an area of 7,414 sq. km. Decreasing population trends brought inevitable consequences on the labour force, and labour resources decreased by 9% from 2014 to 2019. The NECP scenario (without the sensitivity analysis) allows for the continued use of coal, which has a positive effect on the region – i.e., there is no scrapping of coal-based power and consequently in the NECP scenario there is a strong positive impact on the county's GVA (as coal usage is reduced in the baseline). Unlike the NECP scenario, the GD scenario assumes a strong reduction in fossil fuel use (including coal and gas), which leads to a negative response in economic and labour terms. Losses from fossil-based activities drive the results, leading to a net negative employment effect of about 1,600 jobs compared to the baseline and a negligible (but positive) GVA impact. While the impact of the energy transition on employment in Dolj is negative in the GD scenario (1,500 jobs lost) and slightly positive (300 jobs gained) in the NECP scenario, the unemployment effects are significant in Dolj in the baseline scenario, although not necessarily driven by the energy transition. For instance, in all scenarios, agriculture is expected to lose over 25,000 jobs in the next ten years while manufacturing will also lose approximately 5,000 jobs.
- In **Hunedoara** the mining, heavy industry, metallurgical and steel industries remain in operation, although at significantly lower capacity than in its industrial past. Most of the mining operations have closed or will be part of a closure programme in the coming years (Lonea and Lupeni). The demographic decline is double the national average. The GD scenario leads to positive GVA effects (plus EUR 66 million in comparison to the baseline), but negative employment effects (minus about 1,500 jobs in comparison to the baseline), while the NECP scenario has minor GVA impacts (plus EUR 18 million in comparison to the baseline) and close to zero employment effects (compared to the baseline). Meanwhile, CO_2 emissions fall slightly below the national trend in the GD scenario (about 35% reduction) and below the national trend in the NECP (about 11% reduction). The overall positive GVA effects (plus EUR 750 million in a baseline scenario, plus EUR 830 million in a Green Deal scenario) are remarkable, given the relatively high employment losses (minus 11,500 jobs in a baseline and NECP scenario, minus 13,000 jobs in a GD scenario), which shows important gains in the productivity of the local economy.
- **Gorj** County is rich in natural resources both in terms of quantity and variety, mostly surface lignite deposits. Considering that extractive industries and the production of electricity contribute a significant amount of the county's GDP and employ a significant share of the local labour force, the energy transition process may severely affect the county. The total GVA increase (compared to the baseline) is about 30% higher than Dolj (about EUR 210 million), despite the overall smaller GVA base (but much higher energy sector). CO_2 emissions are much higher in the NECP scenario

than in the baseline (about 84% higher due to coal-based power), while they are 27% lower than the baseline in the GD scenario. The overall regional result is dominated by the energy sector and especially by what happens with the coal sector. The approximate 3,000 job losses (compared to the baseline) in the GD scenario are almost exclusively concentrated in the energy sector. Under the baseline, market-driven scenario, the mining and energy sector in the county is expected to lose approximately 7,000 jobs while the loss in a Green Deal scenario will be about 10,000. Since coal-mining and energy production play an important role in the regional economy, GVA will decrease in this sector in all scenarios, substantially less in the NECP scenario though, and much more in the Green Deal and baseline scenarios.

A qualitative assessment of stakeholder readiness to join the transition agenda suggests:

a) To date there has been limited experience of integrating climate change objectives into local development strategies at the local level. Long-term, sustainable implementation of local energy transition agendas would require that local authorities have the know-how and leadership capacity to integrate such targets into local development strategies and visions, rather than approaching JTF as simply another funding instrument to access.

b) While county councils are best positioned to oversee the implementation of a county-level Just Transition plan (NUTS3 region), it is important to acknowledge the role that municipal authorities will have, especially those governing the main urban agglomerations of the Just Transition regions.

c) The readiness of business sector players varies, as expected, depending on business sector, leadership and business development vision. For obvious reasons, companies active in coal mining, oil processing, etc. are more challenged by this process since it requires a radical shift of their core business models or even foresees business closure. Heavy industries with high CO_2 emissions are challenged to switch to different energy sources, which might present a favourable context to invest in technology upgrades or to innovate for increased production efficiency.

d) Public co-funding is expected to make an impact for a range of newer technologies, which are cleaner though not as economically viable as older, more established technologies. Public sector demand for cleaner technology has also been mentioned as a factor that could contribute to higher readiness albeit being potentially riskier as well. For instance, investment interest has been shown in hydrogen fuel plants, either to capture excess internal renewable energy production or to reposition business models. In terms of workforce challenges, absorbing large numbers of unskilled labour made redundant by the energy transition process (which our modelling exercise shows is not the case anyhow) is less of a challenge compared to high-skilled labour that would enable technology upgrades to existing businesses.

e) There are significant disparities of civil society development across the analysed regions. For instance, Gorj has been mentioned as having a less active civil society while Jiu Valley (in Hunedoara) has been characterised as a more civically vibrant region. All in all, there are few NGOs pursuing civic action on the climate change agenda in Romania and those which are active in this field are mostly subsidiaries of international organizations (e.g., Greenpeace or WWF).

While it is too early in the Technical Assistance project and the wider TJTP process to discuss investment needs at a very precise or granular level, in **Section 5, we nonetheless propose a draft prioritisation of regional investment needs.** Based on our modelling analysis, some areas will experience growth in all scenarios, so investment in these areas (including worker qualifications and horizontal value chains) should be considered a priority: construction (including retrofitting work), (low carbon) manufacturing, renewable energy (including construction, operation and maintenance).

Please note that this report has been updated after several rounds of comments by multiple stakeholders and contains the latest available quantitative data and information as of June 1, 2021. The upcoming Deliverable 4 (Report on Challenges, Needs and Possible Actions for the Most Affected Territories) Deliverable 5 (Final Report) will reflect any development of key issues happening after the cut-off date of this report.

1 COUNTRY CONTEXT

1.1 Overview

Over the past several years, reforms spurred by the EU accession led to Romania's economic integration into the EU and gradual economic convergence. **Gross Domestic Product** (GDP) per capita rose from 30% of the EU average in 1995 to 69% in 2019.[2] However, due to the impact of the Covid-19 pandemic, the economy will contract by 5.2% in 2020, driven by the weakening of external demand from Europe alongside pandemic-related restrictions. Although uncertainty remains high, the outlook points to a relatively quick rebound with a forecast of 3.8% GDP growth, similar to the average from 2001-16. The domestic demand constitutes the main driver of the GDP growth.

Table 1: Main Features and Country Forecast Romania

bn RON	Curr.	%	2001-16	2017	2018	2019	2020	2021	2022
GDP	1,059.8	100.0	3.8	7.3	4.5	4.2	**-5.2**	**3.3**	**3.8**
GNI (GDP deflator)	1,043.5	98.5	3.7	7.7	4.5	4.7	**-5.0**	**3.3**	**3.9**
Contribution to GDP growth:	Domestic		5.6	8.2	5.1	8.3	**-4.0**	**4.0**	**5.0**
	Inventories		-0.3	0.8	1.0	-2.8	**-0.6**	**0.3**	**0.0**
	Net		-1.4	-1.7	-1.6	-1.3	**-0.6**	**-1.0**	**-1.2**
Population		million	20.8	19.6	19.5	19.4	**19.3**	**n.a.**	**n.a.**
Population at risk of poverty (a)			23.5 (b)	23.6	23.5	23.8	**n.a.**	**n.a.**	**n.a.**
Employment			-1.5	2.4	0.1	0.0	**-2.6**	**0.3**	**1.2**
Unemployment rate (c)			7.0	4.9	4.2	3.9	**5.9**	**6.2**	**5.1**
Harmonised index of consumer			8.2	1.1	4.1	3.9	**2.5**	**2.5**	**2.4**
General government balance (d)			-3.2	-2.6	-2.9	-4.4	**-10.3**	**-11.3**	**-12.5**
General government gross debt (d)			26.2	35.1	34.7	35.3	**46.7**	**54.6**	**63.6**

Sources: European Commission (2020): European Economic Forecast Autumn 2020; Eurostat (2020)
Notes: (a) % of total population, (b) 2008-16, (c) % of total labour force; (d) as a % of GDP, n.a.: not available

Romania's population has declined in recent decades and the trend is expected to continue. The population has decreased by 3.8 million inhabitants since 1990 and is projected to fall to 17.8 million by 2030 (and 15.5 million by 2050),[3] driven both by demographic change (ageing population) and emigration. As a country, Romania has the largest share of poor people in the EU, with 23.8% of the population **at risk of poverty** (2019).

The 2020 pandemic led to a more accentuated decline in **employment** at the national level (-2.6%) and an immediate rise in **unemployment** (5.9% expected for 2020 compared to 3.9% in 2019). This trend will continue due to a delayed downturn of the labour market. Nearly 500,000 **SMEs**[4] are critical for Romania's economy. SMEs contribute 52.7% to the country´s added value[5] and 65.8% to employment (~4 million jobs[6]). An estimated 70,000 new jobs were created by SMEs between 2019 and 2020.[7] Additionally, Romania has a high number of self-employed (393,400[8]) that operate as Authorized Physical Person (PFA), Individual Enterprises (II) or Family Association (AF).

Nevertheless, policy measures are needed to address some of **Romania's weaknesses regarding small businesses**: The country ranks among the weakest performers in skills & innovation, a key area to stay competitive in a globalised world. Other weak areas, compared to EU Member States, are access to finance, single market and the environment.[9] Challenges in the entrepreneurial environment are also reflected in the *Ease of Doing Business* score (73.3), which is below the average for EU

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2 https://ec.europa.eu/eurostat/statistics-explained/index.php/GDP_per_capita,_consumption_per_capita_and_price_level_indices
3 Eurostat
4 2019 Small Business Act for Europe (SBA) Fact sheet Romania: https://ec.europa.eu/docsroom/documents/38662/attachments/24/translations/en/renditions/native; Whereas the SBA information uses harmonised estimates across the EU, there are in the case of Romania notable differences in term of numbers. The Romanian Trade Registry displays 1 million companies at November 2020. The difference compared to the SAB Fact sheet is that figure includes as well inactive companies.
5 Ibid.
6 Eurostat
7 Ibid.
8 Oficiul National al Registrului Comertului (onrc.ro)
9 Eurostat.

Member States (76.5).[10] Apart from the growth barriers mentioned, **access to finance remains an obstacle for SMEs,** especially those in the rural areas. Bucharest accounts for roughly a third of SME bank loans and only a third of all SMEs meet the minimum lending requirements established by banks. Start-ups usually do not have access to bank financing since they lack track records and collateral.[11]

Projections of the **inflation rate,** expressed in the harmonised index of consumer prices, are low and will decrease to 2.5% in 2020 mainly due to the severe reduction in oil prices. Inflation is projected to remain controlled throughout 2021 and 2022. Here, the policy environment set by the National Bank of Romania with cuts of the key monetary policy rate due to the Covid-19 crisis is beneficial to avoid any inflationary trends.

The general government deficit has risen dramatically, driven by the impact of the Covid-19 crisis and old-age pension increases (from 4.3% in 2019 to 10.3 % of GDP in 2020) far above the 3% of GDP Treaty threshold. Regardless of an economic recovery forecast and the expected expiry of pandemic-relief employment support schemes (in absence of the 2021 budget), the government deficit is set to increase further, not taking into account any measures funded by Recovery and Resilience Facility grants. As a result, **Romania's** debt-to-GDP ratio is projected to increase from 35.3% in 2019 to around 63.5 % in 2022.

Public finances will remain a challenge and Romania will continue to rely on external debt and investments. Here, the fact that the World Bank classified Romania as a high-income country for the first time, based on 2019 data[12], is an important development for investment rating decisions as well as for accession negotiations to the Organisation for Economic Co-operation and Development (OECD)[13]. The Romanian Bucharest Stock Exchange (BVB) has officially become an emerging market as of September 21, 2020, when the first two Romanian companies were included in the FTSE Global Equity Index Series.[14] This allows foreign investors to invest in Romanian companies (others can follow the global listing) and enables the Romanian capital market and economy to absorb new funds in the coming years. It also sends a strong signal to privately-owned and state-owned companies that they can grow significantly via the stock market.

1.2 Main environmental and socio-economic parameters and challenges

1.2.1 Environmental degradation and Energy-intensive industries (EEIs)

As highlighted in the European Semester Report, **one of Romania's key challenges is to combine its increasing economic prosperity with environmental sustainability.** Although Romania has among the lowest greenhouse gas emissions (GHG) per person in the EU, it also has some of the highest rates of carbon intensity. Energy intensity decreased from 0.24 kgoe/EUR in 2013 to 0.20 kgoe/EUR in 2018[15] but remains well above the EU average of 0.12 kgoe/EUR.[16] In 2018, the share of energy-intensive industries in the Romanian economy remains approximately 12% of GDP compared to the EU average of 9% (European Semester, 2020). Around 915 industrial installations must have a permit according to the Industrial Emissions Directive: 48% are in the intensive rearing of poultry and pigs, 11% are in the waste management sector, 10.5% are in the chemicals sectors and 6.3% are in the energy-power sector.[17]

In 2017, **Romania's resource productivity ratio** (i.e. how efficiently the economy uses material resources to produce wealth) was the lowest in the EU, at 0.33 EUR/kg compared to the EU average of EUR 2.04 EUR/kg. Unlike the EU average, which has steadily increased, Romania's productivity ratio has remained stable. The circular use of material, at 1.5%, is significantly below the EU average

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10 The total Doing Business score covers 11 indicators (Starting a business, Labour market regulation, Dealing with construction permits, Getting electricity, Registering property, Getting credit, Protecting minority investors, Paying taxes, Trading across borders, Enforcing contracts and Resolving insolvency) on a scale from 0 to 100, where 0 represents the lowest and 100 represents the best performance. The ease of Doing Business ranking ranges from 1 to 190. World Bank (2020): Doing business 2020. Region Profile – EU. https://www.doingbusiness.org/content/dam/doingBusiness/media/Profiles/Regional/DB2019/EU.pdf

11 https://openknowledge.worldbank.org/bitstream/handle/10986/29864/9781464813177.pdf?sequence=2&isAllowed=y

12 On a yearly basis, the World Bank uses the GNI/per capita income in current USD and for Romania this indicator was USD 12,630 above the World Bank shield of USD 12,535 https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2020-2021

13 https://www.worldbank.org/en/country/romania/overview

14 https://www.bvb.ro/AboutUs/MediaCenter/PressItem/Historic-moment-Emerging-Romania.-The-Romanian-capital-market-becomes-Emerging-Market/5172; the companies are Banca Transilvania and Nuclearelectrica.

15 Source: 2020 European Semester: Country Report - Romania

16 Source: Eurostat, nrg_ind_ei

17 Source: The Environmental Implementation Review, 2019 Country Report Romania

of 11.7% and although SMEs in particular are failing to take resource efficiency and environmental measures, as per the Small Business Act, the job-creation prospects in these sectors are remarkable: between 2011 and 2015 the number of jobs in the environmental goods and services sector increased from 130,000 people to 155,000 people.[18]

GHG emissions from the energy supply sector have been steadily declining. However, despite a higher than EU average share of renewables in overall energy consumption (24.5%), GHG emissions from the energy sector were still at 66% in 2020.[19] Energy is also the main air-polluting sector, followed by metal, the intensive rearing of poultry and pigs and waste management.[20] Air pollution has significant human health consequences in the country. In 2016, around 1.8 years of life lost per 1,000 inhabitants were attributable to fine particulate matters, the fourth highest rate in the EU (this translates to approximately 25,000 premature deaths). Romania has been referred to the European Court of Justice for exceeding PM_{10} levels.

Despite these negative indicators**, investment in air pollution, waste and wastewater** is lacking in the country, with only limited progress made recently in wastewater projects. Despite investments in wastewater projects, the country is undergoing an Infringement Procedure for failing to comply with the standards of the Urban Waste Water Treatment Directive: only 2.5% of Romania's wastewater load is being collected in the accordance with the directive, with less than 10 of the nearly 200 agglomerations comply with the requirements for secondary treatment.[21]

When it comes to **municipal waste recycling,** Romania missed its 2020 target of 50% and the municipal waste recycling rate, instead of increasing, actually decreased from 13.2% in 2013 to 11.1% in 2018, far behind the EU28 average of 46.9% and even behind other CEE countries (Bulgaria - 31.5%, Hungary - 37.4%, etc.).[22]

Romania is on track to meet its 2020 climate targets, but with current policies will miss its 2030 targets. Although increased, the proposed 2030 RES target as per the final NECP of 30.7% is still below the country's potential cost-effective development of RES and below the collective EU target of 34%. For 2030, Romania's national target under the Effort Sharing Regulation will be to reduce emissions by 2% compared to 2005. Romania is projected to miss this target, as emissions are expected to grow by 10% compared to 2005.[23] The financial and human consequences are expected to be dramatic: in absence of more ambitious climate change policies, Romania is expected to lose 8-10% of its GDP due to climate change effects by 2100. In fact, Romania is already losing: due to large flooding events, Romania lost EUR 3.6 bn between 2002 and 2012 and is losing some EUR 6 m/year due to illegal logging. Forests being a significant carbon sink and disaster risk protector.[24]

1.2.2 Poverty and disparities

Romania has the highest **risk at poverty rate** (after social transfers) of 23.8% in the EU,[25] well above the EU-27 average of 16.5% in 2019. Approximately 4.8 million Romanians live at risk of poverty, which exceeds the entire populations of Latvia and Lithuania, the other two countries in top three poorest countries of the EU. Even more worrying is the depth of poverty, as illustrated by the relative median at-risk-of-poverty gap[26] (see Graph 1), which quantifies how level of poverty. The median income of a person at risk of poverty was, on average, 35.2% below the poverty threshold (while the EU-27 average is 24.5%), which indicates that Romania is the country with the poorest poor in the EU.

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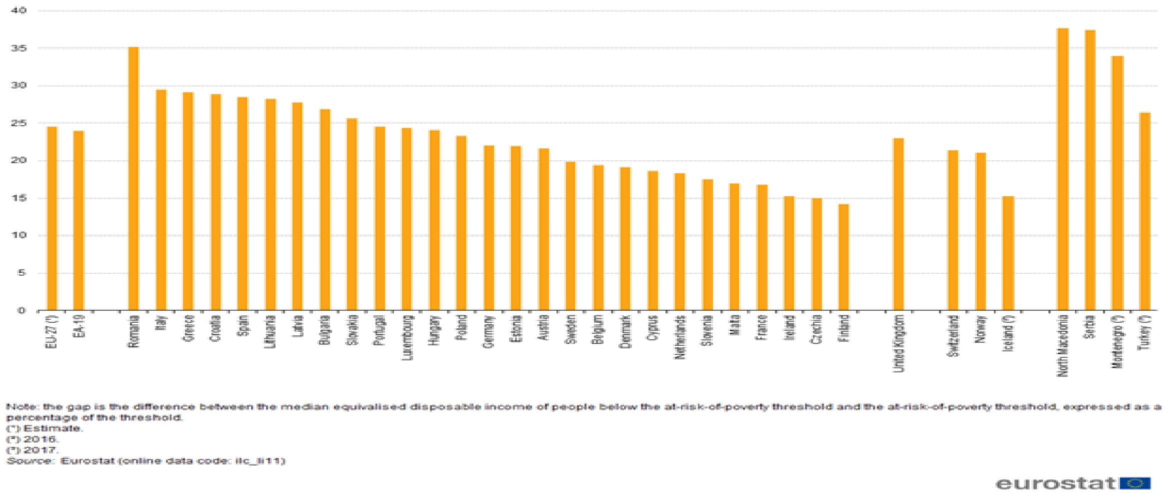
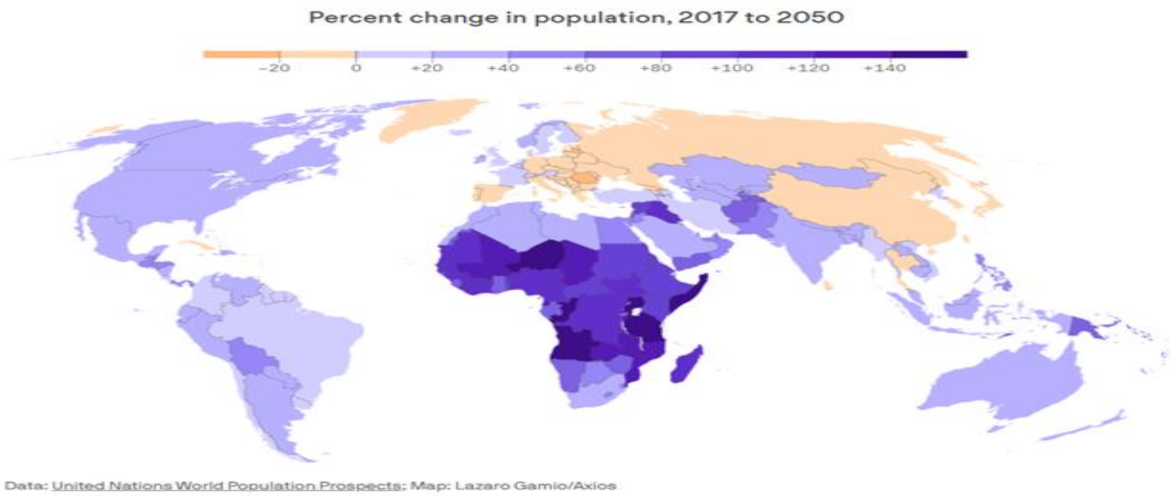
[18] Source: Ibidem
[19] Source: EEA, Energy/Total9without LULUCF, with int aviation
[20] Source: The Environmental Implementation Review, 2019 Country Report Romania
[21] Ibidem
[22] Ibidem
[23] Ibidem
[24] Source: 2020 European Semester Report
[25] As per Eurostat (ilc_li02 indicator): https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Income_poverty_statistics
[23] Latest available data retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Relative_median_at-risk-of-poverty_gap,_2018_(%25)_SILC20.png

Graph 1: Relative median at-risk-of-poverty gap, 2018



The poverty challenges of Romania are further exacerbated by population prospects, which place Romania among the countries with the **sharpest demographic decline** in the world, determined by negative natural growth rates and pronounced outmigration. This challenges the country's social and economic development policies. The Romanian business sector increasingly indicates the availability of the workforce as the most stringent problem they are facing.[27]

Figure 1: Percent change in population based on UN data: 2017 to 2050*28***



Demographic declines are heterogeneous throughout the country, as some regions–in particular small-urban and rural–have been highly affected by economic restructuring during the transition to a market economy, forcing residents to migrate in search of job opportunities. Larger urban metropolitan areas performed better in repositioning their economies and attracting/retaining the workforce, and thus have remained stable or even increased their demographic profile. For instance, counties such as Hunedoara–one of the six JTP regions–lost 23.6% of its population between the 1992-2011 National Censuses, while Ilfov county, mostly consisting of dormitory townships in the peri-urban area of Bucharest, grew by 35.5% over the same period.

[27] The Romania Foreign Investors Council released a press communication in 2019 highlighted that workforce availability is still the top challenge of businesses located in Romania, as indicated by its yearly survey on business sector challenges. Commentary available at: https://www.zf.ro/companii/investitorii-straini-avertizeaza-disponibilitatea-fortei-de-munca-este-cea-mai-mare-problema-pentru-mediul-de-afaceri-18469554

[28] Retrieved from: https://www.axios.com/world-population-countries-growing-shrinking-aed7ae63-7787-4551-bcf4-c3759016ac3f.html

1.2.3 Business environment competitiveness

Business environmental competitiveness, including labour market, skills and job match; fiscal deficit and macroeconomics

Since the 2008-2009 financial crisis, Romania's economy recovered with constant **GDP growth** until Q2 2020, when the COVID-19 crisis took a huge toll on the economy. Romania entered a recession and GDP declined by 10.3% year-over-year during Q2 2020 and by 6% in Q3. According to Eurostat (and the forecast of Trading Economics), 2021 is a recovery year and the Romanian economy will return to constant growth of 3.8% by 2022 onwards.

Graph 2: GDP growth for Romania

Source: tradingeconomics.com / Romanian National Institute of Statistics

The **contribution of the SME sector to the Romanian economy** is crucial. The SME sector increased during 2014-2018, and overall SME value added in Romania grew by 43.1%, with micro-firms generating the highest increase (63.1%). SME employment increased by 7.0%. Nevertheless, the **average productivity of Romanian SMEs** is approximately EUR 15,100, significantly lower than the EU average of EUR 44,600.

Policy measures are needed to address Romania's specific weaknesses regarding small businesses: The country ranks among the weakest performers in skills & innovation, a key area to stay competitive in a globalised world. Efforts have been made by the Romanian government in this regard. In September 2015, the National Strategy for Competitiveness (NCS) 2015-2020 was adopted and complemented in 2018 with the Romanian Industrial Policy. Through these two initiatives, the **Romanian government is coordinating interventions dedicated to competitiveness**, taking into account the potentially competitive national sectors (enumerated below), including territorial dimensions and rural development, labour market development and human factors.

The NCS pre-development analyses has identified **ten potentially competitive economic sectors** that correlate with the areas of smart specialisation mentioned in the National Research, Development and Innovation Strategy 2014-2020.[29] The economic sectors with competitive potential include: tourism and ecotourism, textiles and leather, wood and furniture, creative industries, automotive and components, information and communication technology, food and beverage processing, health and pharmaceuticals, energy and environmental management, bio-economy (agriculture, forestry, fisheries, and aqua-culture), biopharmaceuticals and biotechnology.

Compared to other EU Member States, business challenges include access to finance, single market and the environment.[30] Challenges in the entrepreneurial environment are also reflected in the *Ease of Doing Business* score, which is below the average for EU Member States (75.91).[31] According to the World Bank's Doing Business 2020 report, **Romania ranks 55th out of 190 countries analysed, with a Doing Business score of 73.3**.

29 https://www.edu.ro/sites/default/files/_fișiere/Minister/2016/strategii/strategia-cdi-2020_-proiect-hg.pdf
30 Ibid.
31 The total Doing Business score covers 11 indicators (Starting a business, Labour market regulation, Dealing with construction permits, Getting electricity, Registering property, Getting credit, Protecting minority investors, Paying taxes, Trading across borders, Enforcing contracts and Resolving insolvency) on a scale from 0 to 100, where 0 represents the lowest and 100 represents the best performance. The ease of Doing Business ranking ranges from 1 to 190. World Bank (2019): Doing business 2019. Regional Profile – EU. https://www.doingbusiness.org/content/dam/doingBusiness/media/Profiles/Regional/DB2019/EU.pdf

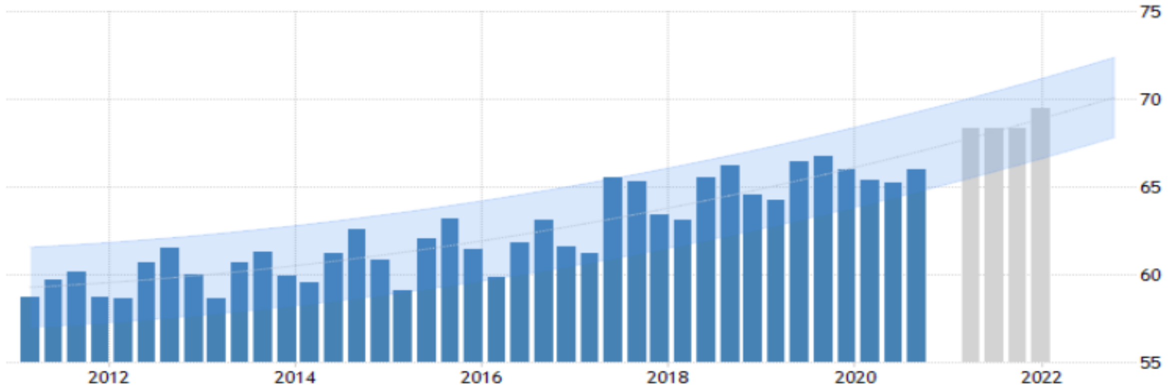
Romania **scored 64.4 out of 100 in the 2019 Global Competitiveness Report** published by the World Economic Forum.[32] The most recent 2019 edition of the Global Competitiveness Report assesses 140 economies. The report uses 98 variables, from a combination of data from international organisations as well as from the World Economic Forum's Executive Opinion Survey. The variables are organised into twelve pillars: institutions; infrastructure; ICT adoption; macroeconomic stability; health; skills; product market; labour market; financial system; market size; business dynamism; and innovation capability. The GCI varies between 1 and 100; a higher average score means higher degree of competitiveness.[33]

Sustainable growth in Romania is hampered by several factors: Resources are not efficiently allocated due to an unpredictable business environment and the strong presence of state-owned enterprises (SOEs). Due to a weak institutional landscape and a lack of commitment to policy implementation, businesses were faced with newly introduced fiscal measures that were later reversed and which negatively affected businesses' ability to plan their operations and investments. SOEs in Romania are generally characterised by weak corporate governance and low productivity, negatively impacting the sectors in which SOEs are active, and indirectly through the inefficient provision of inputs to other sectors of the economy.[34] According to the European Investment Bank (EIB) investment survey 2020,[35] 75% of Romanian firms stated that "climate change has an impact on their future investments" compared to the EU average of 58%. Firms think that a low-carbon future will have a positive impact on their reputation but a negative impact on their supply chains in the next five years.

Apart from the growth barriers mentioned above, **access to finance remains an obstacle** for SMEs, especially for those in the rural areas. Bucharest accounts for roughly a third of SME bank loans and only one-third of all SMEs meet the minimum lending requirements established by banks. Start-ups usually do not have access to bank financing at all since they lack track records and collateral.[36]

The Romanian **labour market is facing quantitative and qualitative constraint**s. Labour force participation is one of the lowest in the EU (overall rate of 68.8% and 60.2% for women in 2017). Low participation results from the weak inclusion of women and lower-educated people in the labour market, while the ageing population and emigration further negatively affect labour supply. Romania's population is estimated to have declined from 22.8 million in 2000 to 19.6 million in 2017. Between 3 and 5 million Romanians currently work and live abroad, while highly educated emigrants accounted for 26.6% of total emigrants. The skills of the workforce also do not fit the needs of a modern economy: tertiary education attainment was 25.6% in 2016, the lowest in the EU, and especially lagged in STEM disciplines. Skills shortages are reported in skilled manual occupations, partially reflecting the low development of vocational training or technical school education. Labour shortages persist in key occupations, including ICT, health, and education, as well as science and engineering professionals and technicians.[37]

Graph 3: Evolution of labour force participation



Source: tradingeconomics.com / NIS

[32] Source: https://www.weforum.org/
[33] With the 2018 edition, the World Economic Forum introduced a new methodology, aiming to integrate the notion of the 4th Industrial Revolution into the definition of competitiveness. It emphasizes the role of human capital, innovation, resilience and agility, as not only drivers but also defining features of economic success in the 4th Industrial Revolution.
[34] https://openknowledge.worldbank.org/bitstream/handle/10986/29864/9781464813177.pdf?sequence=2&isAllowed=y
[35] https://www.eib.org/en/publications/flip/eibis-2020-romania/#p=1
[36] Ibid.
[37] Ibid.

Romania's seasonally adjusted **unemployment** fell to 5.1% in November 2020 from 5.3% in October 2020. The number of unemployed decreased by 15,000 to 462,000. Meanwhile, the jobless rate for declined for both men (5.3% vs 5.5% in October) and women (4.8% vs 5.0%). However, the jobless rate is expected to reach a maximum of 7.5% during Q2 2021 before decreasing to 4.2% in 2022. The long-term unemployment rate in Romania increased to 1.6% in Q3 2020 from 1.2% in Q2 2020. The highest unemployment rate is among youth: youth unemployment increased to 19% in September 2020 compared to 17.4% in January 2020.[38]

2 PROGRESS TOWARDS CLIMATE NEUTRALITY

2.1 Review of strategic documents and key policies on energy transition

To determine the current progress and future milestones in Romania's energy transition, the following documents were reviewed:

- The 2021-2030 Integrated National Energy and Climate Plan (NECP) (the final version submitted to the European Commission in April 2020)
- The National Strategy on Climate Change and Economic Growth Based on Low-Carbon Emissions for 2016-2020 (2016 revision and accompanying Action Plan)[39]
- The 2020-2030 National Energy Strategy, with a 2050 Perspective (November 2018 version)[40]

These documents were chosen because they contain analyses related to GHG emissions trends, modelling exercises with respect to the energy transition and official commitments with respect to emissions reductions and other transition targets (i.e. the NECP). We reviewed these documents to identify a transition timeline, transition milestones, climate neutrality and coal phase-out plans and commitments. We also reviewed the documents to identify current and planned energy transition policies.

2.1.1 Emissions reduction targets

Table 2 summarises the interim and final (2030) emissions reductions targets according to the NECP:

Table 2: Reductions in emissions targets

	2020 interim target	2025 interim target	2030 final target	European GD target
ETS emissions target	-34,7%	-34.4%	-43.9%	-55%
non-ETS emissions target	-5.4%	-1.3%	-2%	-40%
Reference year	2005	2005	2005	1990

In 2030, the total GHG emissions of Romania (EU-ETS and non-ETS, excluding LULUCF) are projected to be 118.35 m tonnes of CO_2.

Although the official targets are measured against 2005 levels, the NECP also estimates targets against 1990 levels. In 2030, total GHG emissions in the national economy sectors are estimated to be reduced by approximately 50% compared to 1990.

The NECP also mentions that these targets do not differ from the targets submitted in the draft version of the plan (unlike the renewables target, which has been revised upwards from the draft version). However, the NECP indicates that *"it is estimated that the final value for 2030 is likely to decrease, among others, as a result of the reduction in the final energy consumption and the decrease in production of electricity from coal."*

[38] Source; EUROSTAT
[39] This is the latest officially adopted national climate strategy, officially adopted through GD 529/2013, although NECP mentions a revised version, covering 2016 to 2013, which is indeed available, but not on the website of the Ministry of Environment; the revised version - probably a draft one - is available on the website of the World Bank, as it has been drafted by World Bank specialists in a Technical Assistance programme;
[40] This document has not been officially adopted by government decision, law, etc. but it is the latest available version of a national energy strategy which also comprised modelling considerations.

The main transition determinants and accompanying policy measures from the NECP are summarised in Table 3.

Table 3: Main determinants and support policies from NECP

NECP Dimension	Main determinant for achieving the target	Support policies for achieving the target
Decarbonisation - GHG emissions & removals	Decarbonisation of energy sector	Promoting investments in new low-carbon power generation capacities - New gas, nuclear and RES power plants, incl. for heating - Heat pumps at source level - Decarbonisation plan at CE Oltenia
		Using the revenues from the EU ETS Mechanisms and the Structural Funds pertaining to the new Multiannual Financial Framework for 2021-2027 for RES and energy efficiency projects
	Decarbonisation of the industrial sector	Implementing the best available technologies (BAT) to reduce emissions and achieve energy efficiency
	Decarbonisation of the transport sector	Priority development and fostering the use of rail transport for transportation of passengers
	Waste Management	Promoting transition to a circular economy (incl. targets rates like 70% municipal waste recycling by 2030; 80% package waste recycling, etc.)
	Secondary determinants, like agriculture, tourism, protection of air, soil, etc.	Various, less defined policy interventions
Decarbonisation - energy from RES	Promotion of use of renewable energy in transport (RES-T)	Promoting electromobility in road transport (light vehicles and urban public transport)
		Promoting the use of biofuels in transport
	Promoting the use of renewable energy in electricity production (RES-E)	Additional taxation on imports of electricity from non-EU countries
		Increase in the RES-E in the residential sector and fostering prosumers' development
	Promoting the use of renewable energy in heating and cooling (RES-I&R)	new buildings in the property/administration of the public administration authorities to be nearly zero-energy buildings
		Efficient biomass and heat pumps in new residences

The National Strategy for Climate Change and Low-carbon Economic Growth for the period 2016-2030, as summarised in NECP, contains several strategic objectives to reduce GHG emissions (see Table 4).

Table 4: Trends and objectives in emissions reduction

GHG Reduction Sector	Trends in Sector	Strategic Measures for GHG Reductions
ENERGY	- transition towards gas-fired operation - refurbishment of electricity distribution grids	- Reducing the intensity of CO2 emissions pertaining to energy activities - Increasing energy efficiency at final consumers ○ national programmes for wide-scale support for the thermal rehabilitation of buildings ○ a pricing system in the district heating system, which reflects the natural gas and heat production costs - Ensuring accessibility of economically vulnerable groups to energy
TRANSPORT	- number of passenger cars is expected to increase - falling trend in the number of passengers in the rail transport - decaying infrastructure	- Using price instruments designed to incentivise green transport (exemption of excise duty for biofuels obtained from biomass, tax reductions for environmentally friendly vehicles, deterring parking tariffs, etc.) - Improving the efficiency of urban transport (SUMPs, efficient demand management) - Reversing the falling trend of rail transport and including projects for intermodal terminal development
INDUSTRY	Various	- Reducing the intensity of carbon emissions in heavy industry through refurbishment - Implementing the best available techniques in terms of GHG emissions - Voluntary approaches, trading in emissions and related taxes
AGRICULTURE	- falling GHG emissions trends, only until 2016 - emissions caused by use of energy - unifying small farms	- transfer of know-how and consulting services regarding climate change aspects among farmers - Supporting investments for modernisation of farms (investments in performing equipment for the storage and use of manure, energy efficiency on farm buildings, etc.) - good agriculture practices (avoiding the use of mechanised equipment; prohibiting/limiting the use of chemical and organic fertilizers; reducing the number of animals on grasslands; using crops with a high capacity of fixing nitrogen into the soil; nurturing

GHG Reduction Sector	Trends in Sector	Strategic Measures for GHG Reductions
		organic farming; Promoting carbon sequestration in agriculture; etc.)
URBAN DEVELOPMENT	- Several municipalities chose to participate in the EU Programme "Convention of Municipalities" - improving energy efficiency in buildings and identifying solutions to improve the local transport system - suburbanisation of the population (may entail an increase in GHG emissions)	- Promoting more condensed development measures, with combined utility, which are focused on transit activities as a mean to reduce distances covered by motor vehicles - Promoting the improvement of energy efficiency in buildings and in major urban infrastructure systems
WASTE MANAGEMENT	Various	- Promoting waste generation prevention: o raising awareness of the effects of waste; o nurturing environmentally friendly production; o nurturing change in the consumers' behaviour; o providing financial incentives to decrease the volume of waste. - Increasing the rate of reuse or recycling of materials included in the waste flow - Developing disposal and collection facilities - Implementing submission/repurchase programmes - Separate collection of biodegradable waste and its composting - elective waste collection - Production of energy from waste - co-incineration.
WATER AND WATER SOURES	Various	- Reducing GHG in the water supply and wastewater treatment sector in the context of a need to extend the availability of water supply and sewage services
FORESTS	Various	- Management of existing forests for carbon storage in the context of sustainable forest administration - Extension of woodland areas - Nurturing sustainable management of privately-owned forests - Realisation of carbon stock management opportunities for forests from protected areas

The National Strategy for Climate Change and Low-carbon Economic Growth **also assesses several potential GHG reduction measures against two factors: (1) abatement potential and (2) cost.** This complex analysis concludes that, in the Romanian context, the first GHG reduction measures to be promoted should be related to energy efficiency since they have high abatement potential (about 30% of the required reduction by 2050) and low (mostly negative) costs–taking into account a time horizon to 2050. Using the same logic, emissions reductions in the energy sector should be prioritised.

The two scenarios–**Green[41] and Super Green[42]**–in this strategy investigate energy mix predictions. In the Green scenario, growth of wind, solar, nuclear, hydro and natural gas energy is expected, with coal and oil phased out by 2050. In the Super Green scenario, coal will be phased out by 2030. Of course, as this version has not been updated, it is difficult to contrast this scenario with the scenarios adopted at the EU level through the European Green Deal and even with the less ambitious ones adopted through NECP. Nevertheless, the NECP, and more concretely the European Green Deal scenario, are closer to the Super Green than the Green scenario. This indicates that reapplying the same modelling tools as used in the original Climate Change Strategy, with more recent targets, could make coal phase-out a possibility by 2030.

According to the modelling comprised in the latest (not adopted officially) version of the **National Energy Strategy,** Romania is set to fulfil its 2020 GHG reduction targets and contribute "equitably" to the European 2030 collective targets. According to this strategy, Romania is expected to emit between 94 and 102 m tonnes of CO_2 in 2030, lower than the 118.35 m tonnes of CO_2 envisaged in NECP. This is a 60-63% reduction from 1990 levels, a target considered "ahead" of the expected 40% EU GHG emissions target by 2030. Still, in this ambitious GHG reduction scenario, the 2030 electricity mix envisioned for the country is surprisingly conservative: 20.5% coal, 18.8% natural gas, 22.5% nuclear, 22.8% hydro, 13.6% wind and solar, 1.1% biomass, and 0.6% oil. Furthermore, coal is expected to say flat in the electricity mix between 2035 and 2050, at 15 TWh.

2.1.2 Current progress and future milestones

Neither the NECP, nor any of the other national strategy and policy documents (adopted or in draft stage) we revised envisage any target date for climate neutrality or for coal phase-out.

The **largest share of Romania's GHG emissions** is attributable to the energy sector. Although a significant reduction was recorded in this sector, it was below the reduction in total GHG emissions from 1990-2017. Thus, we reviewed estimated milestones for this sector in the various documents.

According to the NECP, the **total installed capacity for electricity production is expected to increase** from 18,966 MW in 2020 to 22,003 MW in 2025 and then to 25,053 MW in 2030 (although, on average, the national power system currently produces on average 7,000-8,000 MW, with many power plants being too obsolete to function at safe and economically efficient parameters). An increase of up to 5,255 MW is expected in wind capacity and approximately 5,054 MW in photovoltaic capacity. Coal, with an installed capacity of 3,240 MW in 2020 will decrease to 1,980 MW in 2025 and stay constant at 1,980 MW in 2030. Together with gas, coal is expected to represent about 20% of the installed capacity in 2030, with hydro representing about 30% by that time, wind 20%, and solar 20%, with insignificant installed capacities of biomass and oil.

The NECP also includes **estimated data on primary energy production by energy source** by 2035, based on the PRIMES 2016 Scenario prepared by the Ministry of the Economy, Energy and the Business Environment for the Energy datasheets of the European Commission in October 2019. According to this data, in the context of current policies and measures, coal is expected to cover 12% of the primary energy production in 2030, gas 36%, and renewables 24% (below the target officially assumed in NECP). In 2035, given the same context of current policies, renewables are expected to grow to 33%, gas is expected to decrease to 26% and coal is expected to decrease to 9% and continues to be part of the energy mix. In conclusion, under Romania's current policies and measures, a coal phase-out may be expected only after 2035.

A significant caveat ought to be made with respect to the **EU ETS price assumption** that underpinned the NECP modelling. To our understanding, the assumption is 10 EUR/t CO_2 in 2020, 20 EUR/t CO_2 in 2025, 34 EUR/t CO_2 in 2030, 42 EUR/t CO_2 in 2035 and 50 EUR/t CO_2 in 2040. This forecast seems significantly undervalued, as the price for 1 tonne of CO_2 was EUR 24 in December 2020, a 140% increase from the models' assumption.

41 An EU target of 40% GHG reduction by 2030 in comparison to 1990 levels and modest climate adaptation policies.
42 80% emissions reduction by 2050 in comparison to 1990 and ambitious climate adaptation policies.

In these circumstances, the considerably "greener" picture painted by the WAM scenario in the NECP (a scenario with new, "greener" policies in place to reach the 2030 national targets), in which the electricity generated from fossil fuels decreases in 2030 by 10.15% compared to the WEM scenario (business as usual/existing policies) and both solar and wind increases should likely be adjusted to become even "greener."

The NECP also covers the topic of the **Just Transition**. It mentions the inclusion of the Jiu Valley in the European Commission's Platforms for Coal Regions in Transition and the preparation of the transition strategy through the Structural Reform Support Service Programme. It also mentions the inclusion of this micro-region in the Integrated Territorial Investment allocation for 2021-2027, as well as a local project for reallocation, reskilling and improvement in the workers' competences led by the (former) Ministry of Economy, Energy and Business Environment. Other funds for the Just Transition in the region mentioned in the NECP include the Modernisation Fund under the ETS Mechanism, Phase 4 - expected to cover the retraining of people for sectors with high labour demand, like rail and road infrastructures - and EUR 2 m from the Human Capital Operational Programme (each project under this programme has a maximum value of EUR 400,000 is expected to train at least 100 people). The NECP estimates that 18,600 direct and 10,000 indirect jobs in Gorj and Hunedoara counties will be lost during the Just Transition process, and local SMEs are not expected to fill the gap. Nonetheless, as the coal-fired power-plants in the two counties account for 30% of Romania's emissions from mining and manufacturing, it is clear the transition process will target the counties, in addition to the counties of Dolj, Galați, Prahova and Mureș, which account for 35% of the country's emissions from mining and manufacturing and have a significant number of employees in fossil fuel-based heat and electricity production and manufacturing.

2.2 Existing assessment of investment needs and funding overview

European Context

According to research by the think tank Ember,[43] **Romania is part of a group of seven countries that do not plan to phase out coal by 2030.** However, the installed capacity of coal is scheduled to decrease from 4.6 GW in 2020 to 2 GW in 2030. There are four countries in the European Union that plan to transition from coal to gas and another seven that aim for a full phase out of coal.

The economics of coal fired power plants are challenging in the current environment where renewable energy generation from solar, onshore and offshore wind is extremely competitive[44] and ETS prices are at all-time highs.[45] In this context, keeping coal fired power generation in the power mix becomes challenging, even when the costs of air pollution are not taken into consideration.[46]

Research performed on the Czech Republic shows that with ambitious targets, a coal phase-out for both power and heat can be achieved by 2030.[47] Finally, in late 2020, Czech Republic announced a coal phaseout by 2038.[48]

Romanian Climate Targets

Romanian targets from the National Integrated Plan for Climate and Energy for the 2020–2030 period (PNIESC) include reductions of 43.9% of ETS GHG and 2% of non–ETS emissions compared to the 2005 baseline year.

The share of renewable energy in total energy mix is assumed to increase to 30.7% by 2030. Lastly, energy consumption is assumed to decrease by 40.4% compared to the 2007 baseline.[49]

While these targets are more ambitious than the first round of targets advanced by Romania, they represent significantly lower ambitions than what is economically possible.

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43 https://ember-climate.org/project/just-transition/
44 https://carbontracker.org/reports/how-to-waste-over-half-a-trillion-dollars/; https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Power_Generation_Costs_2019.pdf
45 https://ember-climate.org/data/carbon-price-viewer/
46 https://www.gem.wiki/Air_pollution_from_coal-fired_power_plants
47 https://ember-climate.org/project/coal-free-Czech Republic-2030/
48 https://www.politico.eu/article/czech-coal-commission-recommends-2038-phase-out-date/
49 https://ec.europa.eu/energy/sites/ener/files/documents/ro_final_necp_main_ro.pdf

Investment needs

PNIESC has modelled two scenarios. The first scenario uses existing measures (WEM) and a second scenario uses additional measures (WAM). The main difference between the two scenarios is the economic growth assumptions that impact overall energy demand. The WAM scenario uses a GDP 30% higher than EU projections[50] while WEM assumes a GDP 5% lower than the projected GDP.

The total investment needs required in the WEM scenario are estimated at EUR 14.5 bn while the investments required for the WAM scenario are significantly higher, 56% higher than the WEM scenario (EUR 22.6 bn). All investments are calculated for the energy sector.

A large part of these investment needs is associated with fulfilling the renewable energy targets. However, based on the cost assumption for solar and wind presented on page 146 of PNIESC, the cost of onshore wind and solar PV utility scale are at least 20% higher than the 2020 market prices observed in Europe[51] and the 2030 projections underestimate the significant potential of cost deflation in the sector.[52] As a result, overall investment needs are likely overestimated by at least 10-20% in both scenarios.

According to the European Commission, under both Next GenerationEU–the temporary recovery instrument–and the 2021–2027 Multiannual Financial Framework, 30% of EU funds will be spent to fight climate change.[53] At the European level, this means that EUR 322 bn of the Multiannual Financial Framework and EUR 225 bn of the NextGeneration EU package will be used to fight climate change.

The funds available for Romania under NextGenerationEU are estimated to be around EUR 33 bn.[54] Approximately EUR 10 bn will be available as climate finance, i.e. finance required to fight climate change. Regarding the Multiannual Financial Framework, approximately EUR 38 bn will be available for Romania during the period 2021-2027.[55] Assuming 30% will be available for climate change investments, this translates to upwards of EUR 11.4 bn available from the EU budget for climate investments. In total, through NextGeneration EU and the Multiannual Framework, Romania can access up to EUR 22 bn to fight climate change.

The funds that Romania has access to, not counting private finance sector, match almost 1-to-1 the estimated financing needs of EUR 22.6 bn in the WAM scenario, the more aggressive scenario modelled in the NECP, a GD compliant scenario. In sum, given that the investment needs presented in the NECP are overestimated, Romania has the available funds to proceed to a coal phase-out and increase climate ambitions under the EU budget and the NexGenerationEU instrument.

The non-exhaustive funding sources listed by PNIESC is presented below.

1. Structural funds:
   - European Fund for Regional Development and Cohesion Fund
     - Operational Programme for Sustainable Development
     - Operational Programme for Intelligent Growth and Digitalization
2. InvestEU
3. Just Transition Fund
4. Modernization Fund
5. Innovation Fund
6. European Investment Bank Loans
7. Private sector finance
8. State Budget

[50] 2018 Ageing Report Economic and Budgetary Projections for the 28 EU Member States (2016- 2070)
[51] https://www.solarpowereurope.org/wp-content/uploads/2019/12/SolarPower-Europe_EU-Market-Outlook-for-Solar-Power-2019-2023_.pdf; https://www.renewableenergyworld.com/2020/04/28/bnef-says-solar-and-wind-are-now-cheapest-sources-of-new-energy-generation-for-majority-of-planet/#gref
[52] https://www.dnvgl.com/to2030/technology/solar-pv-powering-through-to-2030.html
[53] https://ec.europa.eu/info/sites/info/files/about_the_european_commission/eu_budget/mff_factsheet_agreement_en_web_20.11.pdf
[54] https://www.romania-insider.com/romania-next-generation-eu-fund-may-2020
[55] http://coe-romact.org/article/romact-review-available-eu-funding-2021-2027

Renewable energy assets are increasingly developed without subsidies in major European markets such as Spain, Germany and Italy, as well as in Nordic EU members such as Finland and Denmark.[56] **Private sector finance will play a key role in funding renewable energy projects up to 2030.** This trend is overlooked by the current national plan.

The **National Strategy for Climate Change and Low-carbon Economic Growth also comprises estimates of the required investment costs**. The strategy provides an overview of the costs for the low-carbon green growth path to 2050 across four key sectors—electricity, energy, water, and transport. An average additional annual investment of 1.5% of GDP is envisaged in the less ambitious Green scenario and 2.4% of GDP in the more ambitious Super Green scenario, both for the period 2015-2050. For 2015–30, the strategy would require an incremental average annual investment of 1.3% of GDP in the Green scenario and 2% of GDP in the Super Green scenario. The strategy assumes that the public sector share of total investment would be limited to less than 10% under the 2030 targets and just over 25% for the 2050 targets. Thus, the private sector and financial instruments are expected to play a significant role in attaining both the 2030 and the 2050 goals most effectively.

2.3 Position of the European Commission towards the Romanian NECP

In the EC's October 2020 Commission Staff Working Document that makes an "Assessment of the final energy and climate plan of Romania", the Commission assesses several of the country's targets submitted in the final NECP version as unambitious. With the exception of the -2% for non-ETS GHG emissions, all other targets are considered as not ambitious enough (e.g. the RES target of 3.3% is below what is economically achievable according to the RES formula; regarding energy efficiency, the planned 25.7 Mtoe in final energy consumption is considered "very low" and the planned 32.3 Mtoe in primary energy consumption is considered low) or non-existent (e.g. no concrete objectives for reducing energy poverty, and no targets for research, innovation and competitiveness after 2020). The document commends the incorporation of elements from the European Green Deal for agriculture, namely organic farming and the reduced use of fertilizers.

Compared to the draft NECP version submitted at an earlier stage, the EC notes that the Romanian government "partially addressed" the Commission's June 2019 recommendations, with only the considerations on energy security and the internal market being "largely addressed".

The Commission's assessment that in many areas it is unclear which policies, measures, timeframes and investment needs are taken into account by the government to reach a certain target is more worrisome (e.g. the RES target, the energy efficiency target, etc.).

Although the final version of the plan contains some investment needs estimates (a total of EUR 150 bn for 2021-2030), it is not clear how the investments are to be distributed by sector, with calculations available only for a limited number of sectors (e.g. buildings).

With respect to the Just Transition agenda, the Commission notes that the NECP identifies Gorj and Hunedoara as affected counties and the plan mentions a high-level figure of jobs to be affected but makes no modelling estimation of the concrete impact.

The Commission also notes that "the mismatch between the objectives of decarbonisation and continued use of coal and gas is not thoroughly addressed."[57]

The document makes several recommendations on the implementation of the NECP, such as:

- implementing measures for reducing GHG emissions for transport and district heating
- phasing in green taxation and budgeting
- strengthening policies on RES and energy efficiency, given insufficient levels of ambition
- finalising the ongoing RES development strategy
- implementing the "energy efficiency first" principle in all energy-related policy and investment decisions
- further supporting the renovation of public and residential buildings and giving due attention to energy poverty and making use of a high variety of financing instruments
- performing a more detailed analysis of the quantifiable social and labour market impact of the just energy transition in certain regions
- providing a detailed assessment of the estimated number of energy poor households and setting a target to reduce this number; supporting socially innovative solutions to reduce energy poverty

[56] https://pexapark.com/blog/in-house-article/solar-ppa-trends-europe-2019/
[57] https://ec.europa.eu/energy/sites/ener/files/documents/staff_working_document_assessment_necp_romania.pdf; page 12

- ensuring that all investments to implement the NECP are in line with exiting air pollution reduction programmes
- designing climate and energy-related aspects in Romania's National Recovery and Resilience Plan, with a specific NRRP target of 37% expenditure on climate

2.4 Governance mechanism and public consultations

The Just Transition Process does not have yet a clearly defined or officially adopted governance mechanism, as mentioned in our earlier reports. **While there is no governance mechanism behind the NECP, the National Recovery and Resilience Plan may bring further clarification**. However, the NECP, with its proposed transition targets, did undergo several consultation processes with the national parliament, local/regional authorities and several public events. The NECP contains the positions presented at these various consultations. The main observations of the national parliament comprised issues regarding the need to correlate the NECP with other policies (some not yet finalised), and did not particularly reflect considerations on the transition process per se. What is more worrisome, despite the publication for consultation of the NECP, local and regional authorities did not make any substantial contributions, and a limited number of them participated in later stages of consultation. The consultations with other stakeholders (e.g. business, civil society) revealed either more conservative positions (e.g. demands for prudence in the RES target increase due to the safety of the National Energy System) or called for more information regarding the actions envisaged for gradually renouncing the use of coal in the energy industry. During the TJTP drafting process, this structural flaw can be addressed by well-functioning working groups and by making sure the workshops comprised within the Technical Assistance project are effectively organised and on time.

During the course of the current Technical Assistance project and between the submission of the first draft of D1 and now, 16 bilateral interviews[58] took place between the consultant team and stakeholders involved in the Just Transition Process, either as members of the working groups or as consultative partners to the OPJT.

In these interviews, particularly with the business, academic and NGO sector representatives, we tried to assess the impact of the energy transition on the affected stakeholders, as well as their positioning with respect to the transition. Annex 12 to the final version of Deliverable 2 comprises the interview guides we used for these interviews. We have followed up in writing with all stakeholders who were not able to provide information on the spot and will incorporate the information received in D4.

In general, however, we were able to draw the following conclusions:

- At the local authority level, understanding and awareness on energy transition/climate change related topics is limited; the only experiences they have with the topic to date has been related to building insulation works. At the moment, throughout the TJTP elaboration process and based on the awareness raising efforts of the MEIP, the level of understanding related to climate issues has a high chance of increasing in the near future.
- Many large businesses are aware of the topic and eager to grasp the funding opportunity; the main challenge large businesses are struggling with is the lack of clarity over what precisely will be financed through OPJTs. They fear the period of time between the "official" adoption of the OP and the submission deadline(s) for projects will not be enough for them to invest the necessary human and financial resources into project preparation (pre-feasibility, etc.). Some firms, despite being large, have less experience in accessing EU funds, but are rapidly ramping up. They see areas like energy efficiency, emissions reductions and optimization of industrial process, on-site renewables, automation as areas where investments are needed and they plan to make investments–some are more opportunistic, simply due the existence of the OPJT, others due to operational efficiency or due to commitments towards climate neutrality.
- The vast majority of stakeholders believe the whole county is affected by the Just Transition Process, for instance because of commuting and migration patterns within the county, and thus should be targeted by the Just Transition Mechanism (JTM).
- Stakeholders pointed out that planning is difficult due to the lack of a clear commitment from the government over a transition roadmap (i.e. that National Energy Strategy is not adopted, no clear coal phase-out is foreseen, restructuring plans of large coal-based firms are not approved, etc.).

[58] Reference cut-off date for interview conclusions in the present report is 16 January 2021. Following this date, an additional number of approximately 80 bilateral and group interviews took place and the adjusted conclusions have been presented in Deliverable 4 draft version and are subject to further analysis in Deliverable 4 final version.

- With respect to skills development (needs, opportunities, etc.), the regional public authorities are less knowledgeable/or preoccupied, yet it will be essential for the Public Employment Services Agencies (PES) to be involved in skills development (in addition to education institutions and training providers) Large enterprises, with the exception of CE Oltenia as per the interviews we had with them and also in line with their restructuring plans, expect stability (or an increase) in terms of unemployment and many fear (and already encounter) qualified labour shortages. These firms have started to partner with local vocational schools and universities on training programmes and, in general, commend the collaboration, while they still believe that for more sophisticated work, like IT and project management, qualified staff will have to be sourced from outside the county.
- Our interviews with the academic environment were limited so far and we plan to explore this area in more depth, but the overall enthusiasm of the energy transition and climate neutrality targets is very low, with little plans and eagerness to explore this opportunity. In general, like businesses, local academic institutions fear a student shortage and have already encountered difficulties to fill qualification targets.

These conclusions will be supplemented in Deliverable 4 and Deliverable 5 with the level of analysis required as per the Terms of Reference.

