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JUST TRANSITION STRATEGIES FOR THE AUSTRIAN AND GERMAN AUTOMOTIVE INDUSTRY IN THE COURSE OF VEHICLE ELECTRIFICATION

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Zusammenfassung

Wie die Zukunft der Arbeit aussehen wird ist eine der Kernfragen für die sozial-ökologische Transformation, vor allem da viele Berufsfelder in Ökologisch nicht nachhaltigen Industrien zu finden sind. Eine dieser nicht nachhaltigen Industrien ist die Automobilindustrie. Die Transformation der Autoindustrie vom Verbrennungsmotor hin zu alternativen Antrieben gefährdet viele Arbeitsplätze in diesem Sektor. Daher ist es wichtig die zu erwartenden Änderungen genauer zu Untersuchen. Für die Gestaltung eine „just Transition" Strategie ist es wichtig zu verstehen welche Beschäftigten Gefahr laufen ihre Arbeitsplätze zu verlieren.

Diese Arbeit bietet einen Überblick über die zu Erwartenden Änderungen in der Beschäftigung der deutschen und österreichischen Automobilindustrie.

Ausgehend vom Altersprofil der aktuell in diesem Sektor Beschäftigten und dem Gefährdungsprofil für die jeweiligen Jobs wird untersucht, wer von zu erwartenden Job Verlusten betroffen sein wird. Anschließend wird untersucht inwieweit Frühpensionsprogramme die zu erwartenden Arbeitsplatzverluste abfedern könnten. Es zeigt sich, dass ein Pensionsantritt mit 58 in diesem Sektor eine 25% Reduktion der Beschäftigung in beiden Ländern vollständig kompensieren könnte.

Abstract

The future of work is of crucial importance in the social-ecological transformation of economies, as many jobs can be found in ecologically unsustainable industries. One such industry is the automotive industry. As the industry is undergoing a transition towards manufacturing cars with other powertrains than the internal combustion engine, many jobs in the sector are endangered. Therefore, it is important to enquire into the expected changes. Understanding which employees are in danger of losing their job aids in the design of policies that shape the sectoral changes in a socially acceptable way, so called Just Transition strategies. This research provides a review of the expected changes in employment in Austrian and German automotive industry. Second, based on the demographic profiles of employees in the sector, it is examined who will be affected by those changes in employment. Subsequently, the suitability of an early retirement programme to cushion reductions in employment is analysed. It is found that retirement at 58 could fully cushion a 25% reduction in employment by 2030 in both countries.

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List of Abbreviations

AMS	Public Employment Service (Austria)
AMZ	Network of automotive suppliers
BA	German Federal Agency of Labour
BEV	Battery electric vehicle
CATI	Chemnitz Automotive Institute
GDR	German Democratic Republic
GHG	Greenhouse gases
ICEV	Internal combustion engine vehicle
Ifo	Institute for Economic Research
ILO	International Labour Organisation
ISCO 08	International Standard Classification of Occupations, most recent version
JT	Just Transition
KLDB	Classification of Occupations (Germany)
NACE	European Classification of Economic Activities
ÖNACE	Austrian Classification of Economic Activities
OEM	Original equipment manufacturer
PHV	Plug-in hybrid electric vehicle
R&D	Research & Development
SME	Small- and medium enterprises
SUV	Sport utility vehicle
VDA	German Association of the Automotive Industry
WBGU	German Advisory Council on Global Change
WZ	Economic Division (German classification of Economic Activities 2008)

1 Introduction

Cars are the dominant mode of personal transport in industrialized countries, making a world without cars hard to imagine (Mattioli, Roberts, Steinberger, & Brown, 2020). This was not always the case. A little more than hundred years ago, Wilhelm II, the last German emperor, exclaimed: “I believe in the horse, the automobile is a passing phenomenon” (quoted in Adler, 2019, own translation). Since, Germany has become internationally renowned for car manufacturing, while horse breeding is of minor public interest. The automotive industry is by numbers and narrative central to the German economy, directly employing over 800.000 people in 2019 and estimates regarding indirect dependence on the industry varying between every seventh and 35th job ("Automobilindustrie," 2020). In Austria, the branch’s representatives point out that it is a “key industry of the producing sector in Austria (Industriellenvereinigung, 2020, own translation). Its importance also became visible in the present economic crisis. As the industry came under strain during the economic recession induced by the COVID-19 pandemic, lobbyists were quick to demand a buyer’s premium for new cars to boost sales and put the economy back on track towards growth, despite limited success of the measure in 2009. Preserving jobs was a main argument brought forward by lobbyists. The final recovery package for the German automotive industry includes a premium for cars with alternative powertrains, excluding internal combustion engine vehicles (ICEV), reflecting higher weight for ecological considerations than in the past (Joho, 2020).