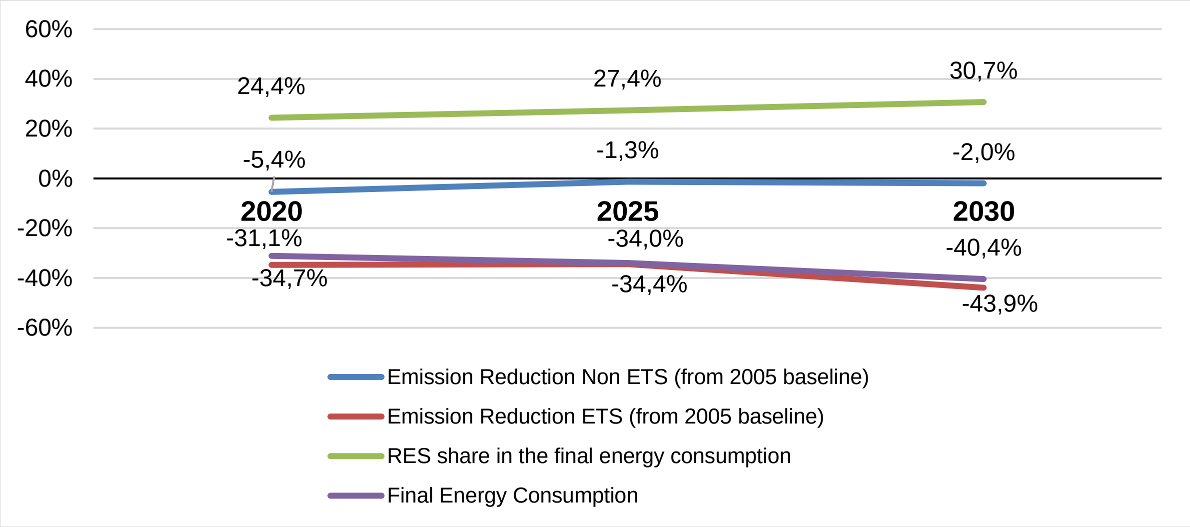
3 TIMELINE OF KEY TRANSITION STEPS

3.1 Alignment with national strategies and policies

3.1.1 Transition timeline reference

A timeline of the steps taken to achieve the targets in the NECP is not available in the document. The plan focuses on key figures and targets that are to be fulfilled by 2030 and how the respective indicators evolve up to 2030. Graph 4 and Table 5 present the evolution of the most relevant indicators that correspond to the targets assumed by Romania.

Graph 4: Key targets of the Romanian NECP



Source: https://ec.europa.eu/energy/sites/ener/files/documents/ro_final_necp_main_en.pdf

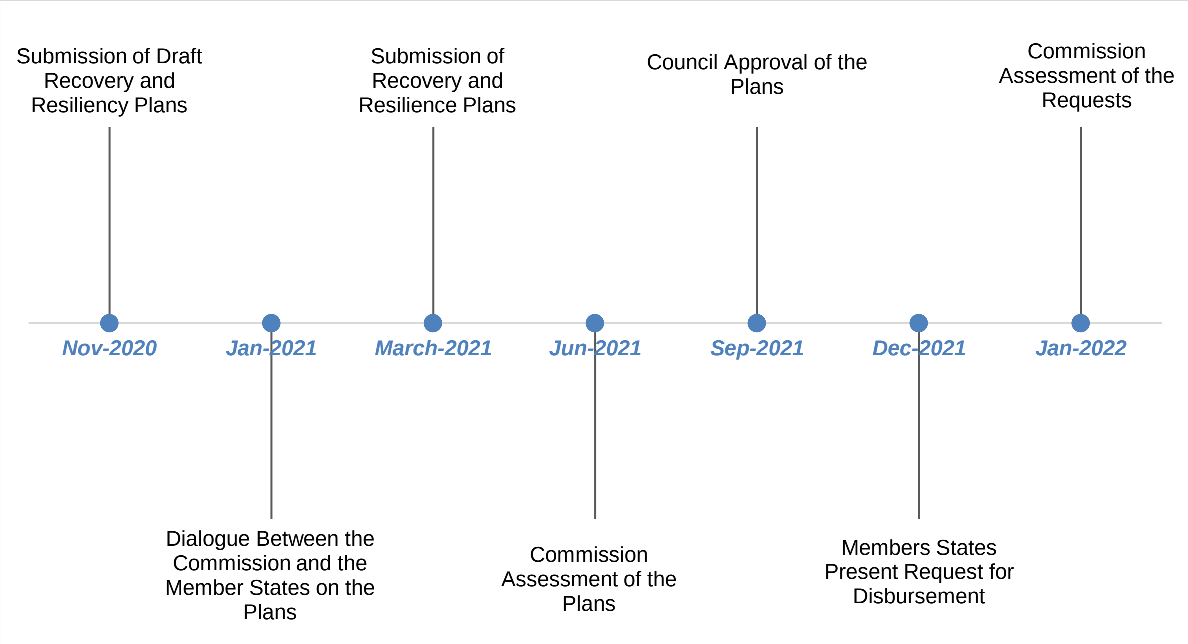
Table 5: Historical and projected trend in emissions in ETS and non-ETS sectors

Year	Emission Reduction Non ETS (from 2005 baseline)	Emission Reduction ETS (from 2005 baseline)	RES share in the final energy consumption	Final Energy Consumption
2020	-5.4%	-34.7%	24.4%	-31.1%
2025	-1.3%	-34.4%	27.4%	-34.0%
2030	-2.0%	-43.9%	30.7%	-40.4%

Source: https://ec.europa.eu/energy/sites/ener/files/documents/ro_final_necp_main_en.pdf

Very important for the analysis is as well the timeline of the recovery and resilience plans (RRP) as per Figure 2. This might require coordination between the two timelines as it has a climate share, which means that substantial funding for low-carbon activities will become available via the RRP.

Figure 2: Recovery and resilience plan timeline



Source: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

3.1.2 Overview of the proposal development stage for the regional development programmes at the county level

Following opening consultations with the county councils, the elaboration stage of the regional development strategies for the next programming cycle varies across each county.

- In Prahova, the consultation process to engage stakeholders on the new county-level development strategy commenced in April 2020, the strategic document is currently being drafted and it expected to be finalised by mid-2021.
- In Galați, the strategy is in an advanced, but not yet final draft stage and nothing has been published to date on the county council's website.
- In Mureș, the county council is currently working on the new county development strategy; they have a first draft of the analysis that has been sent for consultation. Not many comments were received by 7 December 2020. They are also considering a draft list of investment projects for the next programming period, but the list is mainly based on inputs from local authorities, while JTP initiatives are also targeting the private sector and such projects are not reflected/have not been discussed in the consultations for the county-level development strategy.
- In Hunedoara, the council is in the early stage of the procurement procedure and a service provider will be assigned by summer. A draft is expected by the end of 2021.
- In Gorj, the procedure is more advanced, a service provider has already been assigned. A draft is expected by July 2021.
- In Dolj, a draft version of the strategy is available. A final version is expected by the end of Q1 2021.

3.2 Best practice models from other countries

Best practice models are observed from seven countries that plan to phase out coal by 2030: Denmark, Finland, France, the Netherlands, Portugal, Slovakia and Spain. While the scope of the ambition is highly correlated with the economic strength of a country and its energy mix, the lower the share of coal in power generation the easier the coal phase-out. The main issue surrounding coal in a country such as Romania is that coal power generation cannot perform well economically under current market conditions dominated by low-cost renewable energy power and high cost ETS certificates. The higher the GDP of a country the less burdensome are the investments in the energy transition.

Current market conditions dominated by low-cost renewables and high ETS prices are extremely favourable to a carefully managed coal phase-out in Europe with net benefits from an economic and healthcare point of view. Currently, renewables require little to no subsidies to be integrated in a power mix such as Romania's, while savings of around EUR 200 m per year can be made from ending coal subsidies in Romania.[59] Additionally, air pollution and positive health effects of unburnt coal would also be significant.

There are three issues currently hampering renewable energy deployment. First, the sector suffers from high finance costs due to higher country risks and an informal ban of financing new capacity in the energy sector by local banks. A significant number of banks have seen non-performing loans attached to the previous wave of renewable energy development and have withdrawn from the sector. Second, due to the previous energy law (133/2012) and lack of liquidity on the electricity market, it is challenging to conclude long-term contracts through which unsubsidised renewable assets, solar and wind can be developed. Finally, a law creating a framework to development new renewable energy projects is still under development and will most likely enter into effect in 2022.[60] In this context, to reduce financing costs and thus the final costs of replacing coal assets with new renewable energy capacity, Romania needs a solid legislative framework and a more sophisticated and liquid electricity market to handle contracts that exceed one year. Lastly, new renewable energy assets will benefit from the lowest interest rates ever observed in Romania; the National Bank recently reduced its key interest rate to 1.25%.[61]

Two countries can potentially guide Romania's transition path: **(1) Slovakia, who has committed to phase out coal by 2023 and (2) Czech Republic, who has committed to phase out coal by 2038.** The power generation landscape of these countries is interesting. In 2019, about 43% of electricity generation came from coal in Czech Republic, while only 8% of power came from coal in Slovakia. Romania is at the midpoint of this range with 22% of electricity generated by coal in 2019. As previous modelling for Czech Republic has indicated, there are feasible and economically affordable pathways to phase-out coal by 2030 even when coal represents a larger share of generation than Romania's. The transition demands increased renewable energy deployment, wind and solar and coal to gas switching for some units to ensure security of supply and peaks in demand being properly serviced.[62] Additionally, Romania plans to increase its interconnection rate to at least 15.4% of total installed capacity by 2030,[63] which will help to safely and economically manage larger shares of variable renewable energy.

In Slovakia's case, the government accepted the economic reality that the future of coal cannot hold under current market conditions. As a result, it adopted an action plan focused on preparing the workers and local communities for a future without coal in 2019. The focus on bottom-up strategizing was key for this document and local communities had a key role to play.[64]

The key lesson from Slovakia's case is that while broad assessments of coal's viability in the future power systems can be performed by the central government and provided to the local communities, the main direction of action to deliver a coal phaseout need to be shaped by the local communities. Although Slovakia's case is somewhat less difficult, the Czech Republic's situation presents a more difficult case given the higher share of coal in the power mix compared to Romania.

The Czech Republic's coal commission was established in July 2019 under the guidance of the Ministry of Environment followed by a coal platform of Usti Region in October 2019. The coal commission is composed of two ministers, the Environment and Industry and Trade respectively, three directors from key ministries, local elected leaders and representatives of trade unions, business associations and non-governmental actors such as Greenpeace and university representatives. The coal commission analysed multiple phase-out dates (2033, 2038 and 2043 respectively), but they finally recommended a coal phase-out by 2038 at the end of 2020. A plan for the Just Territorial

59 https://balkangreenenergynews.com/delaying-coal-phaseout-would-be-expensive-for-bulgaria-romania-greece/

60 https://www.economica.net/berd-cauta-sa-angajeze-consultant-care-sa-implementeze-schema-de-contracte-de-diferen-a-in-romania_183245.html

61 https://www.zf.ro/banci-si-asigurari/update-decizie-neasteptata-inceput-an-banca-nationala-reduce-dobanda-19868332

62 https://ember-climate.org/project/coal-free-czechia-2030/

63 https://ec.europa.eu/energy/sites/ener/files/documents/ro_final_necp_main_en.pdf

64 https://poweringpastcoal.org/members/slovakia

Transformation is scheduled for release by June 2021. Environmental groups called on the government to reject the coal commission's recommendation and opt for a more ambitious 2030 phase-out, without which they say that the country will not meet its Paris Agreement objectives. In terms of costs, when externalities of coal burning, such as air pollution and health care impacts are properly priced in, the economic benefits are a net positive for the society.[65]

The Czech approach to coal phase-out appears to be driven more by central coordination due to the more sizeable problem it faced. The composition of the coal commission appears to represent the main communities that need to be involved in the process. However, The Czech approach does not appear to involve local civil society groups as much as the Slovakian approach.

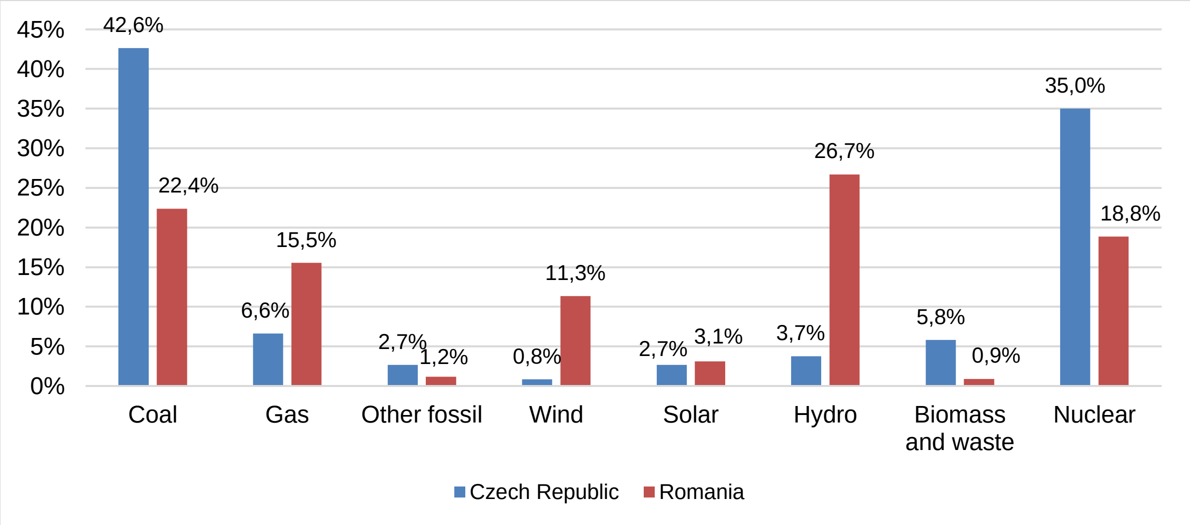
Finally, despite the acknowledgement that coal cannot be part of the energy mix long term, the Czech Republic appears to be favouring a top-down centralised solution to the energy transition by choosing to bet on nuclear as a coal replacement in its energy mix. The risks of such a strategy are significant given the difficulties faced by the nuclear industry to deliver on time and budget for new plants in Europe.[66] Additionally, nuclear energy is virtually impossible to finance through capital markets currently and bank finance without the full risks being assumed by the states through loan guarantees, which are currently not available. Finally, nuclear has high technology costs compared to solar and wind, which are inherently less risky and highly prized investments on the capital markets.[67]

3.3 Assumptions for a possible coal transition timeline

Romania is in a significantly better position than the Czech Republic to deliver a just and accelerated coal phase-out by 2030 or before despite not giving the issue prominence on the public agenda.

Romania benefits from a significantly more flexible power system due to its high share of hydro generation: 27% of power generation comes from hydro in Romania compared to 4% in the Czech Republic (Graph 5). Additionally, Romania only needs to shed about half the share of coal compared to the Czech Republic's power mix. Romania has also acquired significant experience in managing a power system with an increasingly higher share of renewable energy generation since 11% of power generation is sourced from onshore wind. A flexible power system such as Romania's has a lower cost of coal phase-out than Czech Republic's due to the lower cost of integrating renewables in the power system.[68]

Graph 5: Share of fuel type in power generation



Source: Ember

65 https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020; https://www.imf.org/en/Topics/climate-change/energy-subsidies

66 https://www.reuters.com/article/us-finland-nuclear-idUSKCN1QO1IC; https://www.neimagazine.com/news/newsflamanville-3-startup-pushed-back-to-2024-7853088

67 https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/112320-investment-in-us-clean-energy-to-total-55-bil-in-2020-generate-capital

68 https://www.nature.com/articles/s41560-020-00695-4

The main issues surrounding a coal phase-out timeline are political in nature. Just as Czech Republic, Romania first needs to establish a coal commission with broad representation of the main stakeholders that will recommend a target date and prepare plans for a post coal future of the most affected regions.

The **coal commission needs to be created as soon as possible**, ideally by the end of 2021 with first recommendations drafted by mid-2022.

Second, **Romania also needs a timeline to close its 4.6 GW fleet of coal by 2030**. As modelling for Czech Republic suggests, this can be done by 2030 and involves increased renewable energy deployment targets, both onshore wind and solar, but increasingly offshore wind as well. Initial estimates indicate that solar PV capacity needs to increase to somewhere between 8-10 GW as opposed to the 5 GW planned currently. Onshore wind capacity needs to scale to 7-8 GW as opposed to the 5 GW planned currently. Additionally, up to 1 GW of offshore wind will be required during this process. Finally, up to 2 GW of gas will be needed to safely operate the power sector.

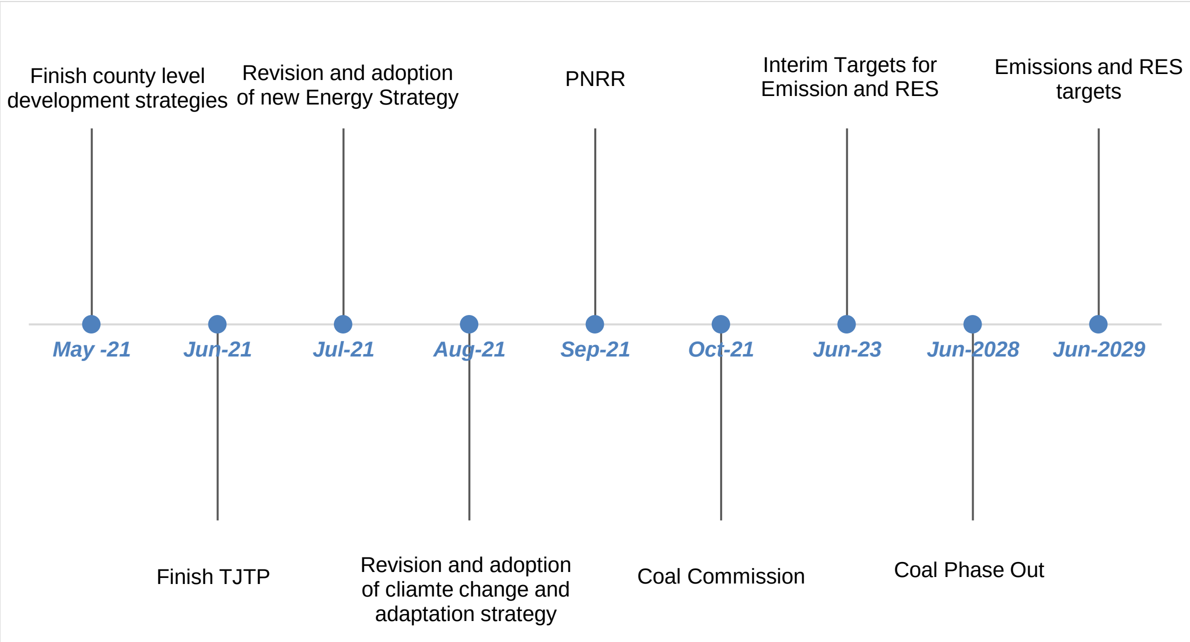
Thirdly and most importantly, while the techno-economic equation from a power system point of view is relatively easy to solve, **the more difficult issues are related to the nature of local economies once coal is no longer used in Romania's power mix.** In this respect, Romania needs funds and plans to ensure a just transition occurs in the most affected regions and that the post-coal local economic environments will be stronger and more sustainable. For a significant portion of citizens in the regions, incomes will be lost in the short- to medium-term. Immediate social impact is expected in the affected regions and disproportionately affects certain groups/ economic sectors, which we will further focus on in Deliverable 4 and Deliverable 5. This issue needs to be kept in mind and addressed in the just transition plans.

In conclusion, the coal phase-out needs a representative commission to manage recommendations and the timeline, increases of renewable energy deployment of solar, onshore and offshore wind, and funds and plans to support a just transition and an economically sustainable future for the most affected regions.

3.4 Recommended timeline of key transition steps

Given that Romania does not have an officially adopted transition timeline, but only disparate elements of information in national strategy and policy documents, the consultant team developed a proposed transition timeline (see Figure 3). The timeline is based on existing documents and our own evaluation of the national and European policy documents, the econometric modelling of the energy transition and our evidence-based evaluation of main market parameters (e.g. ETS price, cost of development of RES technologies, etc.).

Figure 3: Proposed Energy Transition Timeline for Romania



**Higher targets are possible taking into consideration market evolution, including ETS prices, and coal phase-out*

The current and future electricity market fundamentals are extremely unfavorable to maintaining coal in the electricity mix. The combination of low-cost renewables, high ETS prices, decreasing costs of battery storage allowing for higher shares of renewables makes the economics of power generation extremely detrimental to coal.

After the country level development strategies are drafted, followed by the Just Transition Territorial Plans, our recommendation is that both the revised energy transition and the climate change adaptation strategy consider a coal phase-out prior to 2030.

The National Plan for Recovery and Resilience should require and allocate available funds to manage a coal phase-out.

A coal commission with broad representation should be established as soon as possible to analyse, explain and recommend a fixed date for a coal phase-out in Romania. Following the recommendation of the coal commission, interim targets for emissions reductions and renewable energy deployment should be revised upwards given the favorable economics. A coal phase-out before 2030 should be possible under current and medium-term market fundamentals and increased ambitions of emissions reductions.

4 IMPACTS OF THE TRANSITION TO CLIMATE NEUTRALITY ON ROMANIA'S ECONOMY AND SOCIETY[69]

4.1 Transition impacts identified in the NECP[70]

EU Green Deal Stated Goals

The European Green Deal sets a target of net zero emissions by 2050. To achieve this, a target of a 55% reduction in carbon emissions for 2030 compared to 1990 levels has been established[71]. This goal is accompanied by targets in various industries such as farming, energy and transport.

The European Commission released an impact assessment of the 2030 climate target[72] and expects that the share of EU renewable electricity production will double from today's level of 32% to at least 65%[73] by 2030. Final energy consumption savings would reach between 36-37% and primary energy consumption savings would be 39-41% by 2030. By 2030, coal consumption would be reduced by 70% compared to 2015 levels. A final impact of note is the renewable energy share in gross final consumption, which is expected to reach 40% by 2030.

As part of the European Green Deal, the Just Transition Mechanism (JTM) included in the Sustainable Europe Investment Plan is key to ensure the transition towards a climate-neutral economy in a fair way. The mechanism has three pillars, one of which is the Just Transition Fund (JTF) that will provide EUR 37.5 bn of investments to the most affected regions, subject to change[74]. There are multiple target regions in Romania and the country (as a whole) is likely to lose over 10,000 jobs in the transition with jobs dependent on fossil fuels or greenhouse gas (GHG)-intensive processes[75]. Therefore, Romania's initial share of the JTF is 10%.

NECP Stated Goals[76]

The Romania National Energy and Climate Plan (NECP) states that emissions in sectors within the Emissions Trading Scheme (ETS) should fall by 43.9% compared to 2005, and in non-ETS sectors by 2.0%. The target for renewable energy sources in final energy consumption (FEC) is between 30.4% and 31.9%[77]. In the electricity sector, the target is 49.4% (RES-E), 14.2% in the transportation sector

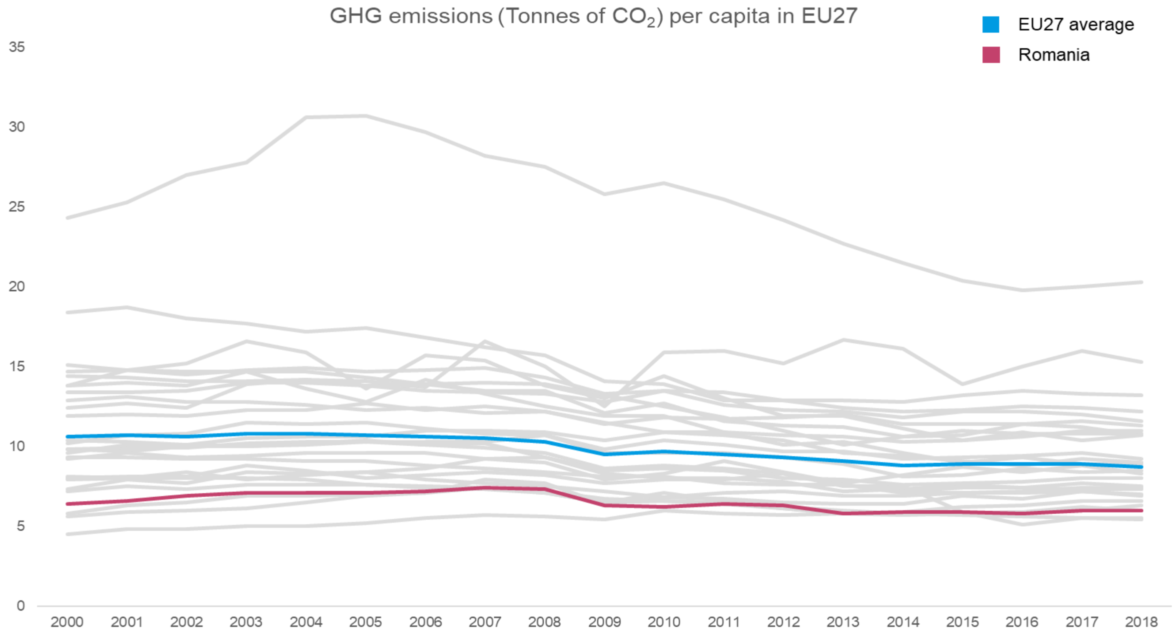
[69] This Chapter relies on the input from Cambridge Econometrics and the application of the E3ME Model.
[70] This analysis of the impact of the transition is made as envisaged in national documents as per the Terms of Reference that are guiding our work
[71] European Commission, 2020a
[72] The impact assessment is at EU level and *'examined the effects on our economy, society and environment of reducing emissions by 50% to 55% by 2030, compared to 1990 levels'.* Our impact assessment for Romania assess two scenarios: (1) NECP scenario, which is built on the current NECP and not yet in line with the more ambitious targets and (2) GD scenario, which is in line with the more ambitious target.
[73] European Commission, 2020c
[74] European Commission, 2020e
[75] Alves Dias et al., 2018
[76] Additionally, the document includes the GD scenario and coal phase-out sensitivity.
[77] Government of Romania, 2002

(RES-T), and 33.0% in the heating and cooling sector (RES-H&C). To achieve this, additional renewable energy capacities of 6.9 GW will need to be developed compared to 2015 levels. However, the European Commission, in its assessment of the NECP, has recommended increasing the overall RES in FEC target by at least 34%. Primary energy consumption is estimated to decrease by 45.1% compared to the PRIMES 2007 projection for 2030, and 40.4% for final energy consumption.

Romania's Progress Towards Climate Neutrality

Romania is already on a declining carbon path with falling energy intensity and has one of the lowest greenhouse gas (GHG) emissions per capita within the EU. However, in terms of carbon intensity of GDP (based on 2018 data) the country ranks 8th among member states. Romania reduced greenhouse gas emissions by almost half between 1989 to 2011 and energy consumption and GDP growth has been decoupled since the late 1990s[78].

Graph 6: GHG emissions in the EU27



Source: Eurostat (2020)

Romania has a diverse energy mix with nearly 50% renewables, one of the largest onshore wind farms in Europe and the technical potential of 86 GW from renewable energy[79]. Nevertheless, the energy sector contributes almost 60% of total GHG emissions[80]. Romania also has the largest tract of naturally regenerated forests in Europe, with LULUCF activities removing more than 25% of Romania's emissions during the 2000-2011 period[81].

Looking forward, Romania is one of seven EU countries without a phase-out date for coal production, but given the outdated coal infrastructure, it is not expected to be profitable after 2030[82].[83] Furthermore, some of the targets within the NECP are below the European Commission's recommendations, such as the renewable energy share in gross final energy consumption. The NECP also does not contain specific strategies to reach the targets stated.

[78] World Bank, 2013
[79] Armani et al., 2020
[80] World Bank, 2015
[81] World Bank, 2015
[82] Bankwatch Network, 2020
[83] 98% of coal and 73% of natural gas units are state-owned through the Ministry of Economy, Energy and Business. None of the coal power plants currently in operation are fully compliant with the Industrial Emissions Directive, most of the power plants benefit from derogations for SO_2, NOx and/or PM. This will, however, expire in June 2020. Some are operating without an environmental (IPPC) permit and some of the hard coal units have emissions 10-15 times more than the allowed threshold for SOx. (The energy sector in Romania - Bankwatch). The average coal unit was 42 years old in 2019, and the estimated economic viability of coal power plants is approximately 40 years. (Coal-in-the-Romanian-NECP.pdf (bankwatch.org)). This means by 2030, average age of 53 and would require large investments to maintain.

Therefore, in this modelling task, two scenarios have been created by Cambridge Econometrics (CE) to account for these differences. One scenario closely follows the NECP while the second one is an ambitious plan in accordance with the GD.

4.2 Modelling national impacts with E3ME

This section describes the national modelling and consists of three parts:

(1) The first part describes the business-as-usual (BAU) case.
(2) The second part provides a brief description of the E3ME macro-econometric model and its connected sub-modules (e.g., FTT: Power).
(3) The third part describes the assumptions used for modelling the two transition scenarios (Green Deal and NECP-based) and the two types of sensitivity analysis ("coal phase-out 2030" / "adjusted initial LCOE prices").

4.2.1 Establishing a business-as-usual scenario

The E3ME model builds on data collected and maintained by CE[84]. Economic, energy, environmental and auxiliary time-series are sourced from various data providers including:

- Eurostat national accounts for economic data in European countries (e.g. nama10 series)
- AMECO database for macroeconomic figures
- PRIMES/Eurostat data for energy figures in European member states
- For a more detailed description, see the E3ME manual (Cambridge Econometrics 2019)

Historical time-series are used for parameter estimations and calibration of the model (more discussion on this in the next section) and as a starting point for the forecasted data. Long-term projections are used for calibrating the long-term forecast. The sources for these forecasts are the Ageing Europe report (Eurostat 2019), the IEA WEO (IEA 2018) or IMF WEO. All of these data sources are used to build a baseline model, which, if needed, is then calibrated to the match pathways for individual countries more precisely.

Therefore, the first step of this modelling exercise is to establish a BAU scenario (or baseline) in line with the technical proposal submitted to respond to the Request for Services of the Project. In energy terms, the BAU scenario is partially calibrated to the NECP and partially based on modelling results from the FTT:Power submodule of the E3ME framework. This approach has been chosen because of the many developments in Romania, which made projections from the PRIMES EU Reference Scenario 2016[85] especially unrealistic in terms of nuclear capacities. Table 6 compares relevant indicators between the baseline and PRIMES energy figures.

Table 6: Major indicators, Romania in the BAU scenario (baseline) compared to PRIMES 2016

	PRIMES	Baseline
CO_2 reduction in energy by 2030, compared to 2005	40%	49%
RES share in power generation (GWh) by 2030 (incl. nuclear)	46%	52%
RES share in final energy consumption (FEC) by 2030	30%	34%
Technology shares (GWh) in power generation in 2030		
Nuclear	31%**	20%
Coal	12%	10%
Hydro	22%	20%
Solar	4%	16%
Wind	18%	14%
Mean annual GDP growth (2021-2025)*	2.06%	3.33%***
Mean annual GDP growth (2025-2030)*	1.58%	2.82%***

Source: PRIMES 2016 Ref Scenario[86] (left), E3ME (right)

[84] Cambridge Econometrics, 2019
[85] Capros et al., 2016
[86] Ibidem

Note: *GDP is an input/assumption in the PRIMES energy modelling, ** the PRIMES 2016 Ref Scenario has included an increase of nuclear capacity by 2025 as a result of the planned new reactors in the Cernavodă plant *** GDP differences are related to Post-Covid recovery.

In economic terms, the baseline scenario accounts for the impacts of COVID-19. It uses estimations available at the time of the modelling (December 2020), from the EC's Summer Economic Forecast[87] for European member states, including Romania. According to the forecast, the estimated impact of COVID-19 results in a 6.0% annual GDP decrease[88] from 2019 to 2020. This impact was factored into the E3ME baseline (see again annual growth rate differences in Table 6, in 2021 a rapid recovery leads to an increased average rate in 2021-2025). As comparison: the IMF, in its October 2020 World Economic Outlook estimated a -4.8% GDP change in Romania for 2020, while its long-term forecast (2023-2025) shows an average 3.64% annual GDP growth[89].

The resulting BAU case or baseline scenario is used as a starting point to model the transition scenarios and serves as a point of comparison to understand the impacts of the transition. It is important to note that due to the market dynamics captured by E3ME and FTT (more on this in the next section), the BAU case already includes notable decarbonisation.

4.2.2 Modelling approach: The E3ME macro-econometric model

E3ME is a macroeconomic model built on Post-Keynesian economic theory and econometric estimations of macroeconomic relationships. It was originally developed by an international research team and has since been maintained by Cambridge Econometrics. It has been used in high-profile, scenario-based policy analysis, including assessment of the EU's 2030 environmental targets[90] , EU skills projections[91] and the 2018 New Climate Economy Report[92].

E3ME is a national level model, which features detailed modelling for each EU member state, including a granular treatment of economic sectors and household consumption categories. Its behaviour is different from computable general equilibrium (CGE) models often used in macroeconomic modelling. E3ME works with a 'bounded rationality' approach, as it uses estimated behavioural relationships, rather than optimisation assumptions. E3ME also features an endogenous treatment of money supply[93] and works with a demand-driven approach. This means that the supply side will try to adjust to demand, subject to constraints. Capacity constraints are one such constraint and they feed back to prices and investment decisions in the model[94]. However, in the model there is usually spare capacity in the economy, therefore policies may lead to increased output and employment[95].

In this modelling exercise, the 'Future Technology Transformations' (FTT) suite of models is also used. FTT models are bottom-up technology models integrated with E3ME. FTT: Power, which is used in the modelling, simulates investment decisions through discrete choice modelling while assuming technology diffusion and learning effects for individual technologies[96]. In the modelling, FTT: Power determines a technology mix by region given a scenario of detailed energy policy such as carbon prices, subsidies and regulations by technology. Changes in the power technology mix result in changes of production costs, reflected in the price of electricity. The model takes electricity demand from E3ME and feeds back a price, fuel use and investment for replacements and new generators. Through E3ME linkages, this trickles through supply chains and is reflected in gross output and investment for the electricity sector.

For further details, please refer to https://www.e3me.com/.

Assumptions in the modelled transition scenarios

CE considered several "cornerstone" indicators of the country's energy profile to set up the representative scenarios. Defined scenarios are calibrated to these major energy indicators. Two main scenarios were modelled in the current exercise. One scenario aims to reach the goals set forth in Romania's National Energy and Climate Plan (NECP). Importantly, this scenario assumes that coal

87 European Commission, 2020g
88 Official provisional GDP figures available as of April 2021 indicate that actual GDP decrease was about -3.9% in Romania.
89 IMF, 2020
90 European Commission, 2020b
91 CEDEFOP and Eurofund, 2018
92 New Climate Economy and World Resources Institute, 2018
93 Pollitt and Mercure, 2018
94 Pollitt et al., 2017
95 Mercure et al., 2019; Cambridge Econometrics, 2019
96 Mercure et al., 2014, Mercure, 2012

capacities are kept active (in accordance with the NECP) through the end of the decade and that natural gas will play an important role in the energy system in the years to come. As a consequence, the development of renewables (particularly solar PV) is weaker. The second modelled scenario, named "Green Deal" is intended to be an illustrative scenario with "higher ambitions", consistent with the goals of the European Green Deal. This scenario aims for a quicker energy system transition, with high levels of RES deployment. As noted before, the baseline scenario already includes notable market-driven decarbonisation. Importantly, the NECP scenario aims for lower decarbonisation rates since coal capacities remain active.

Baseline

As detailed in Table 7, some of the major calibration indicators of the CE were already on track to be met in the baseline scenario. The reduction of final energy consumption (FEC) is already above the NECP target of 39% in the PRIMES 2016 baseline (43%) by 2030. Subsequent modifications of the baseline, such as including consequences of COVID-19, bring total reduction to an even higher level (52% in the baseline). As a result, the RES share in final energy consumption is slightly higher in the baseline that in the NECP target (as consumption reduction is more likely to impact non-renewable sources). Similarly, the RES shares are somewhat higher than the NECP targets in specific sector relevant shares (RES-T, RES-E, RES-H&C) as well. **Therefore, it is important to stress that the baseline scenario, which considers market-based outcomes, leads to a faster decarbonisation process than the NECP scenario does.**

NECP scenario

Major goals, mostly related to the structure of energy consumption and emissions as stated in the NECP, as well as important policy aspects, were considered when setting up the scenario. How the NECP targets can be reached given the baseline scenario was investigated and the scenario was established according to these parameters.

Table 7: Major energy indicators comparing baseline, NECP targets and NECP E3ME scenarios

Values by 2030	**Baseline***	**Target NECP**	**NECP scenario****	**Green Deal**
CO_2 reduction in (current) ETS sectors, compared to 2005	49%	**44%**	46%	72%
RES in FEC	34%	**31%**	34%	39%
RES-E share	52%	**49%**	45%	65%
RES-T share	15%	**14%**	15%	18%
RES-H&C share	38%	**33%**	37%	47%
FEC reduction***	52%	**39%**	55%	62%
Technology shares (GWh) in power generation in 2030****				
Nuclear	20%	**21%**	20%	21%
Gas	17%	**14%**	17%	6%
Coal	10%	**15%**	17%	8%
Hydro	20%	**23%**	21%	21%
Solar	16%	**9%**	10%	28%
Wind	14%	**16%**	13%	14%

Source: NECP of Romania (2020)
Notes: * basis of calibration described in the text
** illustrative Green Deal scenario (55% emission target) outside Romania in EU27
*** compared to PRIMES 2007, PRIMES 2016 already includes 43% reduction compared to PRIMES 2007, energy consumption impacts of COVID-19 added on top of that
**** average share 2029-2030, as nuclear capacity is added in 2030

The NECP scenario was designed to be in line with the NECP targets, which due to the earlier discussion results in a somewhat weaker decarbonisation than the baseline. Nevertheless, the NECP scenario differs from the baseline in important ways. There are major differences in the assumed energy system structure, especially in power generation (PG). The capabilities of FTT:Power (described earlier) are used for this exercise.

In the baseline, by 2030, PG is primarily supplied by nuclear (20%), hydro (20%), gas (17%) solar PV (16%) and wind (14%), which account for 87% of electricity generation. This overlaps in some ways with the NECP scenario, which has similar shares for nuclear, hydro, wind and gas. Nevertheless, in the NECP scenario – due to the assumption of active coal capacity – solid fossil fuel-based generation is still the 3rd most important source in the energy-mix. This has consequences in terms of CO_2 reduction as well. While the scenario's outcome (46% for ETS sectors) is above the NECP target of 44%, it is below the baseline's target of 49%.

The NECP scenario considers several policy measures, that have an effect on the modelled outcomes. Subsidy schemes for solar PV, wind, biogas, biomass and geothermal energy are applied using the illustrative magnitudes of 50% (solar, wind) and 45% (others) gradually decreasing by 2030[97]. These subsidies are applied to the CAPEX of the technologies, therefore reducing overall costs. Furthermore, the scenario assumes higher ETS prices than in the baseline. Assumed ETS prices are about 34% higher in the NECP scenario by 2030, reflecting the tightening of the overall EU market (see Table 8 for the exact values). Furthermore, as the EU has been considering the extension of the ETS system to the buildings and transport sectors[98], the scenario also considers this extension. As a result, ETS prices are levied on the buildings and transport sectors in the NECP scenario. Targeted policies for the transport sector, ICE vehicles and the subsidisation of EVs (electric vehicles) are also included.

Finally, a major aspect of the NECP compared to the market-based baseline is that coal-based PG capacities remain active through the modelling period. In the baseline, coal-based power generation drops to about 1 GW by 2030. In the NECP scenario, an initial decrease to 2 GW by 2025 is followed by stagnation, which results in about 2 GW coal-based PG capacity still operating by 2030.

Green Deal scenario

The Green Deal (GD) scenario is a high-level European scenario, aiming for the "higher ambition" climate goals set out by the European Green Deal (including a 55% CO_2 emission reduction target). The scenario includes increased ETS prices (see below) as well as various policies targeted towards power generation, energy efficiency, etc.

The scenario assumes several policy measures for the energy sector, such as feed-in-tariff measures for solar and wind power (55-60% of LCOE respectively), capital subsidies for both technologies (gradually phased-out by 2030; starting values are 28% for wind, 67% for solar) and energy efficiency measures lead to a 21% total energy demand reduction compared to the baseline. The scenario also includes measures targeting other sectors: taxes targeting ICE (internal combustion engine) vehicles and tax-relief for EVs and heating policies subsidising solar thermal and heat pump technologies.

Nevertheless, contrary to the NECP scenario, the scenario does not consider keeping coal capacities open, nor does it mandate other "fixed" capacities in the modelling.

Table 7 presents a selection of major indicators and compares the GD to: (1) the baseline, (2) NECP targets and (3) the GD scenario.

Rest of the EU27

Crucially, in both scenarios, it is assumed that outside of Romania, EU member states act in accordance with the goals of the European Green Deal. This means that high-level policies are assumed (energy efficiency, electric vehicles (EV) mandates, RES support) to be consist with the GD, leading to a 56% reduction of CO2 emissions in the EU27.

For Romania, this induces spillover and price effects, i.e., technology matures faster and is therefore cheaper to adopt. Another direct effect is the increase of ETS prices, which Table 8 illustrates for the scenarios.

Table 8: ETS price assumptions in the scenarios

EUR / tonnes CO_2	Baseline	NECP scenario	GD scenario
2020	19.2	19.2	19.2
2025	25.6	32.6	32.6
2030	34.3	45.9	45.9

Furthermore, budget balancing is assumed in the scenario. This means that ETS revenues are recycled towards required investments (energy efficiency investment, compensating early scrapping of power equipment if needed and power generation subsidies) while the residual amount is used to reduce income tax and social security contributions.

[97] Subsidy magnitudes are based on data available on subsidy rates as of 2018 in the RES-LEGAL database.
[98] Cambridge Econometrics & European Climate Foundation (2020)

Sensitivity: "coal phase-out by 2030"

In the modelling, a sensitivity analysis with a forced coal phase-out by 2030 was considered on top of the NECP scenario. The sensitivity is configured to reduce coal-based power generation to a minimum level by 2030. Although Romania has yet to decide on a definitive date for coal phase-out[99], this sensitivity provides insight into some of the possible consequences of a process implemented in the current decade. Coal-based capacity is reduced to about 0.8 GW, or an 8% share in total PG generation by 2030. In terms of coal use, this scenario is similar to the outcome of the GD scenario.

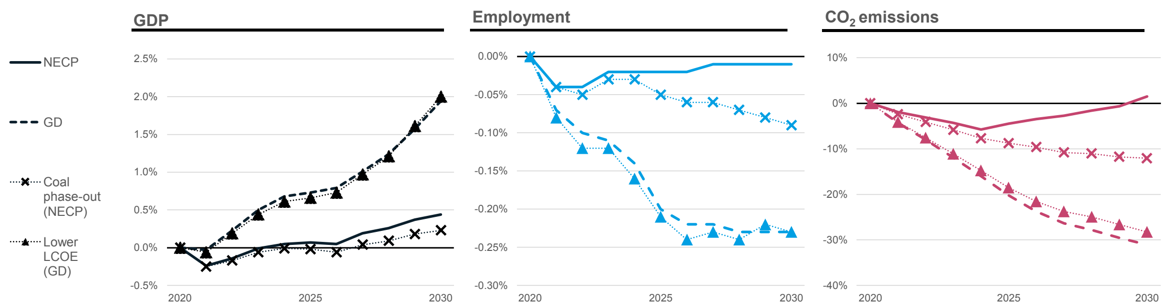
Sensitivity: "adjusted initial LCOE prices"

Starting LCOE prices (2018) in the modelling for renewable energy sources were calibrated to international sources, such as IRENA[100], IEA[101] and BloombergNEF[102]. Nevertheless, local experts on power generation costs in Romania have indicated that these prices might overestimate local LCOEs. Therefore, a second sensitivity has been added to the modelling, considering the effect of lower starting LCOE prices on the scenarios. The setup in this case includes modifying both the baseline and the Green Deal scenarios to use the lower prices. The LCOE price for wind is 50% lower in 2018 than in the original calibration, while the LCOE price of solar PV is about 69% lower in 2018 than in the original calibration.

4.2.3 Results of the national modelling

Graph 7 shows the results from the modelling on the national level for Romania for both the main scenarios and the sensitivities. In the following section these results will be discussed followed by a discussion of the regional impacts of the scenarios. It is important to note that sensitivities were modelled at the national level only.

Graph 7: Key variables



Source: E3ME modelling

GDP

GDP impacts show how the different ambitions impact economic activity. In the NECP scenario, GDP impacts are relatively small throughout the period (between -0.2% and +0.4%). The GD scenario is estimated to have a stronger impact, yielding a long-term positive impact of about 1.9% by 2030. The coal phase-out sensitivity limits the effect of the NECP scenario, here GDP impacts are between -0.3% and 0.2%. Finally, the lower initial LCOE sensitivity produces results closely following results of the main GD scenario.

Employment

Employment, however, does not follow the same pathway. In the NECP scenario, the employment level stays close to the baseline, in fact, considering two decimal points (in percentage terms) there is no visible difference. Nevertheless, it already decreases by about -0.1% by 2030 in the coal phase-out sensitivity. The GD scenario increases this reduction, with negative employment outcomes (compared to the baseline) of -0.1% to -0.2%. The lower LCOE sensitivity closely follows the main GD trend.

[99] Bankwatch Network, 2020
[100] IRENA, 2019, https://www.irena.org/publications/2019/Dec/RE-Market-Analysis-Southeast-Europe
[101] IEA, 2020, https://www.iea.org/reports/projected-costs-of-generating-electricity-2020
[102] BloombergNEF, 2020, https://about.bnef.com/blog/new-report-reveals-economic-path-to-a-rapid-coal-phase-out-in-europe/

CO_2 emissions

Finally, the CO_2 emission reduction target (in ETS sectors) stated in the NECP is 44% compared to 2005. Both scenarios reach this goal: the NECP scenario reaches a 46% reduction by 2030 (but also leads to an increase of 1.5% in total emissions compared to the baseline by 2030), while the more ambitious GD scenario reaches a 72% reduction by 2030 (a reduction of 31.1% in total emissions compared to the baseline by 2030). The sensitivity analysis introduced to assess the impacts of a quickened coal phase-out by 2030 in the NECP scenario. This leads to a 12.1% reduction of total emissions compared to the baseline by 2030 (scoring above the NECP target). Meanwhile, the lower initial LCOE sensitivity shows a 28.3% reduction by 2030 compared to the baseline. Notice that this value is lower than the main GD result (31.1%). This is explained by the fact that as the LCOEs of renewables are lower, the baseline reduction is higher and therefore the scenario is only able to bring a relatively lower reduction (while the overall absolute reduction is similar).

4.3 Identified impacts as per NECP and long-term – at regional NUTS3 level

4.3.1 Regional differences in Romania

There are substantial regional differences in the expected impacts and actions needed to transition towards a climate neutral economy. The JTF article states that while reaching climate neutrality is an important goal, it is also important to work towards this goal in an effective and fair manner[103]. The JTF was established with this in mind, focusing "on regions and sectors that are most affected by the transition given their dependence on fossil fuels, including coal, peat and oil shale or greenhouse gas-intensive industrial processes"[104]. An important aim of the JTF is to avoid increasing existing regional disparities due to the transition process.

Regional disparities are an existing problem in Romania. Historically, much of these disparities can be traced back to the forced and inefficient socialist era industrialisation. Nevertheless, differences between both counties and regions are still increasing today. Oțil, Miculescu, and Cismaș[105] highlight the "very high discrepancies" between more developed (e.g. Bucharest Ilfov) and less developed regions (e.g. Sud-Vest Oltenia), which is amplified by "economic growth factors (physical and human capital, technological progress)" and migratory patterns. As Török[106] notes, the western regions generally have a more diversified economic profile and a more qualified workforce, which has widened the gap between these regions and the mono-industrial counties of the east. However, Török[107] also highlights that increased connectivity can spur regional development, which falls within the goals of the JTF.

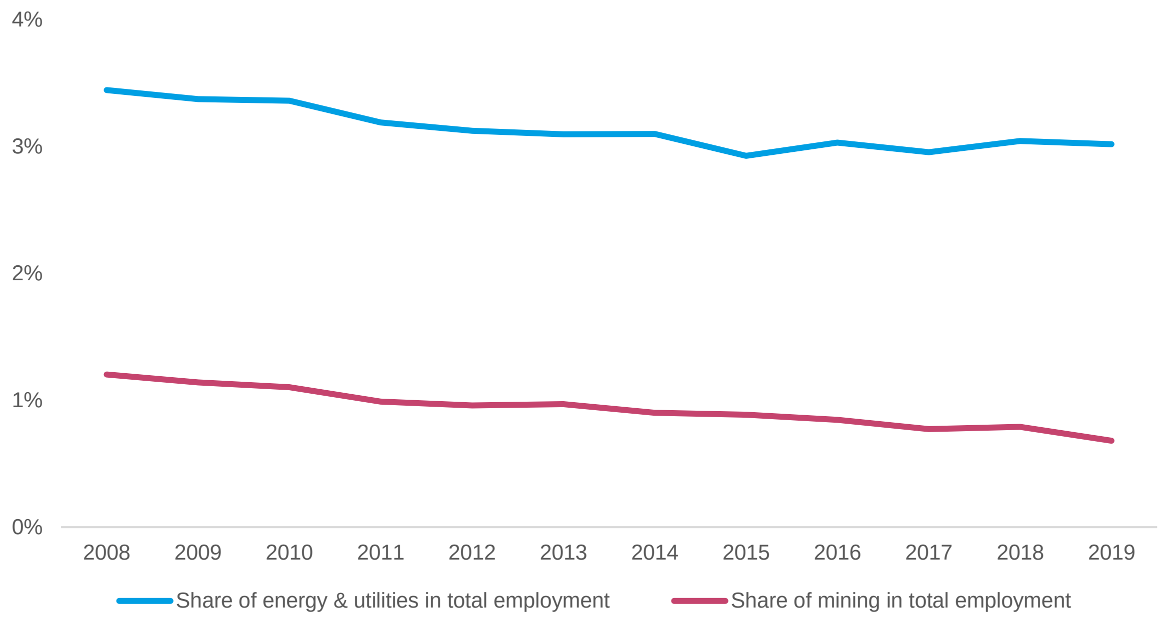
The transition process could escalate some of these regional disparities. As mentioned earlier, substantial progress has been made towards reaching climate and energy goals on the national level, including a reduction of emissions and a high share of renewable energy in power generation. However, a large part of the population is still dependent on fossil fuel-based industries such as coal mining and coal-based power generation.

As illustrated in Graph 8, there is a decrease in employment from the energy and utilities and mining sectors. Employment in the energy and utilities sector (includes mining) contracted from 3.5% in 2008 to 3.0% by 2019, while employment in the mining sector specifically dropped from 1.2% to 0.7% during the same period[108]. This indicates that less than 60,000 people work in the Romanian mining sector nationally. Estimates indicate that the coal mining industry employs about 15-16,000 people[109]. The scale of the contraction is even more apparent when compared to the 1990s, when employment in coal mining was around 50,000 in Jiu Valley alone[110].

Coal mining and coal-fired electricity production is concentrated in the target regions (Hunedoara and Gorj counties), with Gorj accounting for about 80% of total employment in the sector.

[103] European Parliament, 2020b
[104] European Parliament, 2020b
[105] Oțil, Miculescu, and Cismaș, 2015
[106] Török, 2019
[107] Török, 2019
[108] Eurostat, 2020a
[109] Alves Dias et al., 2018
[110] von der Brelie, 2020

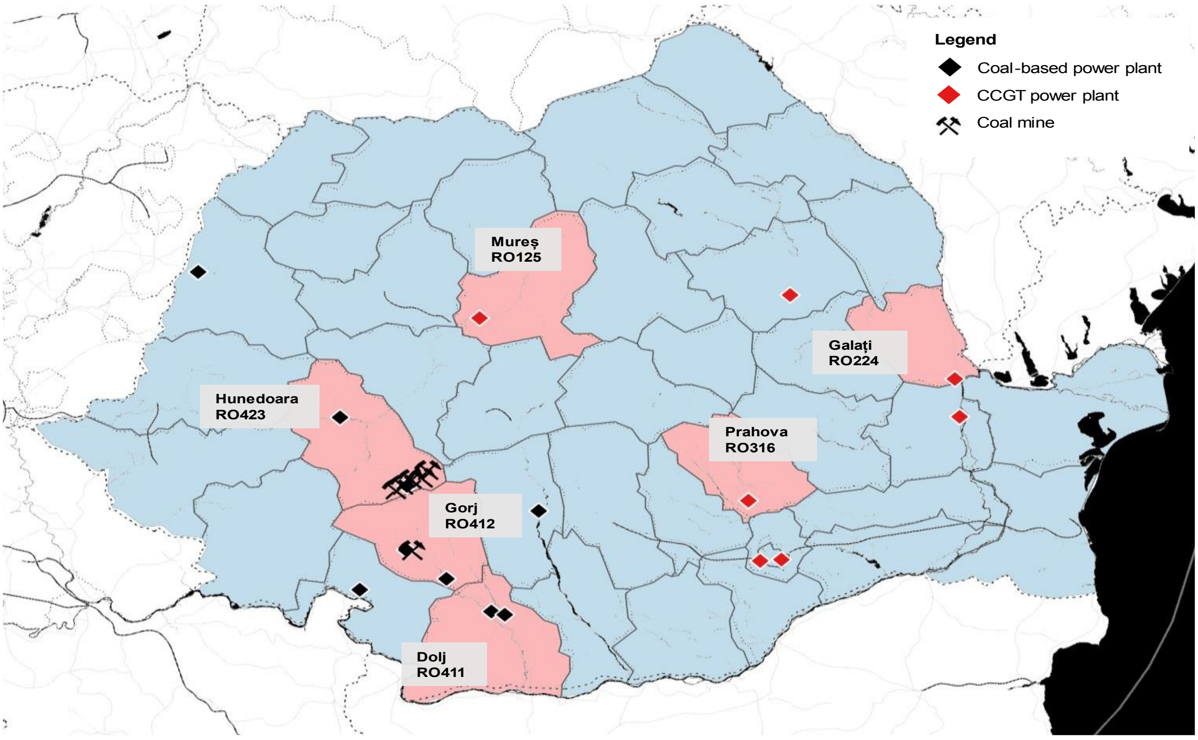
Graph 8: Share of energy and mining in total employment in Romania



Source: Eurostat

According to estimates from reporting in 2018, Romania was expected to lose up to 10,000 jobs in the transition process in coal mining and related jobs[111] . Transition effects will also differ across regions.

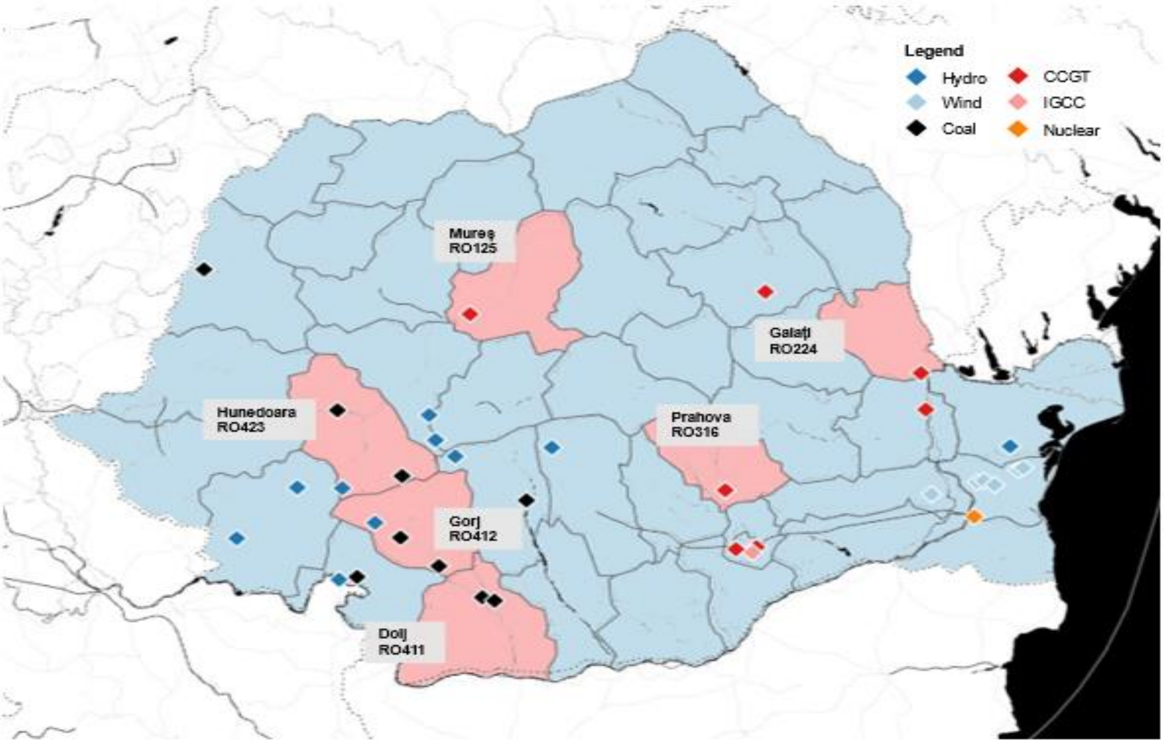
Figure 4: Coal-based power and coal mines and target regions in Romania



Source: JRC Open Power Plants Database (2020) and JRC / Alves Dias et al. (2018): EU coal regions, mapping: CE
Notes: Combined Cycle Gas Turbines (CCGT)

[111] Alves Dias et al., 2018

Figure 5: Large-scale power plants in Romania and the target regions



Source: JRC Open Power Plants Database (2020), mapping: CE
Notes: Combined Cycle Gas Turbines (CCGT) abs Integrated Gasification Combined Cycle (IGCC)

As illustrated in Figure 4, both coal-based power generation and coal mining, sectors most affected by the transition, are concentrated in a limited number of Romanian territories. Hunedoara and Gorj employ 90% of Romania's mining workforce[112]. Most coal-based power generation capacity and active coal mines can be found in Sud-Vest Oltenia (RO41) with a capacity of 4.5GW, and Vest (RO42) with 1.3GW. At the NUTS-3 level, affected regions include Gorj and Dolj (part of Sud-Vest Oltenia) and Hunedoara (part of Vest). Sud-Vest Oltenia also reports a high number of indirect jobs in intra-regional supply-chains related to coal-activities with over 5,000 jobs, and up to 10,000 inter-regional indirect jobs[113].

The southern regions have the highest percentage of people at risk of poverty or social exclusion (approximately 40%) and report the lowest GDPs per capita[114] . Vest is a fast-growing region with a skilled workforce that benefits from its proximity to Western Europe, natural resources, and a diverse industrial infrastructure[115].

Vest (RO42) once contained Romania's biggest coalfield, but since the fall of communism, the mines have closed and employment in the coal sector has suffered as many people left the region[116]. Sud-Vest Oltenia produces most of Romania's hydropower – the main renewable energy source[117].

4.3.2 Expected renewable energy development opportunities in Romania

It is expected that the transition towards climate neutrality will cause employment losses and diminish coal mining and conventional power generation. However, it is also expected that the transition will bring about new areas for investment and new areas of employment. IRENA (2019) states that the energy transition process can be a driver of economic growth in the South-East-European (SEE) region, including Romania. Using the E3ME macro-econometric model, IRENA (2019) concluded that with carbon taxation in place, a transition process can boost GDP and create new jobs in the area.

[112] European Parliament, 2020a
[113] Alves Dias et al., 2018
[114] Eurostat, 2021a
[115] European Commission, 2020f
[116] von der Brelie, 2020
[117] European Commission, 2020d

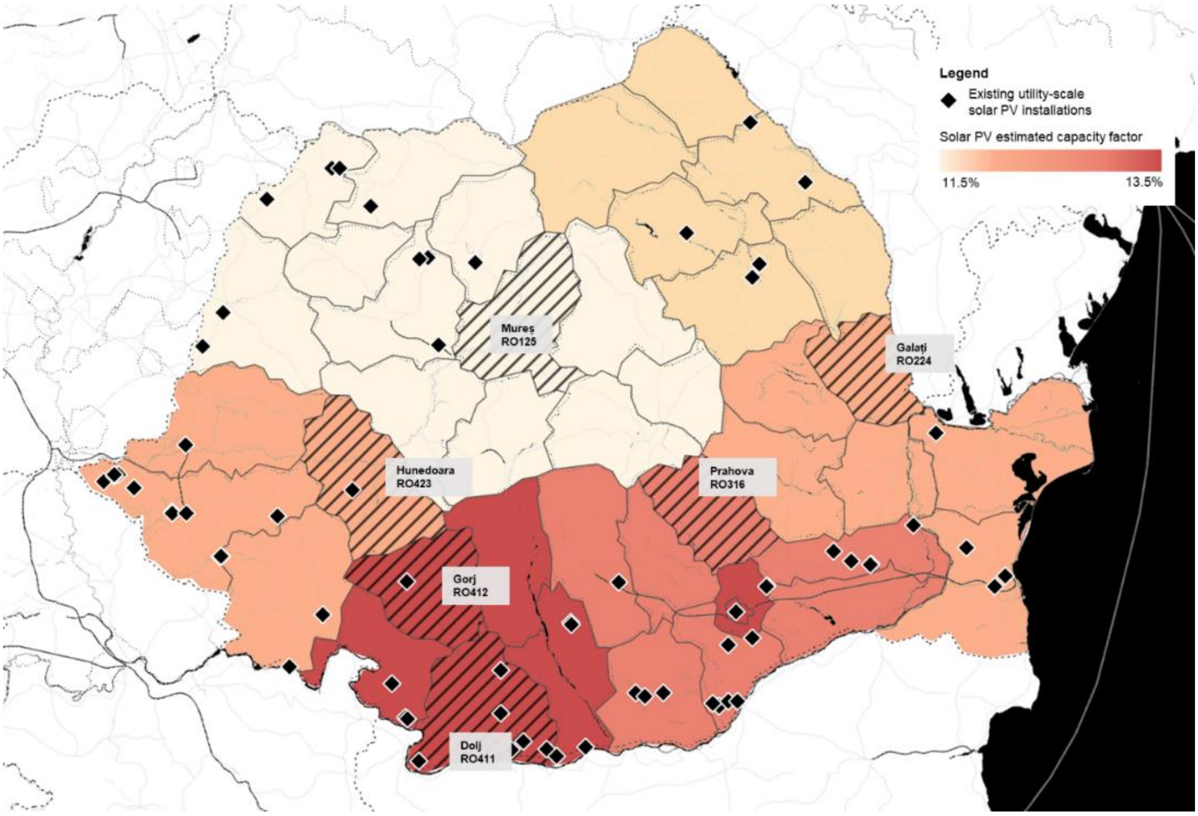
However, the same analysis also noted that such a scheme can produce increasing inequalities if not accompanied with the right policy framework.

IRENA (2019) also notes that the renewable energy sector has already accounted for more than 100,000 jobs in the SEE region in 2017, with about 16,000 jobs created in the bioenergy sector in 2017 (mostly in Romania).

Solar PV and wind power deployment can also create a variety of new job opportunities. IRENA (2019) states that a 50 MW solar PV plant is expected to require more than 229,000 person-days of labour, while a 50 MW onshore wind farm is expected to need about 144,000 person-days for installation, operation and maintenance (O&M) over their lifetimes. The deployment of renewable technologies can also create jobs through supply-chain effects since many roles can be sourced locally. Of course, renewable energy deployment as an economic diversification and job creation measure needs to be accompanied by economic diversification measures in other industries,

The regional analysis shows that new RES deployment can lead to a positive net employment effect of the transition. However, this net positive effect is largely driven by trade impacts. The analysis indicates that while electricity generation provides a positive contribution as the transition moves forward, its impact is relatively small compared to the reductions from fossil and refining activities and fuel extraction.

Figure 6: Solar PV installations and potential in Romania and target regions (as of 2012)



Source: (Ruiz et al. 2019) and (Fabrica de Cercetare 2012), mapping: CE

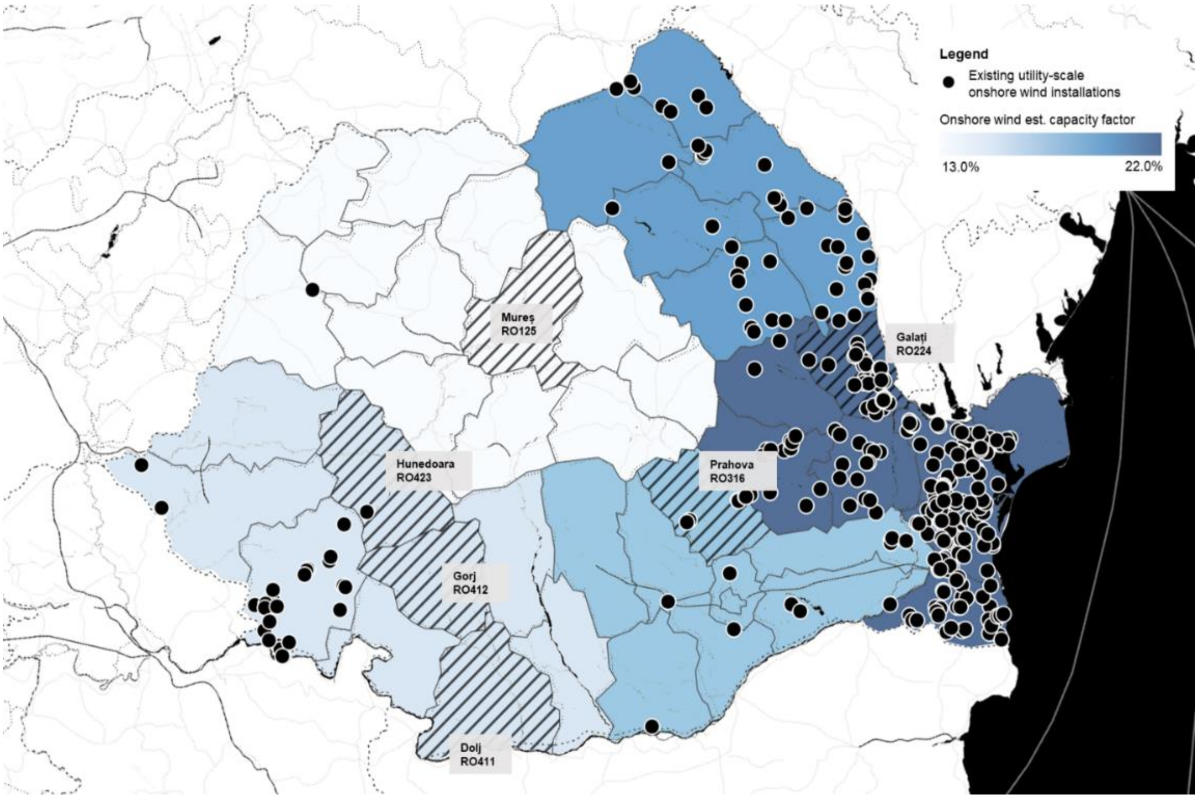
As a result, while the sectoral impacts in the conventional energy sector (including fuel extraction) are expected to be negative, the transition also presents some opportunities for growth and job creation. The overall impact, however, is ambiguous and dependent on accompanying policies. Furthermore, as previously noted, the transition can contribute to regional disparities. As a result, it is also a question whether the new opportunities that arise from the transition overlap spatially with the adverse impacts. Practically, it is important that in the target regions the possibility for new RES deployment be followed, as it can mitigate some of the adverse impacts of the transition.

The regional analysis - described in the following sections - take these into account through allocating new RES commission to regions where there is a higher potential for the specific technologies. The analysis also provides insights on the potential of two prominent technologies: solar PV and onshore wind. Figures 6 and 7 show the technical potential for solar and wind in Romania along with their current installations. Target regions are also indicated on the maps. To date, there is a relatively small number of existing RES installations in the target regions, with the exception of wind power in Galați, a region with the highest estimated wind potential in Romania[118].

Solar PV installations are scarce in the target regions, even though Gorj and Dolj counties are in a region with high potential for solar PV. However, higher costs of the technology in the region may account for the slower adoption[119].

In sum, although RES deployment will create new opportunities in the country, these opportunities will not necessarily benefit the regions that will suffer due to the closing of existing fossil-based industries. Hunedoara county, and Mureș county to a lesser extent, are particularly vulnerable to this disparity.

Figure 7: Onshore wind installations and potential in Romania and target regions (as of 2012)



Source: (Ruiz et. Al. 2019) and (Fabrica de Cercetare 2012), mapping: CE

4.3.3 Methodology of the regional modelling

The regional modelling builds on the results of the E3ME scenarios, as well as further historical data on the NUTS-3 regions of the country collected during the preparation phase of the modelling exercise. The method consists of two main elements:

1. A top-down approach where we use shift-share decomposition and ARIMAX modelling to forecast components of the variables of interest.
2. A bottom-up method that focuses on power generation to assess the regional impacts of the transition. The combined regional modelling method was developed by CE outside of the current project.

118 Ruiz et al., 2019
119 IRENA, 2019

Regionalisation of E3ME outputs: Top-down approach

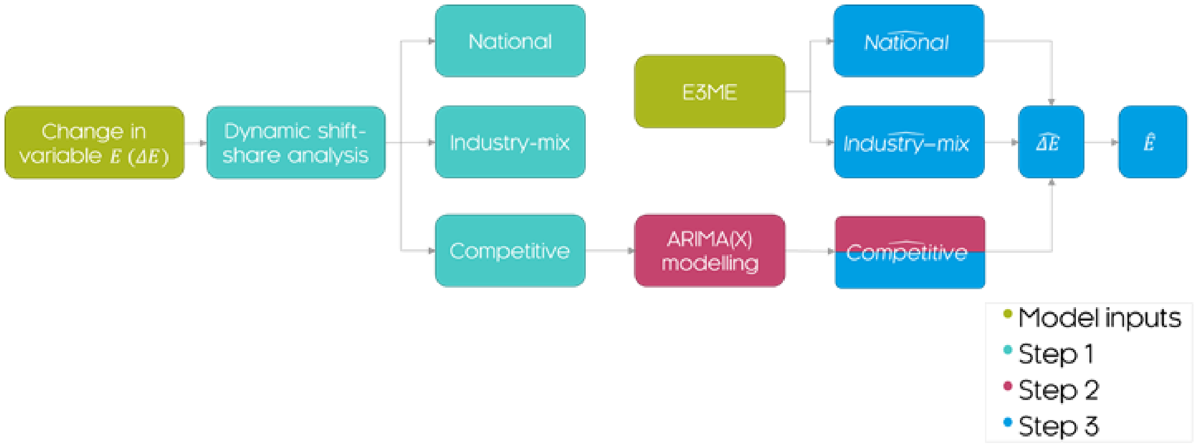
This section explains the "regionalisation" of E3ME forecasts using dynamic shift-share decomposition and ARIMAX modelling.

CE's regionalisation method builds on the solution proposed by (Mayor, López, and Pérez, 2007). Regional estimates from the E3ME national forecast are obtained by combining dynamic shift-share analysis with ARIMA forecasting. More specifically, the process followed (as suggested by the authors) involves the following steps:

1. Applying the dynamic shift-share approach to an economic variable and obtaining the competitive effect by sector and year
2. Forecasting future competitive effect trends by fitting the appropriate ARIMAX model
3. Recursively obtaining values for the variable for each year of the forecast horizon by:
   a) Using available national-level forecasts to compute the national and industry mix effects for the given year
   b) Aggregating the three components to obtain estimates of the change in the economic variable of interest relative to the previous year
   c) Adding predicted change to previous year value

This methodology was adopted to obtain GVA and employment forecasts by sector at the NUTS-3 level for Romania based on forecasts produced by the E3ME model. Figure 8 provides an overview. See Appendix B for detailed steps on this methodology and data requirements.

Figure 8: Overview of top-down approach steps



Source: CE

The shift-share model can be used to decompose regional growth in three components:

1. **National effect:** Change in the region if it changed at the same rate as the national economy.
2. **Industry-mix effect:** Change in the region attributable to differences in sectoral structure between the region and the country. It captures the impact of relative regional specialisation (positive or negative).
3. **Competitive effect:** Change in the region attributable to unique local factors. It essentially captures how a region's industries has grown compared to the national level and attributed to a local comparative (dis)advantage.

Regional bottom-up modelling of the energy sector

This section explains how national power generation capacity results are regionalised based on bottom-up modelling methodology.

In the bottom-up modelling, results from E3ME national level modelling and especially capacity results from the FTT:Power submodule are used for estimating power sector employment and economic output at the regional level.

A summary of the process is provided below:
1. Determine 2017 national power plant capacity and plant age for different technologies.

2. Use E3ME national results to determine annual decommissions and new commissions.
3. Allocate national decommissions to each region.
4. Allocate national commission to each region.
5. Estimate employment and economic output using the capacity of each region and combine with results from the shift-share model.

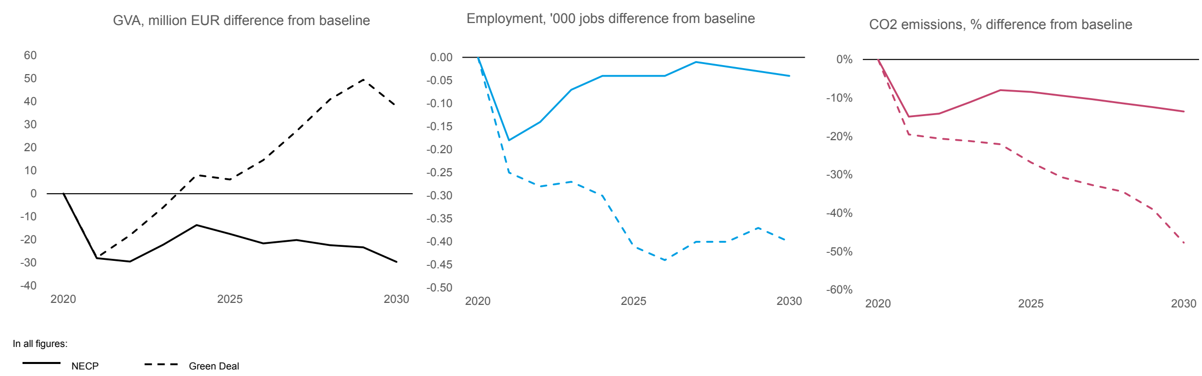
4.3.4 Results of the regional modelling

The national level results were disaggregated to the NUTS-3 level, and results for the six target regions are presented below.

Mureș County (RO125)

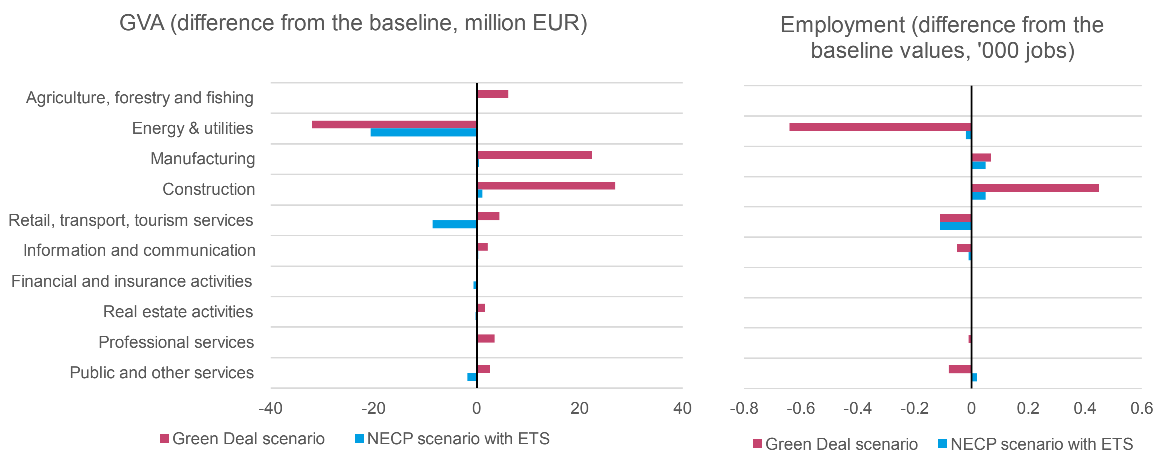
Graph 9 shows the headline results (GVA, employment and CO_2 on the regional level) in the county. Results follow the national trends with some notable differences. While the national results of the NECP produce an overall positive GDP impact by 2030, this is not the case for GVA impact in Mureș. GVA is about EUR 30 million lower by 2030 than in the baseline. CO_2 emissions, however, show better results under the NECP compared to the national results. There is an overall reduction of emissions (approximately 14% by 2030) in the region under the NECP; in the GD scenario, this reduction is also higher (about 48%) than in the national level results.

Graph 9: RO125 regional headline results



As in the national results, GVA and employment show opposite results in the GD scenario, while the GVA impact is negative under the NECP scenario., However, the employment effect, after an initial decrease in the early years, is close to zero in the long-term. As discussed above, this is largely an effect of the energy system transition – the manufacturing and installation of renewables and related equipment could cause increased economic activity (GVA), but might still lead to job losses as it cannot offset other energy sector (e.g., coal or gas-based PG) employment reductions.

Graph 10: RO125 regional sectoral impacts by 2030



Graph 10 shows the sectoral impacts in the region both in terms of GVA and employment. The decrease compared to the baseline in GVA (EUR 9 million) in the service sector only appears in the

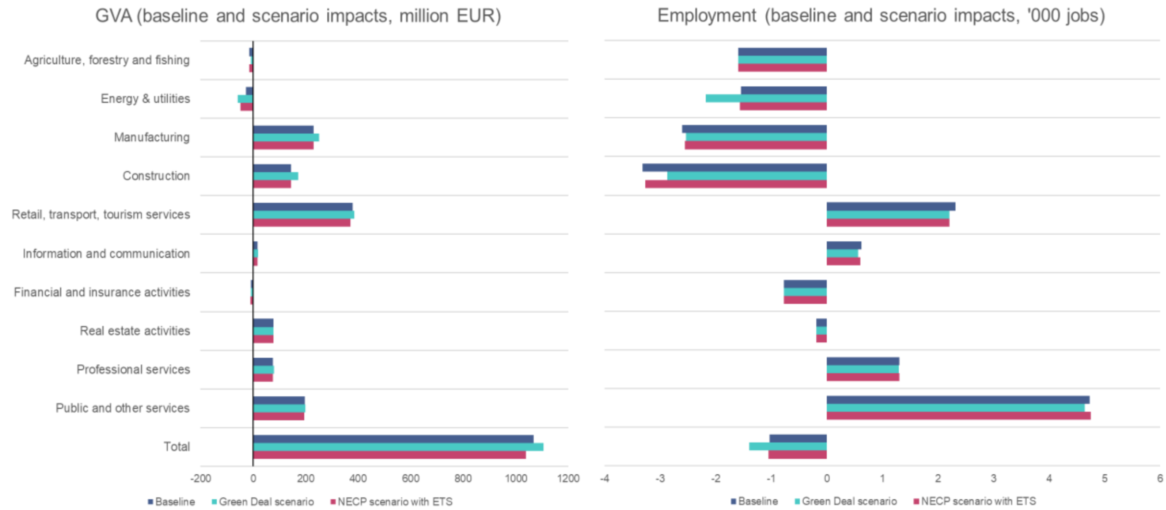
NECP scenario. However, a minor negative employment impact is common to both scenarios (about 100 jobs compared to the baseline). This is explained by the increased ETS prices, an assumption used in both scenarios.

Otherwise, the NECP scenario has mostly muted effects across sectors in terms of both GVA and employment. However, the NECP does show a negative impact in GVA for the energy sector (about EUR 21 million compared to the baseline), albeit with a minor employment effect (less than 100 jobs). This is once more explained by “losing out” from the deployment of new renewables (compared to the baseline) in GVA terms, but keeping higher fossil fuel-based employment (particularly in gas-based PG in Mureș).

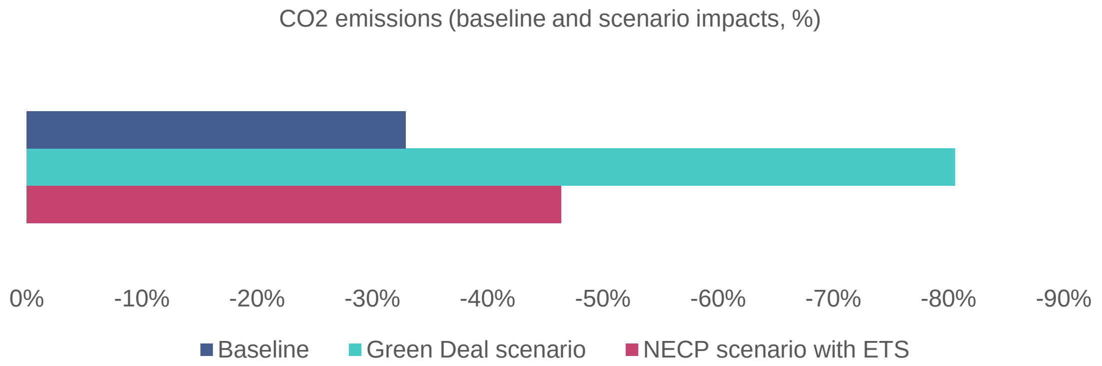
The GD scenario has more substantial impacts both in GVA and employment terms. The explanation, however, is similar: the manufacturing and construction sectors are boosted (total GVA impact of about EUR 49 million in both sectors; employment impact: over 500 jobs) by new renewable installations (in solar PV and in biomass) as well as energy efficiency investments (e.g., retrofitting) while the energy sector loses about 600 jobs because of the reduction of fossil-based PG capacities (gas-based capacities).

Graph 11 below shows the effects across industries in Mureș in absolute terms for both GVA and employment. All in all, Mureș is estimated to lose approximately 1,000 jobs on average in both the baseline and NECP scenarios and slightly more (approximately 1,300 jobs) in the GD scenario. However, the losses are not significantly distributed across sectors. There are gains in the services sector (approximately 4,800 jobs) and losses in the construction and manufacturing sectors. Nevertheless, these two sectors exhibit net GVA growth, highlighting the phenomenon of “jobless growth”. The energy and utilities sector fall in terms of GVA contribution in all scenarios, and loses in terms of employment are particularly observable in the GD scenario due to the lower contribution of natural gas to the energy mix: approximately 2,500 jobs will be lost in a GD scenario in Mureș.

Graph 11: RO125 projected changes in GVA and Employment across sectors by 2030



Graph 12: RO125 projected changes in CO2 emissions by 2030

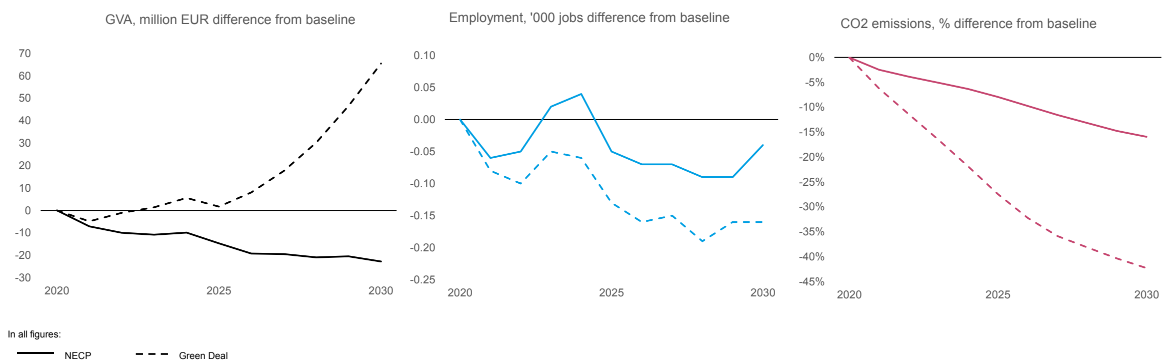


Graph 12 shows the emissions trajectory in Mureș for each scenario. In the baseline scenario, emissions only decrease by 30% in 2030 compared to 2018. In a Green Deal scenario, with strict emissions targets and a significantly lower contribution of natural gas to the electricity production mix, emissions decrease up to 80%. The robust GVA increase in Mureș is recorded under all three scenarios (with the GD scenario exhibiting the highest increase of about EUR 1 billion) and shows that a low-carbon, high-value economic development is possible in Mureș.

Galați County (RO224)

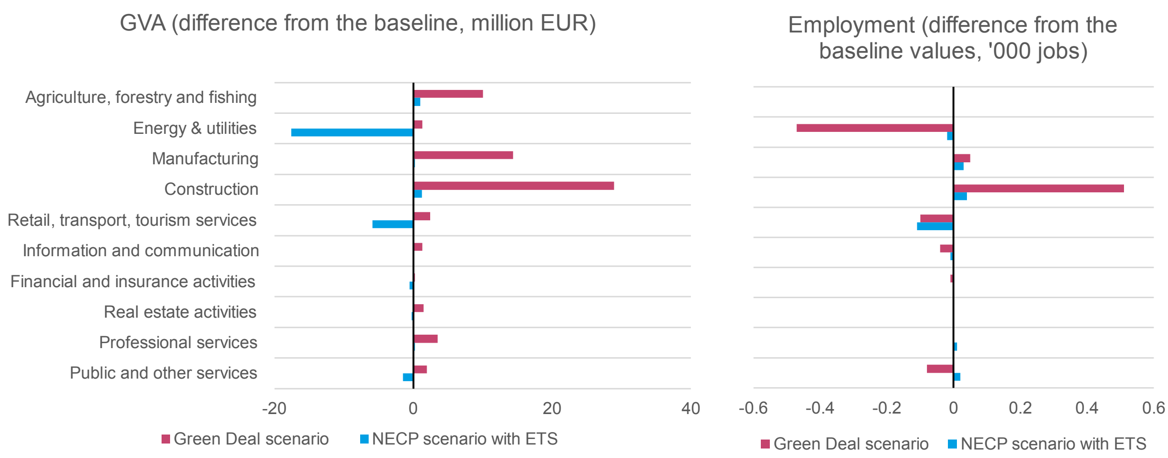
Galați is selected as a target region due to its energy-intensive industry, including steel. However, there are examples of the region already gaining from the transition process. The Galați steel mill has supplied components to the Chirnogeni wind farm (ArcelorMittal, 2013). The Galați steel mill serves as a good example of how existing industries can profit from expanding operations to energy efficiency, such as clean power or EV deployment.

Graph 13: RO224 regional headline results



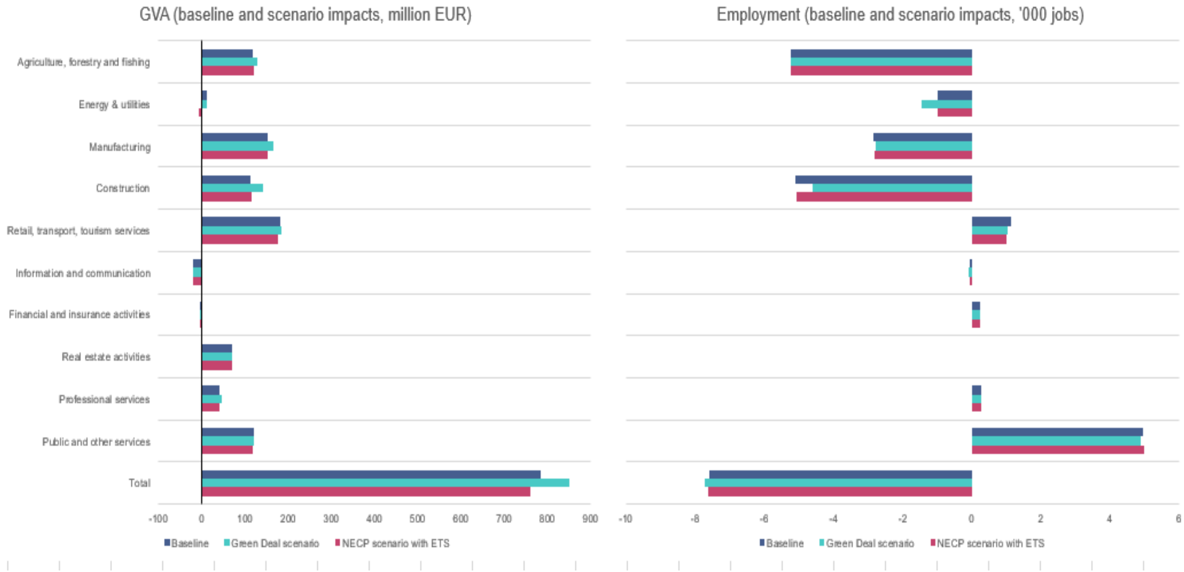
Modelling results for the region show mostly positive impacts for the GD scenario (positive regional GVA of about EUR 66 million compared to the baseline scenario, a small employment decrease of around 200 jobs compared to the baseline, and strong CO_2 reductions of more than 42% compared to the baseline). While there is no employment reduction in the NECP scenario, a more limited CO_2 reduction (16%) and a decrease of GVA (about EUR 23 million compared to the baseline) can be observed. There is an observable temporal variation in employment impacts, which is driven by an interplay between the manufacturing, energy and construction sectors. Manufacturing sector employment increases early on in both the GD and NECP scenarios compared to the baseline, and the increase stays relatively stable through the modelling period (around 200 jobs). Nevertheless, energy sector employment decreases in the long-term and construction employment increases (evident after 2024). Together, these trends lead to the pattern seen on Graph 13 – Employment, manufacturing and construction dominate the effects until 2025, while energy and utilities drive changes afterwards (in the case of NECP, services add to the negative impact).

Graph 14: RO224 regional sectoral impacts by 2030



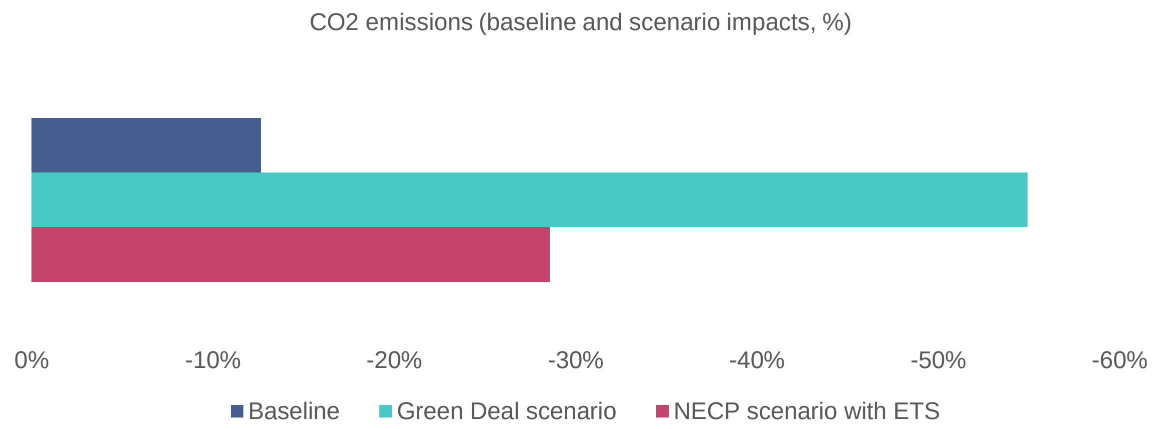
Graph 14 shows sectoral impacts in the region by 2030 in both main scenarios. Sectoral impacts follow a structure similar to Mureș. There are lower levels of GVA (approximately EUR 6 million reduction) in the NECP and employment (around 100 jobs lost) in both scenarios in the service sectors due to price effects of increased ETS. The NECP has negative GVA impacts in the energy sector (about EUR 18 million), with muted employment losses (less than 100 jobs), while the GD shows little GVA impacts (compared to the baseline) but reports higher employment losses (about 500 lost jobs). The GD scenario also shows substantial growth (EUR 43 million overall by 2030) in construction and manufacturing GVA (and in other sectors as a spill over effect), which drives the overall positive GVA effect in the region. In labour terms, the scenario shows reductions in the energy sector but increases in the construction and manufacturing sectors are estimated to add a total of about 600 jobs in the region by the end of the modelling period. Unfortunately, this is gain is insufficient to compensate all losses in other sectors.

Graph 15: RO224 projected changes in GVA and Employment across sectors by 2030



Graph 15 shows the effects across industries in Galați in absolute terms for both GVA and employment. Despite an increase of about 5,000 jobs in the public and other services sector, the losses of jobs in agriculture (approximately 5,000 job losses), manufacturing (approximately 3,000 job losses) and construction (approximately 5,000 jobs losses) in a GD scenario lead to an overall estimated job loss of approximately 7,800 jobs in Galați, with small differences between scenarios. Nonetheless, GVA increased between 2018 and 2030 in Galați by approximately EUR 750 million. The GVA increase is even more significant under the GD scenario (approximately EUR 850 million), driven presumably by the increase in renewables, where Galați has a significant potential to develop. All sectors contribute to GVA growth, especially retail, transport and tourism services, manufacturing and agriculture.

Graph 16: RO224 projected changes in CO2 emissions by 2030

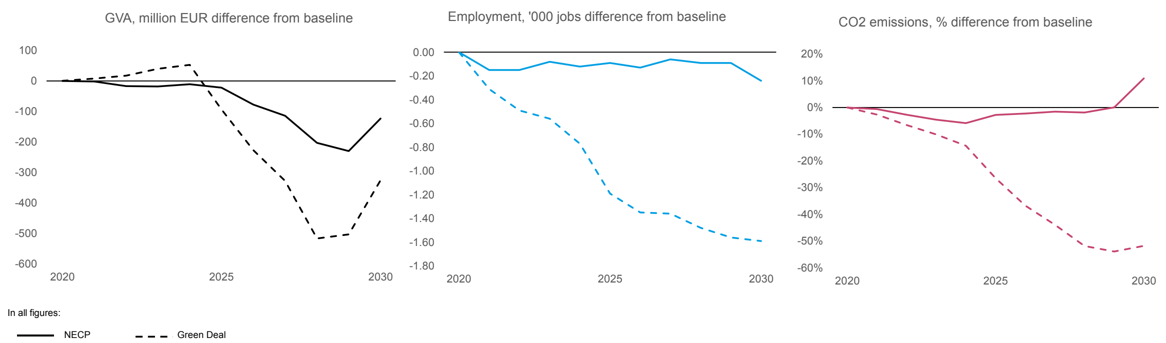


Graph 16 shows modest emissions decrease in the baseline scenario (-10%), larger decreases under a NECP scenario (-30%) and significantly larger decreases (-55%) in a GD scenario.

Prahova County (RO316)

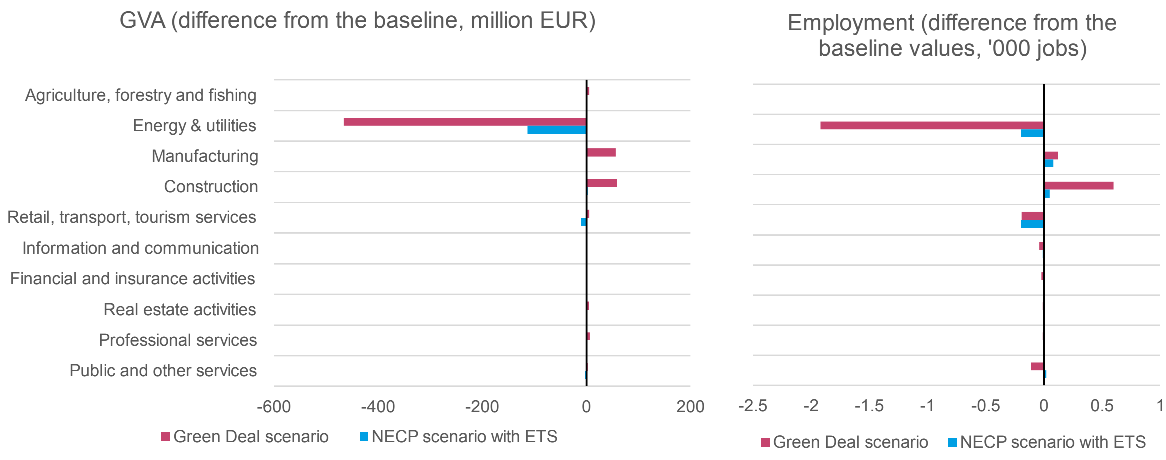
Results in Prahova show differences from the national trends. Both the NECP and GD scenarios have negative impacts on GVA (EUR 120-330 million in the long-term; EUR 230-520 million in the medium-term). Employment impacts are similar to the national trends (higher losses in GD, lower in NECP), but stronger (in absolute terms) than in the previous two counties. Finally, CO_2 emissions show an increase compared to the baseline (11% increase in 2030) in the NECP scenario and a strong decrease (52% reduction) in the GD scenario.

Graph 17: RO316 regional headline results



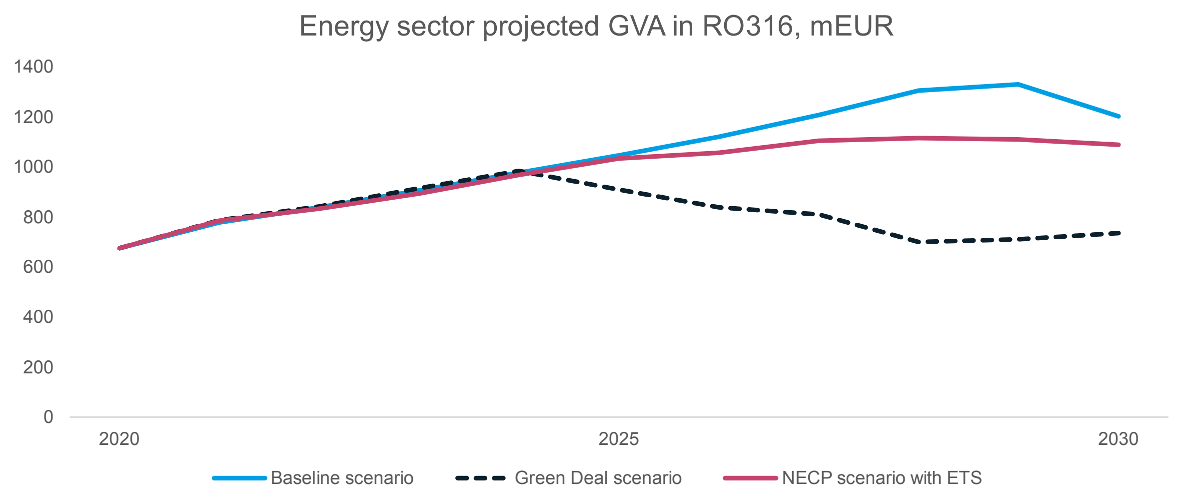
Strong negative impacts in the GD scenario are related to gas-based power generation being severely reduced from 2025 as ETS prices and the prices of other technologies (especially renewables) decrease the demand for gas-based technologies. In the modelling, by the end of 2021, solar capacity overtakes gas capacity. At the same time, renewable deployment, with a focus on solar PV grows substantially. However, it is not able to offset natural gas related losses. Meanwhile, onshore wind is relatively stable across all scenarios (therefore we do not see differences when comparing to the baseline). An upward tick in the final years of the modelling can be observed both in GVA and in CO_2 emissions (NECP scenario). This is a result of falling gas demand (due to nuclear deployment) in the baseline in 2030, but not in the other scenarios.

Graph 18: RO316 regional sectoral impacts by 2030



Graph 18 shows sectoral results in the region by 2030. While some of the previously described trends are visible (e.g., the effect of ETS on services or construction and manufacturing boosted by renewables deployment), impacts in the energy & utilities sector clearly dominates the results. Impact on the sector is about 4 times higher in GVA terms (EUR 470 million/EUR 110 million lower compared to baseline) and about 10 times higher in employment terms (2,000 jobs/200 jobs lower compared to baseline) in the GD scenario than in the NECP scenario. The effect in the GD scenario is largely attributed to the estimated reduction of gas-based PG capacities while in the NECP it is the effect of the slower renewable deployment (compared to the baseline). The baseline keeps much of the gas-based generation and increases RES in the region as well. However, the baseline scenario is calculated with a substantial growth in the GVA of the energy sector in the county, as illustrated by Graph 19. Therefore, decreases compared to the baseline might actually indicate slower growth or stagnation (compared to 2021 for example), rather than actual absolute losses.

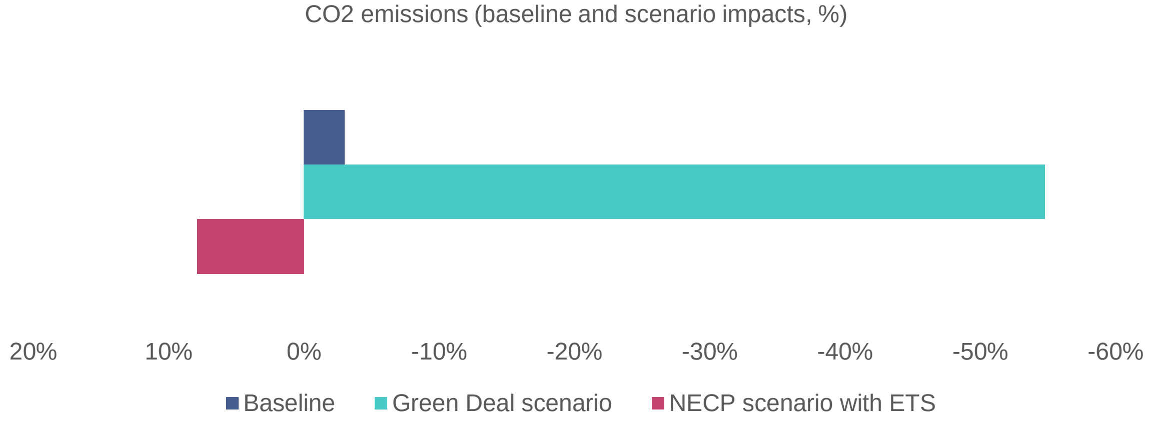
Graph 19: RO316 energy sector projected GVA



Graph 20: RO316 projected changes in GVA and Employment across sectors by 2030

Graph 20 shows an impressive development of the local economy over the next 10 years (close to EUR 3 billion added in GVA between 2018 and 2030). Results are slightly negative in a GD scenario due to the much lower contribution to the regional GVA of the energy sector in a decarbonised reality. Under the NECP scenario, it would contribute close to EUR 500 million and less than EUR 100 million under the GD scenario. In terms of employment, the county is expected to lose approximately 3,500 jobs under the baseline scenario, with close to 5,000 jobs lost in a GD scenario due to losses in the energy sector. Large employment gains are expected in all scenarios in the services sector.

Graph 21: RO316 projected changes in CO2 emissions by 2030



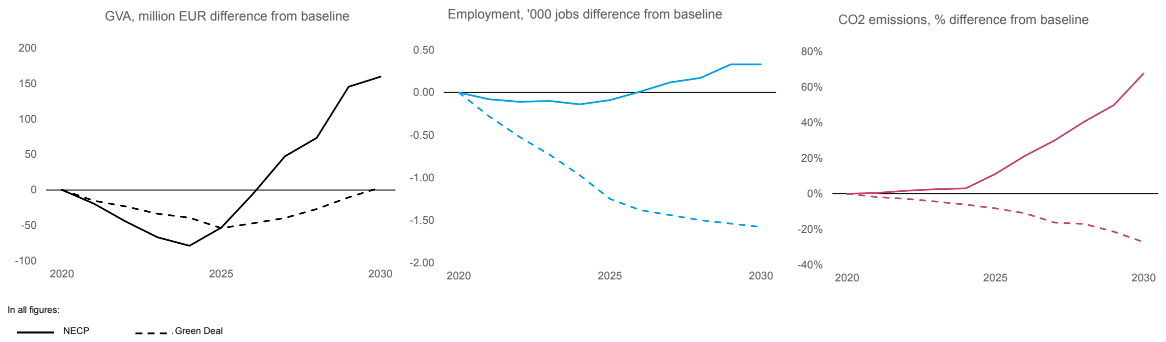
Graph 21 shows that under a NECP scenario emissions increase by close to 8%, while under a Green Deal scenario they decrease by 55%.

Dolj County (RO411)

Dolj and Gorj counties belong to the Sud-Vest Oltenia development region. While coal mining is concentrated in Gorj, Dolj has its own coal-based power generation and traditional industries. This includes the automotive industry (e.g., Ford has a plant in the county), heavy machineries and other manufacturing. There are several higher education institutions in the county that focus on pharmacy and composite materials, which contributes to the county's potential for engineering and high-tech manufacturing[120]. The automotive, aerospace and ICT sectors are further highlighted as potential targets for foreign investment[121].

The regional modelling considers multiple aspects of this profile, e.g., through the shift-share analysis the county's results will be more sensitive to national level changes in manufacturing. However, results are also sensitive to changes in coal-based power generation in the region since it is substantial compared to the rest of the country.

Graph 22: RO411 regional headline results



Results from the scenarios show opposing impacts, as illustrated by Graph 22. The NECP scenario (without the sensitivity analysis) allows for the continued use of coal, which has a positive effect on the region – i.e., there is no scrapping of coal-based power and consequently there is a strong positive impact in the NECP scenario on the county's GVA (as coal usage is reduced in the baseline). The impact leads to an increase in GVA of EUR 160 million over the baseline by 2030. The same trend is observed for employment (~300 jobs increase over the baseline trend) and CO_2 emissions (about 68% higher emissions than the baseline, or 18% lower emissions compared to 2018). The continued use of coal could mean both higher employment and higher emissions in the county.

Unlike the NECP scenario, the GD scenario is calculated with a strong reduction of fossil fuels (including coal and gas). This leads to a negative response in economic and labour terms. Losses from

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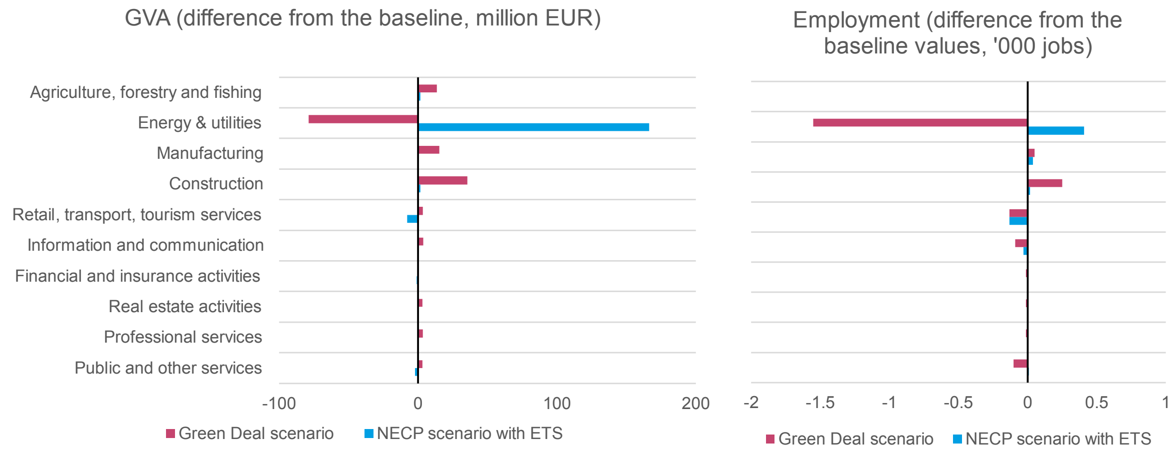
[120] European Commission, 2020d
[121] European Times, 2017

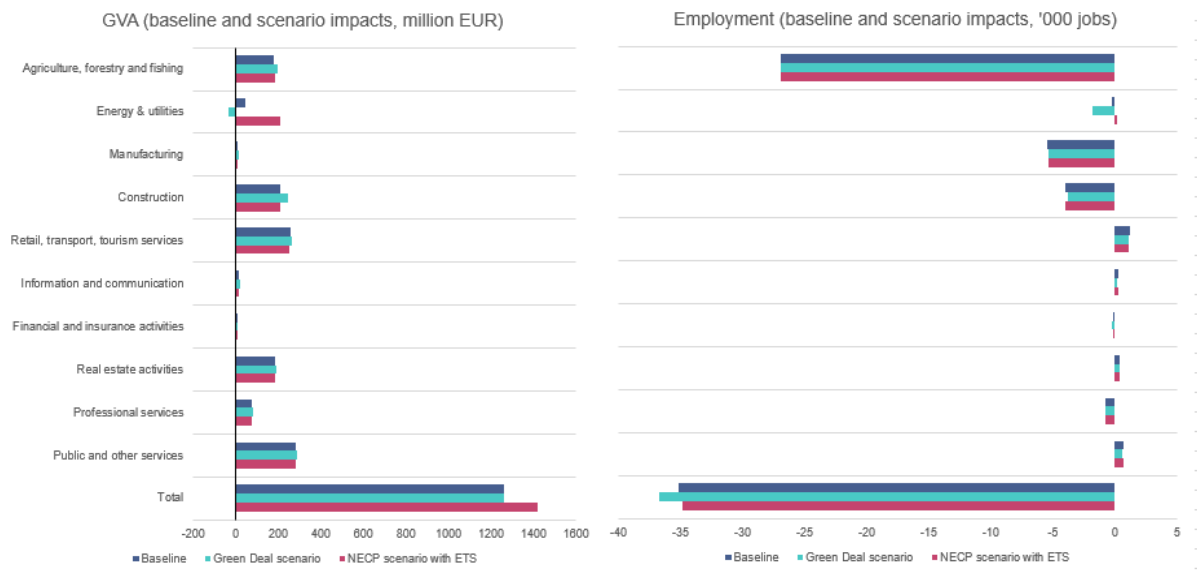
fossil fuel-based activities drive the results, leading to a net negative employment effect (about 1,600 jobs less than the baseline), and a negligible (but positive) GVA impact.

Graph 23: RO411 regional sectoral impacts by 2030



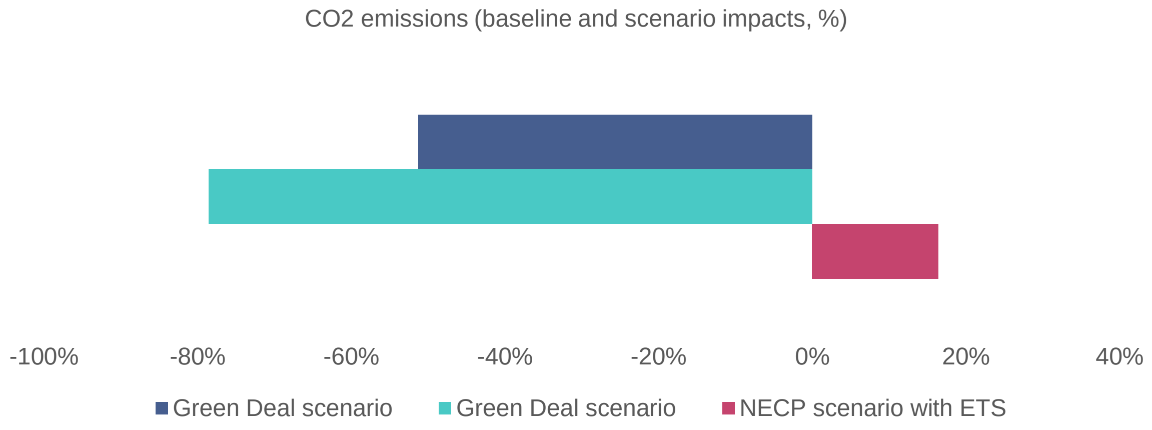
Graph 23 shows the detailed sectoral results. The figure underlines the above discussion, highlighting the dominant role of the energy sector in the results.

Graph 24: RO411 projected changes in GVA and Employment across sectors by 2030



While the impact of the energy transition on employment in Dolj is negative in the Green Deal scenario (1,500 jobs lost) and slightly positive (300 jobs gained) in the NECP scenario, the unemployment effects are significant in the baseline scenario in Dolj, although they are not necessarily driven by the energy transition. For instance, in all scenarios, agriculture is expected to lose more than 25,000 jobs in the next ten years, while manufacturing will also lose approximately 5,000 jobs. More worryingly, while agriculture will still have a net positive GVA growth, the manufacturing sector will stay flat across all scenarios in terms of GVA by 2030. Jobs will also be lost in construction (approximately 3,000, with negligible differences between scenarios). Jobs will also be lost in the energy sector under the GD scenario (approximately 1,500). Under the GD scenario, energy and utilities also end up losing in terms of GVA, while in the NECP scenario their contribution to regional GVA is about EUR 200 million. In sum, the GD and baseline (highly decarbonised as well) scenarios induce negative consequences in terms both of GVA and employment in Dolj.

Graph 25: RO411 projected changes in CO2 emissions by 2030

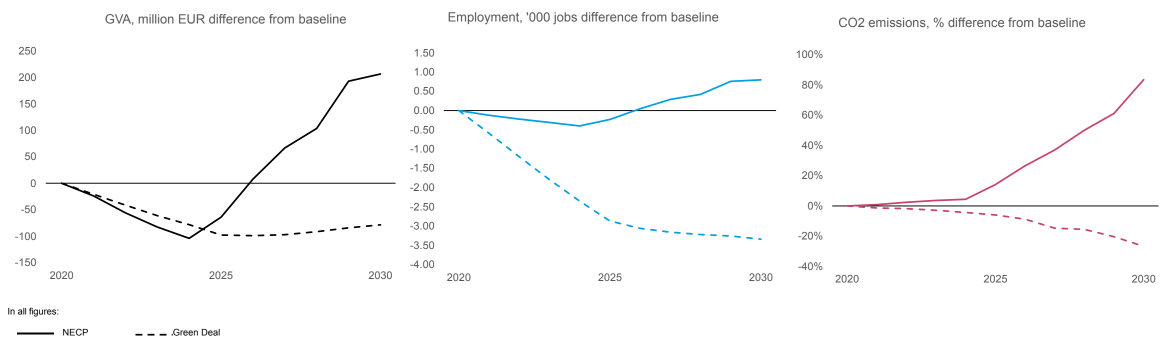


As Graph 25 illustrates, in the NECP scenario emissions increase by 18% in Dolj between 2018 and 2030 and decrease by nearly 50% under the baseline scenario (as the baseline, market-driven scenario is also highly “green”) and nearly 80% in a Green Deal scenario.

Gorj County (RO412)

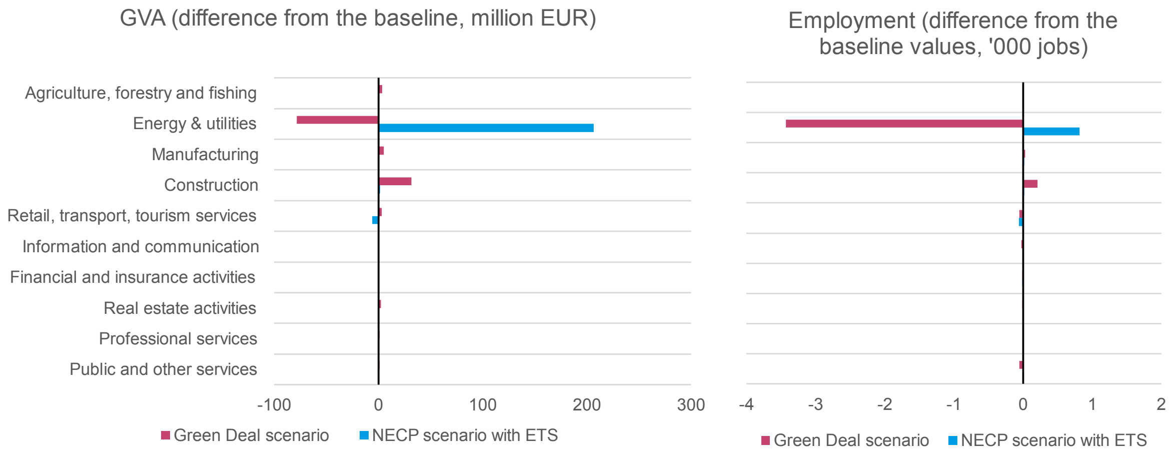
Gorj county is the most important employer in the coal mining industry and has a sizeable coal-based PG capacity. Therefore, it is expected that the transition process can cause significant socio-economic impacts in the county.

Graph 26: RO412 regional headline results



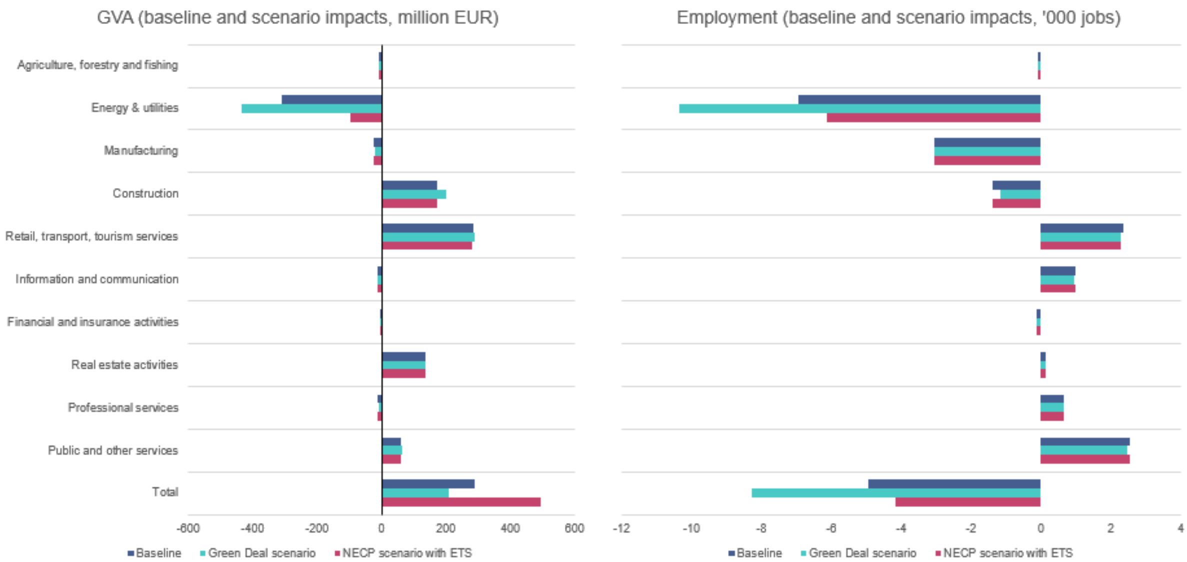
Results for Gorj follow a similar trend to Dolj, partially because some assumptions are defined at the regional level. Nevertheless, the magnitudes of the impacts differ. The total GVA increase (compared to the baseline) is about 30% higher than Dolj (about EUR 210 million), despite the overall smaller GVA base in the county (but much higher energy sector). Similarly, the overall employment increase in the NECP scenario is about two times higher in Gorj than in Dolj (compared to the baseline). This is a direct impact of the NECP scenario keeping coal capacities active through the modelling period. CO_2 emissions follow the same pattern: they are much higher in the NECP scenario than in the baseline (about 84% higher due to coal-based power) and 27% lower than the baseline in the GD scenario.