The public debate on the buyer’s premium in Germany highlights three crucial aspects motivating the research at hand. First, the car industry is important from both an employment and an ecological perspective. In 2018, its global carbon footprint was accountable for 9% of global emissions with the German manufacturer Volkswagen as biggest single emitter (Stephan, Lee, & Kim, 2019). Second, measures argued for on grounds of supposed employment security do not trump ecological considerations anymore. Indeed, German unions engage in debates on the reconciliation between ecology and employment (Blöcker, Dörre, & Holzschuh, 2020). However, in the abovementioned debate IG Metall, the German trade union of metal workers which represents employees in the automotive industry, supported a buyers’ premium of ICEVs while at the same time demanding that the recovery package contributes to ecological conversion of the economy (Specht, Riedel, & Dehaes, 2020). IG Metall’s stance serves as an illustrative example of unions’ ambivalent position in the debate. This ambivalence points, third, towards the need to develop concrete proposals for a transformation of ecologically unsustainable industries focusing on employees.

I aim to foster integrated thinking about these three aspects by inquiring into the expected employment effects of vehicle electrification for the automotive industry in Germany and Austria and unions’ strategies to cushion the estimated employment effects through Just Transition (JT) policies. Battery electric vehicles (BEV) and plug-in hybrid vehicles (PHV)are the most disseminated alternative powertrains and considered key alternatives to ICEVs wherefore I focus on this technology (Bauer, Riedel, Herrmann, Borrmann, & Sachs, 2018). I focus on both countries since the Austrian industry is closely linked to Germany and debate on transformation strategies is more advanced in Austria’s neighbouring country, making it a fruitful exercise to explore the potentials and limitations of German proposals for employees in the Austrian automotive industry. My research thus answers the following question: What can be suitable JT strategies for the

Austrian and German automotive industry given the demography, i.e. age and occupation, of employees in the sector?

Inquiring into the demographic profile of employees in the sector allows to gain a better understanding of who will be affected by sectoral change. Changes in employment structure are a common feature of capitalist economies and especially prevalent in vehicle production in which automation of production is rapidly advancing. Commentators often point out that jobs lost in the turn away from ICEVs will be created elsewhere, for example in the construction of charging infrastructure for battery electric vehicles (BEVs). Of course, preserving jobs linked to an industry based on outdated technologies can hardly be considered an apt roadmap for orientation towards the future (Daum, 2018). At the same time, employees losing their job in one part of the production process are not necessarily the ones to fill newly generated positions elsewhere.

Departing from the age group and occupation of employees in the sector in Germany and Austria, I examine who will be affected by the projected job loss. This allows a shift of perspective from a number of jobs to those people who are in danger of losing employment. Especially in light of the high uncertainty with regards to future developments it is imperative to gain a better understanding of who is affected at what age in order to develop JT strategies that fulfil the sense of the word. In an industry that has a history of failed diversification and a strong attachment to the technological status quo, it is ever more important that organized labour be endowed with the necessary information in order to defend their constituencies' interests against those of the industry (Canzler & Knie, 2018). In this light, it is surprising that scholars working on the conceptualization of a transition towards social-ecological sustainability have long treated work in an abstract manner instead of zooming in onto the role of key actors in the policy arena to sketch out pathways for social-ecologically sustainable work (Brand & Niedermoser, 2016).

Consequently, Brand and Niedermoser (2016) state that the meso level of the transformation is not receiving sufficient attention and that the discourse on the role of trade unions in the social-ecological transformation is pushed to the fringes of academic debate. Since Brand and Niedermoser's (2016) remark, this debate has picked up. To clarify the positioning of my research in this debate, chapter two provides the foundations of my line of argument. First, my theoretical framework and a brief clarification of terms (section 2.1) as well as a brief overview of key figures regarding the German and Austrian Automotive industry (section 2.2) are given. Sections 2.3-2.5 elaborate on unions' current perspectives on JT in the automotive industry and current or past JT strategies and discourses in Austria and Germany. First, scholarly work on the labour-environment nexus, JT and the role of unions (cf. Stevis, Uzzell, & Räthzel, 2018; Wissen & Brand, 2019) is discussed. Second, I consider publications by researchers working for unions or in research institutes connected to trade unions (cf. Urban, 2018; Galgoczi, 2019), as those provide insights into unions' current conceptualisation of the changes ahead and past strategies.