Graph 27: RO412 regional sectoral impacts by 2030



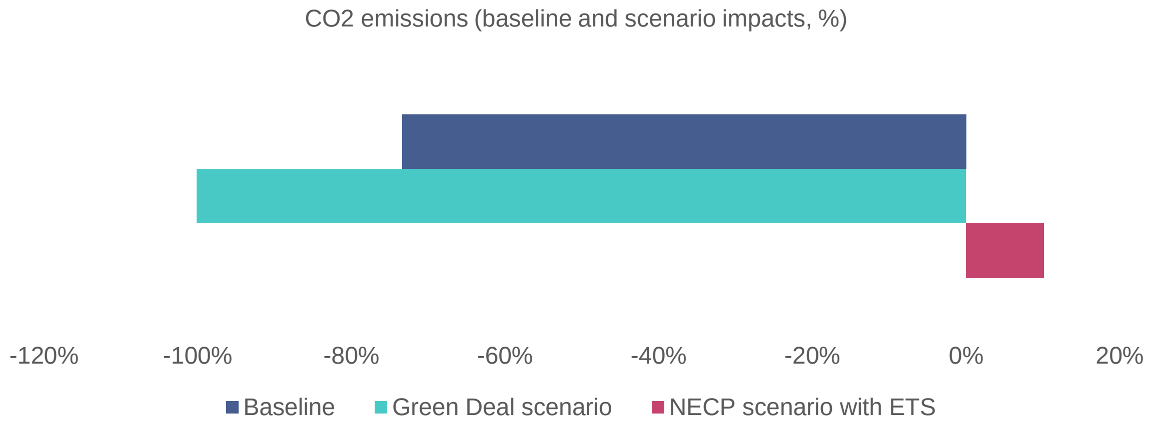
Graph 27 shows sectoral results of the scenarios. As in Dolj, there is an evident takeaway: the overall regional result is dominated by the energy sector and especially by what happens with the coal sector. The nearly 3,000 lost jobs (compared to the baseline) in the GD scenario is almost exclusively concentrated to the energy sector. Similarly, the higher level of energy sector GVA and employment in the NECP is concentrated in the energy sector.

Graph 28: RO412 projected changes in GVA and Employment across sectors by 2030



Graph 28 shows the magnitude of the changes in Gorj under the baseline scenario. Under the baseline scenario, the mining and energy sector is expected to lose approximately 7,000 jobs, while in the Green Deal scenario the loss will be about 10,000. Since coal mining and energy production plays an important role in the regional economy, GVA will also decrease in this sector under all scenarios (although a lot less in the NECP scenario and much more in the GD and baseline scenarios). Under both “decarbonised” scenarios, GD and baseline, the net increase in the regional economy is quite low (EUR 200 million in the GD scenario and EUR 500 million in the NECP scenario). This is largely driven by GVA gains in construction, retail, transport and services. In total, there are substantial jobs losses under all scenarios: 4,000 jobs under the NECP and 8,000 in the GD. Job gains from transport, tourism services, IT&C and public and other services cannot compensate for the job losses in the mining and energy sector. Manufacturing is also a source of job loss in all scenarios (approximately 3,000) and it also loses slightly in terms of GVA. By contrast, construction improves GVA under all scenarios (slightly more under a GD scenario) while simultaneously losing jobs.

Graph 29: RO412 projected changes in CO2 emissions by 2030



Graph 29 shows that emissions decrease by approximately 100% in a Green Deal scenario (as a coal phase-out has immediate consequence) while emissions actually slightly increase (by approximately 10% in the NECP scenario), highlighting the insufficiently ambitious emissions reduction targets in the NECP scenario.

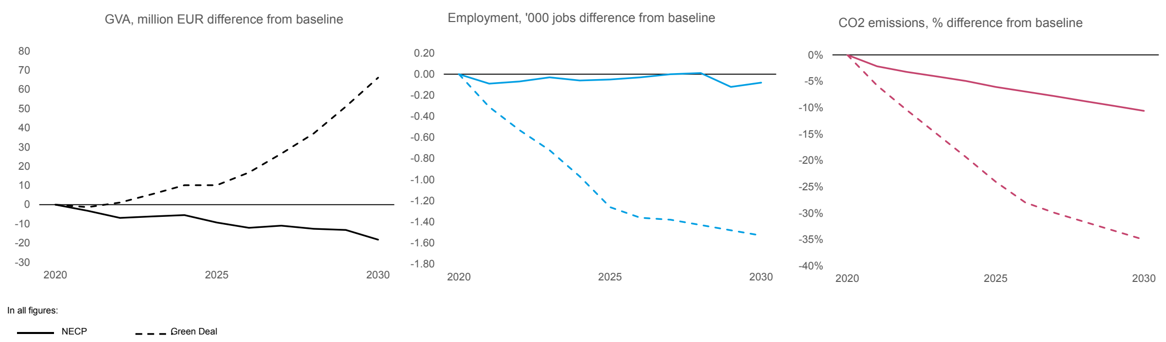
Hunedoara County (RO423)

Hunedoara is a centre of both coal mining and coal-based power generation. It is home to Jiu Valley, which used to be the centre of coal mining. The region has experienced severe economic declines after the closing of its coal mines. There are currently multiple active mines in the region, but most of them are expected to be closed in the coming years. Two mines, Lupeni and Lonea, are to be closed by 2024 and another two major mines, Vulcan and Livezeni, do not yet have a closing date.

Coal mining is traditional in the region and has cultural value in Jiu Valley. Nevertheless, there are ongoing diversification measures in the county as the (largely market driven) transition has already had substantial socio-economic impacts on the region. The region aims to shift its economy towards tourism, services and renewable energy. However, the role of construction and retrofitting is also noted[122].

The first thing to note about the modelling results is their magnitude. Both GVA and employment impacts are relatively small, even more so when compared to Dolj and Gorj. This is partly explained since coal-based electricity generation in the county is mostly phased out not only in the scenarios, but also in the baseline.

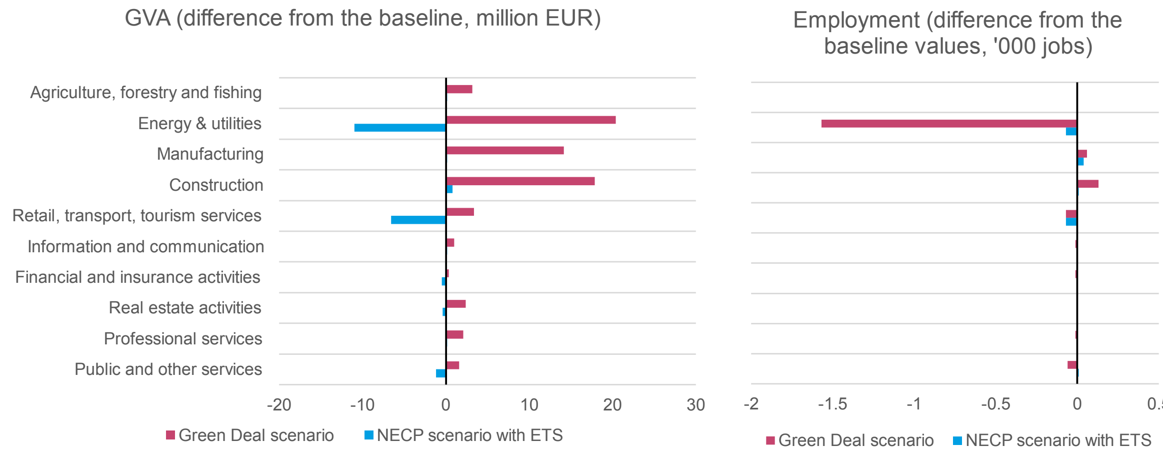
Graph 30: RO423 regional headline results



Graph 30 suggests that results from the scenarios mostly follow national trends. The GD scenario leads to positive GVA effects (an increase of EUR 66 million compared to the baseline), but negative employment effects (a loss of 1,500 jobs compared to baseline). The NECP scenario has minor GVA impacts (an increase of EUR 18 million compared to baseline) and close to zero employment effects (compared to the baseline). Meanwhile, CO_2 emissions fall slightly below the national trend for both the GD scenario (~35% reduction) and in the NECP (~11% reduction).

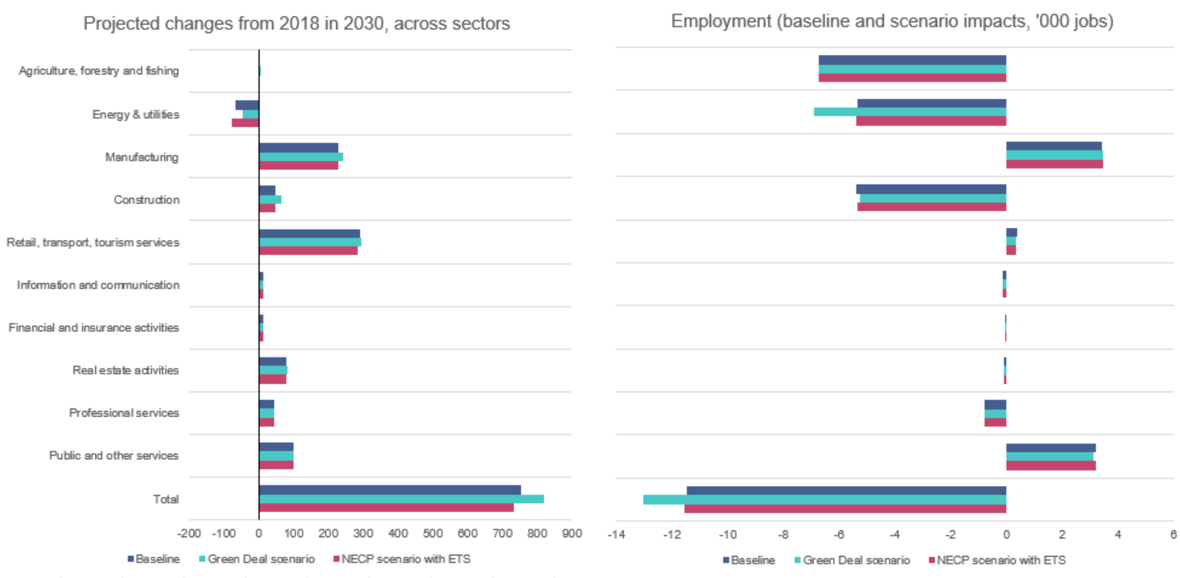
[122] von der Brelie, 2020

Graph 31: RO423 regional sectoral impacts by 2030



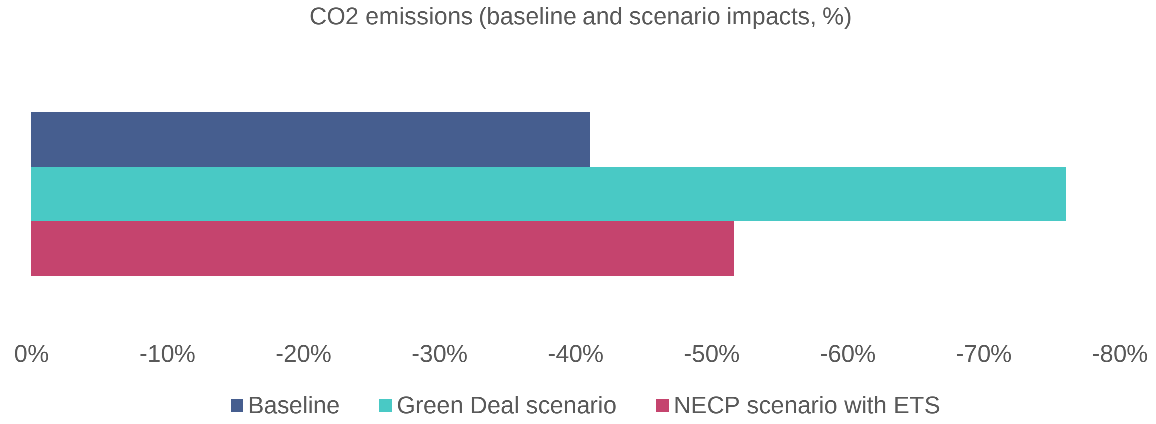
Graph 31 shows the sectoral impacts of the scenarios. The negative GVA impact under the NECP scenario is driven by changes in the energy (EUR 11 million) and services sectors (EUR 7 million). The decrease in the services sector is explained by the unmitigated price effects of the ETS system as described above, while the energy sector “decrease” is the result of lower solar PV growth than baseline. In the GD scenario, GVA is higher than the baseline in multiple sectors. Energy, manufacturing and construction drive the results, with spillover effects in other sectors. GVA is about EUR 52 million higher in these sectors compared to the baseline; however, employment gains are limited. However, there are substantial employment losses in the scenario (compared to the baseline) amounting to about 1,500 jobs in the energy sector. As this was discussed earlier, the result stems from a restructuring of the energy sector. The deployment of renewables brings varying job increases to the manufacturing and construction sectors (about 200 jobs) in the years of deployment, but compared to coal-based generation, operation and maintenance (if the supply chain, e.g., coal mining, is taken into effect as well) employs less people.

Graph 32: RO423 projected changes in GVA and Employment across sectors by 2030



Graph 32 indicates that the Green Deal scenario has more positive GVA effects than either the baseline or NECP scenarios. However, it also has worse employment results. The overall positive GVA effects (increase of EUR 750 million in the baseline scenario, EUR 830 million in the GD scenario) are remarkable given the relatively high employment losses (11,500 jobs lost in the baseline and NECP scenarios, 13,000 jobs lost in the GD scenario). This result highlights important gains in the productivity of the local economy. This is evident in the case of manufacturing, which increases, unlike other counties, both in terms of GVA and employment. Large employment losses are encountered in agriculture (over 6,000 in all scenarios), energy and utilities (5,000 jobs even in the baseline scenario) and construction (5,500 in all scenarios).

Graph 33: RO423 projected changes in CO_2 emissions by 2030



Emissions are decreasing dramatically under all scenarios, by as much as 75% in the Green Deal scenario (see Graph 33).

4.4 General assessment of other impacts

4.4.1 Energy prices and impact on household net income and industry competitiveness

We will try to quantify the impact of energy prices on industry competitiveness and household net incomes in D4 and potentially include the impacts in a revised version of D3 based on further calibrations to the model.

In contrast to the rest of the model, the long-run energy price elasticities used in E3ME are not based on time-series econometric estimations; instead, they are taken from a combination of cross-section estimations and reviewed literature. As part of the contract, we will review, and if necessary, update the energy price elasticities based on the most recent data (with a focus on transport sectors).

The reason for using a different approach for these specific elasticities is that the time-series analysis yields responses to fluctuations in energy prices (i.e. temporary effects) whereas the projections we are interested in here relate more to long-term trends that influence expectations (e.g. on vehicle technologies). For most sectors, the current values used range from -0.2 to -0.3, meaning that a 1% increase in price leads to a 0.2-0.3% reduction in consumption. Short-run elasticities are based on the time-series data and are usually close to zero.

4.4.2 Covid-19 effects on business

The decline of the GDP during the global pandemic[123] is the result of four sets of shocks to trade which occurred simultaneously:

1. A supply shock consisting of a drop in employment;
2. An increase in the cost of international trade imports;
3. A sharp drop in international tourism and travel-related services, and,
4. A demand switch by households who purchase fewer services requiring close human interaction, such as mass transport, domestic tourism, restaurants, and recreational activities, while redirecting demand towards consumption of goods and other services.

The demand disruption is the result of:

- macroeconomic drops in aggregate demand (i.e., recessions);
- wait-and-see purchase-delays by consumers; and,
- investment-delays by firms.

[123] Maliszewska, Mattoo and van der Mensbrugghe (2020), Business Impacts | International Economics (tradeeconomics.com)

The COVID-19 outbreak and its impact on the economy

The COVID-19 outbreak is a severe public health emergency for citizens and societies, with infections in all EU Member States. The various containment measures have had an immediate impact on both demand and supply, and hit undertakings and employees, especially in the health, tourism, culture, retail and transport sectors. Beyond the immediate effects on mobility and trade, the COVID-19 outbreak is also increasingly affecting undertakings across all sectors, for both small and medium enterprises (SMEs) and larger corporations.

Considering that the COVID-19 outbreak affects all Member States and that the containment measures taken by Member States impact undertakings, the Commission considers that State aid is justified and can be declared compatible with the internal market on the basis of Article 107(3)(b) TFEU, for a limited period, to remedy the liquidity shortage faced by undertakings and ensure that the disruptions caused by the COVID-19 outbreak do not undermine their viability, especially of SMEs[124].

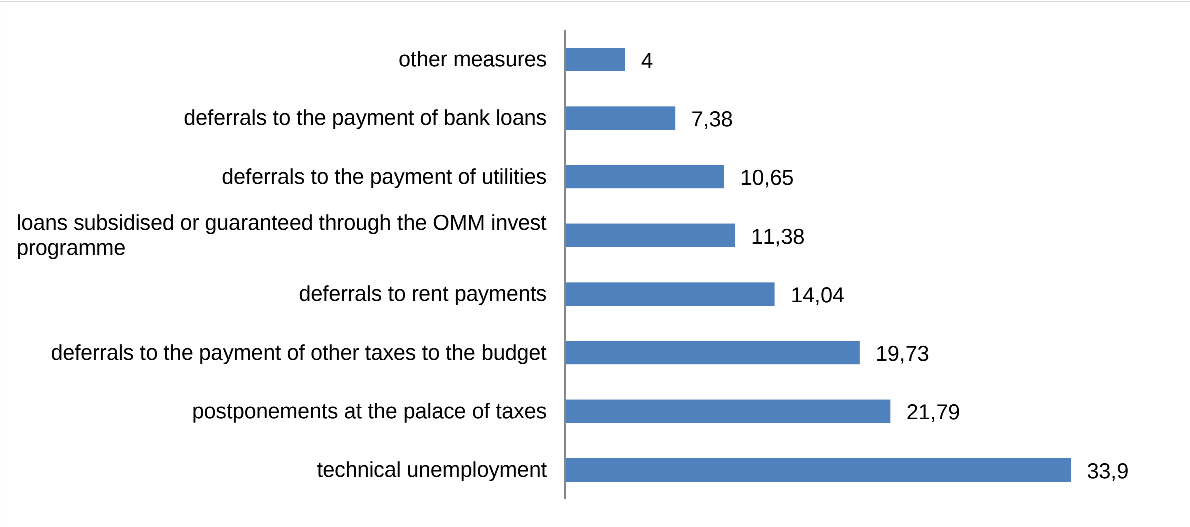
The total amount of the European budget for these measures is formed by 2021-2027 Multiannual Financial Framework (EUR 1,074 bn) and ”Next Generation EU” (NGEU) of EUR 750 bn.

Romania’s proposed anti-COVID-19 measures

Romania will allocate an amount of EUR 79.9 bn (7.4% from the total European budget).

The National Institute of Statistics (NIS) announced in August 2020 that in the second trimester of 2020, Romania’s economy fell by 12.3% (trimestral rhythm) and 10.5% (annual rhythm)[125]. At the EU level, approximately 90% of SMEs have been economically affected, with the services (60%-70%), and constructions & industry (40%-75%) being affected the most. In Romania, approximately 30% of SMEs report that their turnover suffered a loss of 80% compared to the average of the EU, which is 50%. Because there is no official data regarding the state of SMEs during the month of June 2020, the evaluation can be done only on the basis of several NIS surveys and investigations. Research on a sample of 8,831 firms (response rate of 71.3%) highlights the uncertainty businesses currently face. In March 2020, 21.2% of respondents could not have estimated the way in which the businesses would evolve. In April, the percentage grew to 34.3%. Over 50% of the managers could not estimate the evolution in March. This percentage grew to 62.9% in April 2020.[126]

Graph 34: Covid-19 mitigation measures utilisation Dec 2020 (%)



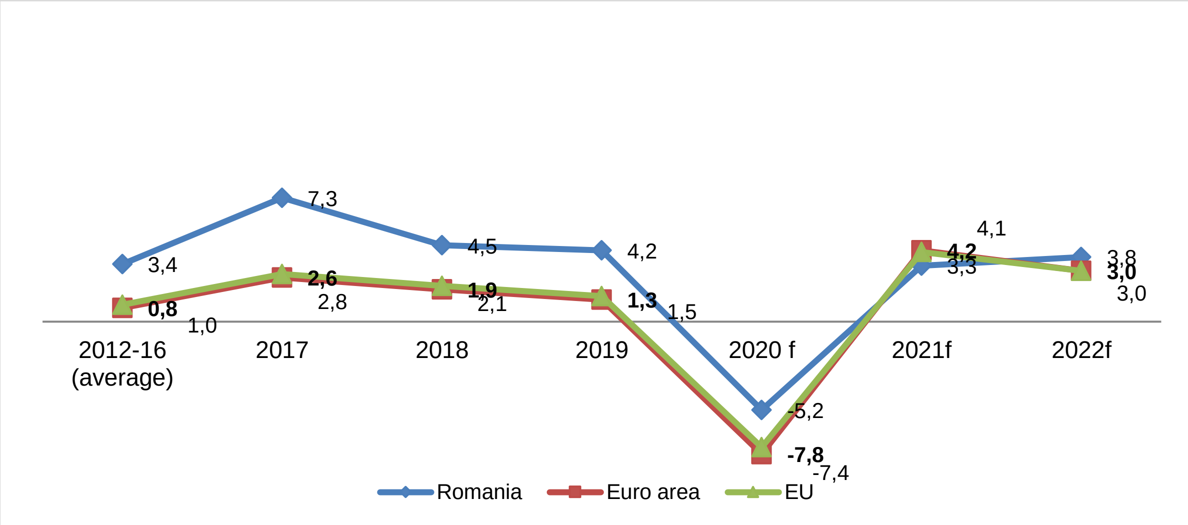
Real gross domestic product (% change) 2012-2022

The real gross domestic product increased by an average of 3.4% during 2012-2016 and 5.3% during 2017-2019 (see Graph 35). In 2020, due to the impact of the Covid-19 crisis, the Romanian economy suffered an estimated 5.2% loss of GDP, which is lower than the estimated loss for other Euro area countries (7,8%) or EU countries (7.4%). The estimated speed of recovery is 3.3% in 2021 and 3.8%

124 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.CI.2020.091.01.0001.01.ENG&toc=OJ%3AC%3A2020%3A091I%3AFULL
125 Euro Monitor, BNR nr.4/2020
126 https://acad.ro/SARS-CoV-2/doc/d12-ImpactCOVID-19-serviciiiIMM.pdf

in 2022 and reflects differences in the structure of each economy, particularly the relative importance of tourism and leisure activities, as well as the magnitude and effectiveness of policy responses (further details are presented in Chapter 4.2.3)

Graph 35: Real gross domestic product

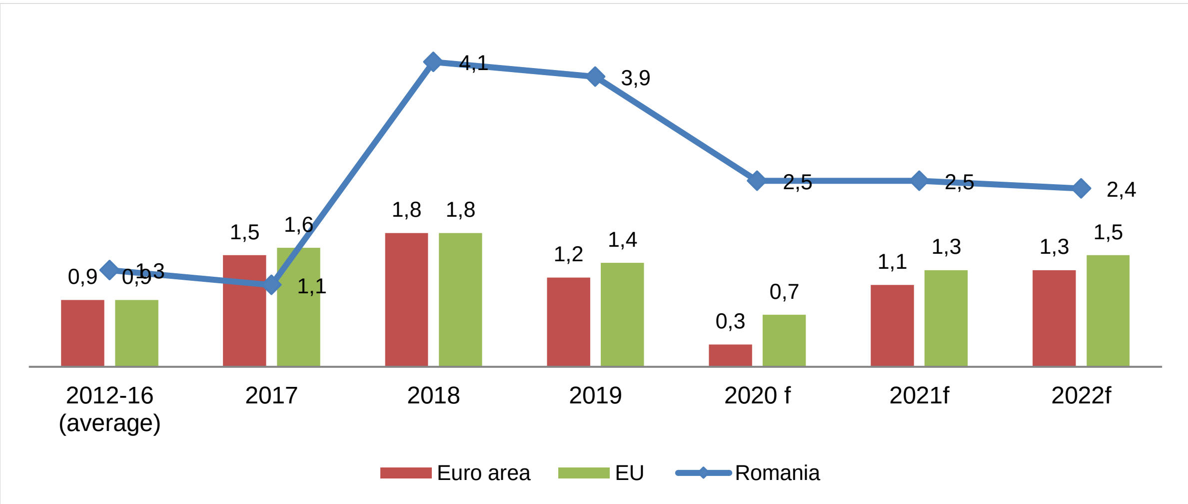


Source: [Autumn 2020 Economic Forecast (europa.eu)]

Inflation forecast (% change in consumer price) 2012-2022

Inflationary pressures in the Euro area are subsiding as the pandemic-induced global recession leaves its impact on both global and domestic factors underpinning price developments (see Graph 36). After slowing sharply at the start of the crisis, inflation is expected to remain weak towards the end of 2020. In 2021 and 2022, inflation is expected to follow a gradual upward trend. Overall inflationary pressures will depend fundamentally on the spread of the virus and the stringency of containment measures in force. The prediction of the inflation rate during 2020-2022 is consistent with the Romanian National Bank target, which aims to comply with the Euro zone admission criteria.

Graph 36: Inflation forecast

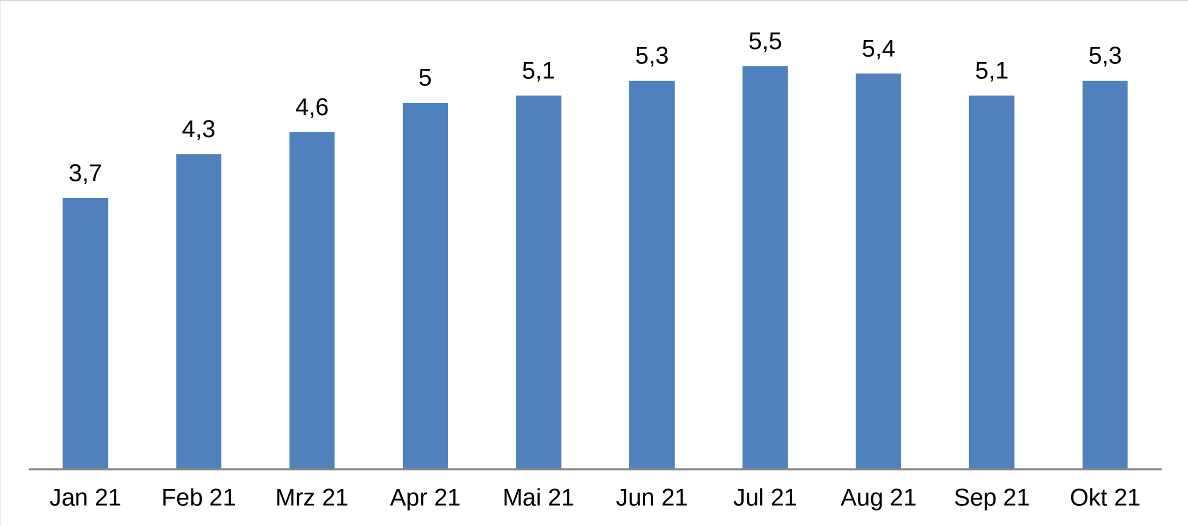


Source: Autumn 2020 Economic Forecast Autumn 2020 Economic Forecast (europa.eu)

Labour market - Unemployment rate 2012-2022

EU labour markets are under a severe strain in 2020 due to the outbreak of the COVID-19 pandemic. The policy measures put in place in all member states, supported by the new EU instrument for temporary Support to mitigate Unemployment Risks in an Emergency (SURE), have so far cushioned the impact of the crisis on workers and incomes. However, a significant deterioration in the labour market is already visible in many indicators, e.g., unemployment, employment growth (see Graph 37).

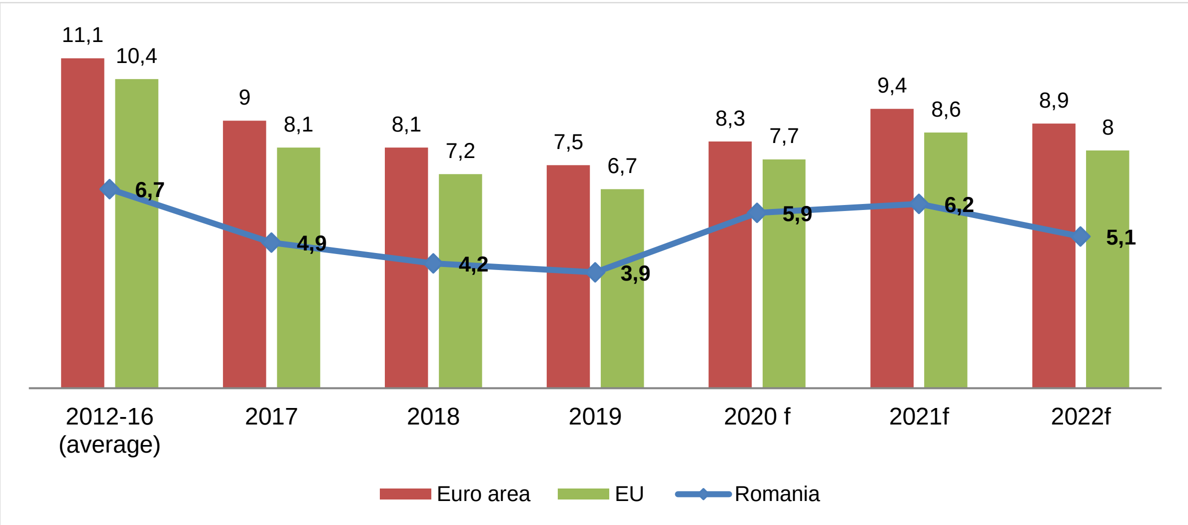
Graph 37: Romanian unemployment rate



Source: [Romania Unemployment Rate | 2004-2020 Data | 2021-2023 Forecast | Calendar (tradingeconomics.com)]

The increased predictions for Romania for the following two years are including the unemployment generated by the restructuring and automatization process of the energy and production sectors (see Graph 38).

Graph 38: Unemployment rate forecast



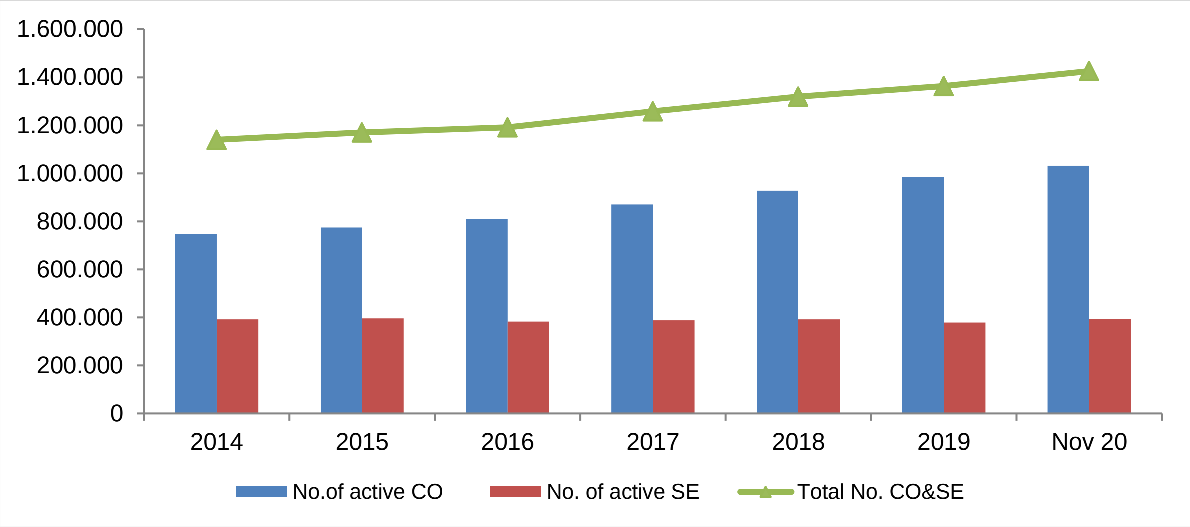
Source: Autumn 2020 Economic Forecast Autumn 2020 Economic Forecast (europa.eu)

Evolution of the number of active companies and self-employed

The evolution of the number of active companies is in contradiction with the general trends of the economic indicators during the first 11 months of 2020. The 1.43 million active companies and self-employed with a growth rate of 4.64% compared with the previous period Nov. 2019 is determined by the positive impact of the Government's mitigation measures taken during 2020 and the defensive strategy adopted by the majority of the active companies, e.g., restructuring of personnel, cancelling or postponing the investments, digitalization and work from home, etc.

The impact of the COVID-19 crisis on active company turnover is still to be determined during the following months when the financial results of 2020 will be reported. However, due to the extension of some mitigation measures during the first months of 2021, the real impact on the economic sector should be assess during the following 2-3 years.

Graph 39: Evolution of active companies and self-employed

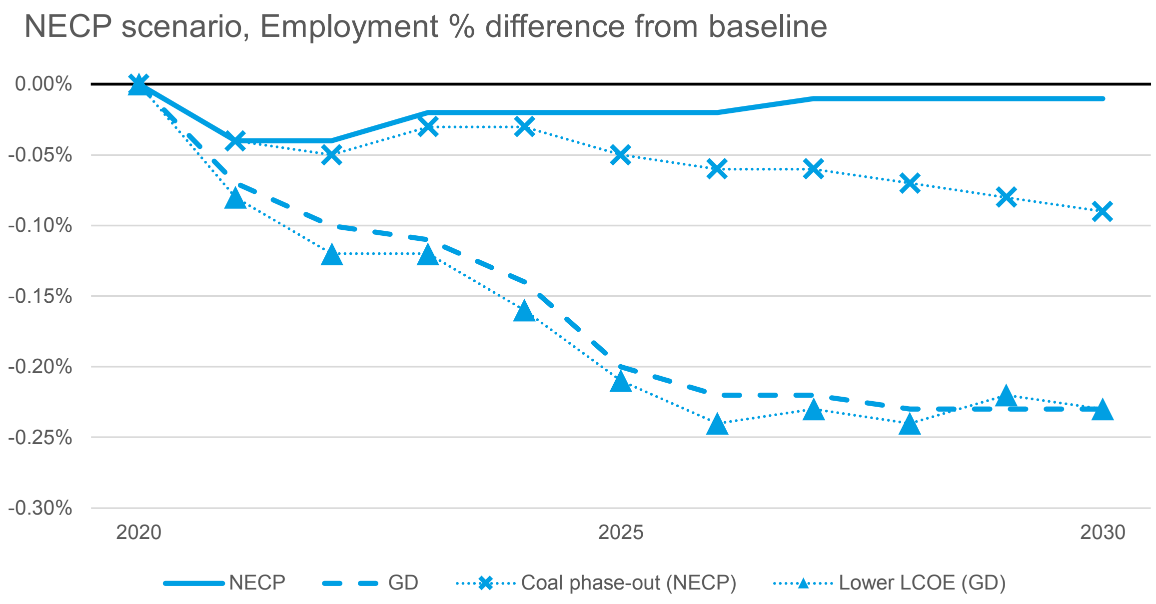


Source: Romanian trade registry [Oficiul National al Registrului Comertului (onrc.ro)](onrc.ro)

4.4.3 Detailed employment impact at sectoral level

Employment impacts of the measures required to meet climate targets in two scenarios were assessed using E3ME macro-econometric model. The two scenarios use a baseline[127] dataset representing the economic situation in 2020 and projected sectoral and economy wide impact on employment every year until 2030. The first scenario looks at impacts on employment from meeting the targets set out in NECP by 2030. The second scenario assesses impacts on employment from more ambitious targets in line with the climate targets in the European Union's Green Deal. Additionally, a sensitivity analysis was performed to estimate the impacts of an accelerated coal phase out before 2030 on employment. The first scenario is referred to as NECP scenario while the second one is referred to as GD scenario.

Graph 40: Change in employment under NECP, GD scenarios and sensitivity analysis



Source: CE modelling

[127] The baseline scenario uses the PRIMES 2016 Reference scenario as of January 2021 which comes with an issue that will be addressed during the project, namely the baseline scenario assumes a significantly higher nuclear capacity than existing as of 2020 with consequences on the current results.

The first conclusion from these analyses is that economy wide *net* employment decreases in the scenarios between 0.2% (GD scenario) and 0.1% (NECP scenario) compared to baseline. The result from the accelerated coal phase-out sensitivity shows a slightly worse outcome of 0.1% reduction (compared to the baseline) than the NECP scenario.

Nevertheless, this net effect covers some underlying dynamics. In the NECP scenario (compared to the baseline), there is lower employment in the short-term in the construction sector (fewer new RES deployments), while there is higher employment in manufacturing sector. On the long-term, however, total employment increases (compared to the baseline), while employment in services is less compared to the baseline due to the ETS price effects.

In the GD scenario the explanation of the effects is less complicated. Most of the negative employment impacts represent the lower employment (compared to the baseline) in the energy sector, due to faster decarbonisation in the scenario (affecting both gas- and coal-related employment). While there are substantial gains in the scenario in the manufacturing and construction sectors, the overall impact is negative. Employment gains in these sectors cannot fully compensate for the losses in the fossil fuel related sectors; supply chain effects as well as the overall price effects of the ETS are also at play. Other sectors also generally show lower employment compared to baseline.

The NECP Scenario

The results of the NECP scenario are explained by varying impacts in different sectors. As discussed above, in the short-term (2020-25) the manufacturing sector reports higher employment than the baseline (4,000-5,000 more jobs), while the construction sector shows a lower employment figure compared to baseline (~4,000 jobs), as does the energy sector (more than 1,000 jobs less). This is because there are less new construction jobs as the decarbonisation, and therefore deployment of RES, happens at a lower scale compared to the baseline. In the long-term (by 2030), construction and energy sector employment grows to match baseline levels, while the gain in the manufacturing sector largely disappears. At the same time, however, due to the ETS extensions and increasing ETS prices, employment in retail and services end up lower than the baseline. Nevertheless, these changes lead to a *net* neutral employment impact (i.e., there is no difference from the baseline in terms of overall employment). However, labour mobility across sectors and across occupations can be substantial.

It is worthwhile to also consider the results of the sensitivity (coal phase-out). Employment outcomes in the sensitivity are generally worse than the main NECP scenario. While the general structure of the employment effects (in sectoral terms) does not change, change in the energy sector influences overall results. Most importantly, employment in the energy sector decreases by more than 4,000 jobs compared to the baseline scenario. Other results stem from this effect (supply chain effects), and employment in most sectors is a few hundred jobs lower in all sectors in the sensitivity.

The Green Deal Scenario

The GD scenario employment results are in line with more aggressive climate targets assumed in this scenario. The construction sector observes higher employment growth than the NECP or baseline scenarios (3.0% more jobs compared to baseline by 2030; the NECP scenario is 0.3% compared to the baseline) as more renewable energy assets are assumed to be built in this scenario.

Net results are, however, negative through the modelling period. This is explained by the substantial reduction of energy sector jobs. Compared to the baseline, the scenario estimates employment in the energy and utilities sector to be about 13% lower than the baseline (as much as 25,000 fewer jobs in the sector compared to the baseline nationally (and about 25,000 fewer jobs than the NECP scenario). Nevertheless, there are sectors where the modelling observes positive impacts. The role of the construction sector has been discussed, but the manufacturing sector also shows national net gains (employment is about 0.2% higher compared to the baseline).

The energy sector drives the results. Employment outcomes in other sectors are mostly spillover or supply chain effects. However, they are also driven by price effects related to ETS prices. Employment is about 13,000 jobs less in service sectors than the baseline due to these effects on the national level.

Table 9: Modelling results for the two scenarios

NECP scenario

Employment impacts, % difference from baseline

sector	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.0%	-0.4%	-0.6%	-0.6%	-0.5%	-0.3%	-0.2%	0.0%	0.1%	0.2%	0.3%
Energy & utilities	0.0%	-0.3%	-0.4%	-0.6%	-0.7%	-0.7%	-0.5%	-0.4%	-0.3%	-0.1%	0.2%
Financial and insurance activities	0.0%	-0.1%	-0.3%	-0.3%	-0.5%	-0.5%	-0.4%	-0.4%	-0.2%	-0.2%	0.0%
Information and communication	0.0%	-0.1%	-0.2%	-0.3%	-0.3%	-0.3%	-0.3%	-0.4%	-0.4%	-0.4%	-0.4%
Manufacturing	0.0%	0.0%	0.1%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.1%
Professional services	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Public and other services	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Real estate activities	0.0%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.1%
Retail, transport, tourism services	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%

Green Deal scenario

Employment impacts, % difference from baseline

sector	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Agriculture, forestry and fishing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Construction	0.0%	-0.3%	-0.3%	-0.1%	0.2%	0.5%	0.9%	1.5%	2.0%	2.5%	3.0%
Energy & utilities	0.0%	-1.6%	-3.3%	-5.1%	-7.0%	-9.0%	-9.9%	-10.5%	-11.2%	-11.8%	-12.9%
Financial and insurance activities	0.0%	-0.3%	-0.7%	-0.6%	-0.8%	-1.1%	-1.1%	-1.1%	-1.0%	-0.8%	-0.5%
Information and communication	0.0%	-0.3%	-0.6%	-0.8%	-1.0%	-1.2%	-1.3%	-1.4%	-1.6%	-1.6%	-1.7%
Manufacturing	0.0%	0.0%	0.2%	0.4%	0.5%	0.4%	0.4%	0.3%	0.3%	0.2%	0.2%
Professional services	0.0%	0.1%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.1%	-0.1%
Public and other services	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Real estate activities	0.0%	0.2%	0.2%	0.2%	0.1%	0.1%	-0.1%	-0.3%	-0.4%	-0.6%	-0.7%
Retail, transport, tourism services	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.2%

Source: CE modelling

Looking at the *net* results, the best scenario in terms of employment for the country is the NECP scenario (or the baseline scenario), which does not have negative employment effects. However, it should be noted that the baseline trend for Romania in terms of employment is negative, i.e., the baseline projection assumes that there will be less jobs in the country in 2030 than there are now. The CEDEFOP Skills Forecast projections estimate that there will be more than 700,000 less people will be in the Romanian labour force by 2030 relative to 2018. At the same time, employment is estimated to drop by 800,000[128].

Scenario impacts should be understood as coming on top of these “natural” projections. It should also be noted that the *net* employment change numbers do not consider some inflexibilities of the labour market. While the E3ME model does account for labour market rigidities through the estimated parameters of observed relationships and dynamics in the labour market, it does not take cross-sector labour mobility needs, within country geographical mobility needs and within sector mobility into account. Therefore, there might be substantial re-training, re-skilling and labour mobility to realistically reach the estimated employment outcomes.

Table 10: Projected sectoral employment changes from 2018 in 2030 in the baseline

Sector	Mureș County (RO125)	Galați County (RO224)	Prahova County (RO316)	Dolj County (RO411)	Gorj County (RO412)	Hunedoara County (RO423)
Agriculture, forestry and fishing	-2	-5	-6	-27	0	-7
Energy & utilities	-2	-1	-3	0	-7	-5
Manufacturing	-3	-3	-5	-5	-3	3
Construction	-3	-5	-5	-4	-1	-5
Retail, transport, tourism services	2	1	6	1	2	0
Information and communication	1	0	-1	0	1	0
Financial and insurance activities	-1	0	0	0	0	0
Real estate activities	0	0	0	0	0	0
Professional services	1	0	0	-1	1	-1
Public and other services	5	5	10	1	3	3
Total	**-1**	**-8**	**-3**	**-35**	**-5**	**-11**
Total (excl Agri)	**1**	**-2**	**2**	**-8**	**-5**	**-5**

[128] Skills Forecast - https://www.cedefop.europa.eu/en/publications-and-resources/data-visualisations/skills-forecast#:~:text=%E2%80%8BCedefop%20skills%20forecasts%20offers,economic%20activity%20and%20occupational%20group.&text=The%20latest%20round%20of%20the,developments%20up%20to%20May%202019

5 REGIONAL ANALYSIS FOR THE TRANSITION REGIONS

5.1 Identification of the main impacts, affected regions and industries

Several key indicators – presented in the summary below – reflect the different profiles of the six JTP territories. These are further explored in the sections below and will be presented in a broader picture on development challenges for each of the counties to be included in D4.

5.1.1 Multiple-criteria matrix

Table 11: Multiple criteria-matrix

Indicator*	Comment on relevance	Dolj	Gorj	Hunedoara	Prahova	Mureș	Galați
Local demography and workforce	Challenges of local workforce availability and labour insertion.						
• Demographic size: number of residents (2019)		621,046	311,918	379,987	712,254	533,064	499,650
• Trends (2012-2020)	Decline of overall population	-5.8%	-8.3%	-8.9%	-6.5%	-3.1%	-6.5%
	Decline of working age population	-8.4%	-9.4%	-13.8%	-10.2%	-6.3%	-10.5%
• Unemployment rate – 2019. (National level: 2.9%)		6.7%	3.5%	3.0%	2.4%	2.7%	5.6%
Local economy	Significance of the local economy in overall national economy Reliance on industries most affected by energy transition						
GDP:							
• GDP (county level, mil RON)		23,735.9	15,510.3	14,784.3	36,566.8	20,894.5	16,733.7
• Share of National GDP		2.49%	1.6%	1.55%	3.8%	2.2%	1.8%
• Avg GDP growth rate over past 10 years		5.6%	5.9%	4.0%	7.3%	5.9%	4.5%
Trends and share of industry in overall county level economy:							
• Workforce employed in industry	Share of total employment at county level (22.3% national level/2019)	18.10%	23.40%	28.7%	28.6%	25.6%	19.2%
	Trend 2008/2019	-9.6%	-20.9%	-30%	-11.1%	-4.1%	-27.2%
• Trend on employment in extractive industry and manufacturing 2008/2019	Extractive industry	-41.2%	-42.9%	-68.9%	-39.4%	-20.0%	-16.7%
	Manufacturing	-9.0%	-6.7%	-7.6%	-9.8%	-2.8%	-27.6%

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5.1.2 Qualitative assessment over the readiness to jump on the transition agenda

The conclusions below are results from a first set of interviews conducted by the Technical Support Team. The reference cut-off date for interview conclusions in the present report is 16 January 2021. Following this date, an additional number of approximately 80 bilateral and group interviews took place and the adjusted conclusions have been presented in Deliverable 4 draft version and are subject to further analysis in Deliverable 4 final version.

Authorities (local level)

There has been **limited experience to date integrating climate change objectives into local development strategies** at the local level. If any, investments envisioned in this respect largely consist of thermal insulation for residential buildings and public facilities, introducing electric vehicles for public transportation (electric busses and trams, etc.) or modernising street lighting to be more energy friendly. Embarking on such investments has been catalysed by the availability of EU funds, rather than pursuing local development visions and public agendas integrating sound climate change principles and targets.

The long-term, sustainable implementation of local energy transition agendas would require local authorities to have the know-how and leadership capacity to integrate such aims into local development strategies and visions, rather than approaching JTF as simply another funding instrument to access. For this reason, more consistent knowledge sharing platforms and opportunities are needed to facilitate the transfer of technical know-how from the EU and central government to local authorities on climate change policy (such as training, public policy coordination events, guidelines, networking, etc.). Otherwise, there is a risk that the knowledge gap between the EU/central government and local level administrations will be reflected in the quality and impact potential of the investments pipeline proposed to JTF and the extent to which the rationale and the benefits of the European Green Deal policy will be understood, acknowledged and assumed by local communities.

While county councils are best positioned to oversee the implementation of a county-level just transition plan (NUTS3 region), it is important to acknowledge **the role of municipal authorities, especially those governing the main urban agglomerations of the just transition regions.** Given the local fiscal system in Romania, municipal authorities of larger cities generally have higher budget flexibility and implementation capacity to access EU funds as well as the mandate to conduct a broader range of key local public investments that potentially contribute to climate change objectives. Interviews with such stakeholders will be pursued in the following weeks of this assignment.

Business sector

The **readiness of business sector players varies,** as expected, depending on sector, leadership and business development vision. Companies active in coal mining, oil processing, etc. are, for obvious reasons, more challenged by this process since it requires a radical shift of their core business model or even envisions business closure. However, heavy industries with high CO_2 emissions that are challenged to switch to different energy sources might see the transition as a favourable context to invest in technology upgrades and innovation for increased production efficiency. For instance, Liberty Galați SA steelworks plans to build a new coal-free plant that is expected to double production, while capitalising on its redundant brownfield reserves (including contaminated sites) to produce solar and wind energy for its own use.

Public co-funding is expected to make a difference for a range of newer technologies, which are cleaner though not as economically viable as older, more established technologies. Public sector demand has also been mentioned as a factor that could increase readiness to invest in riskier, though cleaner, technology. For example, interest has been shown in hydrogen fuel plants as a prospective investment, either to capture excess internal renewable energy production or for business model repositioning. However, embarking in this could be encouraged by an authority investing in hydrail or other types of hydrogen fuelled vehicles or engines for public sector use.

In terms of workforce challenges, **absorbing large numbers of employees made redundant by the energy transition process is less of a challenge compared to skills training required to enable technology upgrades to existing businesses.** Romania has already gone through a massive industry restructuring process in its transition to the market economy, particularly in the 1990s and 2000s, when all of the counties analysed lost tens of thousands of industry jobs. Over the past decade, the ageing and outmigration processes–the latter favoured by Romania when joining the EU free labour market–means that companies are currently struggling to attract and retain qualified employees. The ageing workforce is challenging businesses to create long-term plans that attract local youth and fight the scepticism of youngsters towards an economic sector marked by massive layoffs in recent decades. For instance, approximately 2,000 of the 6,500 employees (including contractors) of Liberty Galați are expected to retire over the next four years, which has prompted the company to test and implement several youth attraction and training programmes.

Different workforce challenges exist in coal mining areas, which expect business closure and are located in regions with smaller demographics and less business diversity (areas in Gorj, Hunedoara).

NGOs

There are **significant disparities of civil society development across the analysed regions**. For instance, Gorj has been mentioned as having a less developed civil society while Jiu Valley (in Hunedoara) has been characterised as a more civically vibrant region.

There are **few NGOs pursuing civic action on the climate change agenda** in Romania and those which are active are mostly subsidiaries of international organisations (e.g. Greenpeace or WWF). The positions taken by such entities so far have stressed the risks of different clean energy alternatives pushed for by the transition agenda, such as impact of hydro-energy on river biodiversity, of wind mills on bird migration routes, etc. The NGOs also raise awareness through climate change education activities. There is a growing civil society interest in broader climate change policies, including the energy transition process. However, civil society needs to be supported in this process–in particular with schemes to support local grassroots entities–as this contributes to broader civic engagement, awareness and participation in the transition process.

5.2 Evidence base and quantitative analysis at the regional level for the most negatively affected territories

5.2.1 Overview of key indicators at the regional level for each county

Prahova County

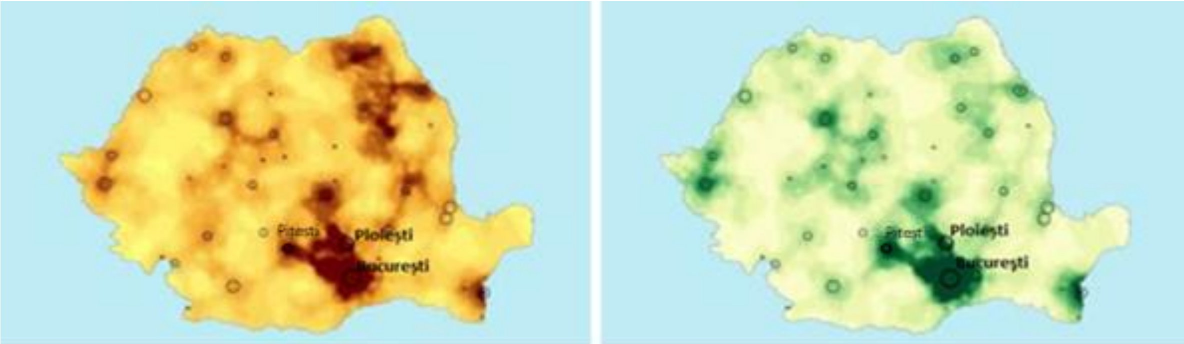
- **Overview**

Prahova is a county located in southern Romania with a population of 712,254 inhabitants and is among the most densely populated regions of Romania. Some 29% of the Prahova's population resides in the county seat city of Ploiești, which is one of the secondary cities of Romania.

Ploiești is 62 km north of Bucharest, which makes it part of the broader economic metropolis, attracting some of the demographics and business activity concentrated in Bucharest Metropolitan Area and its two closest county seats, Ploiești and Pitești (see Figure 9). In this respect, Prahova is among the best connected JTP regions that is serviced by major mobility routes (A1 highway, Otopeni International Airport, the largest in the country, is a one hour drive from Ploiești).

The northern part of the Prahova is mountainous and has a strong touristic profile, featuring ski resorts and spa and agro-tourism facilities, which are supported by demand from the nearby Bucharest metropolitan area. The southern part of the county also includes substantial agricultural lands exploited in intensive agriculture.

Figure 9: Map of population (left) and economic (right) gravitational models



Note: The population gravitational model used Census 2012 population numbers, while the economic gravitational model used firm revenues data for 2011. Source: "Competitive Cities, Reshaping the Economic Geography of Romania", World Bank, 2013.

➢ Demographics

The county lost 18.5% of its population during the post-communist decades, a demographic decline more pronounced than the national trend (see Table 12). The sharpest population decline was registered during the 2000s, following the peak of the economic restructuring process that hit during the end of the 1990s/early 2000s (see unemployment data in the next section). Nevertheless, Prahova remained the second most populated county in Romania (after Iași).

In short, the positioning and demographic size advantages helped offset what has been a very difficult industrial restructuring process.

Table 12: Demographic trend of Prahova County, as compared to national level (total population vs working age population of 15-64 years)

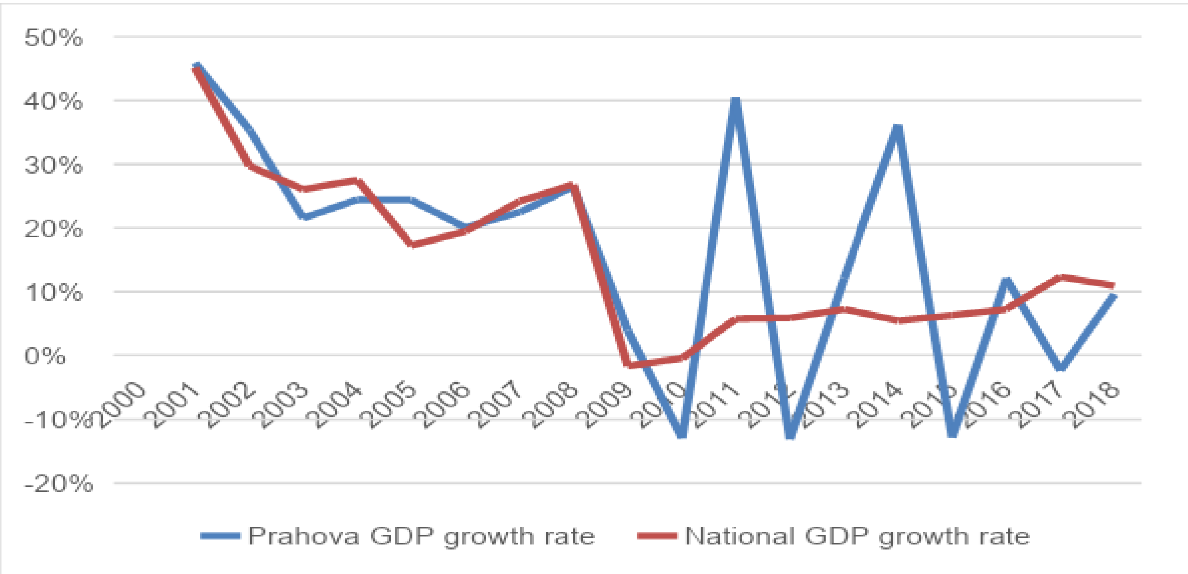
		1992	2002	2012	2020	1992 - 2020	2012 - 2020
Prahova	Total population	874,349	829,945	761,699	712,447	-18.5%	-6.5%
	Working age population			515,812	462,972		-10.2%
National	Total population	22,810,035	21,680,974	20,095,996	19,328,838	-15.3%	-3.8%
	Working age population			13,669,398	12,632,539		-7.6%

Source: INS. 1992 and 2002 data is retrieved from national censuses. 2012 and 2020 are retrieved from NIS indicator "resident population" (POP105A), which models past census data with yearly migration balance and natural growth. Trends in working age population will be added after Census Data for 1992 and 2002 detailed on age groups will be received.

➢ Local economy context and trends

The county contributes to the national economy with a local GDP of 36,566.8 m RON (EUR 7,858 m),[129] which represents a share of 3.8% of the national GDP. Of the six JTP counties analysed, Prahova has the largest demographic and economic base. The local economy has varied substantially since the 2008-2009 financial crisis. Nonetheless, the county recovered at a higher average growth rate than the national rate during the past ten years (7.3% compared to 5.9% – see Graph 41).