Chapter three is dedicated to expected changes in sectoral employment. Quantitative empirical studies regarding the future of employment in the automotive industry in Austria and Germany provide estimates of the employment effects for different types and degrees of changes in the sector (c.f. Bauer et al., 2018; Blanck et al., 2017; Kleebinder, 2019, amongst others). Qualitative studies give insights into employees' perceptions and strategies for the ongoing changes (cf. Blöcker et al., 2020; Wissen et al., forthcoming).The results of the quantitative empirical studies will inform the employment scenario developed in chapter five, while the results of the qualitative studies are important for the design of JT strategies. Studies focusing on the Austrian or German automotive industry published since 2015 and, for quantitative studies, providing estimates at least until 2025 were included. The five-year time frame of publications (2015-2020) was chosen to allow for systematic review of the material within the scope of a master's thesis and ensure that the most recent estimates are included. An overview of earlier works can be found in Mönnig, Schneemann, Weber, Zika, and Helmrich (2018).

Chapter four enquires into the present structure of employment in the automotive industry. I first give an overview about my data in section 4.1 before discussing regional distribution of employment, age- and occupational groups and cross-tabulated data on age and occupation in the German industry. Subsequently, chapter five provides a scenario analysis, derived from the empirical studies reviewed in chapter three, of employment reduction until 2030 and the possibility to cushion the effects thereof with an early retirement programme. I find that an early retirement programme at 58, analogous to the agreement in the German exit from lignite mining, could fully cushion a 25% reduction in sectoral employment by 2030. Moreover, section 5.2 discusses accompanying measures as part of a JT. These measures are important since my macro-level analysis proofs useful to get an understanding of the overall changes ahead but does not allow for tailor-made solutions for regional contexts and specific plants. Chapter six provides a discussion of my results considering the different strands of research discussed in chapters two and three as well as highlighting limitations of my research and pointing out avenues for future investigation. Chapter seven summarizes and concludes.

2 Setting the scene

2.1 Theoretical considerations and clarifications

Before delving into the analysis, it is important to clarify the theoretical underpinnings informing my thesis and provide a brief review of the current state of the debate surrounding JT. The research realized here is situated in the field of environmental labour studies, which encompasses "all research that analyses how workers in any kind of workplace and community are involved in environmental policies/practices and how they are affected by environmental degradation in the broadest sense" (Stevis et al., 2018, p. 3). Specifically, I am examining potentials for the combination of climate and environmental protection and advancement of social justice goals as the automotive industry undergoes a transition towards vehicle electrification. To this end, I consider the demographic specificities of employees directly working in the sector.

The scope of the definition by Stevis et al. (2018) already hints at the wide variety of works to be found the field. My research is based on different strands of the social sciences which operate within different analytical frameworks and discourses, utilizing different assumptions. There is a fundamental tension between the quantitative studies reviewed in section 3.2., which assume a continuation of the status quo, trade unions' work that often follows short term interests of their constituencies and scholarship concerned with pathways towards a social-ecologically sustainable economy. The degree of separation between these different discourses leads to fundamentally different assessments of the changes ahead. For example, 50% of respondents at a degrowth conference answered in a survey realized in 2014 that the automobile industry will no longer be around by 2034 (Schmelzer & Eversberg, 2017). Four years later, trade union representatives continued to assume that they would still be producing ICEVs by then (Iwer, 2018). Hence, a clarification of terms and theoretical underpinnings of my research is imperative.

Over 70 years after Karl Polanyi first published his seminal work on "the great transformation" (Polanyi, 1944), the term is widely used by diverse actors ranging from the German Advisory Council on Global Change (WBGU) to business consultancies, covering anything from digitalization to large scale changes in the very structure of industrial economies. My thesis contributes to the growing field of research on the social-ecological transformation of industrial and post-industrial societies striving to combat the multiple social and ecological crises presently witnessed in an integrated manner (Brand & Wissen, 2017). Consequently, the term transformation is used to denote structural changes to the functioning of the economic system and society as a whole based on the understanding that "the natural and social foundations of planetary cohabitation cannot be protected by processes of a continued economization of sustainability (Adloff & Neckel, 2019, p. 173 ff., own translation). Instead, today's multiple crises necessitate a sustainability revolution through which ecological and social sustainability become the litmus test for the economy, industry, and unions' politics instead of being, as presently, just another criterion to be considered or not. Hence, the understanding of transformation underlying my research is wider than that employed in many trade unions' discourses, which use the term to describe the ecological modernization of vehicle production in the turn to electric vehicles and within the advancement of digitalization (Iwer & Strötzel, 2019). A summary of unions' environmental strategies and approaches to just transitions (JT) is provided below.

Tackling the multiple ecological crises will likely require societies to reconsider their yardsticks for measuring economic success. Presently, this is more often than not equated with growth in Gross Domestic Product (GDP) per capita. However, there is succinct evidence that developed economies can either bid farewell to GDP growth or to limiting global warming within the goals set by the Paris Agreement (Parrique et al., 2019). The need to break with economic growth arises from a strong understanding of sustainability which posits that natural capital is not substitutable with man-made capital, wherefore an economic system can only be sustainable if it does not deplete non-substitutable natural resources. Thus, economic activity must stay within planetary boundaries, i.e. the physical limits of the planet's ability to regenerate itself, in order to enable humanity to strive for the good life for all (O'Neill, Fanning, Lamb, & Steinberger, 2018). Of primary interest in this regard is limiting the concentration of atmospheric $C0_2$ to curb catastrophic climate change. Presently, the empirical evidence clearly indicates that this goal cannot be reached while maintaining global GDP growth, even though literature on decoupling the positive correlation between an increase in GDP and an increase in CO_2 emissions suggests otherwise (Parrique et al., 2019). Indeed, the degree of decoupling needed to allow for GDP growth while at the very least keeping emissions constant if not decreasing is highly unlikely to be realized as it would require an unseen and constantly accelerating pace of technological change (Ward et al., 2016).

Hence, it is imperative to develop a theoretically informed understanding of how to transform the economy to both respect planetary boundaries and cater to humanity's needs. Proposals in this vein are discussed in the degrowth literature which is unified by its objective "to scale down the material and energy throughput of the global economy, focusing on high-income nations with high levels of per capita consumption" (Hickel, 2019, p. 56 ff.). It provides a framework to envision a transition towards an economy that breaks with the Lauderdale paradox, i.e. the inverse relationship between private and public wealth, inherent to capitalism in favour of a society characterized by public wealth and private sufficiency. This new economy will need to be characterized by a massive redistribution of income accompanied by social security measures such as universal basic services and a job guarantee. By combining a vision of a new economy and concrete measures to be taken on the way, "degrowth provides a feasible political pathway toward an ecological economy fit for the Anthropocene" (Hickel, 2019, p. 54). Only one scenario in the reviewed quantitative studies, the 'new mobility culture' scenario in Blanck et al. (2017), points in this direction. Nonetheless, in light of the climate crisis it is imperative to envisage JT strategies that go beyond a mere reduction in sectoral employment and pave the way to a transformation towards an economy which does not rely on continuous planetary destruction in order to function. The following section considers the transformative potential of and current changes in the automotive industry.

2.2 The automotive industry

On a global level, the automotive industry has been resistant to change, notwithstanding the predictability of it being confronted with the necessity of a turn away from ICEVs towards other, potentially more sustainable, power trains (Wells & Nieuwenhuis, 2012). The specific historic and structural reason for this resistance to change exceeds the scope of this research. However, a concise analysis of the German automotive industry can be found in Canzler and Knie (2018). With the climate crisis becoming more palpable, firms in the industry started to develop climate change strategies. Damert and Baumgartner (2018) find that institutional environments, supply chain position, firm size and financial performance determine firms' climate change strategies in the sector, which are classified into four different categories: all round enhancer, legitimating reducer, emergent innovator, and introverted laggard. European original equipment manufacturers (OEMs), e.g. Volkswagen, are largely within the first cluster. Of crucial importance to understanding the differences between Germany and Austria, however, is the finding that "[a]utomobile manufacturers mainly belong to clusters with a high overall level of climate change action, whereas suppliers are mostly located at the other end of the spectrum" (Damert & Baumgartner, 2018, p. 276). Hence, when discussing the employment effects of sectoral changes, one needs to consider the different sectoral structures in the countries under consideration. While Germany disposes of many OEMs, especially in Bavaria, Baden-Wurttemberg and Lower Saxony, the Austrian automotive industry is by and large made up of suppliers (Wissen et al., forthcoming).

In Germany, the automotive industry generated a revenue of €435bn in 2019, which makes it the biggest sector in terms of revenue. It is especially dominant in exports, where one third of revenue can be linked to the automotive industry ("Automobilindustrie," 2020). Its production is tightly intertwined with other sectors of the economy, wherefore changes in the automotive industry have effects on overall economic performance (Jannsen et al., 2019). For Austria, the case is somewhat different, since the automotive sector is only the fourth strongest industrial sector, generating over €15bn of revenue in 2019 (Oschischnig, 2020), characterized by small and medium sized enterprises (SMEs) which mainly produce supplies to be exported to OEMs, often headquartered in Germany (Wissen et al., forthcoming). Due to this intimate link between both countries' industries, it makes sense, from an Austrian perspective, to gather a thorough understanding of trends and developments in the neighbouring country, especially since debate on unions' strategies in the transformation is at a more advanced state in Germany than in Austria.