Graph 41: GDP growth rate of Prahova compared to national trend

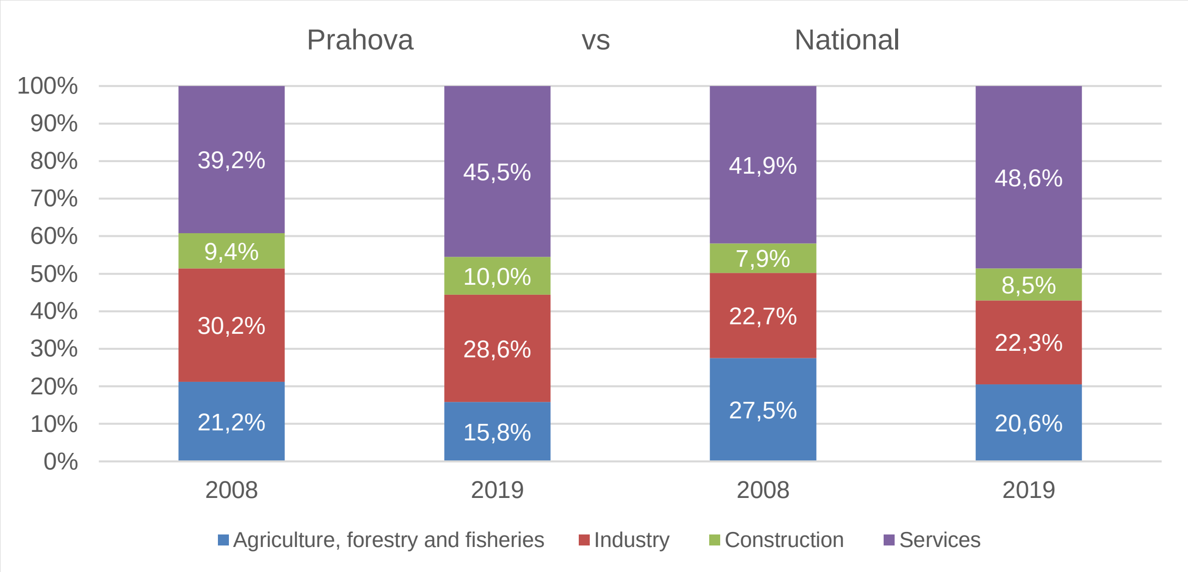


[129] Source: NIS, 2018. Average currency exchange rate for 2018 (NBRO): 1 EUR - 4,6535

Source: NIS, Tempo database

The county's economy–and particularly its county seat city–has long been tied to oil refinery and the production of oil industry equipment (see Graph 42 and Table 13). While these industries suffered significant restructuring processes over the past decades, they still represent the city's main profile and economic activity. Of the four refineries currently active in Romania, three are located in Ploiești: Petrobrazi Ploiești (owned by OMV Petrom), Petrotel Ploiești (owned by Lukoil) and Vega Ploiești.

Graph 42: Employment by main sectors of the economy - 2008-2019 trends



Source: NIS, Tempo database (FOM103D - Civil employment population by activity of national economy at level of CANE Rev.2)

Table 13: Employment by sectors of the economy - 2008-2019 trends, detailed view

Sectors of employment	Prahova (thousand people)				National
	2008	2019	2008-2019		2008-2019
Agriculture, forestry and fisheries	**64.00**	**44.90**	**-29.8%**		**-27.4%**
A Agriculture forestry and fishing	64.0	44.9	-29.8%		-27.4%
Industry	**91.3**	**81.2**	**-11.1%**		**-4.3%**
B Mining and quarrying	6.6	4.0	-39.4%		-38.2%
C Manufacturing	77.6	70.0	-9.8%		-1.8%
D Electricity gas steam and air conditioning supply	2.6	2.1	-19.2%		-32.9%
E Water supply; sewerage waste management and remediation activities	4.5	5.1	13.3%		3.0%
Construction	**28.4**	**28.5**	**0.4%**		**4.5%**
F Construction	28.4	28.5	0.4%		4.5%
Services	**118.6**	**129.3**	**9.0%**		**12.5%**
G Wholesale and retail trade; repair of motor vehicles and motorcycles	38.4	42.4	10.4%		8.5%
H Transportation and storage	16.7	18.6	11.4%		14.1%

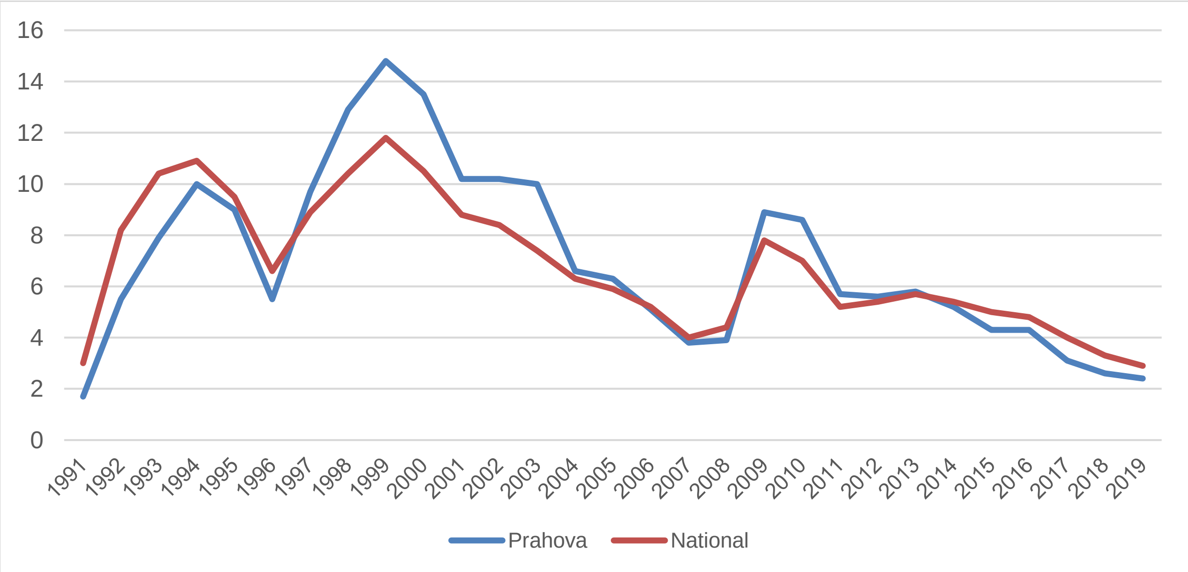
Sectors of employment	Prahova (thousand people)				National
	2008	2019	2008-2019		2008-2019
I Accommodation and food service activities	7.4	7.1	-4.1%		38.2%
J Information and communication	2.8	3.4	21.4%		66.7%
K Financial and insurance activities	2.6	2.0	-23.1%		-13.9%
L Real estate activities	1.8	1.6	-11.1%		-27.5%
M Professional scientific and technical activities	6.3	7.0	11.1%		28.1%
N Administrative and support service activities	6.2	10.9	75.8%		55.2%
O Public administration and defence; compulsory social security	6.4	6.1	-4.7%		-3.8%
P Education	12.1	10.3	-14.9%		-13.2%
Q Human health and social work activities	13.5	14.0	3.7%		9.2%
R Arts entertainment and recreation	1.3	2.4	84.6%		34.7%
S Other service activities	3.1	3.5	12.9%		17.0%
Total	**302.3**	**283.9**	**-6.1%**		**-2.9%**

Source: NIS, Tempo database (FOM103D - Civil employment population by activity of national economy at level of CANE Rev.2)

Employment in industry decreased by 11.1% from 2008 to 2019, implying a loss of 10,100 jobs. Despite declining employment, Prahova still ranks among the most industrialised counties of Romania, as 28.6% of local jobs are in the industry sector (compared to 22.3% nationally). A pattern of business location decisions in the past decade has seen large companies locate production facilities in Ploiești and its metropolitan area, benefitting from lower land and labour costs while retaining headquarters in Bucharest (e.g., production plants of Unilever, Coca Cola, HBC, etc.).

The overall positive trend of the local economy over the past decade is also reflected in unemployment rates, which are below the national level (see Graph 43 and Table 14).

Graph 43: Trend in unemployment rate (%) in Prahova County vs national level



Source: NIS, Tempo (SOM103A)

Table 14: Unemployment rate in Prahova vs national

	2015	2016	2017	2018	2019
Prahova	4.3	4.3	3.1	2.6	2.4
National	5	4.8	4	3.3	2.9

Source: NIS, Tempo (SOM103A)

Oil extraction and refining has been historically located in the Ploiești-Câmpina area, with extraction sites towards the east and west of this axis. In particular, the cities and Ploiești and Câmpina are scarred by hundreds of hectares of brownfield sites left redundant by the shirking of oil refining and oil equipment manufacturing industries[130].

The total number of active professionals (including companies and self-employed) in Prahova county from 2014–2020 increased by 6,650, which represents 3% of active professionals in the country (see Table 15).

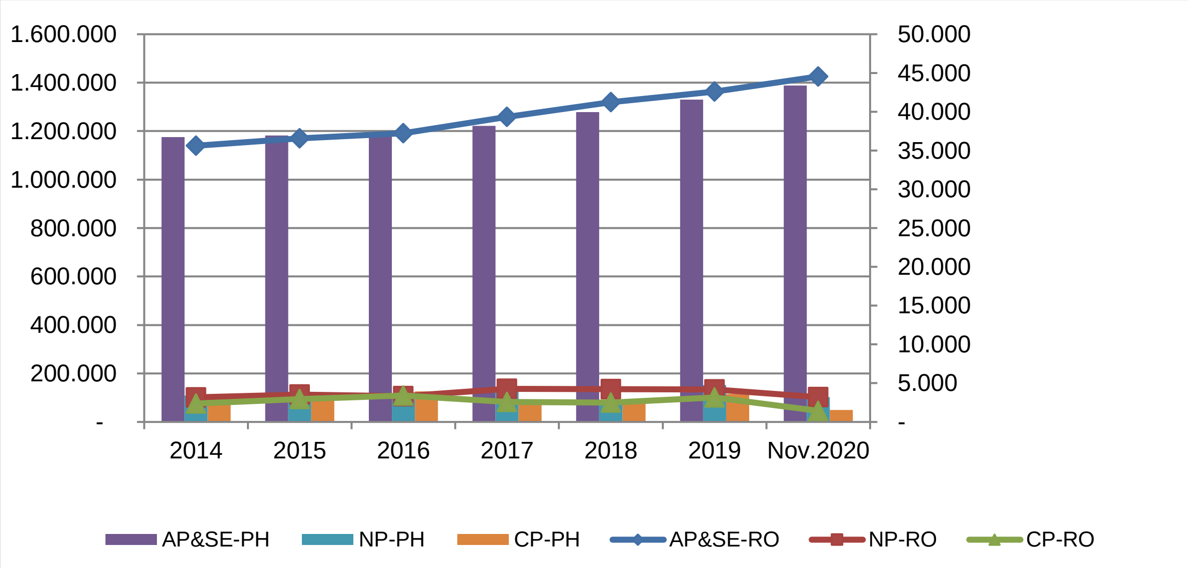
Table 15: Total number of AP&SE, NP and CP in Prahova county (2014-2020)

	2014	2015	2016	2017	2018	2019	Nov.2020
AP&SE-RO	1,139,803	1,170,316	1,191,738	1,258,536	1,319,921	1,363,651	1,425,674
NP-RO	101,627	113,167	105,982	136,699	135,532	134,220	101,706
CP-RO	76,483	94,374	109,113	82,295	80,181	101,601	45,915
AP&SE-PH	36,748	36,932	36,799	38,163	39,969	41,556	43,398
NP-PH	3,385	3,444	3,093	3,942	2,863	4,785	3,217
CP-PH	3,011	3,463	3,952	2,772	2,640	3,617	1,530

Source: Romanian Trade registry

The evolution of active professionals and self-employed (AP&SE), new professionals registered (NP) and closed professionals (CP) in Prahova County compared with the country's total data for the period 2014–2020 is presented in Graph 44.

Graph 44: Evolution of the number AP&SE, NP and CP in Prahova county 2014-2020



Source: Romanian Trade registry

[130] More detailed data and insights into this topic to be added based on an additional set of interviews.

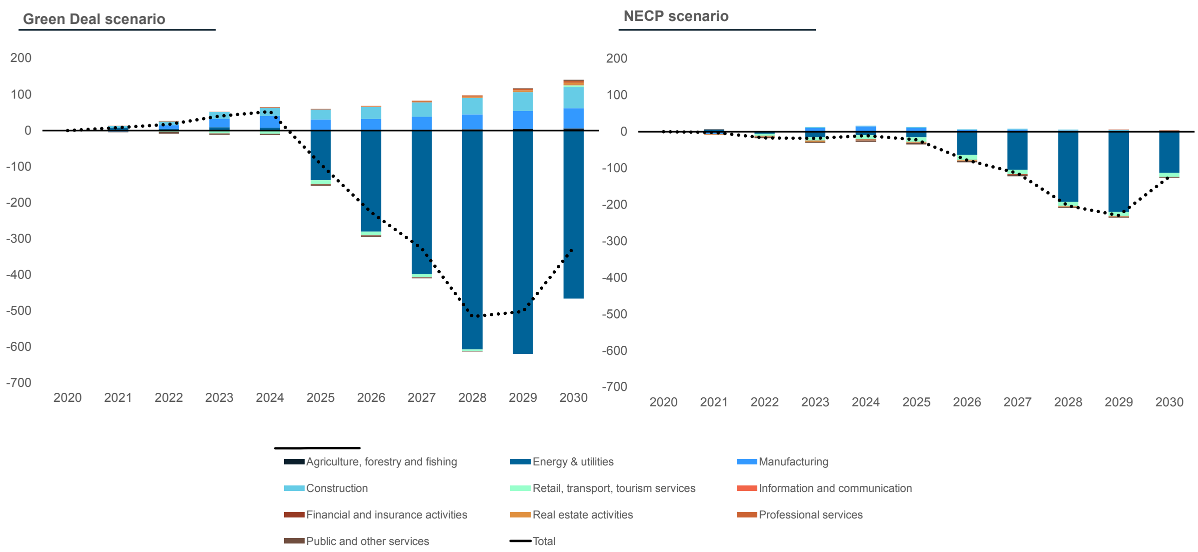
➢ **Regional transition impact**

GVA

Modelling in Prahova is largely driven by the energy sector outcomes. As it can be seen on Graph 45 impacts in the energy and utilities sector dominates GVA outcomes both in the NECP and the GD scenarios. Energy sector GVA is about EUR 120 million lower in the NECP scenario than in the baseline by 2030 (or about 1.2% of total project GVA in the baseline for the region). In the NECP scenario there are also lower GVA outcomes in the retail and services sector, due to the discussed price effects of the ETS system, but this only accounts to about EUR 10 million reduction (compared to the baseline) by 2030.

In the GD scenario the GVA reduction (compared to the baseline) is even higher. The left panel of Graph 45 shows that negative impacts could reach up to EUR 620 million (in 2029), which amounts to about 6% of total regional GVA in the baseline. There are positive impacts in the scenario as well, manufacturing and construction can yield about EUR 120 million increase according to the simulation results, but these gains are unable to offset the losses of the energy sector. Although, it needs to be noted that the baseline projects a high growth to the energy sector by 2030 in the region, therefore, if we compare the outcomes to 2018 data rather than the baseline, we see an about EUR 85 million increase.[131]

Graph 45: NECP scenario, GVA, million EUR difference from baseline



Source: CE modelling

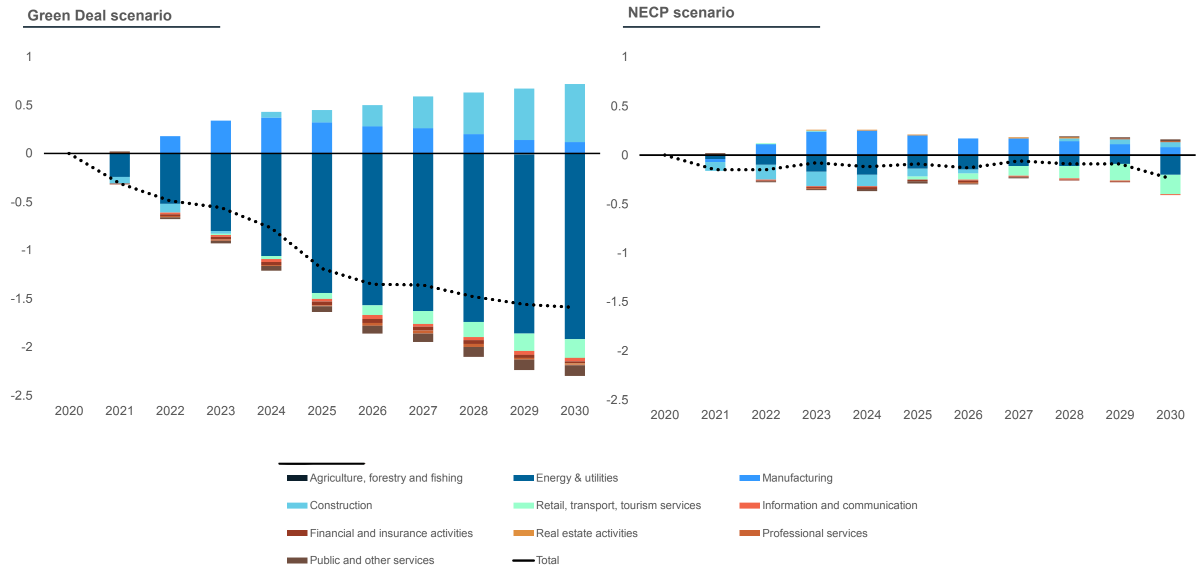
Employment

Employment impacts follow the GVA results. The employment impact in the NECP scenario is relatively muted, with employment effects in the energy sector being more limited than in the GVA results. This can be understood as while GVA is directly affected by production, employment "lags behind" and can accommodate periods with lower production/volatile demand.

Nevertheless, in the GD scenario, employment impacts follow the strong GVA impacts. Employment in the energy sector is estimated to be about 2,000 jobs less than in the baseline by 2030, mainly attributable to supply chain and general income effects although other sectors also see job declines (compared to the baseline). Meanwhile, gains from the construction and manufacturing sectors are relatively limited (amounting to a little over 100 jobs) and fail to offset the adverse impacts.

[131] GVA growth of the energy sector in projections from 2018: Baseline: 84%, NECP: 67%, GD: 12%.

Graph 46: NECP scenario, employment, '000 jobs difference from baseline

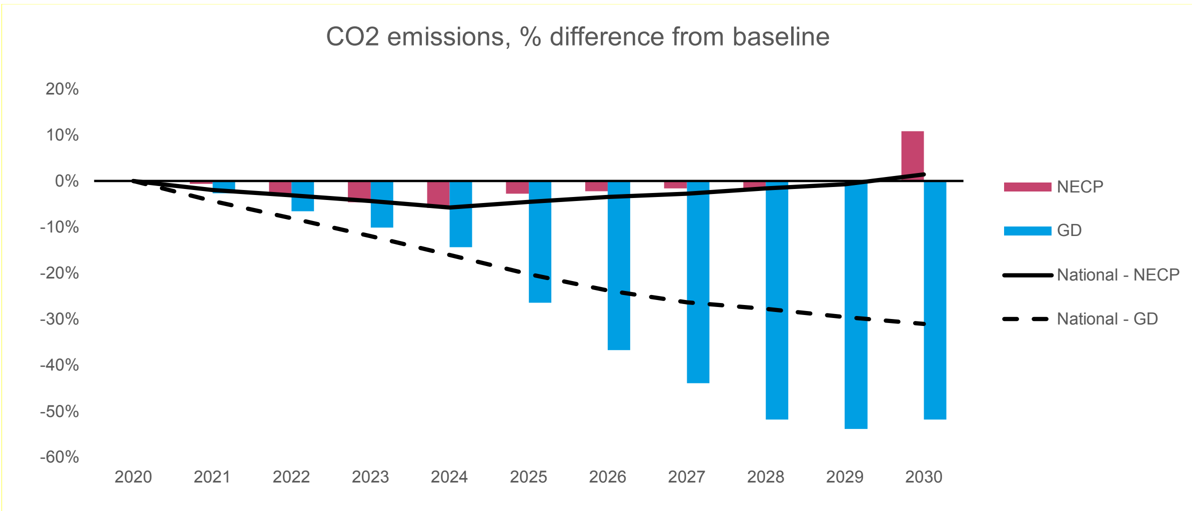


Source: CE modelling

CO_2 emissions

Although CO_2 emissions follow the trends of the national results both in the NECP and GD scenarios, the magnitude is higher. In the GD scenario, the CO_2 reduction is 52% compared to the national figure of 31%. Nevertheless, this is achieved by severely limiting gas-based power generation in the county. In the NECP scenario, however, very mild reductions can be observed throughout the period, often falling behind the national level reduction, and thus, by 2030 emissions in the NECP scenario actually rise 10% above the baseline. This is explained by a reduction of gas-demand in the baseline in 2030 due to the deployment of new nuclear capacity, which has a divergent effect on the NECP and baseline scenarios.

Graph 47: CO2 emissions, % difference from baseline



Source: CE modelling

In Prahova the transition effects are driven almost exclusively by the negative impact of strong decarbonization targets on the local oil & gas industry. The negative GVA impacts in comparison to the baseline range from minus EUR 120 million in a NECP scenario to minus EUR 620 million in a Green Deal scenario. The GVA gains in other sectors due to positive transition effects (e.g.: construction, manufacturing) do not compensate the GVA losses from the oil & gas sector. Employment is not as hit as GVA, except in a Green Deal scenario, where the energy sector is expected to lose 2,000 local jobs by 2030 compared to a baseline scenario.

Gains in other sectors (e.g.: construction, manufacturing) are less than 100 jobs, so cannot compensate, although Prahova encounters high gains in all scenarios, including the baseline in the services sector, which could be a pathway for absorbing the employment shock. In a NECP scenario emissions actually rise by 10% in Prahova compared to the baseline, while in a green scenario they reduce by half compared to the baseline.

Galați County

- **Overview**

Galați is a county located in southeast Romania with a population of 499,650 inhabitants, of which 50% reside in the county seat city (Galați). This is one of the aspects that make it distinctive from the other JTP counties – its demographic and economic activity is mainly concentrated in the county seat city and the metropolitan area, while the rest of the county is more sparsely inhabited and largely rural.

The Galați county seat city is the largest river Danube port of Romania, a position that influenced its industrial profile since it provides easy access to major European waterway routes for sourcing raw materials and distribution. However, its easternmost position–20 km away from the Eastern Romanian and EU border with Republic of Moldova and outside of the current highway network disadvantage the region in terms of land access to EU markets.

- **Demographics**

Galați lost nearly a quarter of its population (22%) during the post-communist decades, a significantly higher demographic decline rate compared to the national rate of the same period (15.3%) (see Table 16). Similar to the other counties analysed, the 2000s brought about the sharpest decline of major restructuring and layoffs. The working age population has decreased at a much faster rate than the overall population, signalling ageing and selective outmigration. This process is more pronounced than the national average.

Table 16: Demographic trend of Galați County, as compared to national level (total population vs working age population of 15-64 years)

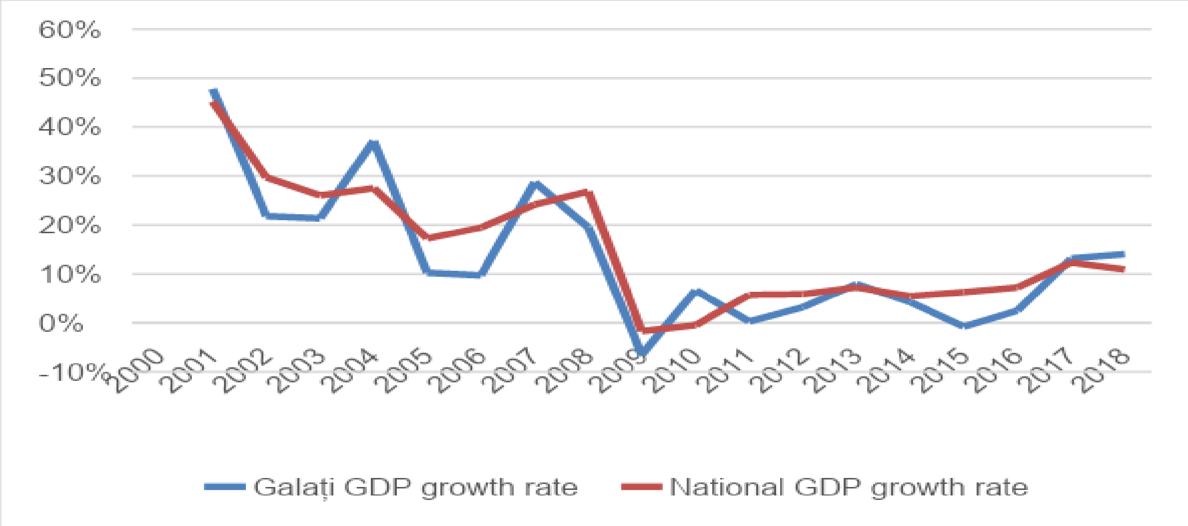
		1992	2002	2012	2020	1992 - 2020	2012 - 2020
Galați	Total population	641,011	619,556	534,577	500,213	-22.0%	-6.4%
	Working age population			363,630	325,588		-10.5%
National	Total population	22,810,035	21,680,974	20,095,996	19,328,838	-15.3%	-3.8%
	Working age population			13,669,398	12,632,539		-7.6%

Source: INS. 1992 and 2002 data is retrieved from national censuses. 2012 and 2020 are retrieved from NIS indicator "resident population" (POP105A), which modells past census data with yearly migration balance and natural growth. Trends in working age population will be added after Census Data for 1992 and 2002 detailed on age groups will be received.

- **Local economy context and trends**

Galați County contributes to the national economy with a local GDP of 16,733.7 m RON (EUR 3,596 m), which represents a share of 1.8% of the national GDP. It had a slower recovery after the 2008-2009 financial crisis, with an average growth rate across the past ten years below the national average (4.5% compared to 5.9%, see Graph 48).

Graph 48: GDP growth rate of Galați compared to national trend

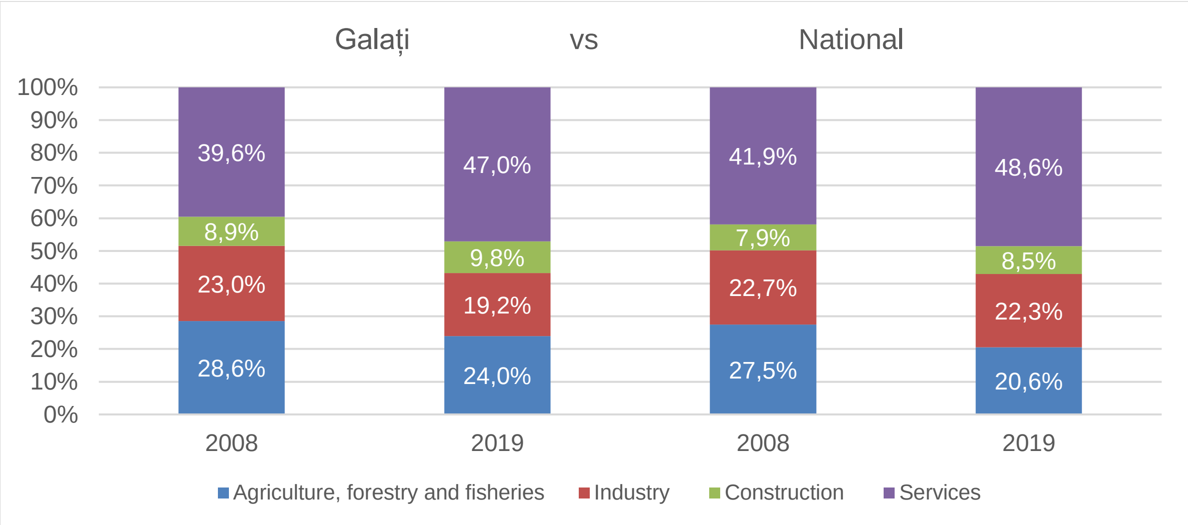


Source: NIS, Tempo database

Its position and harbour facilities favoured the development of the largest steel production facility in Romania – currently named Liberty Galați SA.[132] This industrial activity, established during the 1960s by the Romanian Communist Government, went through successive privatisation and restructuring stages with massive layoffs affecting the local population. Layoffs peaked in the 2000s when the company reduced in size from 27,772 in 2000 to 11,049 by 2009. However, the company remains the largest active in the metallurgy industry in Romania, both in terms of turnover (1.06 bn RON in 2019) and number of employees (5,081 people in 2019). This represents approximately 16% of the workforce involved in the metallurgy industry in Romania.[133]

The local economy also includes, among others, shipbuilding and a growing services sector (based primarily on outsourcing services) in the county seat city, as well as a developing intensive agriculture sector (see Graph 49 and Table 17).

Graph 49: Employment by main sectors of the economy - trends over 2008-2019



Source: NIS, Tempo database (FOM103D - Civil employment population by activity of national economy at level of CANE Rev.2)

132 The company bore several names during its existance. Initially called "Galați Steel Works" ("Combinatul Siderurgic Galați"), renamed SIDEX Galați in 1991, after the fall of the communist regime; acquired from the Romanian Government by Mittal Steel Company in 2001 and then taken over by Arcelor in 2006 and renamed ArcelorMittal Galați. In 2019 it was purchased by Liberty House Group and renamed Liberty Galați SA.

133 Based on data retrieved from www.listafirme.ro, NACE code 24XX – metallurgy industry

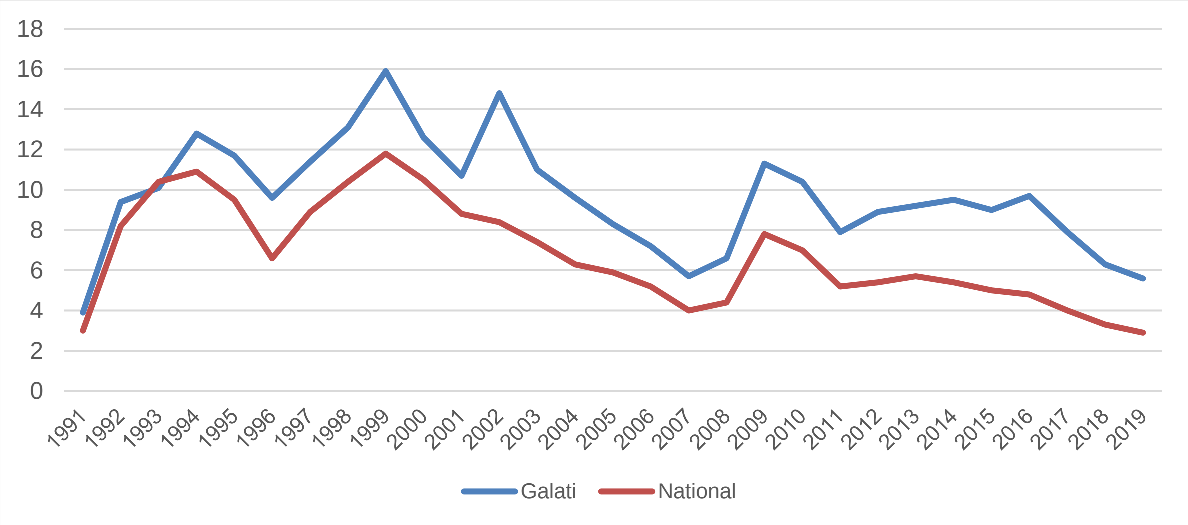
Table 17: Employment by sectors of the economy - trends over 2008-2019, detailed view

Sectors of employment	Galați (thousand people)				National
	2008	2019	2008-2019		2008-2019
Agriculture, forestry and fisheries	**58.90**	**43.00**	**-27.0%**		**-27.4%**
A Agriculture forestry and fishing	58.9	43.0	-27.0%		-27.4%
Industry	**47.4**	**34.5**	**-27.2%**		**-4.3%**
B Mining and quarrying	0.6	0.5	-16.7%		-38.2%
C Manufacturing	40.2	29.1	-27.6%		-1.8%
D Electricity gas steam and air conditioning supply	2.9	1.2	-58.6%		-32.9%
E Water supply; sewerage waste management and remediation activities	3.7	3.7	0.0%		3.0%
Construction	**18.4**	**17.5**	**-4.9%**		**4.5%**
F Construction	18.4	17.5	-4.9%		4.5%
Services	**81.6**	**84.4**	**3.4%**		**12.5%**
G Wholesale and retail trade; repair of motor vehicles and motorcycles	25.0	25.2	0.8%		8.5%
H Transportation and storage	11.1	9.3	-16.2%		14.1%
I Accommodation and food service activities	3.3	4.7	42.4%		38.2%
J Information and communication	1.9	3.1	63.2%		66.7%
K Financial and insurance activities	2.2	1.4	-36.4%		-13.9%
L Real estate activities	0.9	0.8	-11.1%		-27.5%
M Professional scientific and technical activities	3.1	3.3	6.5%		28.1%
N Administrative and support service activities	5.0	7.6	52.0%		55.2%
O Public administration and defence; compulsory social security	5.2	4.5	-13.5%		-3.8%
P Education	10.8	9.7	-10.2%		-13.2%
Q Human health and social work activities	9.2	9.5	3.3%		9.2%
R Arts entertainment and recreation	0.9	1.8	100.0%		34.7%
S Other service activities	3.0	3.5	16.7%		17.0%
Total	**206.3**	**179.4**	**-13.0%**		**-2.9%**

Source: NIS, Tempo database (FOM103D - Civil employment population by activity of national economy at level of CANE Rev.2)

Unemployment in Galați County has been constantly – and significantly - above the national level (see Graph and Table below). This reflects a local economy less capable to absorb the shocks of restructuring and financial crisis and capitalize on its labour resources.

Graph 50: Trend in unemployment rate (%) in Galați County vs national level



Source: NIS, Tempo database

Table 18: Unemployment rate (%) in Galați vs national

	2015	2016	2017	2018	2019
Galați	9	9.7	7.9	6.3	5.6
National	5	4.8	4	3.3	2.9

Source: NIS, Tempo (SOM103A)

The total number of active professionals (including companies and self-employed) in the county between 2014–2020 increased by 4,874, representing 1.9% of the active professionals in the country (see Table 19).

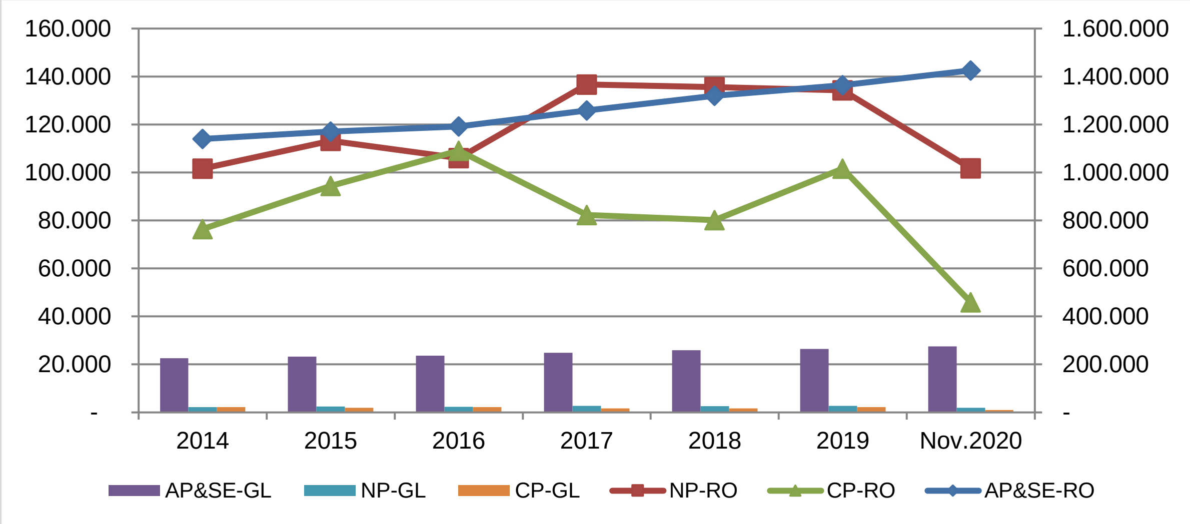
Table 19: Total number of AP&SE, NP and CP in Galați county 2014-2020

	2014	2015	2016	2017	2018	2019	Nov.2020
AP&SE-RO	1,139,803	1,170,316	1,191,738	1,258,536	1,319,921	1,363,651	1,425,674
NP-RO	101,627	113,167	105,982	136,699	135,532	134,220	101,706
CP-RO	76,483	94,374	109,113	82,295	80,181	101,601	45,915
AP&SE-GL	22,584	23,250	23,699	24,877	25,929	26,511	27,458
NP-GL	2260	2472	2337	2725	2646	2762	1868
CP-GL	2187	1939	2251	1631	1627	2148	1043

Source: Romanian Trade registry

The evolution of the total number of active professionals and self-employed (AP&SE), new professionals registered (NP) and closed professionals (CP) in Galați County compared with the country's total data for the period 2014–2020 is presented in Graph 51.

Graph 51: Evolution of the number AP&SE, NP and CP in Galați county 2014-2020



Source: Romanian Trade registry

➢ **Regional transition impact**

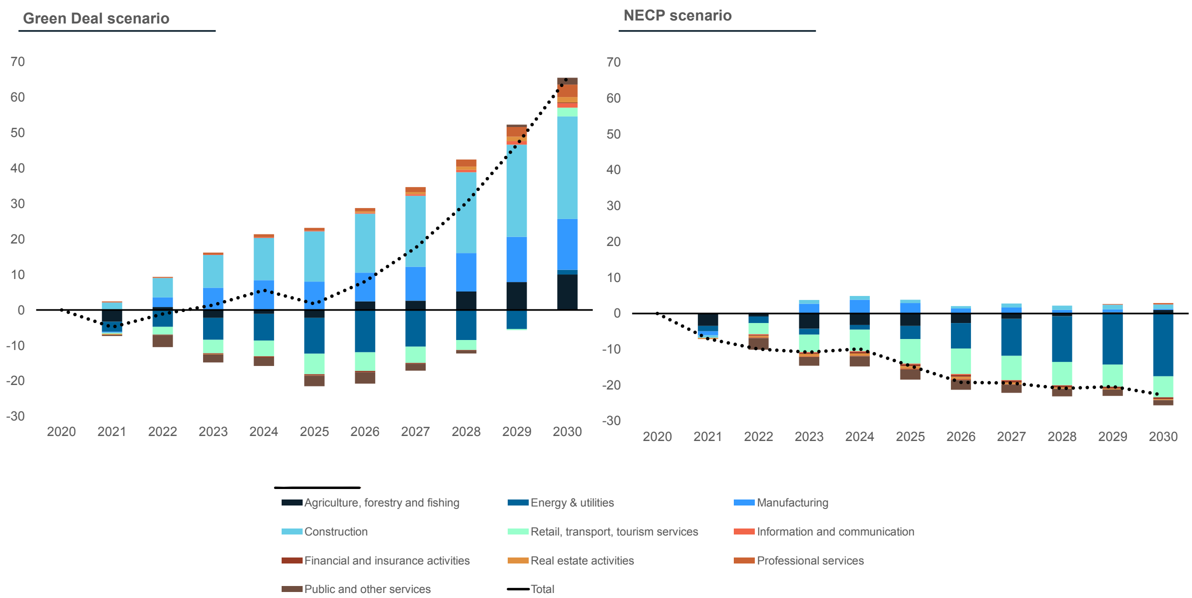
GVA

In Galați, the GVA results follow the pattern of the national GDP outcomes. The NECP scenario shows a lower than baseline GVA level, while the GD scenario, due to the implementation of decarbonisation policies, shows a higher than baseline GVA level, even though there are negative factors.

In the NECP scenario, the energy and retail sectors have prominent losses, with a collective negative impact of about EUR 23 million compared to the baseline (or 0.6% of total regional GVA above baseline in 2030). Losses in the retail sector are attributed to ETS price pressures (described earlier), while the energy decrease is related to slower RES deployment compared to the baseline (which would bring higher GVA numbers).

In the Green Deal scenario, there are two main sectors with higher than baseline GVA (construction and manufacturing) and two sectors with somewhat negative outcomes (energy and retail). Gains are driven by decarbonisation policies such as retrofitting/energy efficiency (construction sector) or renewable-related manufacturing. Together, these sectors increase GVA in the region by EUR 43 million compared to the baseline (or 1.1% of total region GVA above baseline in 2030).

Graph 52: NECP scenario, GVA, million EUR difference from baseline



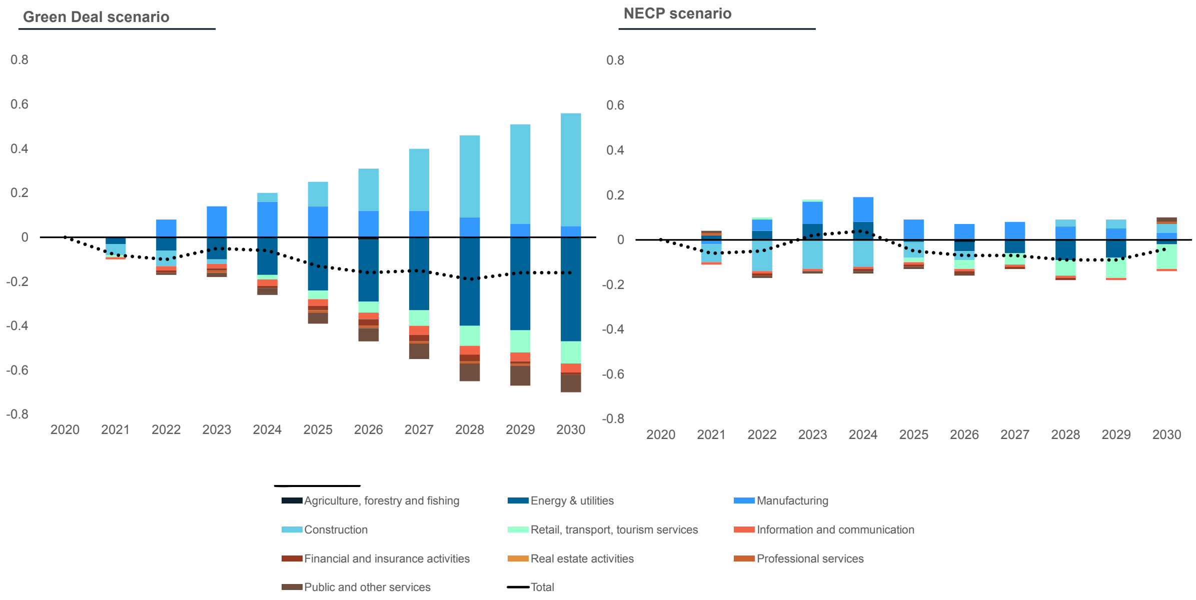
Source: CE modelling

Employment

Employment impacts do not strictly follow GVA results. In the GD scenario, employment growth in manufacturing (about 200 jobs in 2024) and construction (about 500 jobs by 2030) are in line with the high GVA increase in the sectors, but energy related employment losses (about 500 jobs by 2030) are relatively higher than GVA losses and are complemented with losses in other sectors. Aggregating employment changes leads to a net negative employment impact in the scenario.

In the NECP scenario, employment impacts are more muted and the net change (compared to the baseline) stays below a hundred jobs in all years.

Graph 53: NECP scenario, employment, '000 jobs difference from baseline

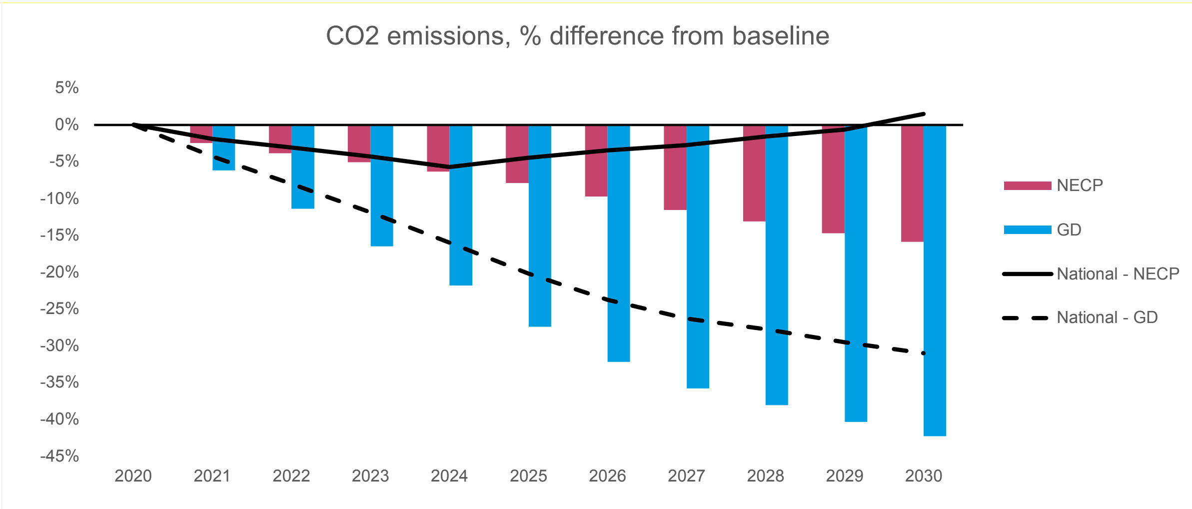


Source: CE modelling

CO_2 emissions

In terms of CO_2 emissions, the county has better outcomes in both scenarios compared to national level results. The reduction in the NECP scenario amounts to about 16% (compared to the baseline), while the reduction is around 42% in the GD scenario. Both values signal emission reductions below the total national reductions in the scenarios.

Graph 54: CO2 emissions, % difference from baseline



Source: CE modelling

In principle, Galati exhibits higher GVA values in “greener” scenarios - the baseline scenario and the Green Deal scenario. In a GD scenario, GVA gains are driven by the construction sector (retrofitting/energy efficiency) and manufacturing. However, the employment evolution is worse in a GD scenario, where the gains in manufacturing and construction do not offset the losses from the energy sector. Emissions fall by about 42% compared to the baseline in a GD scenario and by only 16% in the NECP scenario.

Mureș County

- **Overview**

Mureș is a county located in central Romania with a population of 533,064 inhabitants, of which 25% reside in the county seat city (Târgu Mureș).

The distinctiveness of Mureș is marked by natural gas extraction, which generated several of its most developed industrial activities, such as AzoMureș SA, the country’s largest nitrogen fertilizers factory and CTE Iernut, a 800Mw energy plant based on natural gas owned by Romgaz SA.

While the county is not connected yet by any highway routes to other large towns in the country, two planned major highways (A3 and A8), currently in different stages of development, will go through Târgu Mureș connecting southern and eastern Romania to western country borders. This is expected to significantly improve the connectivity of this county and the access of its local business to markets.

- **Demographics**

Mureș county is one of the least affected JTP counties in terms of demographic decline and industrial restructuring. Its rate of decline, both overall and for its working age population, is consistently below the national average (Table 20).

Table 20: Demographic trend of Mureș County, as compared to national level (total population vs working age population of 15-64 years)

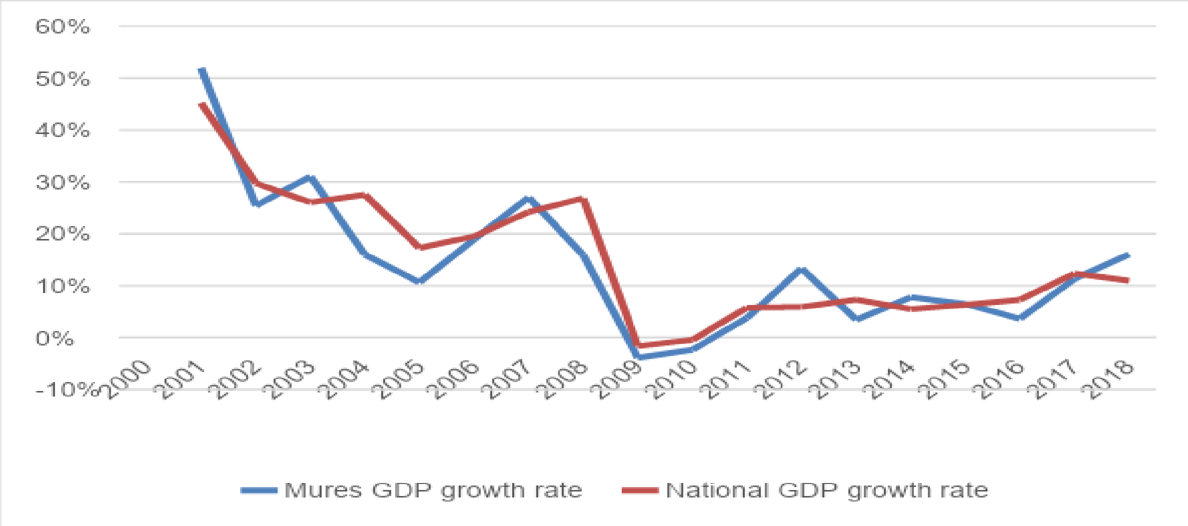
		1992	2002	2012	2020	1992 - 2020	2012 - 2020
Mureș	Total population	610,053	580,851	550,214	533,186	-12.6%	-3.1%
	Working age population			367,283	344,291		-6.3%
National	Total population	22,810,035	21,680,974	20,095,996	19,328,838	-15.3%	-3.8%
	Working age population			13,669,398	12,632,539		-7.6%

Source: INS. 1992 and 2002 data is retrieved from national censuses. 2012 and 2020 are retrieved from NIS indicator "resident population" (POP105A), which models past census data with yearly migration balance and natural growth. Trends in working age population will be added after Census Data for 1992 and 2002 detailed on age groups will be received.

- **Local economy context and trends**

Mureș County contributes to the national economy with a local GDP of 20,894.5 m RON (EUR 4,490 m), which represents a share of 2.2% of the national GDP. Its economy recovered after the 2008-2009 financial crisis at a similar growth rate as the national average during the past ten years (5.9%, see Graph 55).

Graph 55: GDP growth rate of Mureș compared to national trend

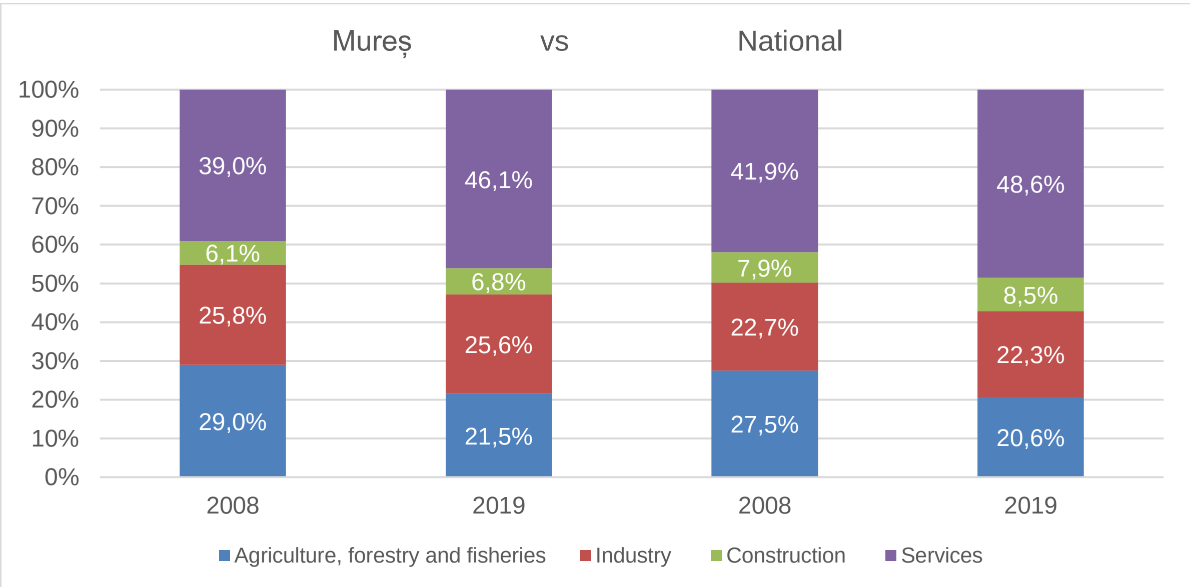


Source: NIS, Tempo database

The distinctiveness of Mureș county is marked by natural gas extraction, which generated several of its most developed industrial activities, such as AzoMureș SA, the country's largest nitrogen fertilizers factory and CTE Iernut, a 800Mw energy plant based on natural gas owned by Romgaz SA. Of the six JTP counties, Mureș registered the lowest job loss in industry, -4.1% from 2008 to 2019. The decline in the energy production and distribution sector, marking an employment decrease of -17.4% over the same reference period is mainly attributed to the restructuring of key players in the energy distribution sector headquartered in Mureș, such as EON Energie Romania SA and Delgaz Grid SA.

AzoMureș SA also decreased its employment by 68% since 2000 (from 3,531 to 1,120 people). However, it increased turnover six-fold over the same period (from 269 m to 1,633 m RON). Employment trends are detailed in Graph 56 and Table 21.

Graph 56: Employment by sectors of the economy - trends over 2008-2019



Source: NIS, Tempo database (FOM103D - Civil employment population by activity of national economy at level of CANE Rev.2)

Table 21: Employment by sectors of the economy - trends over 2008-2019, detailed view

Sectors of employment	Mureș (thousand people)				National		
	2008	2019	2008-2019		2008	2019	2008-2019
Agriculture, forestry and fisheries	**68.70**	**49.40**	**-28.1%**		**2407.40**	**1747.00**	**-27.4%**
A Agriculture forestry and fishing	68.7	49.4	-28.1%		2,407.4	1,747.0	-27.4%
Industry	**61.2**	**58.7**	**-4.1%**		**1,981.5**	**1,896.5**	**-4.3%**
B Mining and quarrying	3.0	2.4	-20.0%		81.4	50.3	-38.2%
C Manufacturing	52.9	51.4	-2.8%		1,691.0	1,660.2	-1.8%
D Electricity gas steam and air conditioning supply	2.3	1.9	-17.4%		81.8	54.9	-32.9%
E Water supply; sewerage waste management and remediation activities	3.0	3.0	0.0%		127.3	131.1	3.0%
Construction	**14.5**	**15.6**	**7.6%**		**691.5**	**722.8**	**4.5%**
F Construction	14.5	15.6	7.6%		691.5	722.8	4.5%
Services	**92.4**	**105.6**	**14.3%**		**3,666.6**	**4,126.3**	**12.5%**
G Wholesale and retail trade; repair of motor vehicles and motorcycles	29.6	34.8	17.6%		1,168.4	1,267.8	8.5%
H Transportation and storage	12.5	13.0	4.0%		422.0	481.7	14.1%
I Accommodation and food service activities	4.9	5.9	20.4%		161.8	223.6	38.2%
J Information and communication	1.6	3.1	93.8%		131.7	219.5	66.7%
K Financial and insurance activities	2.6	1.4	-46.2%		116.9	100.7	-13.9%
L Real estate activities	0.6	1.2	100.0%		46.9	34.0	-27.5%
M Professional scientific and technical activities	2.7	3.2	18.5%		165.9	212.5	28.1%
N Administrative and support service activities	2.8	6.9	146.4%		217.0	336.8	55.2%
O Public administration and defence; compulsory social security	4.6	4.4	-4.3%		219.8	211.5	-3.8%
P Education	12.6	11.5	-8.7%		431.9	374.8	-13.2%
Q Human health and social work activities	12.7	14.3	12.6%		401.6	438.6	9.2%
R Arts entertainment and recreation	1.7	2.2	29.4%		62.3	83.9	34.7%

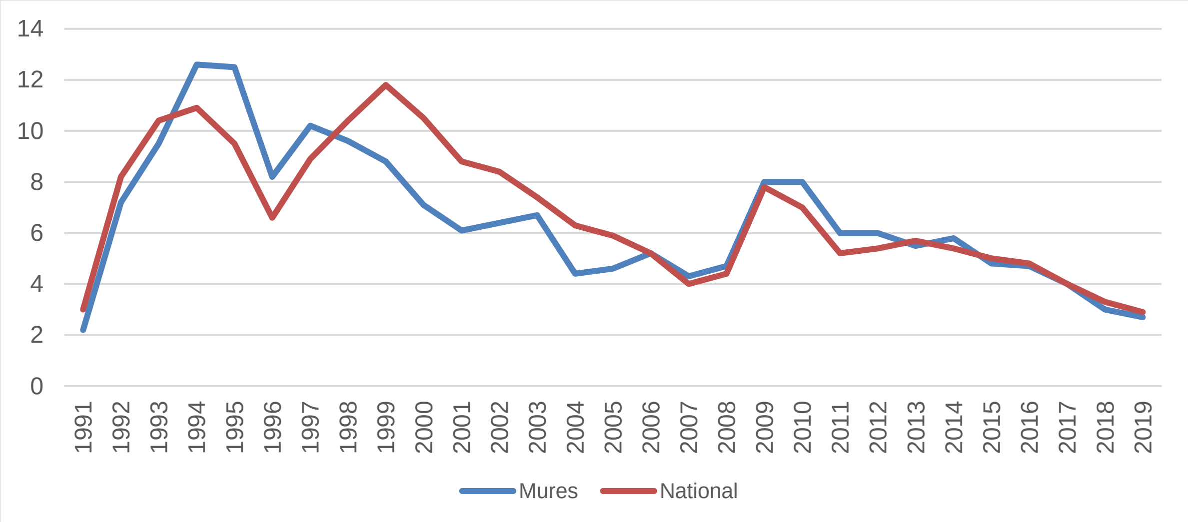
Sectors of employment	Mureș (thousand people)				National		
	2008	2019	2008-2019		2008	2019	2008-2019
S Other service activities	3.5	3.7	5.7%		120.4	140.9	17.0%
Total	**236.8**	**229.3**	**-3.2%**		**8,747.0**	**8,492.6**	**-2.9%**

Source: NIS, Tempo database (FOM103D - Civil employment population by activity of national economy at level of CANE Rev.2)

Târgu Mureș is a university centre featuring a variety of higher education qualifications which supported, over the past decade, the development of higher knowledge intensive services such as medical services and pharmaceuticals. Pharmaceutical production and commerce–a cluster of 50 companies headquartered in Mureș County–employ roughly 2,000 people and generate a turnover of 2,012 m RON (2018), a steady increase from the 733 m RON recorded in 2008.

The unemployment rate in Mureș County is slightly lower than the national average, 2.7% compared to 2.9% in 2019. Over the past two decades, Mureș generally scored better than the national average in terms of unemployment, except for a few years following the financial crisis (see Graph 57).

Graph 57: Unemployment rate (%) in Mureș vs national



Source: NIS, Tempo (SOM103A)

Table 22: Unemployment rate (%) in Mureș vs national

	2015	2016	2017	2018	2019
Mureș	4.8	4.7	4	3	2.7
National	5	4.8	4	3.3	2.9

Source: NIS, Tempo (SOM103A)

The total number of active professionals (including companies and self-employed) from 2014 to 2020 in the county increased by 8,244, representing 2.43% of the active professionals in the country (2019). (see Table 23 and Graph 58).

Table 23: Total number of AP&SE, NP and CP in Mureș county 2014-2020

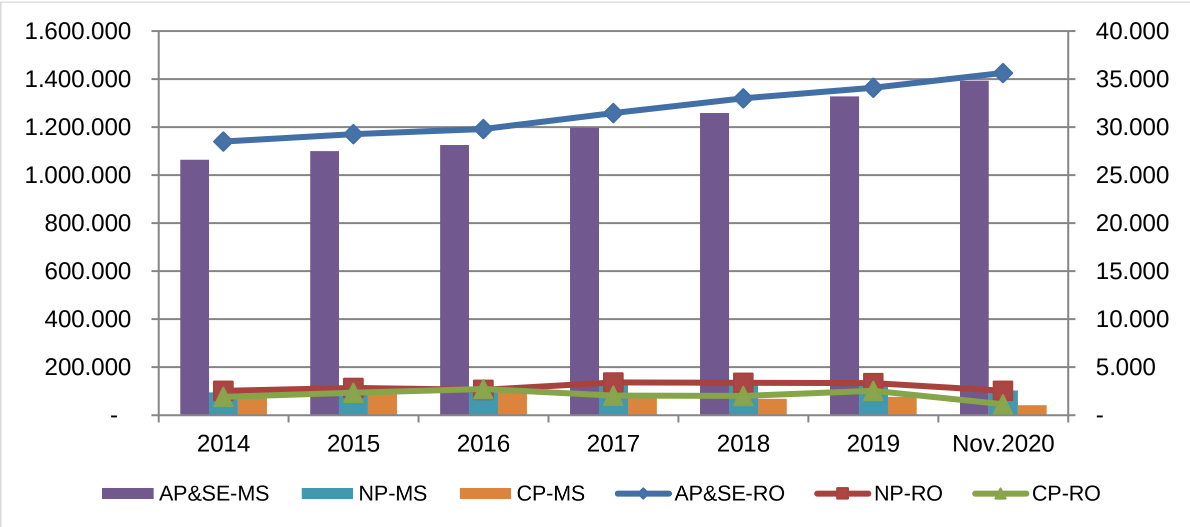
	2014	2015	2016	2017	2018	2019	Nov.2020
AP&SE-RO	1,139,803	1,170,316	1,191,738	1,258,536	1,319,921	1,363,651	1,425,674
NP-RO	101,627	113,167	105,982	136,699	135,532	134,220	101,706
CP-RO	76,483	94,374	109,113	82,295	80,181	101,601	45,915
AP&SE-MS	26,593	27,494	28,133	29,945	31,470	33,184	34,837

	2014	2015	2016	2017	2018	2019	Nov.2020
NP-MS	2,394	2,623	2,483	3,326	3,225	3,458	2,578
CP-MS	1,862	2,478	2,519	1,847	1,717	1,929	1,034

Source: Romanian Trade registry

The evolution of the Total number of active professionals and self-employed (AP&SE), new professionals registered (NP) and Closed Professionals (CP) in Mureș County compared with the country's total data for the period 2014–November 2020 is presented in the Graph below.

Graph 58: Evolution of the number AP&SE, NP and CP in Mureș county 2014-2020



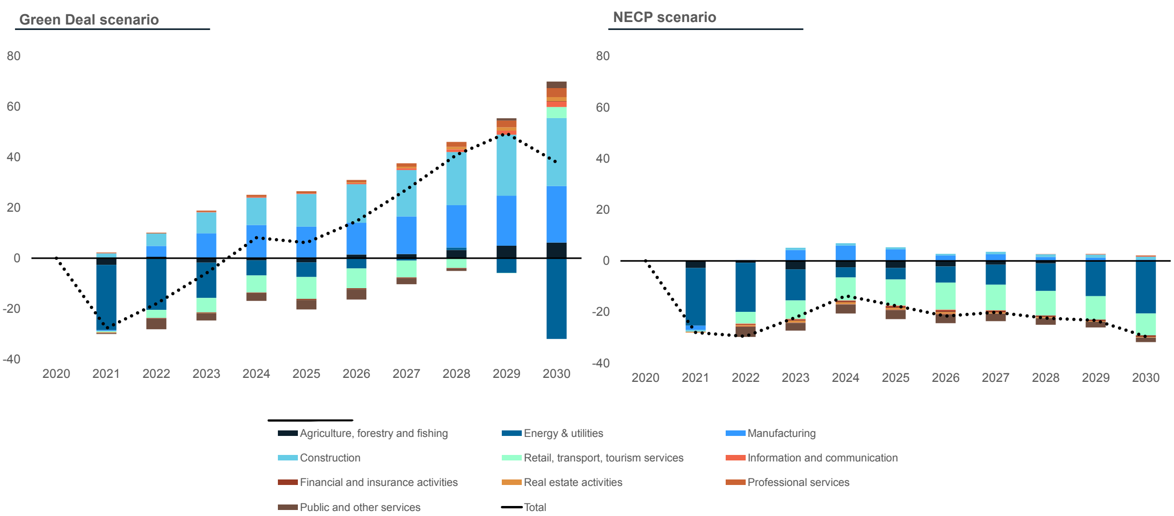
Source: Romanian Trade registry

➢ **Regional transition impact**

GVA

According to the preliminary modelling at sectoral level, the highest negative GVA impact across all sectors in the NECP scenario is estimated in the energy & utilities sector and the retail sector. Together, the difference from baseline in these sectors amounts to EUR 30 million in 2030 (or 0.6% of projected regional GVA in the baseline). Effects in other sectors are relatively limited (see Graph 59). As discussed previously, the decrease in the retail and services sectors are due to higher ETS prices and ETS extension, while energy "losses" compared to the baseline result from a slower deployment of RES in the county (compared to the baseline)

Graph 59: NECP scenario, GVA, million EUR difference from baseline



Source: CE modelling

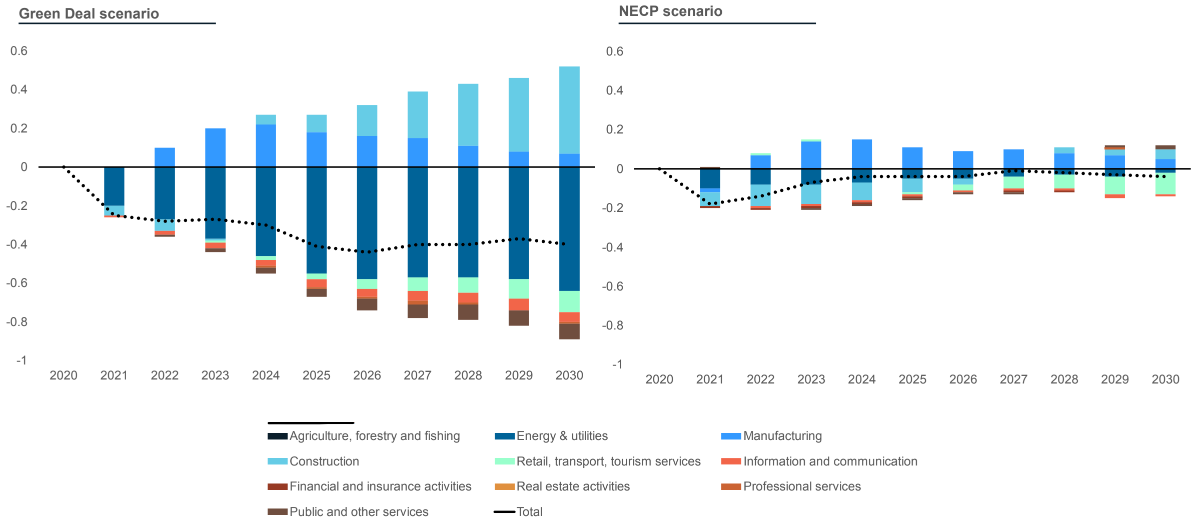
The GVA impact (Graph 59, left panel) in the GD scenario follows a dynamic that has been described while discussing the national level modelling results. GVA changes (compared to baseline) fluctuate in the energy sector (between 0 and EUR 30 million reduction), and there is evidence of the same price effects affecting the retail and services sector as in the NECP (between EUR 9 million reduction and EUR 4 million gain compared to the baseline). Nonetheless, results are driven by increased activity in the manufacturing and construction sectors (a consequence of decarbonisation policies), which adds about EUR 50 million GVA in the county by 2030 (or 1% of projected regional total GVA).

Employment

Similar to the national results, the employment results of the scenarios contrast with the GVA results. The employment levels in the NECP scenario are close to baseline, despite the higher than baseline GVA results. The employment levels in the GD scenario show decreased levels (compared to the baseline).

Sectoral differences in the NECP scenario are relatively muted. Construction, retail and services employment is somewhat lower compared to the baseline. This is explained by a lower rate of RES deployment (construction) and the effect of ETS prices (retail and services). In the GD scenario, impacts are much more pronounced, while there are substantial gains (compared to the baseline) in the manufacturing and construction sectors (over 500 jobs by 2030) this is offset by losses in the energy & utilities sector due to the decarbonisation of the energy sector (over 600 jobs by 2030, decarbonisation includes gas-based power generation in the GD scenario).

Graph 60: NECP scenario, employment, ‘000 jobs difference from baseline

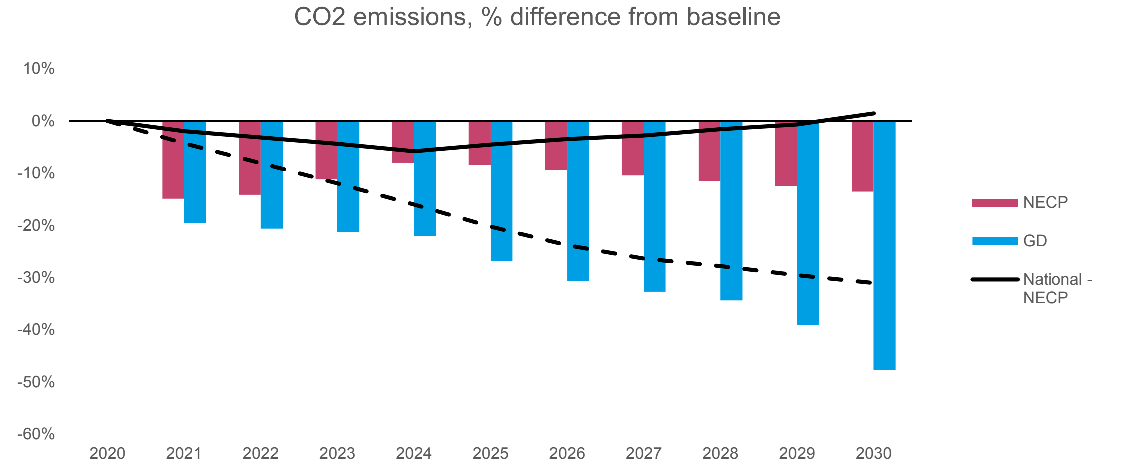


Source: CE modelling

CO_2 emissions

In terms of CO_2 emissions, both the NECP and the GD scenarios yield results in Mureș that are higher than the national emission reduction. In the GD scenario, emissions reduction reaches 48% by 2030 (compared to the baseline), while the NECP yields a reduction of about 14% in the county, despite a total national change of a 1.5% increase.

Graph 61: CO2 emissions, % difference from baseline



Source: CE modelling

In Mures, the NECP scenario exhibits GVA losses compared to the baseline (approximately EUR 30 million), while GVA in the GD scenario is higher than the baseline by approximately EUR 40 million, driven by increased activity in the manufacturing and construction sectors (a consequence of decarbonisation policies). Employment levels are close to baseline in the NECP scenario and show decreased levels in the GD scenario (compared to the baseline) - with gains in the manufacturing and construction sectors offset by losses in the energy and utilities sector. Both the NECP and the GD scenarios yield emissions decreases vis-a-vis the baseline.

Dolj County

➢ **Overview**

Dolj is the largest county in the southwest Oltenia region and one of the largest in Romania with an area of 7.414 sq. km. The region has 686,350 inhabitants, which represents 31% of the southwest Oltenia population. Some 304,142 people, representing 43.7% of the region's population, live in the economic and social urban centre of the county and region, Craiova (the county seat city).

➢ **Demographics**

The administrative structure of Dolj county includes three municipalities (Craiova, Bailesti and Calafat), four cities (Segarcea, Bechet, Filiași and Dabuleni), 104 communes and 378 villages. The county seat, Craiova, is also the most important economic and social centre in the county, with others grouped on the southern part on the Danube bank, small in size with a predominantly agricultural profile,

The number of inhabitants has decreased continuously at a relatively constant pace in the rural areas while in the urban area the evolution looks less severe. For instance, in 2017-2018 the Craiova municipality registered a decrease of 1,600 inhabitants (0.52%). The decline was strongly influenced by the migratory movement (see Tables 24 and 25 and Graphs 62 and 63).[134]

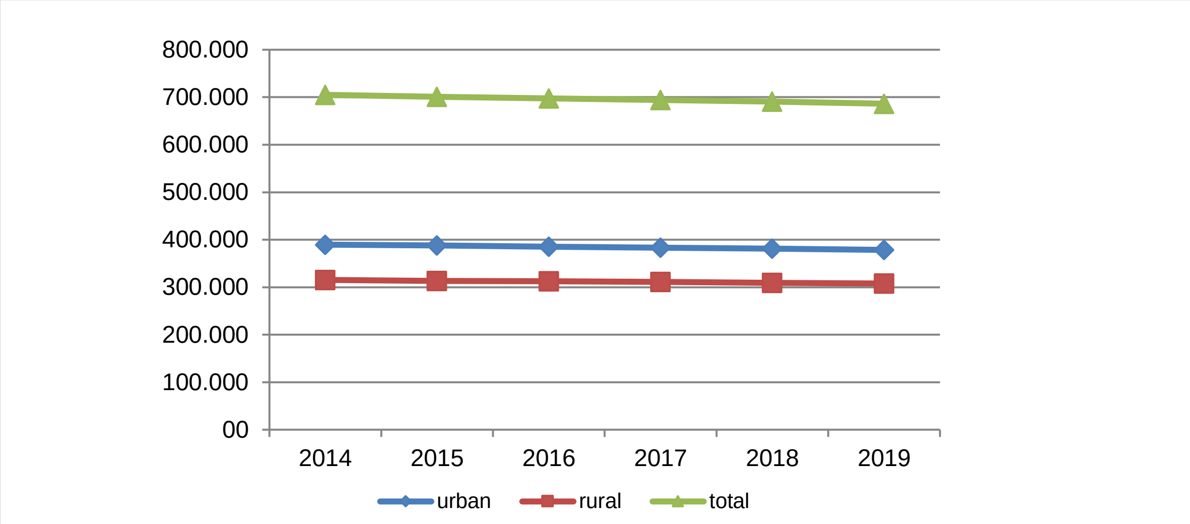
Table 24: Number of inhabitants urban/rural Dolj county 2014-2019

	2014	2015	2016	2017	2018	2019
Urban	389,625	387,707	385,116	383,416	381,266	378,571
Rural	315,382	313,542	312,775	311,084	309,490	307,779
Total	**705,007**	**701,249**	**697,891**	**694,500**	**690,756**	**686,350**

Source INS, TEMPO online

[134] The continuous decline of the population between 2014 and 2019 in Dolj county, from 705,007 in 2014 to 686,350 inhabitants in 2019, means a decrease of 18.657 people more than the number of residents from Bailesti, one of the smaller cities with about 17,500 residents.

Graph 62: Number of inhabitants urban/rural Dolj county 2014-2019

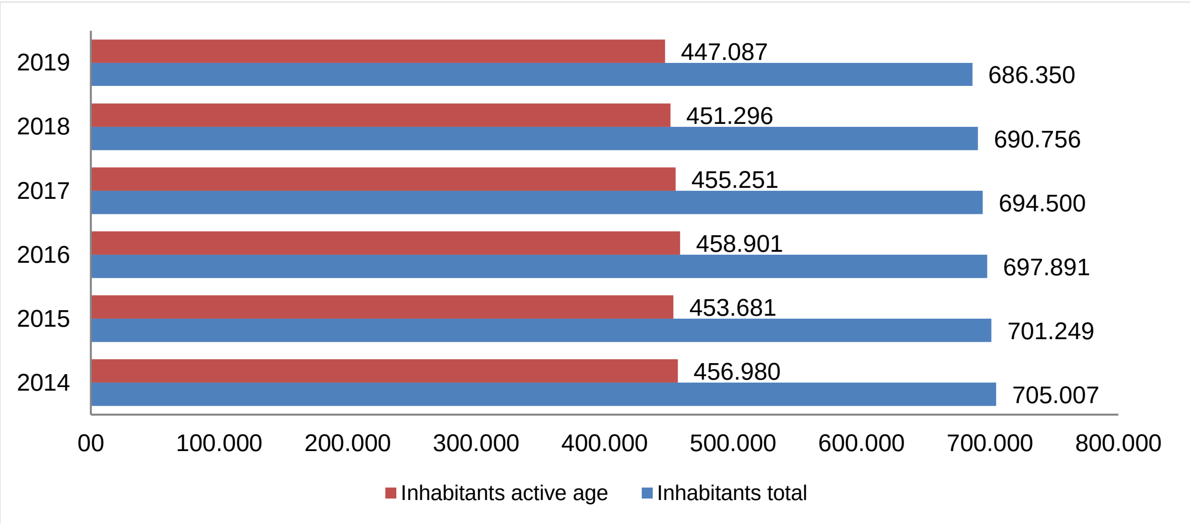


Source NSI, TEMPO online

Table 25: Number of inhabitants compared to inhabitants in active age Dolj county, 2014-2019

	2014	2015	2016	2017	2018	2019
Inhabitants total	705,007	701,249	697,891	694,500	690,756	686,350
Inhabitants in active age	456,980	453,681	458,901	455,251	451,296	447,087

Graph 63: Number of inhabitants compared to inhabitants in active age Dolj county, 2014-2019

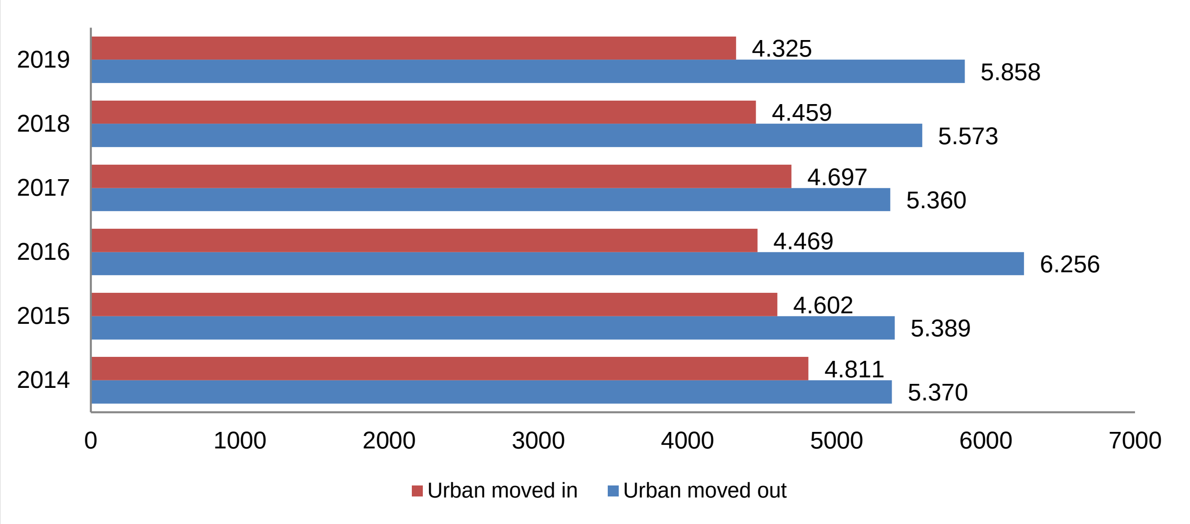


Source NSI, TEMPO online

The number of working age inhabitants (15-65 years) represented 65% of the total population in 2019, almost the same as in the year before and similar to the 2014-2018 interval.

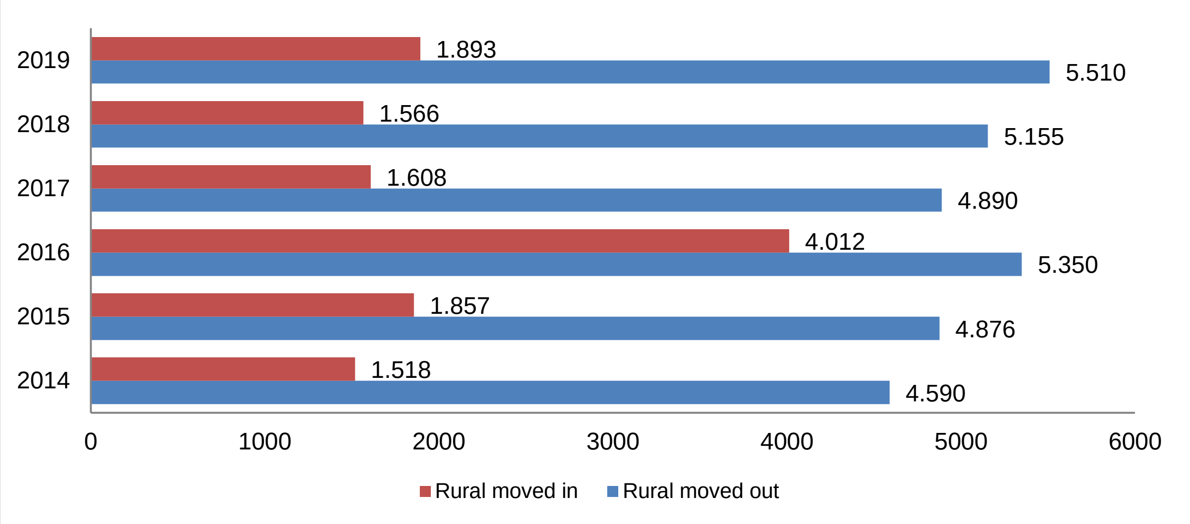
Moreover, a closer look at the structure of the population by age and area of residence depicts the fact that the aging process of the population is consistently more advanced in rural areas where 20,7% of the inhabitants are over 65 years old compared to urban area with 15,6% in 2019, relatively constant for last few years.

Graph 64: Migration out of the county compared to new comers in the county urban area, Dolj, 2014-2019



Source: NSI, TEMPO online

Graph 65: Migration out of the county compared to new comers in the county rural area, Dolj, 2014-2019



Source: NSI, TEMPO online

The consistent negative trend results from the combination of less natural growth and emigration and local migration (to other counties of Romania). In 2019, 5,858 people decided to move to another county or region of Romania while 4,325 people chose to resettle in Dolj, a net loss of 1,533 inhabitants in urban areas. In rural areas, the decrease was even more severe in recent years: 5,510 people left for another county while 1,893 people resettled in Dolj - a decrease of 3,617 people.

The temporary leave of people in search of better paid jobs in the European area is a growing phenomenon in the last three to five years and does not show any sign of diminishing. A small number of those who have left temporarily decide, in time, to apply for residence documents and settle in the country where they migrated.

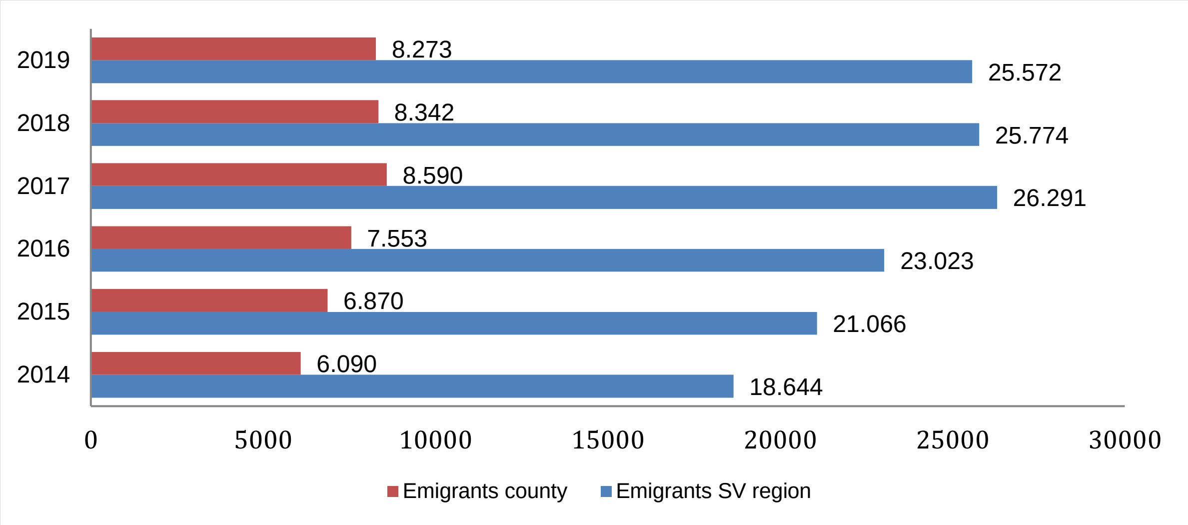
This constantly negative trend results from the combination of the negative values of natural growth with those of emigration and local migration (in other counties of Romania) not to count the immigration factor which has low values and can't make a relevant impact.

Between 2014 and 2019, the number of emigrants, both temporary and permanent, has increased from 6,090 to 8,723, a percentage of 43.2%. The number of people who emigrate from Dolj County every year represents a share of 30% from the regional total.

Table 26: Number of emigrants, both temporary and permanent residence in other country, Dolj county, 2014-2019

	2014	2015	2016	2017	2018	2019
Emigrants SW region	18,644	21,066	23,023	26,291	25,774	25,572
Emigrants county	6,090	6,870	7,553	8,590	8,342	8,273

Graph 66: Number of emigrants, both temporary and permanent residence in other country, Dolj county, 2014-2019



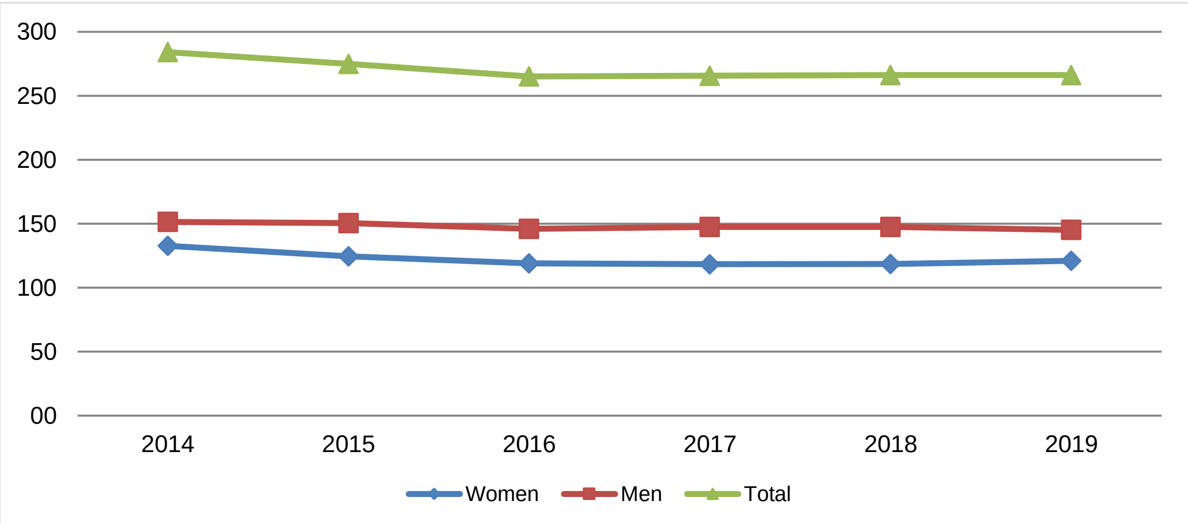
Source: NSI, TEMPO online

The decreasing population trends have impacted the labour force in Dolj. In 2019, the level of labour resources decreased by 9% compared to 2014.

Table 27: Active population women/ men Dolj county 2014-2019 (thousands of people)

	2014	2015	2016	2017	2018	2019
Women	132.7	124.6	119.0	118.4	118.6	121.0
Men	151.4	150.4	146.1	147.4	147.5	145.2
Total	**284.1**	**275.0**	**265.1**	**265.8**	**266.1**	**266.2**

Graph 67: Active population women/ men Dolj county 2014-2019 (civile, thousands of people)



Source: NS, TEMPO online

The active population of Dolj is 266,200, of which 145,200 are men (54.6%) and 121,000 are women (45.4%). The population has a slight downward slope from 2014-2019.

The unemployment rate at the county level decreased from 9.4% in 2014 to 6.7% in 2019, which is above both the regional average of 3.4% and the national average of 2.9%.

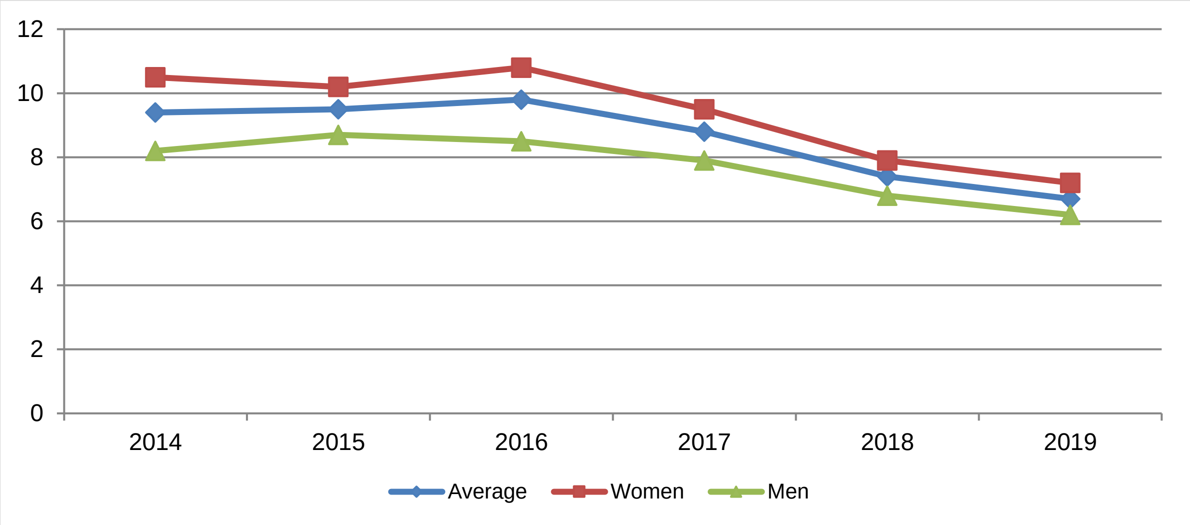
Importantly, 79.3% of the unemployed come from rural areas. The risk of unemployment generally increases with age. The most vulnerable are those who qualified in the former communist regime (before 1989) in professions that are no longer required in the local labour market. By age, 30.4% of the unemployed were between 40-49 years old in 2014, 27.7% were over 50 years old, 23.3% between 30-39 years old, and 18.6% were under 30 years old.

Table 28: Unemployment rate women/ men, Dolj county 2014-2019

	2014	2015	2016	2017	2018	2019
Women	10.5	10.2	10.8	9.5	7.9	7.2
Men	8.2	8.7	8.5	7.9	6.8	6.2
Average	**9.4**	**9.5**	**9.8**	**8.8**	**7.4**	**6.7**

Source: INS, TEMPO online

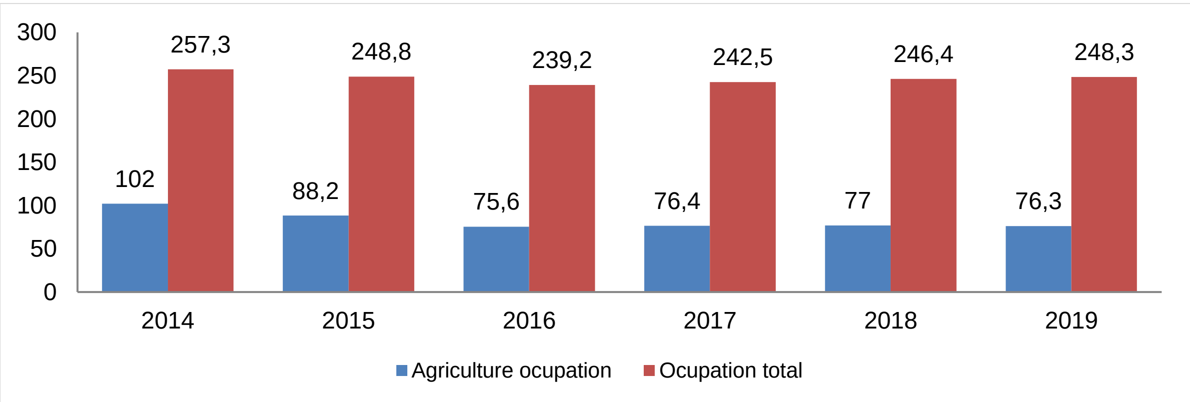
Graph 68: Unemployment rate women/ men, Dolj county 2014-2019



Source: NSI, TEMPO online

Regarding the workforce and employment structure, Dolj has a high share of workers in the primary (e.g., agricultural) sector, with 76,300 workers in 2019. This accounts for more than 30% of the total occupied population. However, the evolution of the agricultural sector shows a consistent decline in employment from 2014 to 2019 (see Graph 69).

Graph 69: Number of people in agriculture sector Dolj county 2014-2019

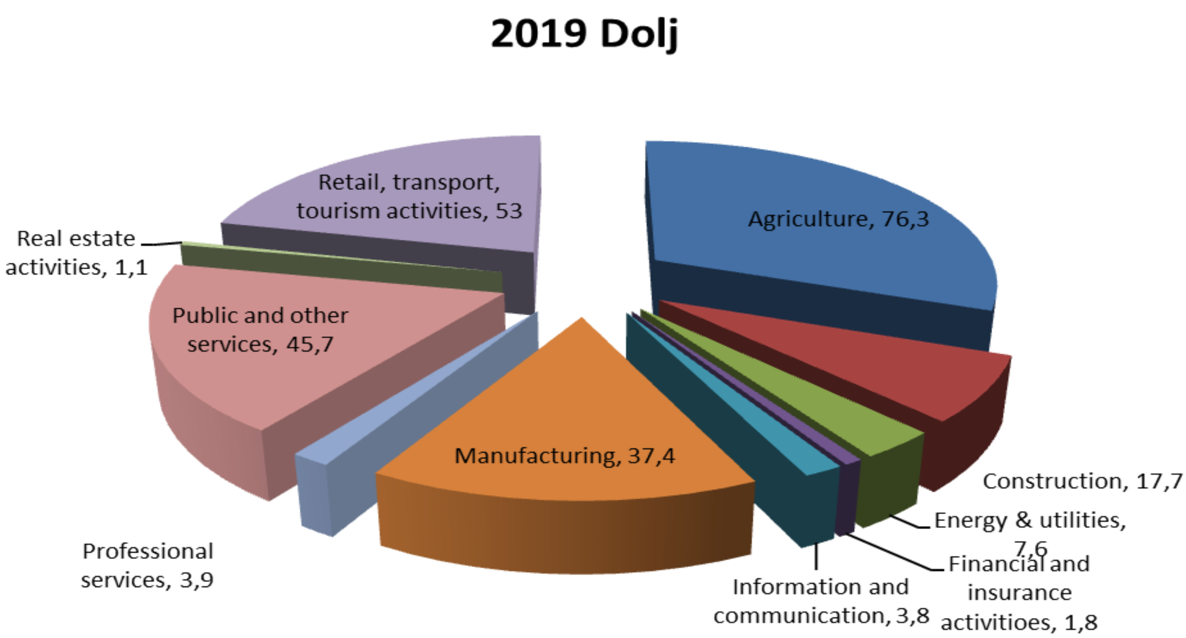


Source: NSI, TEMPO online

The services sector is the most relevant from the jobs perspective in Dolj County, as it provided in 2019 a significant share from the total jobs, with almost 6% more than in 2014.

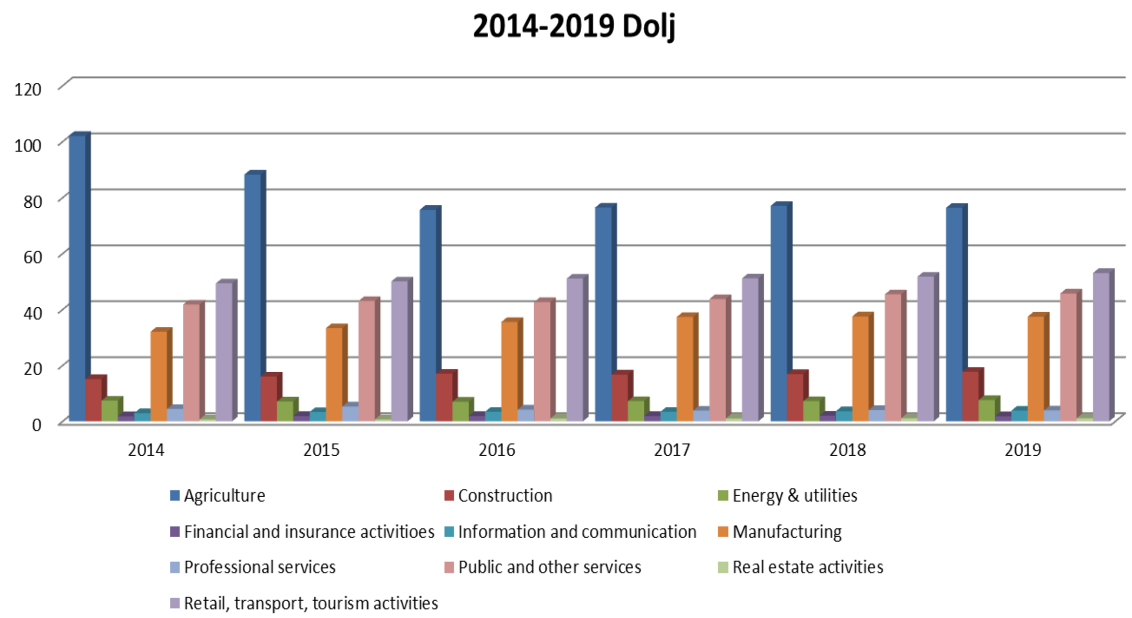
More than 21% of the total Dolj workforce was engaged in retail, transport and tourism activities in 2019, a gain of 2.1% since 2014. Manufacturing activities accounted for 15% of jobs in 2019, an increase of 2.7% from 2014. Construction activities accounted for 7.1% of jobs in 2019, 2.2% higher than 2014.

Graph 70: Workforce share per economy sectors Dolj county 2019



Source: NSI, TEMPO online

Graph 71: Workforce evolution per economy sectors in Dolj county 2014-2019



Source: NSI, TEMPO online

In 2018, the South West Oltenia region had the lowest average number of employees compared to other regions. Despite the decline of inhabitants, the evolution of employees in Dolj County is positive and ranks first among the counties in southwest region, with 130,506 people in 2018 and 134,187 in 2019.

- **Local economy context and trends**

Regarding the Dolj economy, the GDP is RON 23.735,9 m and contributes 2.5% to the national GDP.

Before 1989, the Dolj economy developed intensively through the forced industrialisation and urbanisation process by building factories and industrial enterprises with thousands of employees. Several industries thrived during this time, including: the production of locomotives, engines and electric transformers ("Electroputere Craiova"), automobiles ("Oltcit Craiova"), airplanes and components for aviation ("Avioane Craiova"), chemical fertilizers and synthetic products ("Doljchim"), and the production of electricity ("Isalnita Thermal Power Plant"). During this time, Dolj was also one of the most important agricultural areas in Romania. These traditional industries have been maintained over the years, varying by weight and structure.

Currently, the production of cars and car components is concentrated through Ford Romania, which is extremely important in the economic landscape of the region. Ford has more than 6,000 employees and numerous component suppliers that boost the local economy. The Craiova Aircraft Factory, established for the purpose of producing military aircraft for the Romanian Air Force (IAR 93, IAR 99), continues modernisation work and maintenance services for military aircraft and today employs about 300 people (275 in 2019), which has been relatively constant in the last six years. However, this figure pales in comparison to the pre-1989 peak of 45,000 employees.

The energy industry has developed around the Isalnita and Craiova II thermal power plants, both using coal supplied from the lignite mines in the Oltenia basin. With 634 employees, the Isalnita thermal power plant has an installed capacity of 630MW while Craiova II has 569 employees and 300 MW. Both facilities are administered by Oltenia Energy Complex (OEC), which started a restructuring process in 2020.

In addition to traditional industries, many local activities have high potential through internal and external competitive advantages, such as: textile and clothing industry, food industry, electrical equipment industry, agro-food products, railway transport equipment and emerging activities such as the production of plastics (especially PVC joinery), metal construction, machinery and equipment and construction materials.

The service sector also consistently contributes to the local economy. However, over the last ten years, the share of services has decreased slightly in favour of the primary and secondary sectors. However, some service sub-sectors have grown in recent years such as commerce (wholesale and retail), transport and storage, hotels and restaurants, information and communications. For instance, in the commerce sub-sector, turnover increased between 2014 and 2018 by 3.602 trillion RON while the hotels and restaurants sub-sector increased turnover by 241 trillion RON and added 600 employees.

The economic profile of Dolj is industrial-agrarian by tradition, with roots from the communist period. During the last ten years, the share of these two primary sectors increased. Consequently, the region has one of the highest employment rates of agricultural activities in Romania with 76,300 people in 2019. This is a slight decline compared to 2018 (77,000 people) and 2014 (102,000 people).

The Craiova **county seat is also a university centre** two state universities and one private university that generate research and innovation as well as provide technology transfer infrastructure.

The energy sector in Romania has been in transformation over the last 30 years. The main reasons for changes in energy production were induced by general economic trends, low profitability or the lack of adaptation to the new environmental norms.

In the context of current European decarbonisation policies, the transition to an environmentally friendly economy presents a challenge to the Romanian energy sector and Dolj County. The thermal power plants from Isalnita and Craiova II is no exception.

Under the administration of the OEC, the two thermal power plants will enter the restructuring programme as a result of a rescue loan obtained from the European Commission, by the final EC Decision 1068 of 24 February 2020. The restructuring programme has been developed based on a detailed modelling approach that accounts for aspects of the business and includes an investment plan (decarbonisation plan) that will ensure the viability of OEC and will be implemented in 2021.

For Isalnita, the installed power of 630 MW will be reduced by half from 2021 by closing one of the two plants of 315 MW, and the second plant will be closed until 2025. Starting in 2026, the plant will operate on natural gas with a capacity of 850 MW. A photovoltaic park will be built on the closed slag and ash deposits.

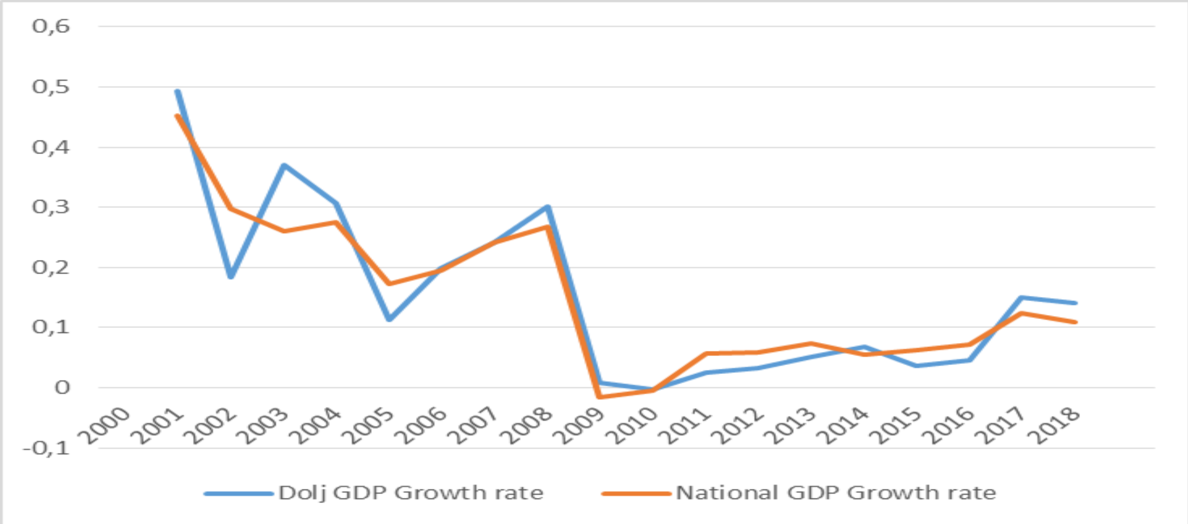
For Craiova II, the 300 MW plant will remain operational until 2023, at which point it will be outsourced to local authorities and will continue to provide heat for Craiova inhabitants. A new 200 MW facility using natural gas will be built to replace the old lignite plant. Specific funds will be accessed to carry out the modernisation (such as the Modernisation Found).

With these transition measures the employment impact will be immediate and propagate in the local community. According to the human resources strategy included in the restructuring programme, the impact will be mitigated by detailed planning measures for jobs and functions, aiming to keep as many employees as possible. The impact of the transformations will impact both employment at the thermal power plants as well as other actors in the supply chain.

According to estimations from the National Commission for Strategy and Forecast, the South West Oltenia region is projected to contribute similar figures to the national GDP: 7.76% in 2019 and 7.84% in 2022 compared to 7.75% in 2018.

Within the development region, the highest GDP values were registered by Dolj County over the 2014-2018 period (RON 23,735.9 m in 2019) and this trend is expected to continue during the next forecast period (2019-2022).

Graph 72: GDP evolution Dolj county 2000-2018

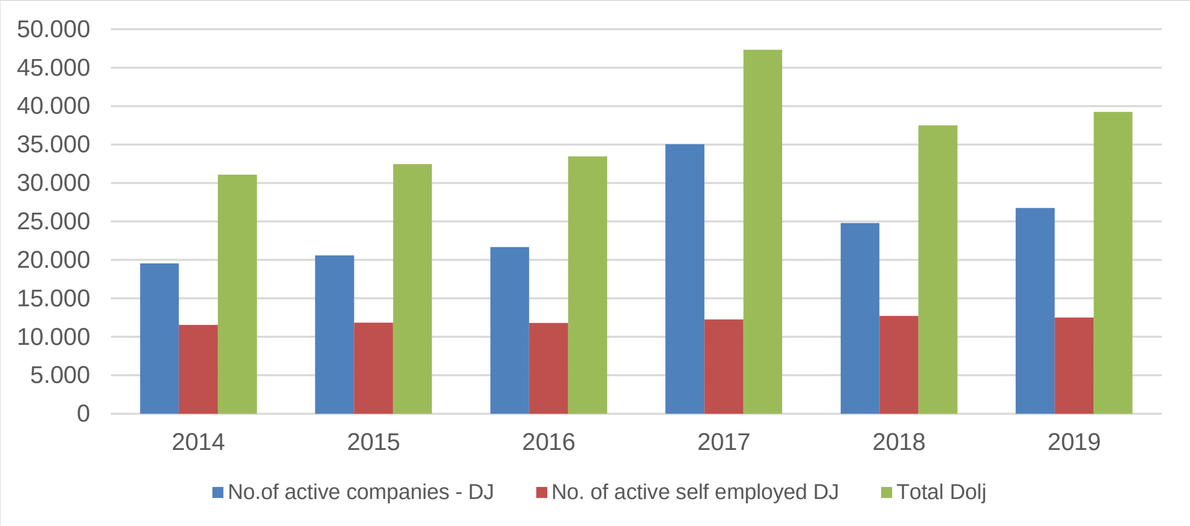


Source: NSI, TEMPO online

Table 29: Number of active companies and active self-employed in Dolj county 2014-2018

	2014	2015	2016	2017	2018	2019
No. of active companies	19,531	20,608	21,692	35,055	24,808	26,748
No. of active self employed	11,547	11,850	11,787	12,270	12,702	12,499
County total	**31,078**	**32,458**	**33,479**	**47,325**	**37,510**	**39,247**

Graph 73: Number of active companies and active self-employed in Dolj county 2014-2018



Source: ONRC

Dolj County has the most active enterprises in the South West Oltenia region (37% of total enterprises). The distribution by sector shows an increased concentration in retail, transport, tourism activities (21.3%), manufacturing activities (15.1%), construction (7.1%) and public and other services (18.4%).

Dolj County has the most companies (20 firms) in the top 50 ranking of the largest companies in the southwest region, which includes: Ford Romania, Cez vanzare, Distributie Energie Oltenia, Cummins Generator Technologies Romania SA, Dumagas Transport SA, Azalis SRL, Comdata Service SRL, and Foraj Sonde SRL.

The total number of active professionals (including companies and self-employed) between 2014–2019 increased by 32,593, representing 9.84% of active professionals in the country (see Table 30).

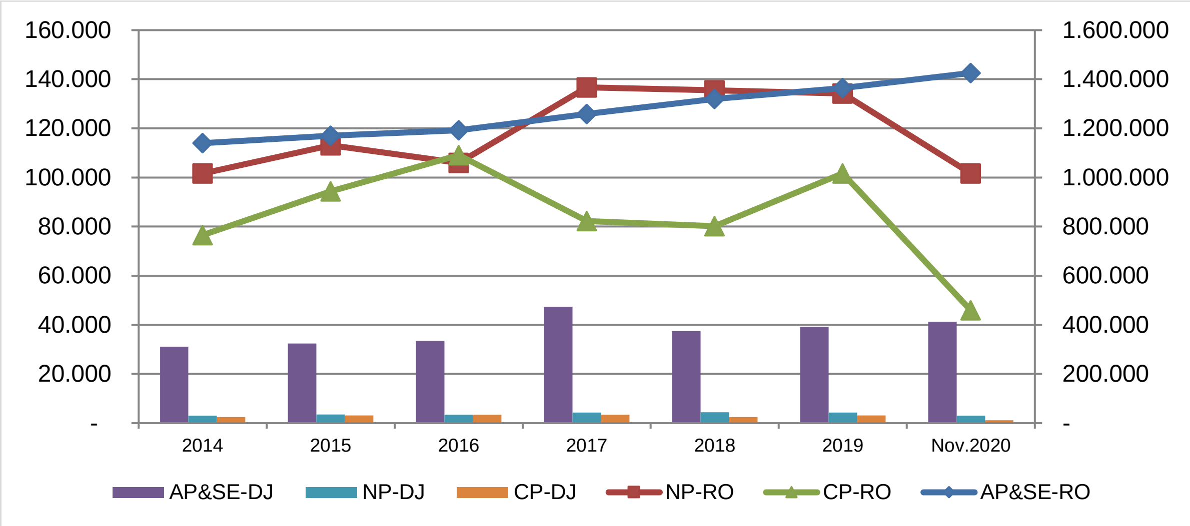
Table 30: Total number of AP&SE, NP and CP in Dolj county 2014-2020

	2014	2015	2016	2017	2018	2019	Nov.2020
AP&SE-RO	1,139,803	1,170,316	1,191,738	1,258,536	1,319,921	1,363,651	1,425,674
NP-RO	101,627	113,167	105,982	136,699	135,532	134,220	101,706
CP-RO	76,483	94,374	109,113	82,295	80,181	101,601	45,915
AP&SE-DJ	31,078	32,458	33,479	47,325	37,510	39,247	41,278
NP-DJ	2,962	3,505	3,401	4,334	4,477	4,281	3,001
CP-DJ	2,464	3,196	3,340	3,389	2,478	3,147	1,141

Source: Romanian Trade Registry

The total number of active professionals and self-employed (AP&SE), new professionals registered (NP) and closed professionals (CP) is presented in Graph 74. The graph compares Dolj County to national data for the 2014–2020 period.

Graph 74: Evolution of the number AP&SE, NP and CP in Dolj county 2014-2020



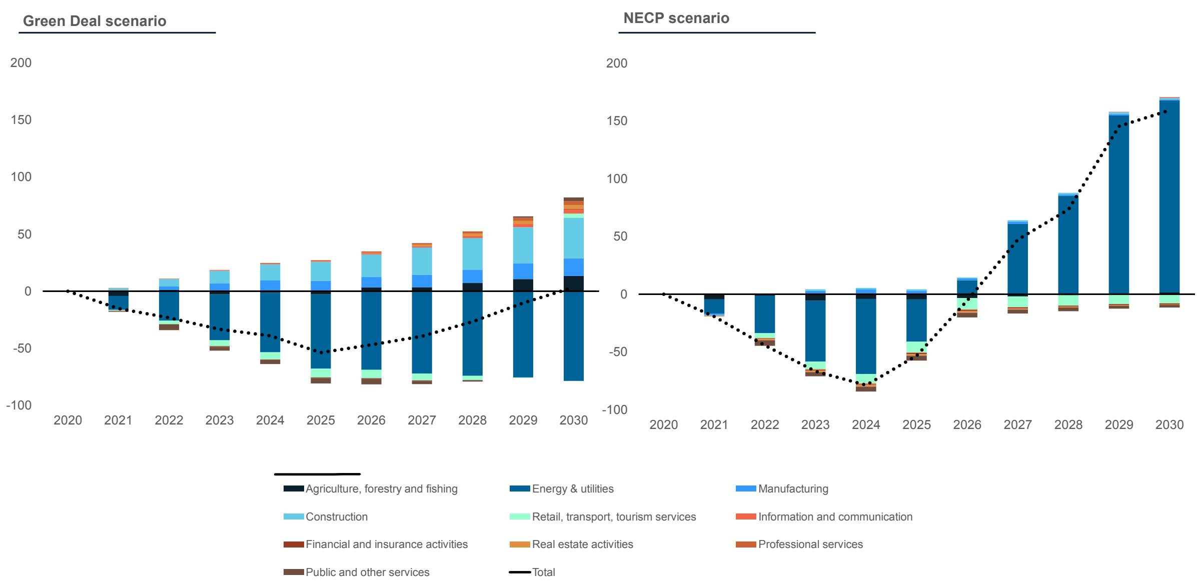
Source: Romanian Trade Registry

➢ **Regional transition impact**

GVA

GVA impacts in Dolj are driven by the energy sector. In the NECP scenario, the main rational behind this effect is the concentration of coal related activities in Dolj and in Gorj counties. The simulated GVA difference in the energy sector (compared to the baseline) in the NECP scenario is about EUR 160 million by 2030 (or about 2.7% of the total region GVA compared to baseline). Meanwhile, the sector decreases in the GD scenario (compared to the baseline) as a result of decarbonisation. The loss is about EUR 79 million in GVA terms compared to the baseline. However, there are several sectors with positive outcomes (higher GVA) in the GD scenario, most prominently manufacturing and construction (connected to RES deployment for example). Together, these sectors produce GVA gains that offset the energy sector losses. Thus, the net GVA effect is positive in the GD scenario as well by 2030.

Graph 75: NECP scenario, GVA, million EUR difference from baseline

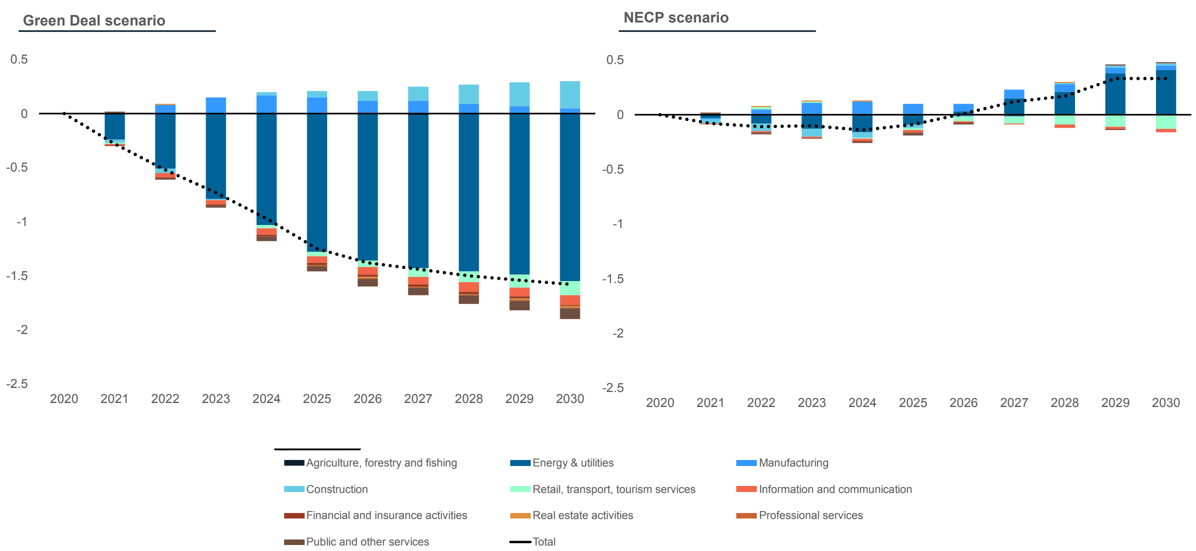


Source: CE modelling

Employment

Employment outcomes in the scenarios reflect their characteristics. Results in the GD scenario show the positive impact in the construction and manufacturing sectors, but also show that these gains are insufficient to offset larger losses in the energy sector. Energy sector losses amount to about 1,500 jobs in the region. In the NECP scenario, however, as one of the main assumptions of the scenario is that coal-based capacities are kept open, a positive employment impact (compared to the baseline) is observed. Employment in the energy sector is about 400 jobs higher by 2030 than in the baseline.

Graph 76: NECP scenario, employment, '000 jobs difference from baseline

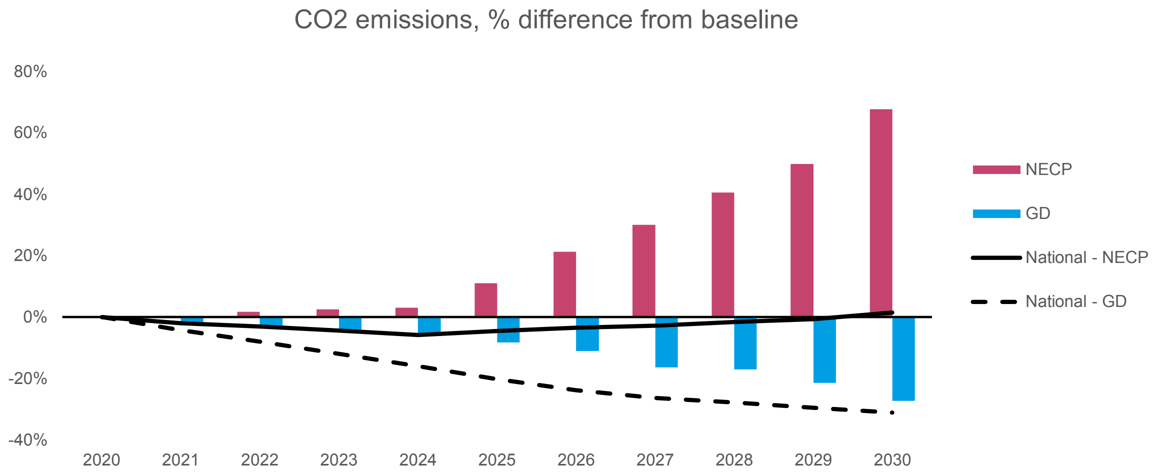


Source: CE modelling

CO_2 emissions

In terms of CO_2 emissions, both scenarios yield results close to the national outcomes. The GD scenario is slightly beneath (27%) the national outcome of 31%. Nevertheless, the NECP scenario is well above the national outcome. The result indicates that in the NECP scenario in the county CO_2 emissions are 68% higher than in the baseline. This is explained by coal-based power generation that is kept active in the scenario and which is concentrated in this region.