In 2018, a decrease in production of 9% could be observed in the German car industry, pointing towards ongoing challenges to the sector not connected to COVID-19. However, which changes lie ahead is contested amongst experts. While there is a certain agreement that climate change is the dominant challenge to tackle, complemented by digitalization on different levels, the most common assumption about the future of the car can be summarized as CASE- connected, autonomous, shared, electric. The industry sees electrification as an adequate response to climate change and does consider the sale of Sport Electric Vehicles (SUV) important to finance this transition. Meanwhile, critical commenters do recommend a voluntary segmentation of the industries' big firms due to their inability to generate the innovations needed to tackle climate change. On a more fundamental level, a reduction of the overall number of vehicles, hand in hand with a large-scale mobility transformation, is seen as a necessary step to curb climate change (Jannsen et al., 2019).

While the fundamental challenges are similar in Austria, the supplying firms have a somewhat different focus when it comes to concrete changes. Firms in the automotive industry are often suppliers with more or less direct ties to OEMs and limited on-site decision-making or highly specialized suppliers of niche products, for which they are leading on the market, so-called hidden champions. In 2017, only 39% of firms found themselves to be highly affected by electrification, while 61% saw robotics, battery- and energy technology, sensorics, data mining and -analysis as important strategic developments. Ecological changes to production, in contrast, were only found to be important for 13% of surveyed firms even though more than a third did envisage that the most important changes to the sector will be induced by environmental legislation (Bernegger, Reiter, & Schwarzendorfer, 2018). The situation of automotive suppliers in the ongoing transformation merits special attention as their position in the value chain differs from OEMs, while 75% of value added in automobile production are created by suppliers (VDA, n.d.).

The value chain of automotive suppliers is hierarchically structured in tier one (produce modules and systems directly sold to OEMS), tier two (components), and tier two (parts) suppliers. Additionally, many small service companies, e.g. engineering bureaus, are part of the automotive industry even though they are not formally accounted for in the tier-hierarchy. Many big tier one suppliers are located in Germany, e.g. Bosch and Continental (Klöpper & Lenz, 2013). However, there are stark regional differences. Areas such as Thuringia are characterized by SMEs situated in tier two and three of the suppliers' hierarchy. These are less innovative and often badly equipped for the expected transformation in the sector, which indicates specific regional challenges (Blöcker et al., 2020). Overall, however, companies in the sector are found to be "highly competitive and innovative, with good growth prospects", especially when disposing of on-site research and development (r & d), despite increasing competition from Central and Eastern European countries, the cost pressure of which is mainly felt by pure manufacturing plants. Correspondingly, employees have comparatively high vocational skills (Krzywdzinski, 2019, p. 220).

In contrast, most suppliers in Austria are under increasing cost and productivity pressure by OEMs from abroad. Even though many firms are tier one suppliers with own r&d departments, the firms' future is highly dependent on OEMs' strategies. These OEMs are mainly German, which is reflected in investments, one third of exports going to Germany and the presence of OEM plants, e.g. BMW and MAN, in the country. Moreover, many plants are no independent companies but subunits of bigger firms, which means that local management has very little, if any, decision-making power in strategic questions. The second group of firms are highly specialised SMEs, usually family-led, which are innovative and have a leading role in their niche, so called 'hidden champions'. Similar to Germany, employees dispose of a high skill level obtained in vocational training which is an important asset as employees' knowledge can be activated in the conversion towards different products. Wissen et al. (forthcoming) do find potential amongst employees towards this end.

2.3 Trade unions in the social-ecological transformation

Representation of the sector's employees is organized in both countries through trade unions. In the transition towards an economy in which 'good work' applies to people and planet, trade unions thus have a crucial, yet far from clear-cut role. While the biggest German union IG Metall already put forward a study on a transformation towards ecologically sustainable industries in 1992, its counterpart for the German mining sector is one of the gravest opponents to the phase- out of lignite mining (Flemming, 2018). In the Austrian context, trade unions' stances towards environmental concerns were until recently characterized by general enmity (Soder, Niedermoser, & Theine, 2018). Therefore, it is important to, first, understand the role of unions in societal negotiation processes and, second, the theoretical considerations on the reasons for the ambivalent role of unions as well as potentials and limitations for unions' turn towards progressive environmental action.

Both Germany and Austria have a strong corporatist tradition, which means that trade unions are institutionalized and legally protected actors representing workers' interests in the policy making process and against employers (Herberg, Haas, Oppold, & von Schneidemesser, 2020). At the same time, these institutionalized pathways have come to form what is called a 'social partnership', a process through which unions became more moderate and interested in compromise compared to their historical roots (Soder et al., 2018). Therefore, unions can be understood as societal institutions that, to differing degrees, are facing "in three directions: towards the market, society, and class. In the first, unions are perceived as labour market institutions engaged in collective bargaining; in the second, unions focus on improving workers conditions and status in society, advancing social justice and equality; in the third type, they are schools of class conflict in the struggle between capital and labour"(Hampton, 2018, p. 472). In the context of tackling climate change, a fourth and related role stems from unions' ability to influence the collective consciousness in relation to specific challenges. In simpler words and linked to the work realized here: unions' stances towards the tackling of the climate crisis will influence the wider societal perception regarding adequate measures to take (Soder et al., 2018). Unions' strategies in the social-ecological transformation of the automotive industry are therefore of importance to their constituencies, the sector and society.