Graph 77: CO2 emissions, % difference from baseline



Source: CE modelling

Green scenarios affect Dolj due to the concentration of coal activities in the region. In the GD scenario, regional GVA is lower than the baseline by EUR 79 million, while in the NECP (not so green) scenario, it is EUR 160 million higher. Compared to baseline, in the GD scenario, approximately 1,500 additional jobs are lost, mostly in the energy sector (the baseline has pronounced negative trends in both agriculture and manufacturing). In the NECP scenario, CO2 emissions are 68% higher than in the baseline in the region.

Hunedoara County

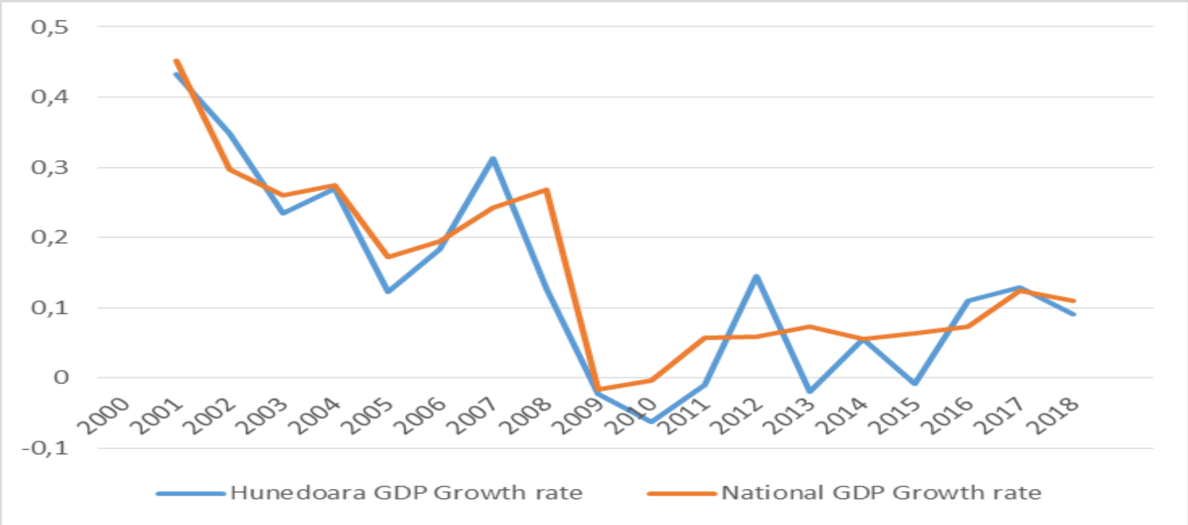
- **Overview**

With an area of 7,063 sq. km., Hunedoara is located on the middle course of the Mureş River, in the vicinity of the Apuseni Mountains, Orăștiei and Şureanu, Retezat-Godeanu, Vâlcan and Parâng and Poiana Ruscă. The most important rivers in the region include the Mureș, Strei, Mare River, Crișul Alb, and Jiu. The beauty and variety of the natural setting, the thermal water resorts of Geoagiu and Calan, as well as the richness of cultural elements (artistic, ethnographic, historical) give Hunedoara tourism potential. The potential tourist destinations being grouped into five main areas: Ținutul Pădurenilor (Forestland), Țara Zarandului, Valea Mureșului, Țara Hațegului, Jiului Valley.

Hunedoara is part of the west development region along with three other counties: Timis, Arad and Caras-Severin. As one of the most industrialised counties of Romania before the 1990s, the decline of the main industrial sectors, metal production and heavy industry, energy production and the mining activities and the population migration as a consequence of the Romania's economy restructuring process, led to a lower contribution of Hunedoara county to the national and regional economy.

In 2018, Hunedoara GDP was RON 14,784.3 m, which represents a 1.55% contribution to the national GDP. The GDP growth rate of 9% was the lowest among the six counties included in the study.

Graph 78: GDP evolution Hunedoara county 2000-2018



Source: NSI, TEMPO online

The mining, heavy industry, metallurgical and steel industries still operating in Hunedoara county are a small footprint of the region's robust industrial past. After the closure of mines and factories, some enterprises were set up to operate in the extractive industry, especially building materials and rocks. Additionally, several enterprises operate in steel and metallurgy through steel production and various raw or finished materials of metal.

Most of the mining holdings are now closed or included in a closure programme in the coming years. The first mining operations planned for closure during 2021–2022 are Lonea and Lupeni, due to security reasons (self-ignition). The deadline for closure is 2024. The Livezeni and Vulcan mines will remain operating to provide raw material (coal) to Hunedoara until 2026.[135]

The steel and metallurgical plants located in Hunedoara and Calan have ceased operations, with the exception of some enterprises/parts/point processes that were saved by the acquisition of economically viable units by companies with foreign capital during 2004-2006 (e.g. LNM Holding that transformed into ArcelorMittal Hunedoara, although in a greatly diminished capacity).

[135] Interview with the representatives of CE Hunedoara

- **Demographics**

The administrative structure of Hunedoara County includes seven municipalities (Deva, Hunedoara, Petroşani, Vulcan, Lupeni, Brad, Orăştie), seven cities (Călan, Haţeg, Petrila, Uricani, Aninoasa, Simeria, Geoagiu) and 55 communes.

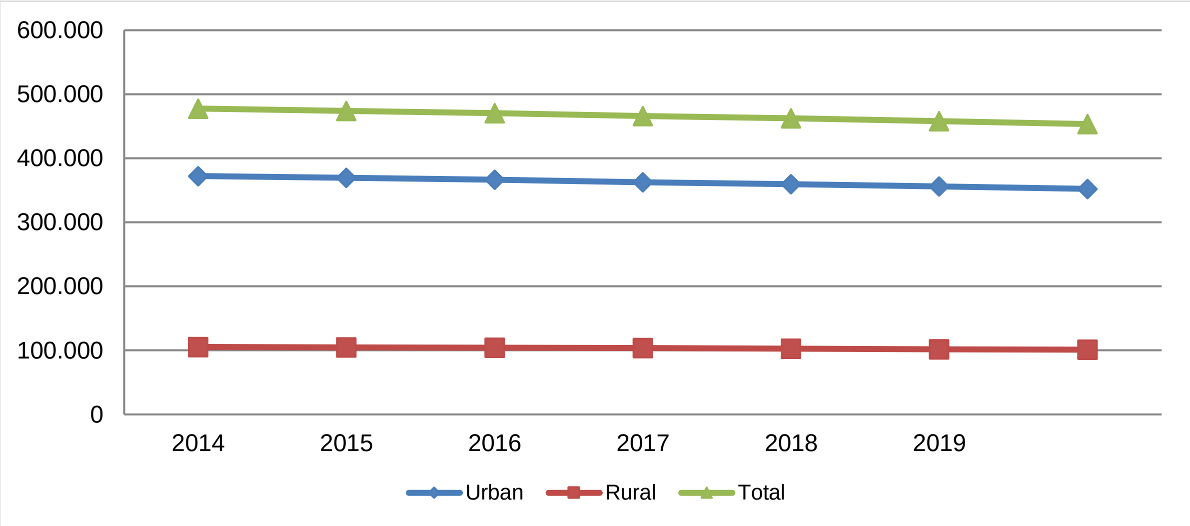
By population, Hunedoara county ranks third after Timiş and Arad. A large share of the population lives in urban areas (77.7%), which is much higher than the national average. In 2015, Hunedoara county had the highest urban population percentage in Romania.

According to the 2011 General Census of Population and Housing, Hunedoara county had a population of 660,544 inhabitants, representing 3.3% of Romania's total population and 31.8% of the west region. After severe migration from 1996–2014, the population of Hunedoara fell to 453,431 inhabitants.

Table 31: Number of inhabitants urban/ rural Hunedoara county 2014-2019

	2014	2015	2016	2017	2018	2019	2020
Urban	372,301	369,472	366,402	362,753	359,675	356,255	352,298
Rural	105,374	104,706	104,049	103,462	102,636	101,870	101,133
Total	**477,675**	**474,178**	**470,451**	**466,215**	**462,311**	**458,125**	**453,431**

Graph 79: Number of inhabitants urban/ rural Hunedoara county 2014-2019



Source: NSI, TEMPO online

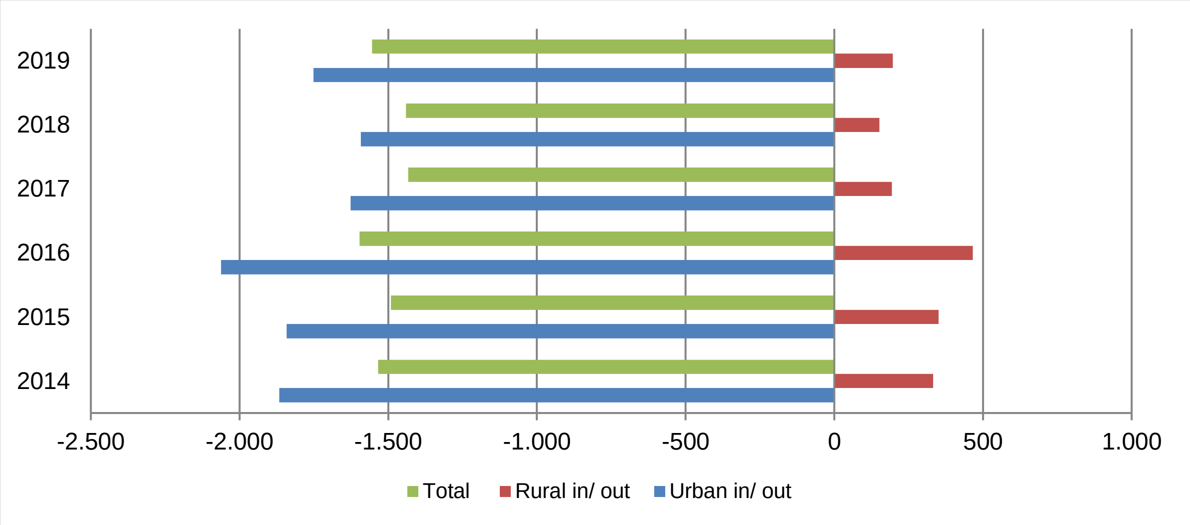
Analysing the evolution of inhabitants of Hunedoara county, a demographic decline of 0.61% is observed between 2014 and 2019, more than the 0.33% national average. The decline is attributed mainly to migration, both internal and external. Related internal migration (changes of residence) in the county or to other counties, either from urban to rural or vice versa only a small proportion of people who change their residence are relocating in the countryside, and the trend is decreasing (from about 18% in 2014, to about 11% in 2019).

Most migrants choose to settle in more developed cities where they can find a better paid job. In this respect, Timis county (and its town of Timisoara) is an attractive destination. Given that external migration is higher among qualified young people, this phenomenon also produces significant demographic consequences. Both a decline of the growth rate and economic activity are observed for the region. Table 32 shows migration flows between 2014 and 2019.

Table 32: Migration out of the county compared to newcomers in the county urban and rural area, Hunedoara 2014-2019

	2014	2015	2016	2017	2018	2019
Urban in/ out	-1,866	-1,842	-2,062	-1,627	-1,592	-1,751
Rural in/ out	332	351	466	194	152	197
Total in/ out	**-1,534**	**-1,491**	**-1,596**	**-1,433**	**-1,440**	**-1,554**

Graph 80: Migration out of the county compared to newcomers in the county urban and rural area, Hunedoara 2014-2019

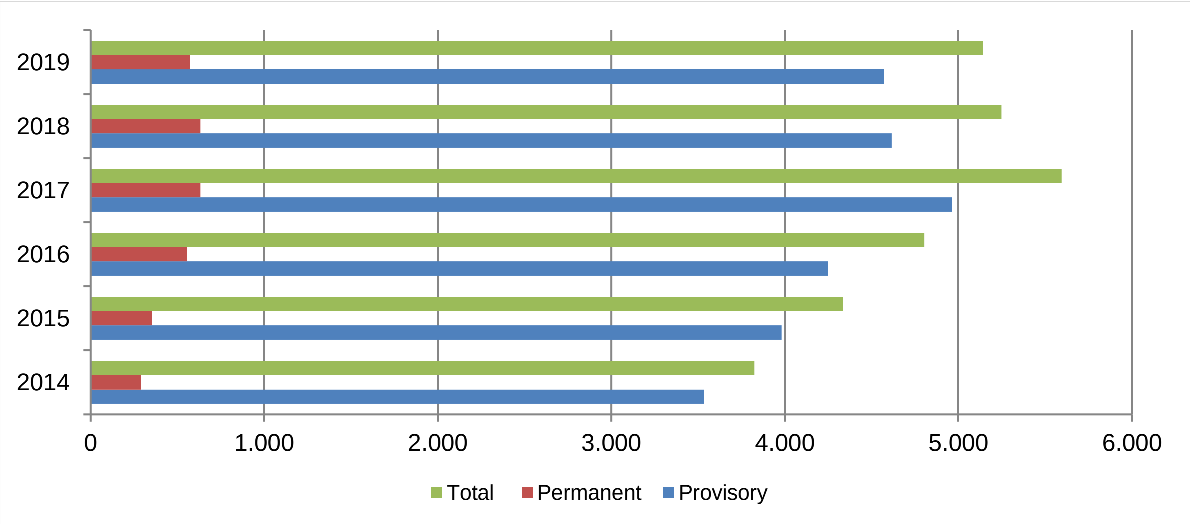


Source: NSI, TEMPO online

Table 33: Number of emigrants, both temporary and permanent residence in other country, Hunedoara county, 2014-2019

	2014	2015	2016	2017	2018	2019
Provisory	3,535	3,982	4,249	4,963	4,615	4,571
Permanent	290	354	555	632	633	571
Total	**3,825**	**4,336**	**4,804**	**5,595**	**5,248**	**5,142**

Graph 81: Number of emigrants, both temporary and permanent residence in other country, Hunedoara county, 2014-2019



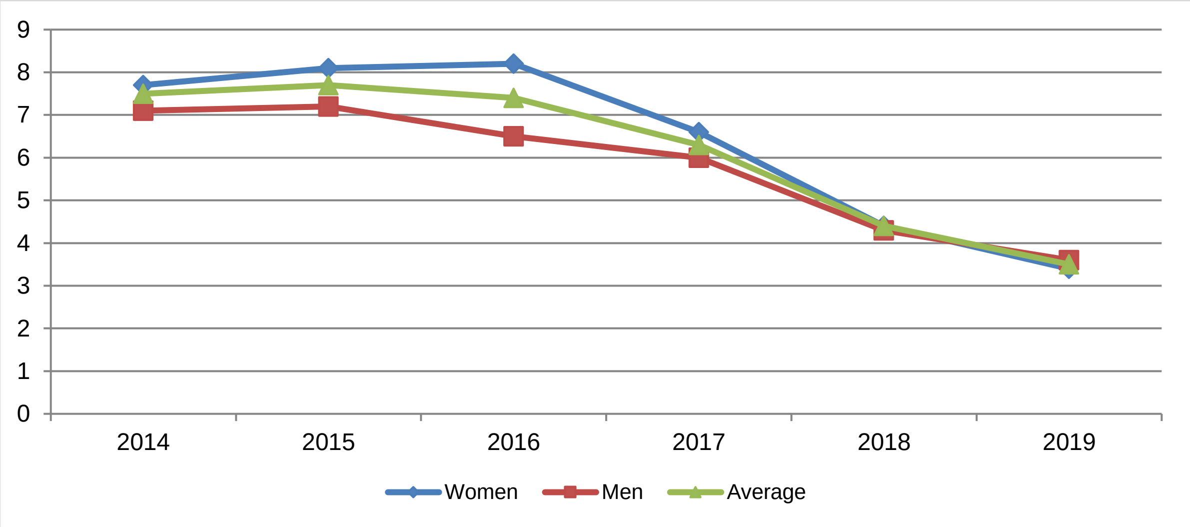
Source: NSI, TEMPO online

The unemployment rate at the county level decreased from 7.5% in 2014 to 3.5% in 2019, with a small difference between women and men. Total unemployment is higher than the national average of 2.9%.

Table 34: Unemployment rate women/ men Hunedoara county 2014-2019

	2014	2015	2016	2017	2018	2019
Women	7.7	8.1	8.2	6.6	4.4	3.4
Men	7.1	7.2	6.5	6	4.3	3.6
Average	7.5	7.7	7.4	6.3	4.4	3.5

Graph 82: Unemployment rate women/ men Hunedoara county 2014-2019



Source: NSI, TEMPO online

➢ **Local economy context and trends**

The number of active professionals[136] (Pf), including companies and self-employed registered, in Hunedoara county represented 1.8% of the total in Romania in November 2020. However, the trend is positive, which is impressive considering the ongoing pandemic.

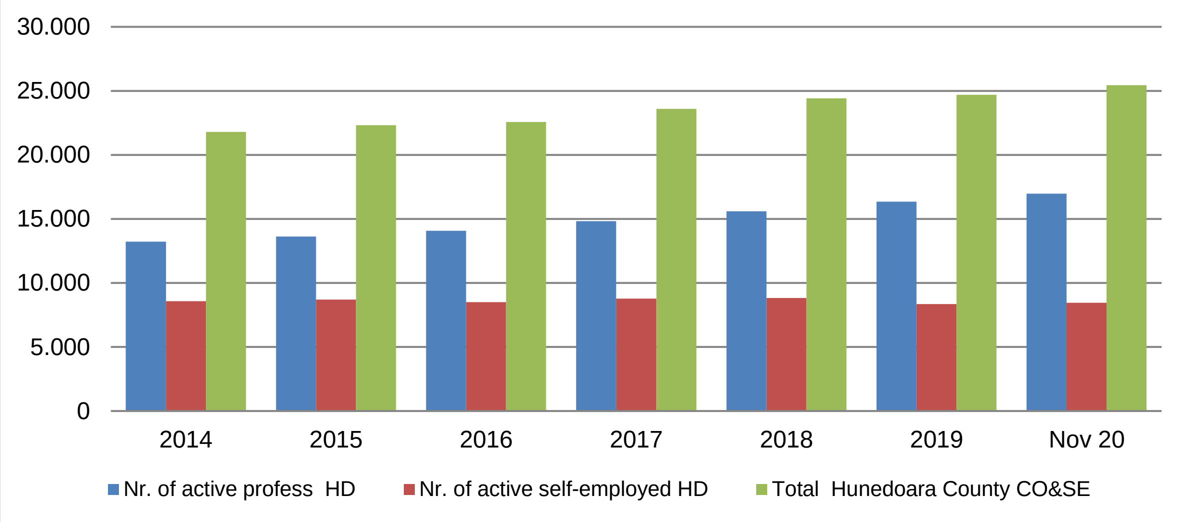
Table 35: Evolution of the number of active professionals (companies and other entities) and self-employed, Hunedoara county, 2014 – 2020

Nr. of active professionals	2014	2015	2016	2017	2018	2019	Nov-20
Nr. of active professionals HD	13,214	13,627	14,083	14,820	15,606	16,340	16,982
Nr. of active self-employed HD	8,575	8,704	8,497	8,768	8,820	8,349	8,455
Total Hunedoara County CO&SE	21,789	22,331	22,580	23,588	24,426	24,689	25,437
Total Romania Pf&SE	**1,139,803**	**1,170,316**	**1,191,738**	**1,258,536**	**1,319,921**	**1,363,651**	**1,425,674**

Source: Romanian Trade Registry

[136] Legal registered entities (Professionals) registered in the Trade Register who have not declared their suspension of activity and are not in any of the states that may lead to the loss of legal personality are considered active from a legal point of view. Out of the total number of professionals registered in the Trade Register, professionals with temporary suspension of activity, branches, radiated professionals, professionals in dissolution, liquidation, judicial reorganization, bankruptcy, insolvency, etc. were excluded.

Graph 83: Evolution of the number of active professionals (companies and other entities) and self-employed, Hunedoara county, 2014 – 2020



Source: Romanian Trade Registry

The number of active companies also follows a positive with an increase of 3% between 2018 and 2019. However, active companies in the region only make up 1.6% of the total in Romania (Table 36).

Table 36: Evolution of active companies, Hunedoara county, 2015 - 2018

Indicator	Values /year			
Active companies (number)	**2015**	**2016**	**2017**	**2018**
Total HD, out of which:	8,659	8,696	8,932	9,196
Micro (0-9 employees)	7,621	7,667	7,920	8,226
Small (10-49 employees)	855	849	833	793
Medium (50-249 employees)	157	155	156	154
Large (> 250 employees)	26	25	23	23
Total active companies (RO)	513,850	527,792	553,796	576,545
Share total HD/RO	1,69%	1,65%	1,61%	1,60%

Source: Romanian Trade Registry

In 2018, the structure of active companies registered in Hunedoara county was dominated by micro-companies 8,226 (1-9 employees), which represented 89% of total companies registered in the county, together with the registered number of self-employed (8,880). Small companies (up to 50 employees) make up 8.6% of the total and medium-sized companies make up 1.7% of the total.

Table 37: Evolution of the number of newly registered companies and closed (radiated) companies

New/ closed companies	2014	2015	2016	2017	2018	2019
New companies registered in Romania	**101,627**	**113,167**	**105,982**	**136,699**	**135,532**	**134,220**
New companies HD	1,859	2,073	1,959	2,630	2,471	2,495
Radiated companies RO	**76,483**	**94,374**	**109,113**	**82,295**	**80,181**	**101,601**
Radiated companies HD	1,760	2,207	2,248	1,790	1,674	2,297
Share total new HD/RO	2,30%	2,34%	2,06%	2,18%	2,09%	2,26%
Share total radiated HD/RO	1,83%	1,83%	1,85%	1,92%	1,82%	1,86%

Source: ONRC, https://www.onrc.ro/index.php/ro/statistici?id=251

Trends for company employees suggest a decrease of 1.1% (1,200 jobs lost) from 2018 to 2019 (see Table 38). From 2014-2019, the massive loss of jobs in the industry and energy production sector (6,400 jobs) was compensated by an increase in tourism and hospitality (16.6%) professional, scientific and technical activities (32%), and information and communication (16.7%).

Table 38: Evolution of the number of employees, Hunedoara county, 2014 – 2019

Indicator	Values /year					
Number of employees in active enterprises/ CAEN	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total number of employees in active enterprises	106,877	105,922	106,944	106,767	105,407	104,195
Agriculture, forestry and fisheries	2,908	2,948	2,752	3,040	2,949	3,137
Industry	41,485	42,494	40,714	39,261	36,569	35,997
Production and supply of energy	3,021	2,933	2,740	2,275	2,156	2,120
Water distribution; sanitation,s.a	3,403	3,391	3,517	3,787	3,574	3,733
Construction	9,392	8,019	8,511	8,886	8,705	8,619
Trade; repair car and moto	19,162	18,915	20,040	19,572	20,697	20,260
Transport and storage	4,129	3,716	3,856	3,707	3,900	3,934
Hotels and restaurants	2,596	2,790	2,917	3,354	3,218	3,028
Information and communications	627	634	726	699	723	732
Financial intermediaries and insurance	1,139	994	1,059	1,042	1,115	1,046
Real estate transactions	267	341	321	305	279	313
Professional, scientific and technical activities	1,492	1,479	1,711	2,054	2,007	1,976
Administrative service activities	3,724	3,706	3,885	4,153	4,171	3,749
Public administration and defence	3,974	3,894	4,060	4,159	4,116	4,132
Educational	7,028	6,933	6,976	6,828	6,887	6,797
Health and social care	7,354	7,470	7,872	8,324	8,504	8,839
Creative activities of shows, cultural	907	908	793	716	807	843
Other services	693	681	751	667	760	793

Source: http://statistici.insse.ro/ FOM104F

The total number of active Professionals (including companies and self-employed) between 2014 – Nov. 2020 in the county was on a growing trend with an increase of 2,900 representing 1.8% of the active professionals in the country (2019).

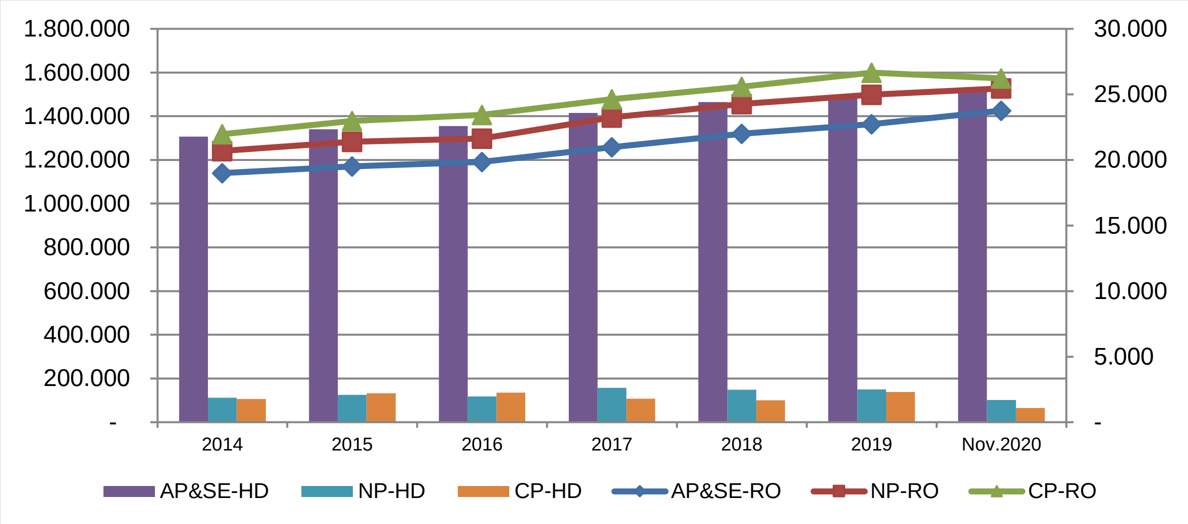
Table 39: Total number of AP&SE, NP and CP in Hunedoara county 2014-2020

	2014	2015	2016	2017	2018	2019	Nov.2020
AP&SE-RO	1,139,803	1,170,316	1,191,738	1,258,536	1,319,921	1,363,651	1,425,674
NP-RO	101,627	113,167	105,982	136,699	135,532	134,220	101,706
CP-RO	76,483	94,374	109,113	82,295	80,181	101,601	45,915
AP&SE-HD	21,789	22,331	22,580	23,588	24,426	24,689	25,437
NP-HD	1,859	2,073	1,959	2,630	2,471	2,495	1,696
CP-HD	1,760	2,207	2,248	1,790	1,674	2,297	1,085

Source: Romanian National Trade Registry

The trends for active professionals and self-employed (AP&SE), new professionals registered (NP) and closed professionals (CP) in Hunedoara county are compared with national data in Graph 84.

Graph 84: Evolution of the number AP&SE, NP and CP in Hunedoara county 2014-2020



Source: Romanian National Trade Registry

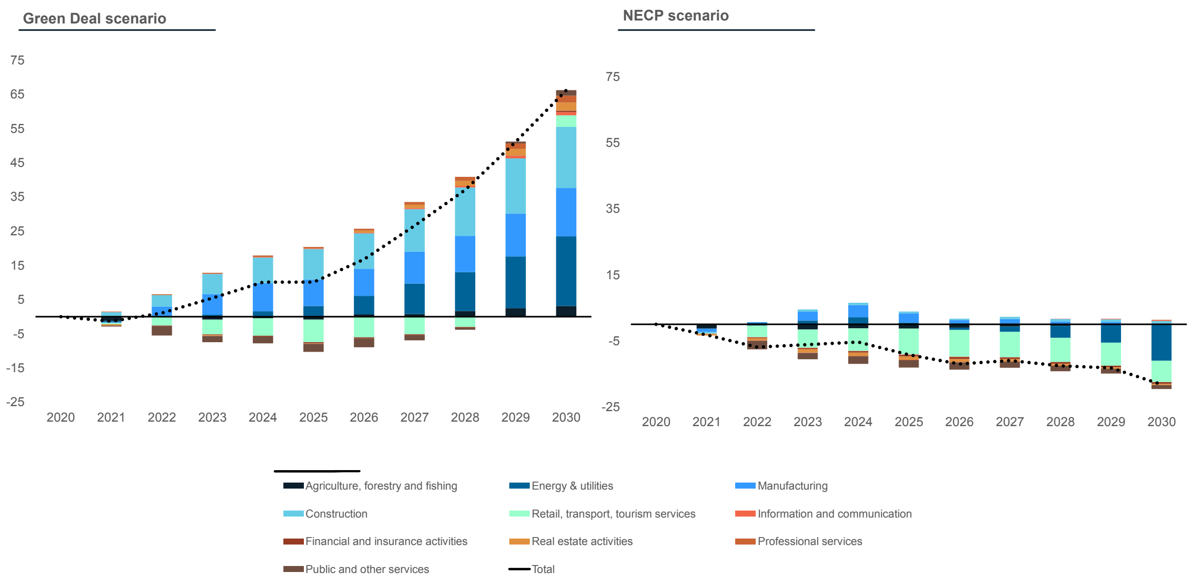
➢ **Regional transition impact**

GVA

Results in Hunedoara largely follow trends seen in the national results. In terms of GVA, the GD scenario provides a more positive outcome compared to the baseline, while the NECP provides a negative impact albeit with a smaller magnitude. Additionally, there were negligible employment effects under the NECP scenario and more substantial negative impacts in the GD scenario.

In the NECP scenario, GVA results are driven by decreases in the energy sector (EUR 7 million by 2030) and retail sector (EUR 11 million by 2030). As discussed earlier, this is explained by ETS price pressures and slower RES deployment. In the GD scenario, the positive impacts are driven by construction, manufacturing and energy sector gains (compared to the baseline). These amount to EUR 52 million by 2030 (or 1.4% of total regional GVA compared to baseline). All impacts are driven by RES deployment and other decarbonisation policies.

Graph 85: NECP scenario, GVA, million EUR difference from baseline

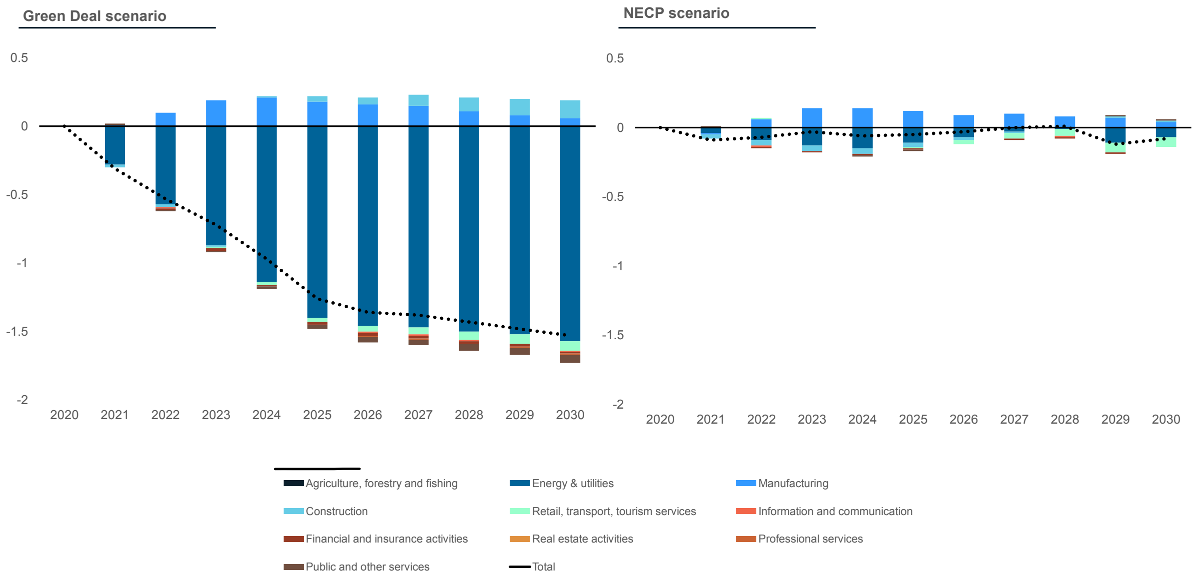


Source: CE modelling

Employment

Employment impacts also follow national trends. First, in the NECP scenario, employment impacts are rather limited and the net change is within 100 jobs throughout the period. Nevertheless, much stronger effects can be observed in the GD scenario, where Hunedoara loses directly in two ways: (1) lost employment due to a reduction of coal-based or gas-based power generation, and (2) lost employment because of the downsizing of coal mining. These effects can be observed on Graph 86. Employment losses (compared to the baseline) amount to 1,500 jobs, almost solely driven by the energy sector. Gains are important in manufacturing and construction (about 200 jobs) but fall short of offsetting the stark effects in the energy sector.

Graph 86: NECP scenario, employment, '000 jobs difference from baseline

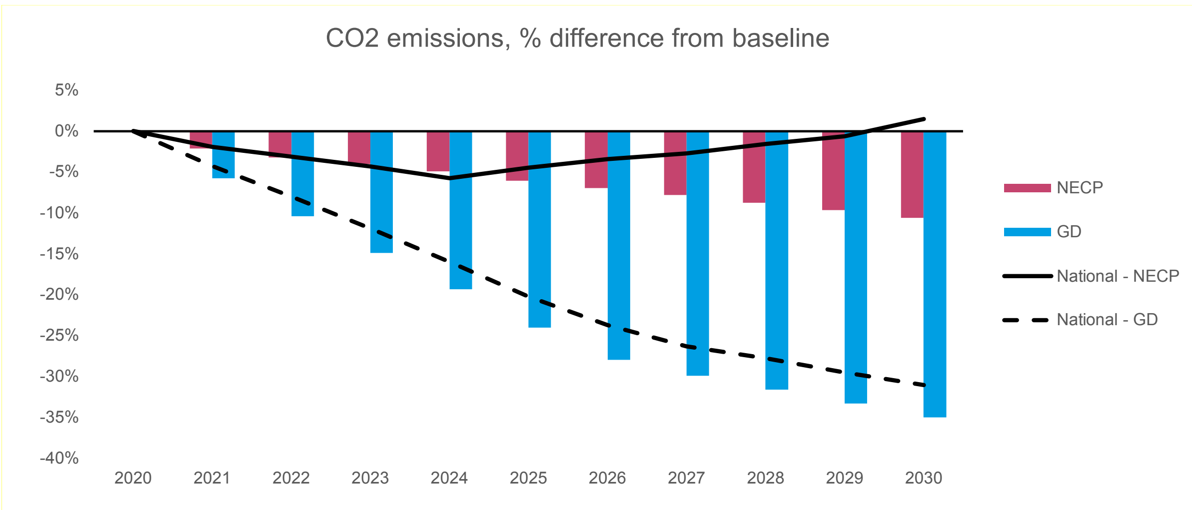


Source: CE modelling

CO_2 emissions

CO_2 emissions have somewhat better outcomes in the county relative to the overall national results. Emissions in the NECP scenario stay below the baseline (11% reduction), while emissions in the GD closely follow the national result (35% reduction in the county, 31% nationally).

Graph 87: CO2 emissions, % difference from baseline



Source: CE modelling

In Hunedoara, in terms of GVA results, the GD scenario provides a better, more positive outcome (compared to the baseline) while the NECP provides a negative impact with a smaller magnitude. A GD scenario brings gains of approximately EUR 52 million by 2030 compared to the baseline, distributed mostly between gains in the energy and construction sectors. In terms of employment, the NECP scenario is similar to the baseline scenario, while the GD scenario would drive losses of approximately 1,750 jobs compared to the baseline. Emissions closely follow the national trajectory.

Gorj County

- **Overview**

Gorj County is part of South West Oltenia and covers an area of 5,602 sq. km. (1.96% of Romania's total area). Gorj had a population of 315,494 inhabitants in 2019 and 311,918 in 2020, a decrease of 1.13%. Gorj is rich in natural resources, both in terms of quantities and diversity. Their major exploitation refers to surface lignite deposits. Gorj also has approximately 250,000 hectares of arable agricultural land.

Gorj has a diversified tourist potential, represented by picturesque natural settings, monuments of art and architecture of great artistic value, representing an important folklore and ethnographic heritage, these settlements and places present their history, from ancient times to the present day. The main touristic attractions in Gorj include: the sculptural ensemble Constantin Brâncuşi from Târgu Jiu and the memorial house "Ecaterina Teodoroiu", Mountain Resort Rânca.In Gorj, there are over 25 mountain hiking routes, including two long-distance European tourist routes (E3 and E7), three climbing areas (Sohodolului - Runcu, Galbenului - Baia de Fier, Oltețului - Polovragi), five speleological areas that make up the largest speleological potential in Romania, a ski resort (Rânca), and hunting and fishing spots that attract a large number of tourists annually. The Gorj economy includes extractive industry and electricity production via coal. These two industries employ most of the population and contribute the most to the county's GDP. The continuous decrease of the amount of energy produced by burning coal due to its high price and the transition to renewable and nuclear sources will create important problems in the economic and social structure of the county.

In 2018, the employed population of Gorj County was 72,903, which represents 0.87% of the employed population at the national level. By sector, 25.5% were employed in productive fields, of which 9.3% were employed in the extractive industry and 7.6% work in coal extraction. Sectors with 10% or more of the workforce include the manufacturing industry, wholesale and retail trade; repair of motor vehicles and motorcycles. Other sectors have shares under 5%, such as the production and supply of electricity and heat, gases (3.4%). Although the county offers areas with tourist potential, the share of the population employed in this field is 2.3%. Agriculture is a non-performing sector, although most of the employed population is in rural areas. A peculiarity of the Gorj cities is the prevalence of industry. As for the mono-industrial cities such as Ticleni (extractive industry), Rovinari and Turceni (industry producing electricity by burning coal), they will be most affected by the energy transition. In this context, it should be mentioned that employees in the extractive industry and the production of electricity by burning coal are not only inhabitants of urban areas, but also in adjacent rural areas and that the impact of the extractive industry and the production of electricity based on coal, due to the need to reduce the greenhouse effect, will lead to massive layoffs. In many cases, coal workers are the only source of income for some families. The exploitation of the Gorj coal quarries as well as the thermal power plants are units of a single company, the Oltenia Energy Complex, which is currently in a restructuring process. Considering that the extractive industries and the production of electricity contribute about 70% to the county's GDP and employ about 59% of the local labour force, the massive industrial decline will significantly affect the county. The turnover of the Oltenia Energy Complex, the largest local employer, fell substantially from RON 69 m in 2017 to RON 31 m in 2018.

➢ **Demographics**

Gorj is the fourth most populous county in the South West Oltenia region.

Table 40: The evolution of the number of the resident population on January 1 on the developed macro-region and counties

	2014	2015	2016	2017	2018	2019
Region of development S - W Oltenia	2,033,784	2,015,792	1,993,482	1,972,940	1,949,813	1,926,860
Dolj County	650,767	646,620	641,040	635,606	631,026	625,656
Gorj County	334,849	331,428	327,537	323,634	319,903	315,494
Mehedinti County	259,026	256,011	252,600	249,336	244,960	241,262
Olt County	423,445	418,463	412,491	407,717	400,763	394,389
Valcea County	365,697	363,270	359,814	356,647	353,161	350,059

Source: NIS, Tempo online

Gorj has the fourth most urban population in the South West Oltenia region, with 16% in the period 2018-2019.

Gorj has two large cities (Târgu Jiu and Motru), seven small cities (Târgu Cărbunești, Ţicleni, Tismana, Turceni, Novaci, Rovinari, Bumbeşti-Jiu), and 61 communes.

Table 41: The evolution of the number of the resident population on January 1st on the developed macro-region and counties with urban residence

	2014	2015	2016	2017	2018	2019
Development region S-W Oltenia	936,575	929,177	918,765	901,198	899,946	892,200
Dolj County	337,643	335,558	332,687	327,283	327,664	325,216
Gorj County	151,213	149,613	147,810	145,115	144,250	142,734
Mehedinti County	119,873	118,461	116,417	112,759	112,921	111,704
Olt County	164,912	163,423	161,197	157,523	157,229	155,628
Valcea County	162,934	162,122	160,654	158,518	157,882	156,918

The urban population of Gorj County is about 1.4% of the total urban population of Romania.

Table 42: The evolution of urban population in Gorj County/ Regional level

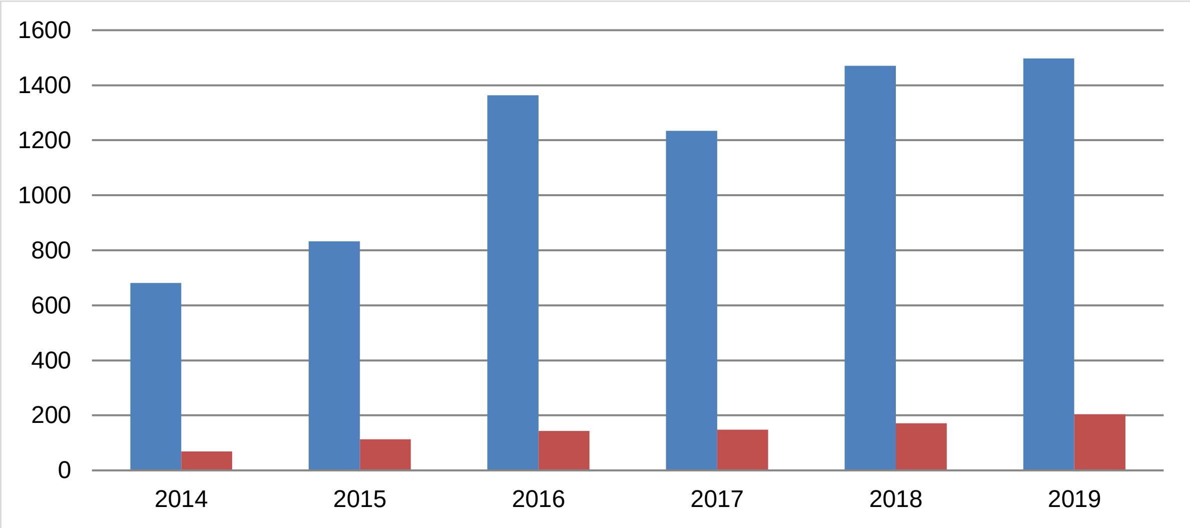
	2014	2015	2016	2017	2018	2019
TOTAL	10,752,617	10,703,051	10,636,418	10,531,819	10,506,097	10,455,362
Development region S-W Oltenia	936,575	929,177	918,765	901,198	899,946	892,200
Gorj County	151,213	149,613	147,810	145,115	144,250	142,734
Weight in total, %	1.4	1.4	1.38	1.37	1.37	1.36

Starting in 2018, the share of rural population at the regional level decreased by about 0.2%. The share of the rural population in Gorj County registered a slight decrease, consistent with the regional level.

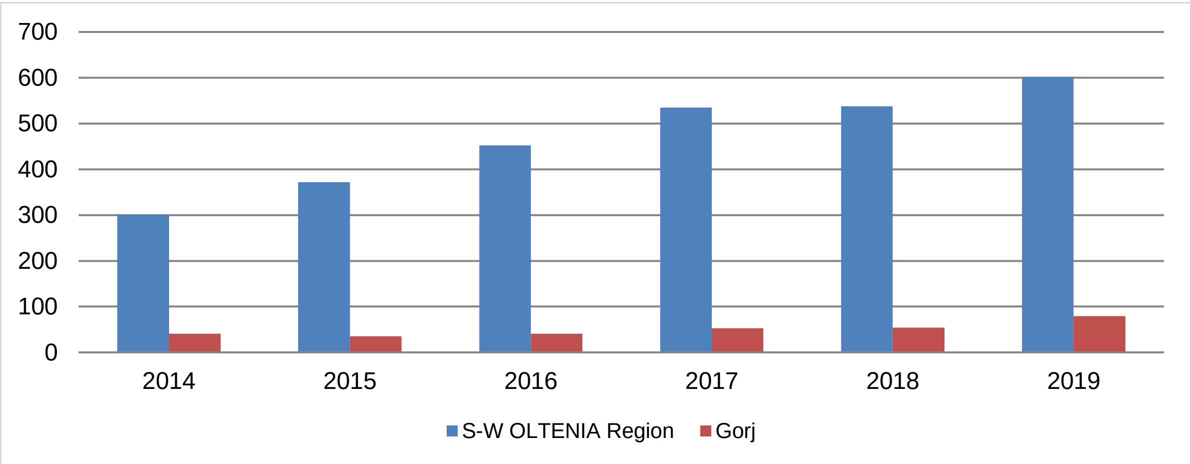
The demographic decline is also strongly influenced by the migratory movement, which takes into account both settlements and departures with domicile or residence, as well as the number of emigrants or immigrants.

During 2014-2019, the migratory movement in Gorj County was consistently around 10% of the total region. A visible jump, around 2%, was registered between 2018 and 2019.

Graph 88: Emigrants evolution between 2014-2019

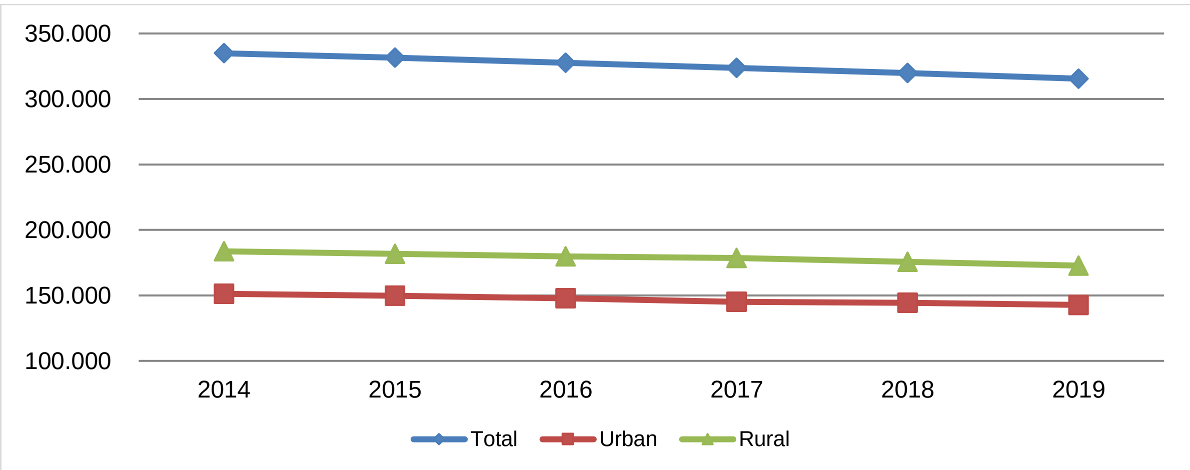


Graph 89: Immigrants evolution between 2014-2019



The evolution of the active labour force from 2014-2018 is presented in Graph 90. In Gorj County, the active labor force is mainly from urban areas, with a near 50-50 gender split.

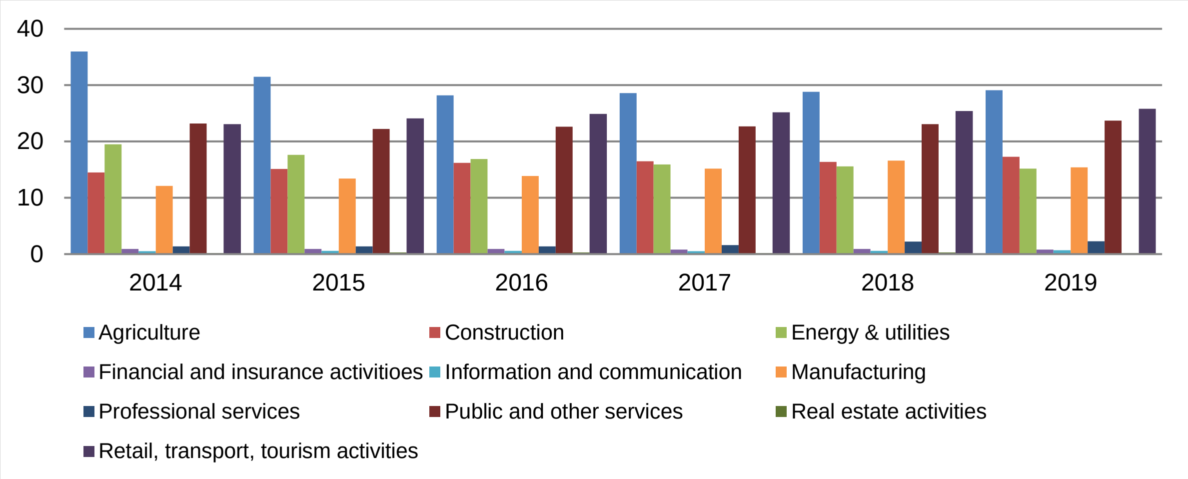
Graph 90: Population by residence between 2014-2018



Regarding the workforce and employment structure, Gorj County stands out in a national and regional context, with a high share of workers in the primary sectors. However, the evolution between 2014 and

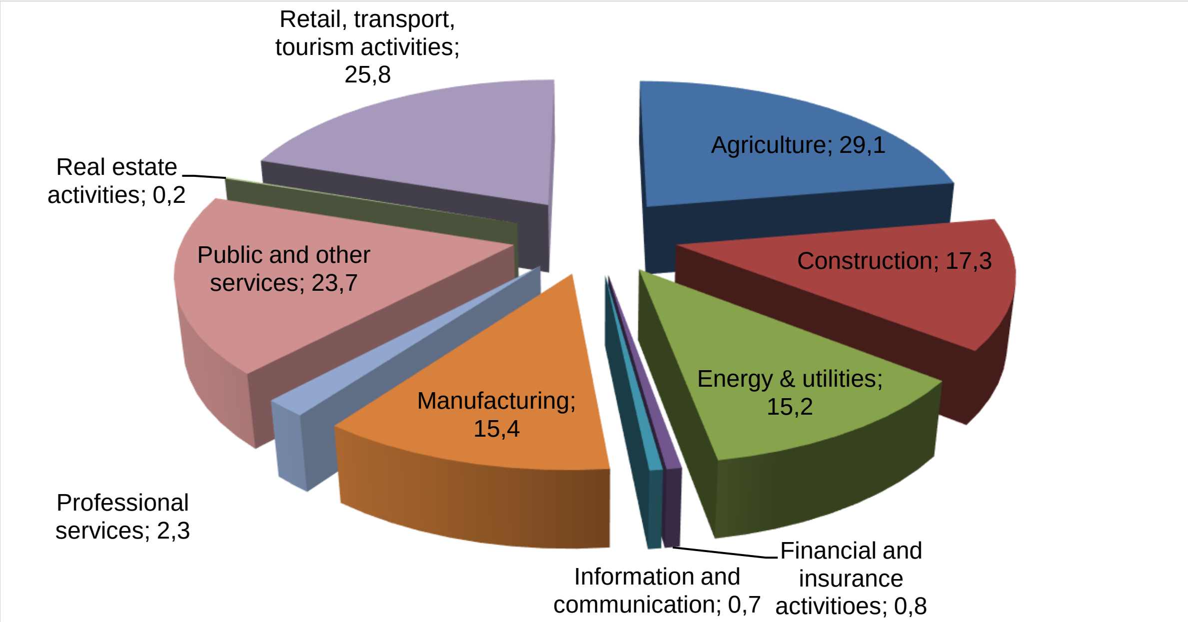
2019 shows a consistent decrease of the population in agriculture from 24.4% to 18.8%, an increase of 3.6% in manufacturing and a decrease of 2.8% in the energy industry.

Graph 91: Workforce evolution per economy sectors in Gorj county 2014-2019



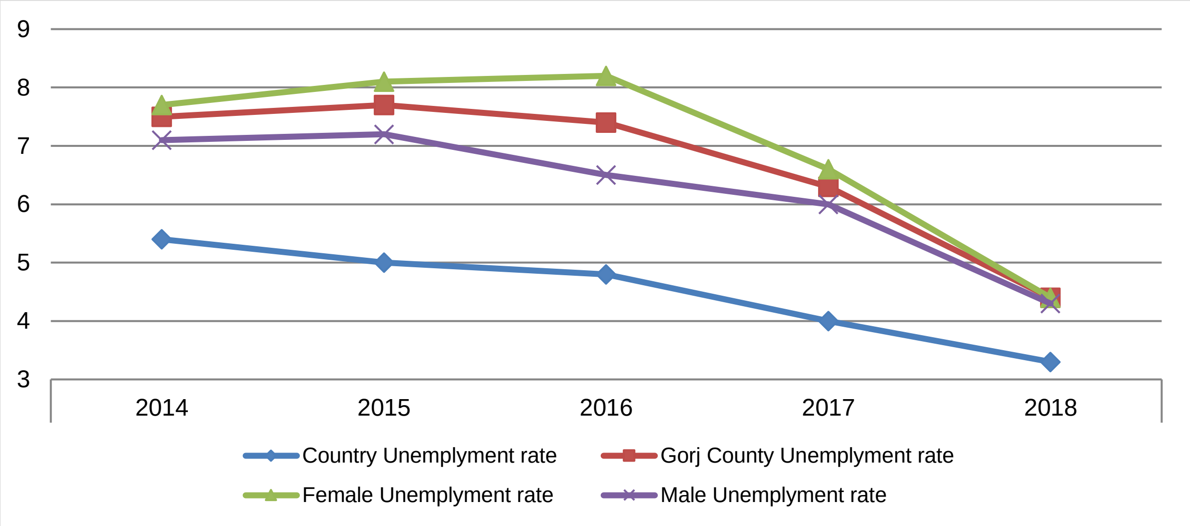
Source: NSI, TEMPO online

Graph 92: Workforce share per economy sectors Gorj county 2019



The shrinking labour force is accompanied by a decrease of the unemployment rate, with 2.1% at the national level, where the unemployment rate decreased from 5.4% to 3.3% between 2014 and 2018 and 3.1% at Gorj county level, where the unemployment rate decreased from 7.5% to 4.4% between 2014 and 2018.

Graph 93: Gorj County Unemployment rate evolution 2014-2018



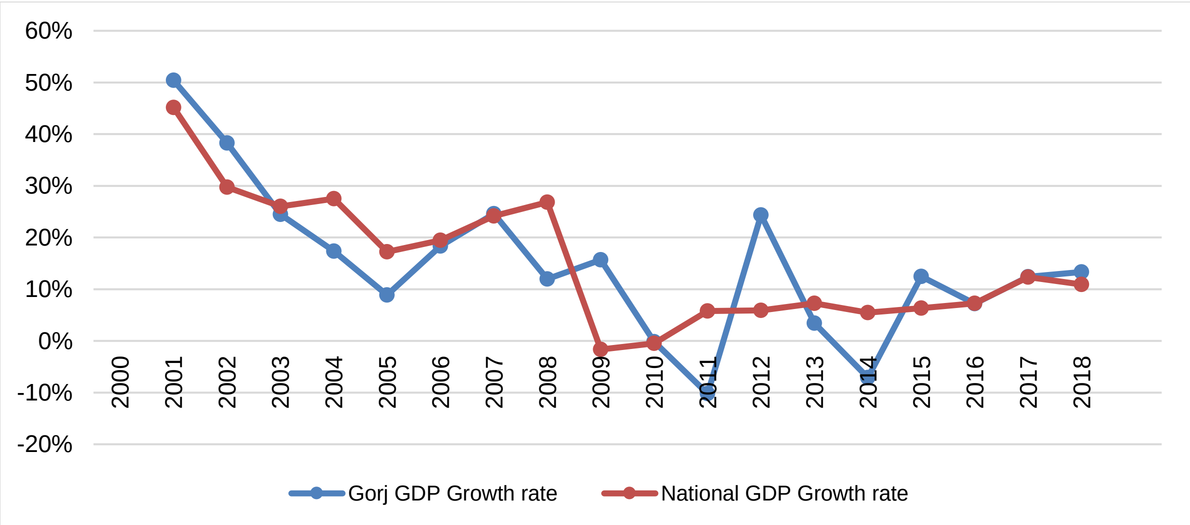
➢ **Local economy context and trends**

The GDP in terms of EUR has increased constantly as well as the GDP per capita. Overall the GDP of the Gorj county supported with 1.6% the national GDP in 2018.

Table 43: Evolution of GDP, Gorj county, 2014 – 2018

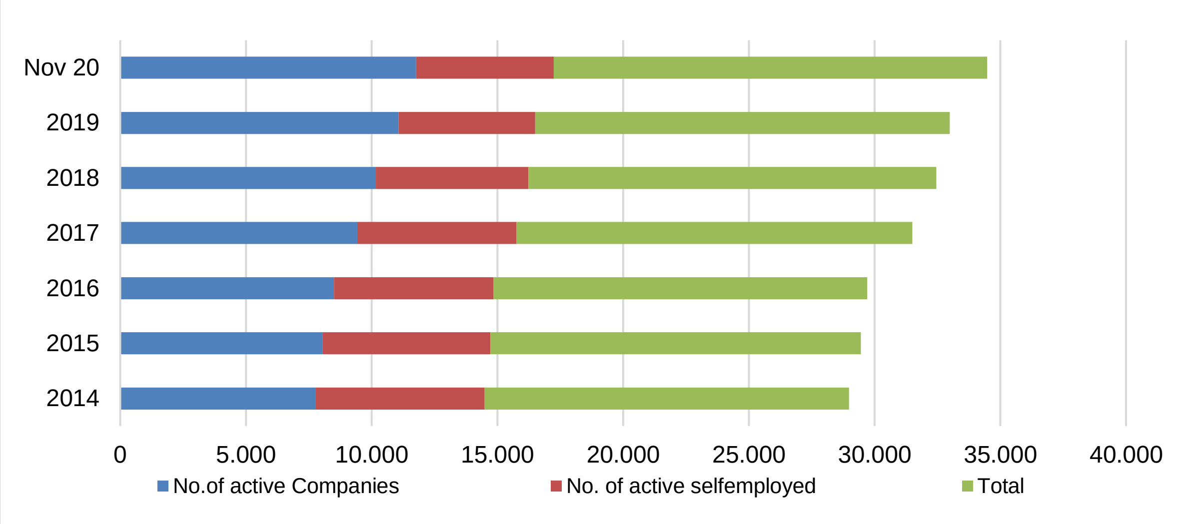
	2014	2015	2016	2017	2018
Exchange course RON/ EUR	4.4446	4.4450	4.4908	4.5681	4.6535
GDP/ Gorj County- m EUR	2272.35	2555.4	2711	2996.4	3333.04
GDP/Gorj County/ Inhabitant - EUR	6119.24	6925.13	7396.7	8227.6	9214.2

Graph 94: 10 years GDP's Gorj County Evolution



The number of active enterprises in Gorj county has increased from 2014 and 2018 by 15%.