Accordingly, trade unions are recently receiving heightened scholarly attention in transformation debates, most notably in German-speaking sociology and political science. The debate is picking up within trade unions as well, importantly in the context of IG Metall (Urban, 2018). Brand and Niedermoser (2016) find that unions remain wedded to ecological modernization discourses and do not sufficiently recognize the multiple ecological crises currently underway. Consequently, unions long failed to be progressive actors in the social-ecological transformation but took capital's side in hindering the adaptation of ecological changes to production in the name of protecting jobs. One possible path forward is a focus on the 'solidary mode of living' as a way to connect traditional social justice discourses of trade unions to ecological goals, thereby repoliticizing their mandate and widening it beyond the sphere of paid labour towards broader societal questions. Even though my research stays exclusively within the realm of paid labour, a widened trade union engagement with societal questions is without doubt desirable form the perspective of social-ecological transformation.

The challenge arising from the suggestion of a focus on the 'solidary mode of living' within unions' strategies is, unsurprisingly, its concrete formulation since it does require a break with current union goals focusing on better deals for their constituencies within the status quo. Wissen and Brand (2019) offer a starting point in this regard. The point of departure for *working class environmentalism* is found to be the understanding that physical labour realized by workers is the "primary interface between society and nature" (Barca, 2012, p. 75). Through labour, nature is appropriated for society. Production, instead of consumption, is at the heart of an environmentalism that works for the workers instead of middle classes. This holds the opportunity to politicise labour's fundamental connection with societal reproduction, health, and environment, linking union's work against societal oppression to that against the domination of nature. To this end, the authors see two key challenges: building alliances between different progressive actors and comprehension of the organic connection between labour, reproductive work, and ecology. The second point goes beyond the strategic understanding of the connection between work and environment currently propagated by unions. Indeed, this shift implies the reinvention of unions as societal actors, for which Brand and Wissen (2019) offer starting points linked to recent history: orientation towards conversion debate in the seventies and eighties in which unions highlighted the need for production oriented towards the use value of products, which is compatible with a culture of private sufficiency, and the support for working time reduction policies.

2.4 Just transition and conversion in the automotive industry?

The challenges analysed by Wissen and Brand (2019) and the subsequent proposals for the way forward, link to recent work on JT generally and the specific role of unions in the transformation of the automotive sector, which shall be briefly elaborated upon here. Herberg et al. (2020) expand on the call for new alliances of progressive actors in society and, in the German context, call for the development of co-creation processes including both unions and social movements to increase civil society's leverage in the transformation of the automotive industry. There is interest from both actors working on social- and environmental policy for cooperation and common activities, e.g. the work on regional sustainability strategies or discursive cooperation of different kinds (Petschow et al., 2019). Unions' engagement with environmental questions is studied by the field of labour environmentalism in which unions' activities depart from interests extending "beyond wages and working conditions" (Stevis et al., 2018, p. 5) as union members are not only workers but also citizens affected by the negative effects of GHG emissions.

At the same time, however, unions are not uniform players but internally contested institutions which need to reconcile diverging and sometimes opposing goals, which is illustrated by IG Metall's ambivalent stance towards the recovery package in the wake of the Corona crisis mentioned in the introduction. Broadly, unions' environmental strategies can be analysed regarding their depth, i.e. ranging from a technical fix approach to environmental degradation to a holistic understanding of the simultaneity of social and environmental issues and their realization through specific labour-nature relationships, breadth in spatial scale, and agency ranging from reactive to proactive approaches. (Stevis et al., 2018). For example, a union developing a JT strategy for the automotive industry that includes conversion, general working time reduction and strict environmental and social standards for resource procurement in battery production would be on the progressive side of all three categories.

The key element in unions' strategies for social-ecological transformation is 'just transition' (JT) which denotes a "concept and strategy tool for managing the transformation towards a net zero-carbon economy in a way that is both balanced and fair" (Galgóczi, 2019, p. 8). In its more inclusive conceptualisation, balanced and fair does not only apply to workers but all those "affected by the urgently required shift to a low-carbon world, be it workers, frontline communities or marginalized groups" (Morena et al., 2018). This latter understanding corresponds to deep, broad, and active labour environmentalism in the analytical scheme of Stevis et al. (2018). JT has both a process dimension engaged with the "distributional effects of climate policies" and managing transitions in employment, and an outcome dimension, i.e. a view to "the new employment and social landscape in a decarbonised economy" (Galgóczi, 2019, p. 22). While JT is widely discussed amongst unionists and considered a key aspect of the social-ecological transformation, it is far from uncontested. Indeed, there is often resistance against JT by unionists as allegedly being "just an invitation to a fancy funeral" (""Just Transition"- Just What Is It?," 2016, p. 11).

Given the variety of approaches to JT, further specification is needed. Kreinin (2020) offers a typology based on Hampton's (2015) work on trade union climate approaches. Neoliberal political economy approaches (NEP) are characterized by proposals for market-based mechanisms to tackle the climate crisis, for example via emissions trading. This approach can be found in the European Commission's proposal for a Just Transition Fund (Kreinin, 2020). However, the Commission's conceptualisation of the climate crisis as a fundamental social challenge, leans more towards ecological modernization (EM) narratives in which the state is the main actor to "'internalise the environmental 'externalities"'(Kreinin, 2020, p. 47), without challenging the roots of the climate crisis, i.e. the functioning of the global capitalist economy. Calls for 'green growth', as stipulated by the ILO, and a focus on technological fixes combined with active labour market and training programmes are characteristic of the approach. Both NEP and EM narratives stand in contrast with social-ecological transformation (SET) approaches, as the latter challenges the economic system instead of taking a moderate stance compatible with capital's interests. One example for such an approach is the South African Food Sovereignty Campaign, which demands transformation of South Africa's food system based on a "Deep Just Transition" (Kreinin, 2020, p. 51) aimed towards the protection of nature and human emancipation, e.g. by overcoming "racial or gender oppression" (Kreinin, 2020, p. 51). While EM narratives may sound optimistic as they promise the reconciliation of economic growth and climate protection, only the SET approach is apt to give rise to optimism regarding the avoidance of the climate catastrophe and the advancement of societal justice. In contrast, both NEP and EM are "severely limited in achieving the radical changes required by multiple crises facing society" (Kreinin, 2020, p. 51).

In a similar vein, the Just Transition Research Collaborative defines "four ideal-typical approaches to just transition" (Morena et al., 2018): transformation, structural reform, managerial reform, and status quo. The types are ordered by depth of transition in descending order. Status quo JTs focus on greening capitalism and use job creation as single yardstick for the fulfilment of justice requirements. Managerial reform goes a step further, aiming for an improvement in equity and justice. However, there is no challenge to the economic system. Moreover, the authors differentiate whether there is an exclusive scope, i.e. the union is focusing on the demands of its members, or an inclusive scope including wider society. The ILO transition guidelines, classified as EP approach by Kreinin (2020), fall in this category. Third, "[a] structural reform approach to Just Transition is one in which both distributive justice and procedural justice are secured"(Morena et al., 2018, p. 14), involving institutional change towards widening democracy in economic decision-making and ownership structures. Finally, transformative approaches aim at an "overhaul of the existing economic and political system that is seen as responsible for environmental and social crises" (Morena et al., 2018, p. 14), which is akin to the SET approach identified by Kreinin (2020).

How can these classifications help understanding unions' strategies in the transformation of the automotive industry? In contrast to coal, few commentators see the end of the automobile in the near future. Indeed, the industry continues to grow on a global level and has only seen stagnation in Germany since 2018. However, far reaching changes are expected (Galgóczi, 2019). The visibility of these changes has been highlighted by the impact of the COVID-19 outbreak on the industry. Even academics close to the industry have recently demanded a programme for the automotive industry comparable to that for the exit from lignite mining, including (re)training, support for entering into new employment fields and facilitating credits for new production amongst, for example, suppliers (Götz & Hahne, 2019). The thus implied drastic change of the industry would also necessitate conversion, i.e. shifting plants' production towards different goods. Entry points for such policies have been found in recent qualitative studies focusing on employees' perspectives on changes in the automotive industry. Blöcker et al. (2020) and Wissen et al. (forthcoming) both find potential and willingness for conversion amongst staff, including ideas for alternative goods, while reporting that such initiatives are rarely, if ever, taken up by management.