Graph 95: Evolution of the number of active enterprises in the period 2014-2018



The total number of active professionals (including companies and self-employed) between 2014–2020 in the county increased by 2,008 workers, which represents 1.2% of active professionals in the country (2019) (see Table 44).

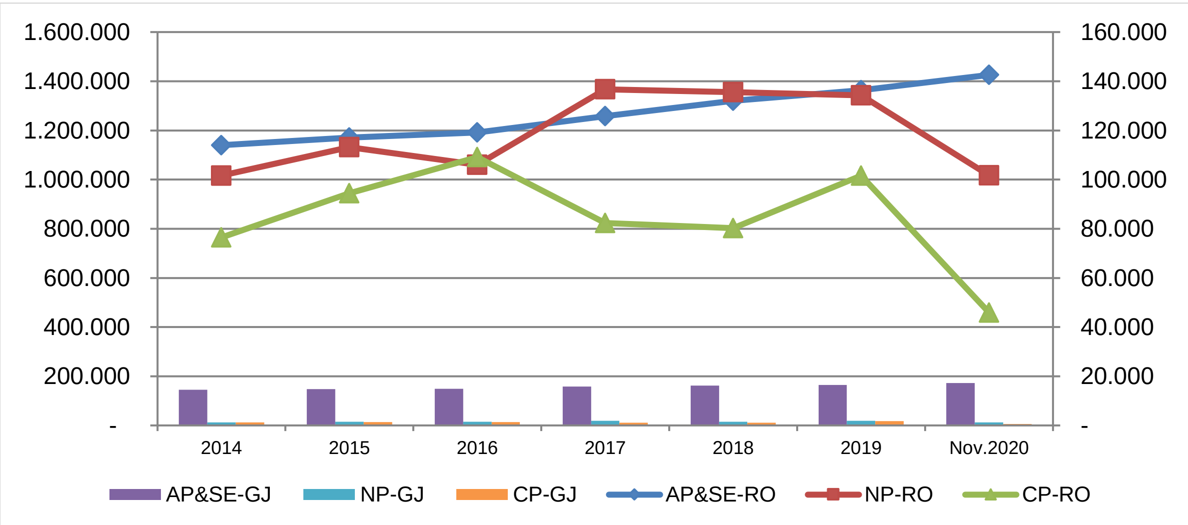
Table 44: Total number of AP&SE, NP and CP in Gorj county 2014-2020

	2014	2015	2016	2017	2018	2019	Nov.2020
AP&SE-RO	1,139,803	1,170,316	1,191,738	1,258,536	1,319,921	1,363,651	1,425,674
NP-RO	101,627	113,167	105,982	136,699	135,532	134,220	101,706
CP-RO	76,483	94,374	109,113	82,295	80,181	101,601	45,915
AP&SE-GJ	14,490	14,724	14,852	15,750	16,230	16,498	17,239
NP-GJ	1,184	1,515	1,463	1,862	1,543	1,864	1,197
CP-GJ	1,225	1,344	1,414	1,076	1,068	1,765	546

Source: Romanian National Trade Registry

The evolution of the total number of active professionals and self-employed (AP&SE), new professionals registered (NP) and closed professionals (CP) in Gorj County compared with the country's total data for the period 2014–2020 is presented in Graph 96.

Graph 96: Evolution of the number AP&SE, NP and CP in Gorj county 2014-2020



Source: Romanian National Trade Registry

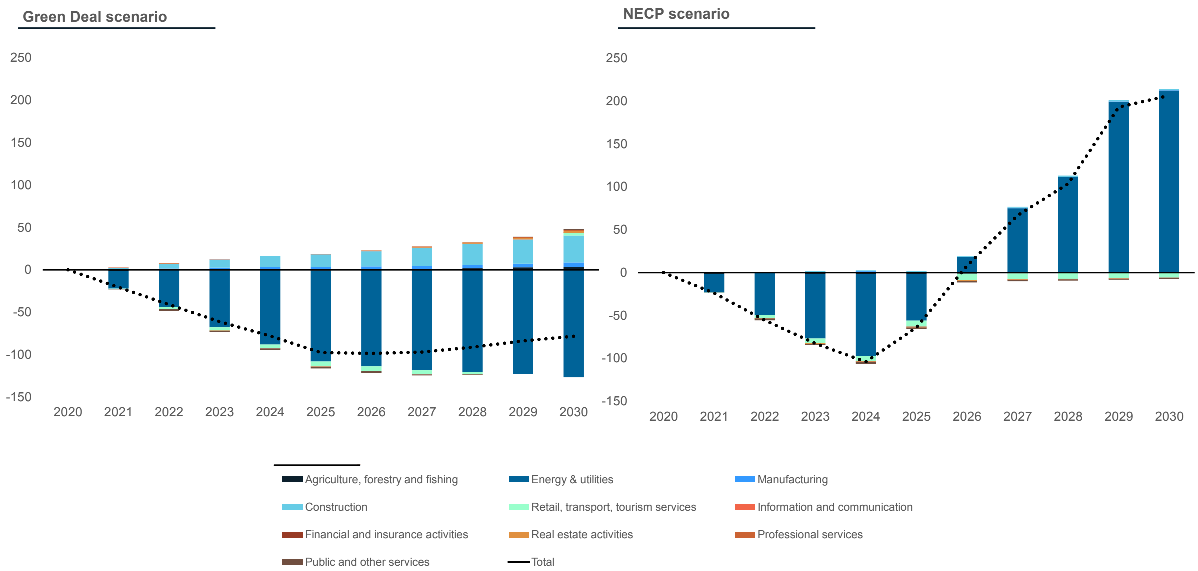
➢ **Regional transition impact**

GVA

Impacts across the main indicators in Gorj are very similar to results presented for Dolj. However, there are some substantial differences and magnitudes differ. Some of the similarities between the two counties are driven by technical limitations, i.e., some data/assumptions were defined on the NUTS-2 level and therefore impacts could be very similar for the two counties.

GVA impacts in Gorj, similar to Dolj, are driven by the energy sector. Coal mining and coal-based power generation is concentrated in Dolj and Gorj in much of the projection (a large part of activities in Hunedoara is assumed to be closed down in the model). Therefore, the scenarios can have some of the highest effects. In the case of the NECP, consequently, the simulations show a nearly EUR 210 million higher GVA in the energy sector than in the baseline (in 2030). This would mean that the energy sector represents about 22% of total regional GVA in the scenario. While this is definitely a high value, in 2017, the energy sector represented 27% of total regional GVA in Gorj.

Graph 97: NECP scenario, GVA, million EUR difference from baseline



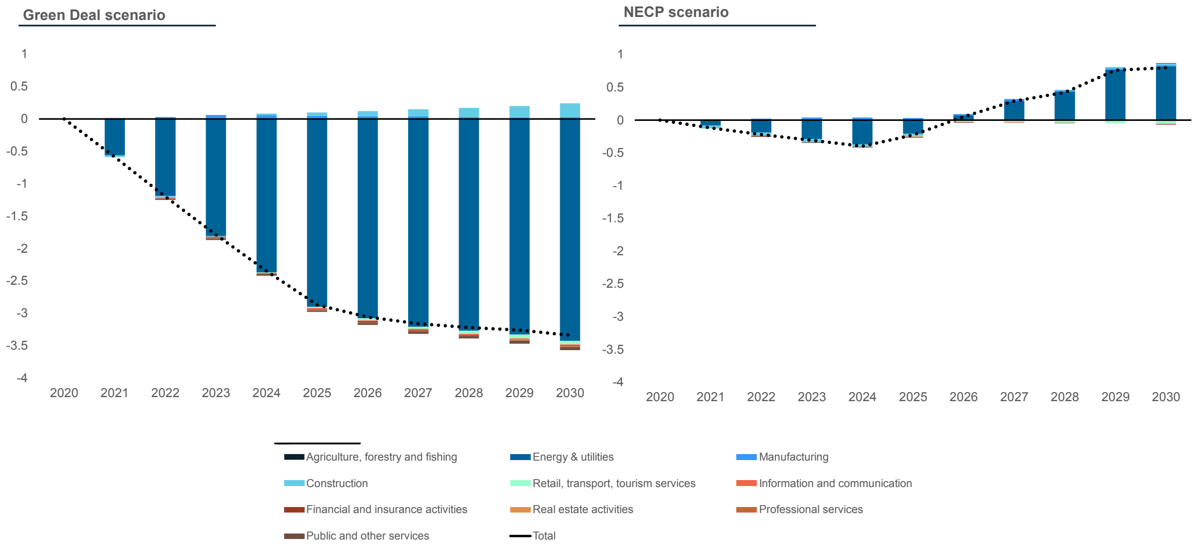
Source: CE modelling

The GD scenario, however, differs from previous observations in Dolj. In Dolj, gains in other sectors were able to compensate energy losses in the long-term and create a net positive effect. However, this is not the case for Gorj. The GVA decrease compared to the baseline amounts to about EUR 130 million in the energy sector by 2030, while gains in other sectors compensate EUR 48 million in 2030.

Employment

Employment outcomes follow a similar logic. In the GD scenario, the county suffers from the severe reduction of coal related activities. Employment is estimated to be about 3,400 jobs lower than the baseline by 2030. Construction and manufacturing (sectors with positive outcomes) can only increase employment by about 200 jobs. Meanwhile, in the NECP scenario, there are substantial gains: keeping coal capacities active means that employment levels retain about 1,000 jobs in the energy sector relative to the baseline.

Graph 98: NECP scenario, employment, ‘000 jobs difference from baseline

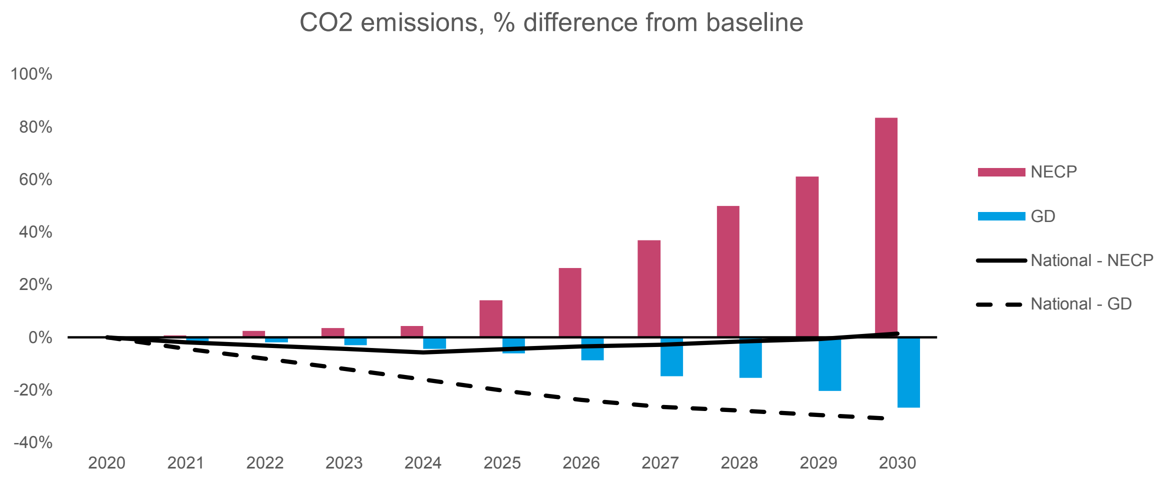


Source: CE modelling

CO_2 emissions

Emissions outcomes are similar to results in Dolj. The NECP scenario results in much higher emissions in the county than the national outcome (84% over the baseline emissions). The GD scenario results in emissions slightly below the national outcome (27%). The NECP results are explained by keeping coal-based power generation active in the scenario, which is concentrated in this region.

Graph 99: CO2 emissions, % difference from baseline



Source: CE modelling

In Gorj, simulations of the NECP scenario show an increasing GVA of nearly EUR 210 million in the energy sector over the baseline in 2030. In the GD scenario, GVA decreases compared to the baseline by about EUR 130 million in the energy sector by 2030. Gains in other sectors compensate for EUR 48 million in 2030. In the GD scenario, employment is estimated to be about 3,400 jobs lower than in the baseline by 2030. In the NECP scenario coal capacities remain active and employment levels increase by about 1,000 jobs in the energy sector over the baseline. Emissions exceed the national baseline by 84% in a NECP scenario, while in a GD scenario they fall 30% below the baseline.

5.3. Regional analysis of relevant policies towards climate neutrality as well as to mitigate potential negative impacts

5.3.1 Assessment of the transfer level of NECP strategy into the regional development strategies at the NUTS-3 level

None of the county-level development strategies for the programming period 2021-2027 have been elaborated to date. Although some county councils shared that they have a draft version of the strategies (e.g., Galați, Mureș, Dolj), no such documents have been submitted, even in their draft form, to the team of consultants. As a result, no assessment can be made to what extent these strategies include NECP perspectives, targets, policies.

We will continue to ask MEIP and the local working groups to provide us with these draft documents.

5.3.2 Assessment of the transfer level of NECP strategy into the company strategies of the economic operators of energy production

Assessment of the transfer level of relevant policies into the strategies of the economic operators is at an early stage following the first round of stakeholder consultations. A more complete analysis and set of conclusions will be available once a wider range of business enterprises have been interviewed during the next stages of the consultation process

5.4. Priority investment needs

It is too early in the current Technical Assistance project and in the wider process for TJTP elaboration to talk about identified investment needs at a very precise or granular level. We will present such needs and potential areas for investment in D4. It is clear however, based on our econometric analysis, that some areas will experience growth in all scenarios. As a result, investment in these areas (including worker qualifications and horizontal value chains) should be considered a need: construction (including retrofitting work), (low-carbon) manufacturing, renewable energy (including construction, operation and maintenance).[137]

Mureș: According the first draft sections of the TJTPs from the county council/working group set up at the local level, the identified investment needs aggregate the investment plans of the most GHG intensive enterprises in the county (AzuMureș and Romgaz) and are in the field of gas-fired electricity production, energy efficiency, cogeneration, water management, RES and hydrogen development. Several other, less defined, investment needs are mentioned in the draft document such as circular economy, "economic revitalization", urban regeneration and skills development for areas of "intelligent specialization."

Gorj: According the first draft sections of the TJTPs from the county council/working group set up at the local level, no investment areas for a just transition have yet been identified. The draft focused exclusively on analysing the impact of job loss concerning the CE Oltenia restructuring process. However, we anticipate that efforts will be required to address the challenges of reconverting the wide degraded land surfaces of lignite exploitations and the poverty and local development challenges of the small mono-industrial towns of the county, so far dependent on mining and energy production.

Hunedoara: According the first draft sections of the TJTPs from the county council/working group set up at the local level, no investment areas for a just transition have yet been identified. The draft comprises an extensive description of the evolution of the local economy (increases/decreases based on sector of activity; evolution of employment based on activity sectors), as well as a description of the CE Hunedoara's status and restructuring plans. Regeneration of degraded brownfield sites and improving the quality of life and development prospects of the predominantly small townships in the hardest hit areas will have to be tackled.

The other three working groups/county councils did not submit the drafts requested by the Ministry of European Investments and Projects (the original deadline was 17 December 2020) by the date of the submission of the draft report.

[137] We will place particular emphasis in Deliverable 4 on the mitigation plans for the short-term negative impacts.

The table below will be further refined in Deliverable 4 based on stakeholder interviews and on investment "fiches" collected from stakeholders, especially businesses. It takes into account the preliminary Commission services' views on priority investment areas and framework conditions for the effective delivery of the 2021-2027 Just Transition Fund investments in Romania. The table also summarises the work on the TJTPs carried out by county councils/working groups and submitted to MEF by the date of the submission of the draft report, the stakeholder interviews, and the data assessment (including modelling) conducted by the Technical Support Team[138].

Table 45: Initial assessment on priority investment needs responding to Annex D of the 2020 European Semester Report for Romania

County	High priority investment needs	Medium priority investment needs	Low priority investment needs
Galați	Investment in the deployment of technology and infrastructures for affordable clean energy, greenhouse gas emission reduction, energy efficiency and renewable energy; Upskilling and reskilling of workers	Investment in regeneration and decontamination of sites, land restoration and repurposing projects	
Mureș	Investment in the creation of new firms, including through business incubators and consulting services.	Investment in the creation of new firms, including through business incubators and consulting services.	Investment in research and innovation activities and fostering transfer of advanced technologies
Prahova	Investment in the deployment of technology and infrastructures for affordable clean energy, greenhouse gas emission reduction, energy efficiency and renewable energy.	Investment in regeneration and decontamination of sites, land restoration and repurposing projects; Productive investments in SMEs, including start-ups, leading to economic diversification and reconversion; Investment in the deployment of technology and infrastructures for affordable clean energy, energy efficiency and renewable energy.	Investment in research and innovation activities and fostering transfer of advanced technologies; Upskilling and reskilling of workers.
Gorj	Investment in the deployment of technology and infrastructures for affordable clean energy, greenhouse gas emission reduction, energy efficiency and renewable energy; Job-search assistance to jobseekers.	Investment in regeneration and decontamination of sites, land restoration and repurposing projects.	Productive investments in SMEs, including start-ups, leading to economic diversification and reconversion; Investment in research and innovation activities and fostering transfer of advanced technologies.

[138] Reference cut-off date for interview conclusions in the present report is 16 January 2021. Following this date, an additional number of approximately 80 bilateral and group interviews took place and the adjusted conclusions have been presented in Deliverable 4 draft version and are subject to further analysis in Deliverable 4 final version.

Dolj	Investment in the deployment of technology and infrastructures for affordable clean energy, greenhouse gas emission reduction, energy efficiency and renewable energy.	Productive investments in SMEs, including start-ups, leading to economic diversification and reconversion.	Investment in the creation of new firms, including through business incubators and consulting services; Investment in research and innovation activities and fostering transfer of advanced technologies
Hunedoara	Investment in the deployment of technology and infrastructures for affordable clean energy, greenhouse gas emission reduction, energy efficiency and renewable energy.	Investment in regeneration and decontamination of sites, land restoration and repurposing projects	Productive investments in SMEs, including start-ups, leading to economic diversification and reconversion.

6. Impacts of the Activities of the Transition Regions for Other Regions in Romania

The NECP indicates that several other NUTS3 regions could be impacted by the transition (including counties such as Timiș, Arad, Suceava, Bihor, and Iași). However, the current Technical Assistance project only covers and performs quantitative and qualitative analysis on the six most affected NUTS3 regions (Gorj, Hunedoara, Dolj, Galaț, Mureș and Prahova). These six regions account for 65% of the country's GHG emissions from the mining and manufacturing industries.

During the stakeholder engagement, we received mixed perspectives on inclusion of other regions in the transition process: some large enterprises with country-wide operations mentioned that other regions should be included since they have potential for a digital, low-carbon transition. Some local authorities and large business administrators mentioned the idea of spillover effects in neighbouring counties – for instance in terms of workers' commuting patterns or energy value chains. At the same time, stakeholders expressed the desire to not dilute funding by incorporating other regions.

Our perspective is that the drafting process of the TJTPs (both the analytical process and the stakeholder engagement process) could be useful for other counties to incorporate in their local development processes and help determine priority investment needs that foster the spirit of a just transition, which can be funded through other European and national mechanisms. Given the low awareness of citizens and local public authorities on the elements of the current climate and energy policies, as well as on the meaning of a just transition, the educational materials that will be disseminated on the Ministry of European Investments and Projects' website could be further disseminated to other local authorities (municipalities and regional authorities) to inspire a similar project pipeline development. In particular, education on the climate transition – what it entails, why it is needed, the benefits for the economy and the population at large – should be carried out at scale in the country, vis-à-vis local public authorities and citizens at large, as evidenced even at this early stage of stakeholder consultation. In addition, a "How To Guide" can be developed to inspire other regions to: (1) do their own high-level impact assessment of the transition process and (2) develop investment strategies and ideas for their own county/region. For instance, we estimate the IT&C development projects and schemes to foster local digital entrepreneurship, investment projects in renewable energy, brownfield redevelopment projects, etc. These projects could be easily replicated elsewhere in the country to assist the transition to a diversified, low-carbon economy for all of Romania's regions. Lessons and transfer mechanisms should be developed early on by the Romanian government.

7. Conclusions and Recommendations for Identified Investment Needs and for the National and Territorial JTPs

For a preliminary assessment of the current investment needs, please refer to section 5.3 "Priority investment needs" of this report.

From the stakeholder interviews we conducted while drafting this report, some conclusions and recommendations on the investment needs can be drawn:

- Local authorities must lead, in line with our recommendations in draft D2, an extensive stakeholder engagement process to identify investment areas and opportunities, especially for SMEs, but also taking into account local entrepreneurs and local academic and research environments. The only economic stakeholders engagement so far appear to be "the usual suspects," i.e. large energy or energy-intensive companies that have clear investment plans in areas such as clean(er) power generation (i.e. mostly gas); energy efficiency; and industrial improvement processes. Without this type of engagement, the TJTPs risk being skewed towards the investment needs of large enterprises (of which many fall out of the scope of JTF Regulation).
- Large enterprises, given their know-how and available resources, should engage in the identification of potentially parallel investment needs and opportunities, following either their low-carbon expansion plans or their layover plans – what new business can they engage in; what new businesses do they foresee to be developed by third parties at the local level given their expansion/layoff plans, etc.
- Large enterprises must engage in a concrete dialogue process with local authorities, especially municipalities, on potentially joint cooperation ideas in scope of the JTF regulation such as brownfield redevelopment. Our initial assessment indicates the potential and need for such investment (e.g., large idle land available and owned by the enterprises; contaminated sites; decontaminated sites not yet developed; industrial heritage buildings that will remain idle, etc.). However, no discussions have been initiated to date. National and local civil society organisations and specialists (e.g., urban planners, architects, etc.) can contribute to such conversations. In any case, given the TJTP elaboration process calendar, these "more creative" type of conversations must be initiated as soon as possible.
- Skills developers (e.g., county school inspectorate, county vocational schools, educational NGOs and educational services companies, local employment offices, etc.) are not currently engaged in the Just Transition process (some are engaged "on paper" but have not been properly involved). Their engagement is critical to identify investment needs and opportunities. The Technical Support Team has discussed bilaterally with almost all six school inspectorates and with all six local employment offices, has informed them on the content of the Regulation and on the opportunities arising out of the just transition process. We recommend that their engagement is followed-up by MIPE and by the County Councils. Furthermore, these institutions have been engaged during all regional workshops and results will be provided in the updated version of Deliverable 4.

8. ANNEXES

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Annex 1: List of stakeholder consultations

Annex 2: E3ME methodology description

Annex 3: Regional modelling methodology description

ANNEX 1: LIST OF STAKEHOLDER CONSULTATIONS

List of stakeholder consultations

Register of interviews conducted by the team of experts by 16 January 2021:

No.	Date	Name of the stakeholder	Type of stakeholder	Relevance*
1	11-Dec-20	Galați County Council	Public authority	Galați
2	11-Dec-20	RDA West	Public authority	Hunedoara
3	14-Dec-20	Hunedoara County Council	Public authority	Hunedoara
4	15-Dec-20	Mureș County Council	Public authority	Mureș
5	15-Dec-20	Gorj County Council	Public authority	Gorj
6	16-Dec-20	Prahova County Council	Public authority	Prahova
7	16-Dec-20	RDA South	Public authority	Prahova
8	17-Dec-20	RDA Center	Public authority	Mureș
9	21-Dec-20	Dolj County Council	Public authority	Dolj
10	4-Jan-21	Complexul Energetic (CE) Hunedoara	Enterprise	Hunedoara
11	5-Jan-21	Greenpeace Romania	NGO	Hunedoara, Gorj
12	6-Jan-21	Petroleum-Gas University of Ploiesti	Academia	Prahova
13	6-Jan-21	Complexul Energetic (CE) Oltenia	Enterprise	Dolj, Gorj
14	6-Jan-21	OMV Petrom	Enterprise	Prahova
15	8-Jan-21	Liberty Galați	Enterprise	Galați
16	8-Jan-21	WWF Romania	NGO	National
17	15-Jan-21	Hunedoara Municipality	Public authority	Hunedoara

**Based on Working Group membership or partnership structure for the OPJT*

Note: The conclusions are results from a first set of interviews conducted by the Technical Support Team. The reference cut-off date for interview conclusions in the present report is 16 January 2021. Following this date, an additional number of approximately 80 bilateral and group interviews took place and the adjusted conclusions have been presented in Deliverable 4 draft version and are subject to further analysis in Deliverable 4 final version.

ANNEX 2: E3ME METHODOLOGY DESCRIPTION

E3ME - Methodology Description

The theoretical background

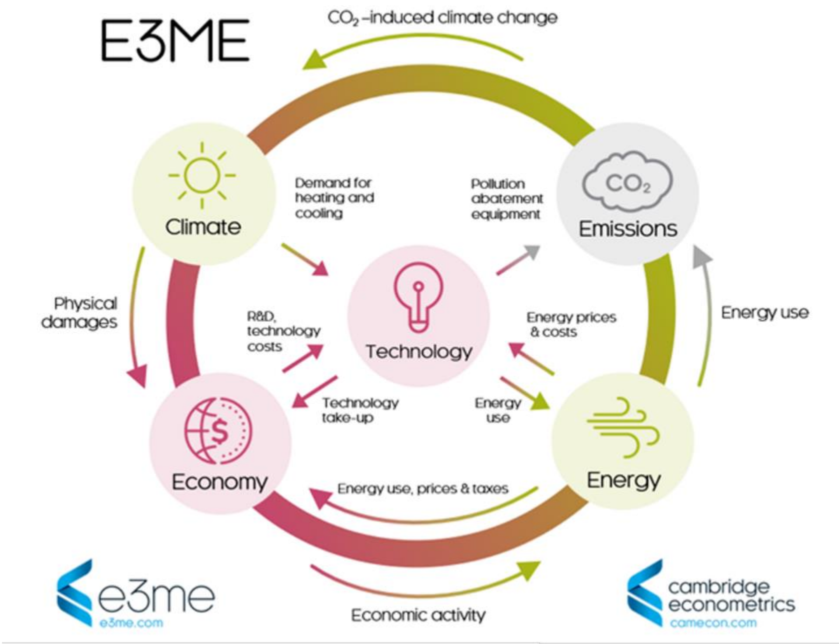
Economic activity undertaken by persons, households, firms and other groups in society has effects on other groups after a time lag. These effects, both beneficial and damaging, accumulate in economic and physical stocks. The effects are transmitted through the environment, through the economy and the price and money system (via the markets for labour and commodities), and through the global transport and information networks.

The markets transmit effects in three main ways: through the level of activity creating demand for inputs of materials, fuels and labour; through wages and prices affecting incomes; and through incomes leading to further demands for goods and services. The economic and energy systems have the following characteristics:

- economies and diseconomies of scale in both production and consumption
- markets with different degrees of competition
- the prevalence of institutional behaviour whose aim may be maximisation, but may also be the satisfaction of more restricted objectives
- rapid and uneven changes in technology and consumer preferences
-

An energy-environment-economy (E3) model capable of representing these features must therefore be flexible, capable of embodying a variety of behaviours and of simulating a dynamic system.

Structure of the E3ME model



The E3ME model is well suited to analysing the linkages between the economic and energy systems, with links to environmental emissions. Figure below shows how the three main components (modules) of the model - energy, environment and economy - fit together. Each component is shown in its own box. Each data set has been constructed by statistical offices to conform with accounting conventions. Exogenous factors coming from outside the modelling framework are shown on the outside edge of the chart as inputs into each component.

Key dimensions of E3ME

The main dimensions of E3ME are:

- 61 countries – all major and G20 economies, the EU27+UK and candidate countries plus other countries' economies grouped
- 43/69 industry sectors, based on standard international classifications
- 28 categories of household expenditure
- 22 different users of 12 different fuel types

The econometric specification of E3ME gives the model a strong empirical grounding. E3ME uses a system of error correction, allowing short-term dynamic (or transition) outcomes, moving towards a long-term trend. The dynamic specification is important when considering short and medium-term analysis (e.g. up to 2025) and rebound effects, which are included as standard in the model's results[139].

Basic modelling approach

Our modelling approach is based on simulation properties and bases forecasts on a combination of past behaviour and assumptions about key future trends (e.g. population). It allows for a broad range of policies to be tested[140]. This modelling approach is qualitatively different from the standard optimisation tools that are used in other analyses and draws on theories from post-Keynesian and evolutionary economics. Instead of trying to find least-cost pathways, the model simulates the responses to stimuli (including changes in drivers such as economic, demographic or technological development, or both regulation and market-based policies) and is parameterised on real-world time-series data.

Compared to the other macroeconomic models in operation currently across the world, E3ME has advantages in the following four important areas:

- Geographical coverage: E3ME provides global coverage, with explicit coverage of the world's major economies (all G20 countries). OPEC member countries are either identified explicitly or grouped together so that aggregate impacts can be evaluated.
- Sectoral disaggregation: The detailed nature of the model allows the representation of detailed forecasts with differentiation by sector and by country. Similarly, the impact of any policy measure can be represented in a detailed way, for example showing the winners and losers from a particular policy.
- Econometric pedigree: The econometric and empirical grounding of the model makes it better able to represent performance in the short to medium terms, as well as providing long-term assessment. It also means that the model is not reliant on the rigid assumptions common to other modelling approaches.
- E3 linkages: E3ME is a hybrid model. A non-linear interaction (two-way feedback) between the economy, energy demand/supply, material consumption and environmental emissions is an undoubted advantage over models that may either ignore the interaction completely or only assume a one-way causation.

Comparing E3ME to Computable General Equilibrium (CGE) models

E3ME is often compared to Computable General Equilibrium (CGE) models. The CGE model has become the standard tool for long-term macroeconomic and energy-environment-economy (E3) analysis. CGE models are used all over the world; notable examples include GTAP[141] or GEM-E3-FIT[142]. Many of these models are based on the GTAP database that is maintained by Purdue University in the US.

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[139] See: Barker, Terry, Sebastian De-Ramon, and Hector Pollitt. 'Revenue Recycling and Labour Markets: Effects on Costs of Policies for Sustainability'. Modelling Sustainable Development: Transitions to a Sustainable Future, 2009, 104–26.

[140] See discussion in: Mercure, Jean-Francois, Hector Pollitt, Andrea. M. Bassi, Jorge. E Viñuales, and Neil R. Edwards. 'Modelling Complex Systems of Heterogeneous Agents to Better Design Sustainability Transitions Policy'. Global Environmental Change 37 (1 March 2016): 102–15. https://doi.org/10.1016/j.gloenvcha.2016.02.003.

[141] Hertel, Thomas Warren. Global Trade Analysis: Modeling and Applications. Cambridge University Press, 1997.

[142] Capros, P., Denise Van Regemorter, Leonidas Paroussos, P. Karkatsoulis, C. Fragkiadakis, S. Tsani, I. Charalampidis, and Tamas Revesz. 'GEM-E3 Model Documentation'. JRC Working Papers. JRC Working Papers. Joint Research Centre (Seville site), July 2013. https://ideas.repec.org/p/ipt/iptwpa/jrc83177.html.

In many ways, the modelling approaches in CGE models and E3ME are similar; they are used to answer similar questions and use similar inputs and outputs. However, underlying this there are important theoretical differences between the modelling approaches and it is important to be aware of this when interpreting model results.

The CGE model favours fixing behaviour in line with economic theory. In a typical CGE framework, optimal behaviour is assumed, output is determined by supply-side constraints and prices adjust fully so that all the available capacity is used. CGE models typically assume constant returns to scale; perfect competition in all markets; maximisation of social welfare measured by total discounted private consumption; no involuntary unemployment; and exogenous technical progress following a constant time trend.

In contrast, econometric models like E3ME interrogate historical data sets to try to determine behavioural factors on an empirical basis and do not assume optimal behaviour. In E3ME, the determination of output comes from a post-Keynesian framework and it is possible to have spare capacity. The E3ME model is demand-driven, with the assumption that supply adjusts to meet demand (subject to any constraints), but at a level that is likely to be below maximum capacity. Unlike CGE models, E3ME does not assume that prices always adjust to market clearing levels.

The treatment of the financial sector in E3ME is also very different to that in CGE models. E3ME does not assume that there is a fixed stock of money but instead allows for the potential of endogenous money, i.e., banks increasing lending for investment, which in turn stimulates demand. This is broadly consistent with how the financial system works in reality (see McLeay et al, 2014[143] for a description, and Pollitt and Mercure, 2018[144], for a wider discussion).

The differences described above have important practical implications for scenario analysis. The assumptions of optimisation in CGE models mean that all resources are fully utilised, and it is not possible to increase output and employment by adding regulation. E3ME, on the other hand, allows for the possibility of unused capital and labour resources that may be utilised under the right policy conditions, making it possible (although certainly not guaranteed) that additional regulation could lead to increases in investment, output and employment. The range of policy options also increases once assumptions about optimal behaviour (e.g., profit and utility maximising, perfect competition or fully rational behaviour) are dropped.

Many of the assumptions that underpin CGE (and DSGE) models have been increasingly questioned as to whether they provide an adequate representation of complex real-world behaviour. Examples include perfect competition, perfect knowledge and foresight, and optimal rational behaviour and expectations. Some CGE models have been adapted to relax certain assumptions but the underlying philosophy has not changed.

Comparing E3ME to econometric forecasting models

E3ME is sometimes also compared to short-term econometric forecasting models. These models are usually used for short-term forecasting exercises, often with a quarterly or even monthly resolution, and are used to describe short and medium-term economic consequences of policies with a limited treatment of longer-term effects. This restricts their ability to analyse long-term policies and they often lack a detailed sectoral disaggregation.

E3ME, on the other hand, combines the features of an annual short- and medium-term sectoral model estimated by formal econometric methods, providing analysis of the movement of the long-term outcomes for key E3 indicators in response to policy changes. Economic theory, for example theories of endogenous growth, informs the specification of the long-term equations and hence properties of the model; dynamic equations which embody these long-term properties are estimated by econometric methods to allow the model to provide forecasts. The method utilises developments in time-series econometrics, with the specification of dynamic relationships in terms of error correction models (ECM) which allow dynamic convergence to a long-term outcome.

[143] McLeay, M, Radia, A and Thomas, R (2014) 'Money creation in the modern economy', Bank of England quarterly bulletin, 2014Q1.

[144] Pollitt, Hector, and Jean-Francois Mercure. 'The Role of Money and the Financial Sector in Energy-Economy Models Used for Assessing Climate and Energy Policy'. Climate Policy 18, no. 2 (7 February 2018): 184–97. https://doi.org/10.1080/14693062.2016.1277685.

Energy-emissions modelling in E3ME

The energy module in E3ME is constructed, estimated and solved for each energy user, each energy carrier (termed fuels for convenience below) and each region. Aggregate energy demand is determined by a set of econometric equations, with the main explanatory variables being:

- economic activity in each of the energy users
- average energy prices for each energy user in real terms
- technological variables, represented by investment and R&D expenditure and spillovers in key industries producing energy-using equipment and vehicles

The econometric parameters in the equations are derived from time series covering the period 1970-2015. The econometric techniques used to specify the functional form of the equations are the concepts of cointegration and error-correction methodology.

In brief, the process involves two stages. The first stage is a levels relationship, whereby an attempt is made to identify the existence of a cointegrating relationship between the chosen variables, selected on the basis of economic theory and *a priori* reasoning, e.g., for employment demand the list of variables contains real output, real wage costs, hours-worked, energy prices and the two measures of technological progress.

If a cointegrating relationship exists then the second stage regression is known as the error-correction representation, and involves a dynamic, first-difference, regression of all the variables from the first stage, along with lags of the dependent variable, lagged differences of the exogenous variables, and the error-correction term (the lagged residual from the first stage regression). Due to limitations of data size, however, only one lag of each variable is included in the second stage.

Stationarity tests on the residual from the levels equation are performed to check whether a cointegrating set is obtained. Due to the size of the model, the equations are estimated individually rather than through a cointegrating VAR. For both regressions, the estimation technique used is instrumental variables, principally because of the simultaneous nature of many of the relationships, e.g., wage, employment and price determination.

Energy price elasticities

In contrast to the rest of the model, the long-run energy price elasticities used in E3ME are not based on time-series econometric estimation; instead they are taken from a combination of cross-section estimation and reviewed literature. As part of the contract we will review and if necessary update the energy price elasticities, based on the most recent data (with a focus on transport sectors).

The reason for using a different approach for these specific elasticities is that the time-series analysis yields responses to fluctuations in energy prices (i.e., temporary effects) whereas the projections we are interested in here relate more to long-term trends that influence expectations (e.g., on vehicle technologies). For most sectors, the current values used range from -0.2 to -0.3, meaning that a 1% increase in price leads to a 0.2-0.3% reduction in consumption. Short-run elasticities are based on the time-series data and are usually close to zero.

Disaggregating energy demand

Fuel use equations are estimated for four energy carriers (coal, oil, gas and electricity) with four sets of equations estimated for the fuel users in each region. These equations are intended to allow substitution between the four energy carriers by users on the basis of relative prices, although overall fuel use and the technological variables are also allowed to affect the choice.

Under the current treatment, the remaining fuels are determined either as fixed ratios to aggregate energy use or are assumed to be used in a similar way to other, closely related fuels (e.g., other coal and hard coal, crude oil and heavy fuel oil, other gas and natural gas).

Determination of global energy prices

The final set of fuel demands must then be scaled to ensure that they add up to the aggregate energy demand (for each fuel user and each region).

One important feature of E3ME, which distinguishes it from most other macroeconomic models, is that it includes a dynamic representation of energy cost-supply curves. This means that if policies are put in place that reduce global fuel demand, it is the highest-cost sources of fuel that are cut first, within a distribution of uncertainty. The result is that climate policies are more likely to result in reduced energy extraction in the US (shale), Canada (tar sands) and Latin America (deep-sea reserves), more than might be expected from applying a simpler coefficient-based approach. This, however, does not mean that OPEC countries do not see a loss of production in scenarios where energy demand falls, just that it is not as high (in real terms) as some other models would predict.

The energy cost-supply curves can also be used to predict future energy prices. For further information about the cost-supply curves, see Mercure and Salas (2012)[145].

Economic modelling

The economic structure of E3ME is based on the system of national accounts, with further linkages to energy demand and environmental emissions. The labour market is also covered in detail, including both voluntary and involuntary unemployment. In total, there are 33 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, international trade), prices, energy demand and materials demand. Each equation set is disaggregated by country and by sector.

E3ME's historical database covers the period 1970-2018 and the model projects forward annually to 2050. The main data sources for European countries are Eurostat and the IEA, supplemented by the OECD's STAN database and other sources where appropriate. For regions outside Europe, additional sources for data include the UN, OECD, World Bank, IMF, ILO and national statistics. Gaps in the data are estimated using customised software algorithms.

Economic interdependence

Output and employment in E3ME economic model are determined by levels of demand, unless there are constraints on available supply. This results in four loops or circuits of economic interdependence, which are described below.

The full set of loops comprises:
- Interdependency between sectors: If one sector increases output it will buy more inputs from its suppliers who will in turn purchase from their own suppliers. This is similar to a Type I multiplier.
- The income loop: If a sector increases output it may also increase employment, leading to higher incomes and additional consumer spending. This in turn feeds back into the economy, as given by a Type II multiplier.
- The investment loop: When firms increase output (and expect higher levels of future output) they may also increase production capacity by investing. This creates demand for the production of the sectors that produce investment goods (e.g., construction, engineering) and their supply chains.
- The trade loop: Some of the increase in demand described above will be met by imported goods and services. This leads to higher demand and production levels in other countries. Hence there is also a loop between countries.

Output and determination of supply

Total product output, in gross terms, is determined by summing intermediate demand and the components of final demand described above. This gives a measure of total demand for domestic production.
Subject to certain constraints, domestic supply is assumed to increase to match demand. The most obvious constraint is the labour market (see below). However, the model's 'normal output' equations

[145] Mercure, J-F and P Salas (2012), 'An assessment of global energy resource economic potentials', *Energy*, vol 46(1), pp 322-336.

provide an implicit measure of capacity, for example leading to higher prices and rates of import substitution when production levels exceed available capacity.

The labour market and incomes

Treatment of the labour market is one area that distinguishes E3ME from other macroeconomic models. E3ME includes econometric equation sets for employment (as a headcount), average working hours, wage rates and participation rates. The first three of these are disaggregated by economic sector while participation rates are disaggregated by gender and five-year age band.

The labour force is determined by multiplying labour market participation rates by population. Unemployment (including both voluntary and involuntary unemployment) is determined by taking the difference between the labour force and employment.

Due to limitations in available time-series data, E3ME adopts a representative household for each region. Household income is determined as:

$$Income = Wages - Taxes + Benefits + Other\ income$$

Household income, once converted to real terms, is an important component in the model's consumption equations, with a one-to-one relationship assumed in the long run.

Price formation

For each real variable, there is an associated price, which influences quantities consumed. Aside from wages, there are three econometric price equations in the model: domestic production prices; import prices; and export prices. These are influenced by unit costs (derived by summing wage costs, material costs and taxes), competing prices and technology. Each one is estimated at the sectoral level.

Emissions modelling

E3ME's emissions module calculates air pollution generated from end-use of different fuels and from primary use of fuels in the energy industries themselves, particularly electricity generation. The model includes 12 different types of emissions, including CO_2. However, the treatment of emissions other than CO_2 is less detailed and results are not usually disaggregated by sector. In addition, it should be noted that many of the impacts of the other emissions (e.g., PM10) are localised and cannot be captured by a model that operates at national level.

CO2 emissions

Emissions data for CO_2 from energy consumption are available for each of the energy users in the model. Coefficients (tonnes of carbon emitted per toe) are implicitly derived using historical data (and sometimes also baseline projections). This forms the relationship between energy consumption and emissions. Process CO_2 emissions, for example from the chemicals and cement sectors, are also included explicitly in the modelling, but are linked to production from those sectors rather than energy consumption. In this modelling exercise, our focus is on CO_2 emissions from energy consumption and industrial processes.

Feedbacks to the economy

The modelling does not include any feedbacks from emissions or estimates of climate change to the economy (i.e., climate-related damages are not considered). The reason is that the effects are too uncertain, given the current academic literature on potential effects. Although this is the standard treatment in economic modelling exercises, it does mean that some potentially beneficial effects of reducing greenhouse gas emissions are missed.

Further information

Further information about E3ME is available in the model manual (Cambridge Econometrics, 2014), which is published on the model website www.e3me.com.

ANNEX 3: REGIONAL MODELLING METHODOLOGY DESCRIPTION

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Regional Modelling - Methodology Description

Top-Down Modelling

Shift-share model

First, define growth rates at three separate levels:
- Total growth rate at the national level
- Sectoral growth rate at the national level
- Sectoral growth rate at the regional level

The standard (static) shift-share model can be used to separate total change into the three components.

The difference between the static and the dynamic shift-share models is that the former includes only two years in the analysis, while the latter calculates for every time period. The annual results are then aggregated over the entire period to get the final shift-share effects.

ARIMA forecasting of the competitive component

Auto-Regressive Integrated Moving Average (ARIMA) models are based on the notion that data can be thought of as the realisation of a stochastic process. The goal is to find a simple model that captures the essential characteristics of the stochastic process (i.e., to achieve pattern replication rather than pattern explanation). Hence, the only systematic information used in modelling a time series is:
- The past behaviour of that series
- Deterministic components (e.g., constant, dummy variables, time trend)

These models are estimated through Maximum Likelihood Estimators (MLE) and are characterised by three main parameters:
- p: the order of the autoregressive (AR) part of the model
- d: the degree of first differencing required to achieve stationarity
- q: the order of the moving average (MA) part of the model

ARIMA models can be augmented with further explanatory variables (provided forecasts are available for these additional / eXtra variables), forming **ARIMAX models**. The statistical underpinning of ARIMAX models is similar to ARIMA models, with the additional restriction that the added explanatory variables must be stationary as well.

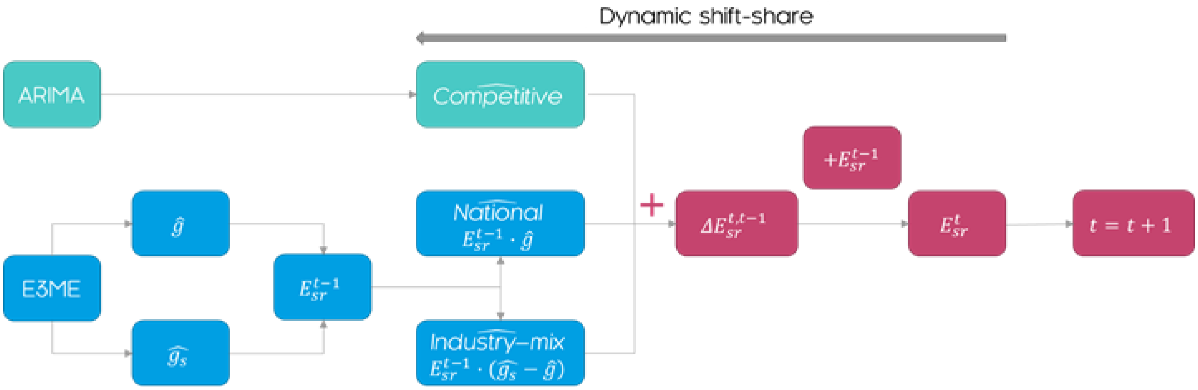
Having obtained time series with the competitive effect for GVA and employment through dynamic shift-share and regional population projections, a separate ARIMAX(p, d, q) model was specified for each sector, of each region within each country.

The parameters for the ARIMAX model for each region-sector combination were determined using already existing Python libraries. More specifically:
- The Augmented Dickey-Fuller test was used to determine the degree of differencing required to achieve stationarity of the variables used in the model. This was implemented through the relevant method of the *statsmodels* library.
- The order of the AR and MA components was determined using the automatic selection functionality of the *pmdarima* library. The *auto_arima* method of *pmdarima* performs a grid search over potential model parameters and selects the model that minimises the information criterion set by the user. The Bayesian Information Criterion (BIC) was used for the purposes of this project.

Given the relatively short time horizon of the input data, the maximum order was set to two for both the AR and MA components, while the p-value threshold for achieving stationarity was set to 10%. This relatively lax approach was preferred to preserve information that would have been lost due to additional orders of differencing to achieve stationarity (which would have decreased forecast accuracy) and due to the expectation that the variables would have been stationary over a longer period of time. For the same reason, the competitive effect and the population variables were allowed to have different orders of integration (d), as ensuring a common d is likely to have required additional differencing of the variables to achieve stationarity, resulting in further loss of information.

Reverse dynamic shift-share

This step is where ARIMA(X) forecasts are integrated with E3ME results. The following recursive process is applied for each time period of the forecast horizon:



This process can be seen as a “reverse dynamic shift-share”, as forecasts of the three shift-share components are combined to give expected change in the variable year-by-year and eventually the final predictions of the variable levels.

Data input and processing

All historical regional data can be obtained from Eurostat datasets.

Sectoral classification

The sectoral classification of employment and GVA data includes the following aggregated NACE Rev.2 sectors of Eurostat (hereinafter: 10 NACE sectors):

Sector code	Sector name
A	Agriculture, forestry, and fishing
BDE	Mining and quarrying; electricity, gas, steam and air conditioning supply; water supply and sewage
C	Manufacturing
F	Construction
G-I	Wholesale and retail trade, transport, accommodation, and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M-N	Professional, scientific, and technical activities; administrative and support service activities
O-U	Public administration and defence; compulsory social security; education; human health and social work activities; arts, entertainment and recreation, repair of household goods and other services
TOTAL	Regional/Country total

Employment (NUTS-3)

Historical employment data by NUTS-3 regions, for the 10 NACE sectors, obtained from Eurostat’s *nama_10r_3empers* dataset for the period 1995-2017.

GVA (NUTS-3)

Gross value added (GVA) at basic prices by NUTS-3 regions, for the 10 NACE sectors, obtained by from Eurostat’s *nama_10r_3gva* dataset for the period 1995-2017. The implicit price deflator from the *nama_10_a64* dataset should be used to align price levels (by converting the data to constant 2010 euros), assuming that all regions within the same country have the same price level (as regional deflators were not available).

Population (NUTS-3)

Population data obtained from Eurostat's *demo_r_pjanaggr3* dataset. If needed, missing values for all NUTS-3 regions can be filled using shares from the *nama_10r_3popgdp* dataset.

Population projections (NUTS-3, 2020-2025-2030)

Population projections for NUTS-3 regions are based on the JRC's Urban Data Platform Plus dataset, by NUTS3 regions for the years 2020, 2025 and 2030, available at: https://urban.jrc.ec.europa.eu/#/en/download

Bottom-up energy modelling

This section explains the logic applied to determine how country (*ctry*) capacity per technology (*tech*) is split between NUTS-2 regions (*reg*) over time (*t*).

Step 1 - Determining 2017 capacity and capacity age

1. Using the JRC Open Power Plants Database (**JRC-PPDB-OPEN**), national capacity in 2017 is split up to the RO NUTS2 regions by technology type. This does not always match total national capacity figures provided by Eurostat or E3ME-FTT:Power data – therefore, the JRC-PPDB-OPEN database will need to be scaled up to 2017 E3ME-FTT capacity results.

2. The JRC-PPDB-OPEN database also provides the **commissioning date**, however the coverage of this is limited, only **69%** of powerplants in the JRC-PPDB-OPEN dataset have commissioning dates. The rest will be estimated, using the average of the commissioning data available:
   a. Within a given region, if the same technology is available compute the average and use that as a proxy for missing commissioning date of same technology
   b. If the same technology is not available within the same region then use the average of the same technology within the country
   c. If that is not available, use the average of the same technology of the EU

3. Missing capacity, commission year, and location data will be manually filled using:
   a. The JRC Geothermal Power Plant Database
   b. The Global Power Plant Database
   c. The Wind Power database
   d. The JRC Hydro-Power database
   e. Other ad-hoc online sources.

4. The 2017 NUTS-2 capacity data from JRC-OPEN-PPDB database will be scaled to match total 2017 national capacity data from E3ME-FTT:Power.

5. Using the commissioning year data, we will estimate the age of each powerplant. This will be used to determine where the national level decommissions (from E3ME) should be removed from the regional level (step 3 below). In short, the oldest power plant will be scrapped first.

6. At this point we have a database with data for all *reg* and all *tech* in 2017 as exemplified below.

2017 capacity and age by technology (tech) and NUTS3 region (reg)

NUTS-2 Region	Technology	2017 Capacity (GW)	Age (years)
RO041	Solar	2.5	4
RO041	Solar	1.5	7
RO041	Gas	5	10
RO041	Gas	2.1	19
RO041	…	…	…

RO042	Solar	2.5	4
RO042	…	…	…
…	…	…	…

Step 2 - Using E3ME national results to determine annual decommissions and new commissions

E3ME-FTT: Power provides annual country-technology capacity results (MEWK) and annual country-technology new capacity commissions (MEWI).

This will allow us to understand how much new capacity will be installed (MEWI) and how much capacity will be decommissioned (DECOM) in each year-country-technology.

Step 3 - Allocating national decommissions to each NUTS-2 region

1. Once we identify the amount of capacity decommissioned in each year-technology-country, we can prepare the below table for each country-technology combination.

Decommissioning profile example for the RO-Solar capacity case – country level

NUTS-2 Region	Tech	2017 Capacity (GW)	2017 Age (years)	2018	2019	2020	2021	…
RO01	**Solar**	**2.5**	**3**					…
RO01	**Solar**	**1.5**	**7**					…
RO02	**Solar**	**2.5**	**4**					…
…								
Total = DE DECOM	**-**	**-**	**-**	**-0.5**	**-1**	**-0.25**	**-3**	**…**

2. The **2017 Capacity** and **2017 age** columns are prepared from the original database files. The 2017 age is calculated by taking the commissioning year from 2017.
3. The **"Total = DE DECOM**" row was estimated in Step 2 using the E3ME-FTT:Power results. In this example the results show the amount of Romanian solar capacity that E3ME-FTT:Power decommissioned in each result year.
4. The cells shaded in light blue must be filled in to determine which capacity from which region is decommissioned in each year. This decision is based on the age of each region's capacity as determined in Step 1. In 2018, decommissioning will occur based on capacity age in 2017. In 2019, it will be determined on the age in 2018 and so on. As a logical rule, the oldest capacity will be decommissioned first, irrespective of its NUTS-2 location.

Decommissioning profile example for the Romanian-Solar capacity case – regional level

NUTS-2 Region	Tech	2017 Capacity (GW)	2017 Age (years)	2018	2019	2020	2021	…
RO01	**Solar**	**2.5**	**3**				-0.75	…
RO01	**Solar**	**1.5**	**7**	-0.5	-1			…
RO02	**Solar**	**2.5**	**4**			-0.25	-2.25	…
…								
Total = DE DECOM	**-**	**-**	**-**	**-0.5**	**-1**	**-0.25**	**-3**	**…**

5. In the case where capacity in different regions have the same age, we will estimate the weighted average age of all capacity (across all technologies) in each region. And the power plant in the region with the highest weighted average age will be decommissioned. This assumes that decision makers will remove (and therefore potentially replace) technology in regions with older infrastructure first.

Step 4 - Allocating national commissions to each NUTS-2 region

Commissioning profile example for the Romanian-Solar capacity case – country level

NUTS-2 Region	Tech	2017 Capacity (GW)	2017 Age (years)	2018	2019	2020	2021	…
RO01	**Solar**	**2.5**	**3**					…
RO01	**Solar**	**1.5**	**7**					…
RO02	**Solar**	**2.5**	**4**					…
…								
Total = MEWI	**-**	**-**	**-**	**+1**	**+0.5**	**+1**	**+0.25**	**…**

The **"Total = MEWI**" row is calculated in Step 2 using the E3ME-FTT:Power results. This shows the amount of Romanian solar capacity that E3ME-FTT:Power commissioned and/or replaced in each result year. The empty cells must be filled in to determine which capacity from which region is commissioned in each year.
The allocation of new (and replaced) capacity will differ by technology. E3ME-FTT:Power results will provide an estimate of the capacity installed by technology each year at the national level (MEWI). The model then allocates this additional capacity by NUTS2 region.

New solar and onshore wind capacity

1. The decision to allocate new solar (PV and CSP) and onshore wind capacity will be based on **technical potential** results and **capacity factors** prepared by the JRC in the ENSPRESO database[8].
1. The ENSPRESO technical potential results will act as an upper capacity limit. No capacity can be installed in a region over and above its estimated technical capacity figure. The ENSPRESO capacity factors allow us to determine which regions will have the highest Solar and Onshore wind efficiency.
2. Each country's NUTS-2 regions will be ranked based on their capacity factors.
3. In each year, regions will be allocated replacement capacity (calculated in Step 2). All excess capacity "additional capacity" will be allocated on the basis of each NUTS-2 region's capacity factor and remaining technical potential.

New coal, oil, gas, nuclear and biomass capacity

This capacity can, in practice, be built anywhere and does not depend on the availability of wind or solar radiation. Therefore, the decision rule to allocate new capacity will differ.
1. Allocate the capacity in proportion to the share of the technology's capacity in each NUTS2 region in the current year (i.e., the previous year's capacity including decommissions).

New hydro and geothermal capacity

Unless new data is found, new capacity of hydro and geothermal capacity will only be allocated to regions which have already installed this capacity in the past. The approach follows the same logic as the allocation of coal, oil, gas etc.

Step 5 – Estimating employment and economic output

Once the decommissions and commissions are allocated to NUTS2 regions by definition the model has attained the net effect of capacity in each region for each technology type. Then, the next step is to calculate generation and economic output. The methodology for each are detailed in the original Task 6.2 methodology report. Once this has been done, the final economic output from the power sector is scaled to output from E3ME and combined with the results from the shift-share model.

Miscellaneous assumptions

- Fuel Cells from FTT:Power assumed to map to 'Other' from the databases. This is scaled accordingly.
- IGCC and CCGT technologies were grouped into 'Gas' technology.

ENSPRESO capacity factors and technical potential

Solar PV and CSP

The ENSPRESO results provides solar PV and CSP capacity factors, technical capacity (GWe) and Power Production (TWh) for several NUTS 2 regions. These results assume a land efficiency of 170 MW/km^2 and a 3% utilisation of the available natural areas.

Onshore wind

The ENSPRESO results provide onshore capacity factors and technical capacity for most NUTS 2 regions. This data varies by scenario, sub-scenario, and wind conditions. The data assumed in this project follows the:

- **EU-Wide low restrictions scenario**: A hypothetical scenario in which the exclusion of surfaces for wind converges in all countries to a low level.
- **Turbine type**: large 400m setback distance
- **Wind condition**: Share of land with certain CF range >25%
- **Capacity factory**: Real average CF over whole region

The wind condition affects the area of suitable land that has a certain capacity. So, when the value "Share of land with certain CF range: >25%" is 1 it means that all available land has a capacity factor higher than 25%. When the value "Share of land with certain CF range: >25%" is 0 it means that, with the type of turbine assumed, there is no available land with a capacity factor higher than 25%.

Data preparation – final results

Estimating generation

Electricity generation is estimated via the multiplication of the capacity factor and the number of hours in a year. The capacity factor for Solar PV, CSP and Onshore is available at a NUTS-2 level and is used in this calculation. The capacity factor is not available for other technologies at the NUTS-2 level, so the national capacity factor (MEWL) is used to calculate generation.

Estimating LCOE

There are several different LCOEs available in the FTT:Power module. Each one varies by which policy inputs are included or not, and some are intended solely for investors purposes not for the market. For this project we want to use the LCOE which represents the market electricity price. The electricity market is competitive; it passes on price decreases (subsidies) but absorbs price increases (carbon taxes). Therefore, we use the LCOE which includes subsidies but excludes carbon tax (MECC).

To estimate LCOE the capacity factor from the NUTS-2 level is used for Solar PV, CSP, and Onshore. Since the capacity factor does not vary by NUTS2 region for the other technologies, we just use the LCOE created by the original E3ME model to reducing computing power and quicken the module.
The results from the E3ME are originally outputted for 24 power generating technologies. In order to get the results for the 13 technologies – as in the regional module E3ME-FTT-ER – we take simple averages across each of the technologies LCOEs (e.g. Gas LCOE is an average of CCGT, CCGT CCS, IGCC and IGCC CSS's LCOE).

Employment factors

The employment factors have been updated according to the latest literature. The table below shows the coefficient of jobs per installed MW capacity for each technology.

Technology	Jobs/MW
Oil	0.15
Coal	0.3
Gas	0.14
Large Hydro	0.59
Nuclear	0.59
Solar PV	0.15
CSP	1
Onshore	0.4
Offshore	0.2
Geothermal	0.4
Biomass	0.87
Ocean	0.3
Other	0.14

JRC Open Power Plants Database
JRC (2020); JRC Open Power Plants Database (JRC-PPDB-OPEN); Available at: https://zenodo.org/record/3574566#.XyMFkCgzaUk

ENSPRESO capacity factors and technical potential
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