Similarly, IG Metall's strategy in the transformation, as summarized by Strötzel and Brunkhorst (2019) is not primarily geared towards conversion. Departing from an understanding of its constituency as employees, users of mobility services and citizens with an interest in living in a healthy environment, IG Metall claims to strive for "securing future-proof jobs via a collective bargaining policy which is forward-looking" (Strötzel & Brunkhorst, 2019, p. 254). By and large, the union stays within the EM type of JT as defined by Kreinin (2020) exemplified by the emphasis on investments in technology, efficiency increases and electrification of private vehicles. Moreover, most strategies focus on OEMs in the Southern German states and are difficult to transfer to tier two or - three suppliers. Consequently, most strategies focus on securing employment under these signs: lobbying against low-wage competition within the EU, participation in the federal platform for new mobility, proposing a 'short-time transformation allowance' i.e. working time reductions to support plant' restructuring as well as partial retirement for older employees, expansion of initial as well as internal further education, job security plans on the company level, agreements on collective bargaining, company pension schemes, and profit sharing (Strötzel & Brunkhorst, 2019). From the perspective of transformation in a wider sense, the demanded working time reduction policies may be a valuable first step towards comprehensive working time reduction in the sector. Moreover, the authors' call for increasing democratic control over production which , albeit being little more than lip service as of today, taps into one of the central levers for product conversion, as these initiatives, if at all, often originate from the employee side and are blocked by management (Wissen et al., forthcoming).

For Austria, such detailed union strategies are presently missing. However, the findings of Wissen et al. (forthcoming), albeit focusing on the plant level, point towards a similar understanding of the transformation ahead as unionists' Northern counter parts. Overall, there are thus little signs for industrial conversion, even though some conversion potential can be detected amongst employees. Moreover, the transition strategies currently realized stay within an EM framework unlikely to be apt for tackling the climate crisis as the sheer magnitude of individual vehicle production, electric or else, is ecologically unsustainable (Stephan, Lee, & Kim, 2019). Nonetheless, the strive for working time reduction and acknowledgement of the necessity to democratize the control of production may provide valuable entry points for policies apt to tackle the climate crisis while securing social justice.

2.5. *Just transition discourses and – practices in Austria and Germany beyond the automotive industry*

The debate on JT in the automotive industry in Germany is influenced by the country's past experience with JT which occurred after German reunification, during the recent shutdown of hard coal mining in the Ruhr area, and, presently, in the exit from lignite mining. The latter two examples illustrate the caveats of JT policies. In this context, unions' just transition plans relied heavily on prolonging the time frame for exiting mining (Galgóczi, 2019). This may be understandable from an employment perspective but can hardly be considered just for the climate as exiting coal by 2038 is unlikely to be compatible with the 1,5°C goal set out in the Paris Agreement (Seidler & Römer, 2019). Similarily, the Just Transition Research Collaborative classifies the Ruhr's transition as exemplifying a 'status quo' JT aiming at the "greening of capitalism" and putting forward job creation as a proxy for justice (Morena et al., 2018).

With regards to policy measures, the JT solution for the Ruhr region included aid in finding new jobs in the energy or mining sector, compensated retraining programmes, and, importantly, an early retirement scheme, through which workers can retire at the early age of 49 after having worked at least 20 years, and "then receive a monthly stipend until they qualify for a pension" (Morena et al., 2018, p. 229). Early retirement provisions are also central to the exit from lignite mining, which allows for retirement at age 58 for miners compensated with a so-called 'adjustment payment' (*Anpassungsgeld*), bridging the five years before being eligible for retirement at 63, the earliest possible age for retirement in Germany. The estimated cost of €4,8bn will be shared by federal and state authorities (Tagesschau, 2020). There is thus a high practical relevance of early retirement schemes in German JT policies.

However, the isolated JT of the Ruhr region, heavily focused on employment of miners while being less successful with regards to regional development shows the limits of the exclusive status-quo approach to JT. Even though regional development programs focusing on tourism, knowledge economy, waste management and environmental technology were introduced, unemployment in the region is nearly twice as high as the national average accompanied by high rates of child poverty (Morena et al., 2018). It remains to be seen whether the regional development plans for the exit from lignite mining, for which up to €40bn are available, will be more successful (BMWi, 2020). This shows the necessity to envisage inclusive, deep JT programs apt to cushion regional transformation for affected communities instead of focusing on workers only (Morena et al., 2018).

Recently, an optional four-day work week for plants in the automotive industry was proposed by IG Metall chairman Jörg Hofmann as way to protect jobs as the industry undergoes structural change. Hofmann advocated for this measure including partial wage compensation and incentives to use the newly-won time for professional development. It is at present not clear whether the proposal will be part of IG Metall's next collective bargaining round in 2021 (Hagelüken & Peters, 2020). In Austria, the four-day workweek is discussed within SPÖ and labour representation as a measure to tackle the current crisis. However, while the ÖGB chairman signals support, other important actors are critical of SPÖ chairwoman Rendi-Wagner's proposal (Weißensteiner, 2020). This points towards the dynamism of debate regarding JT and the growing policy spaces in its design.

In contrast to Germany, Austria does not have a history of JT and debates on it are only slowly picking up. However, a recent position paper developed by different civil society actors including unions vida, ProGe and younion as well as the Viennese Chamber of Labour outlining core demands for JT, merits attention. The paper shows a clear SET approach, including the demand for turning away from individual motorized transport and fossil fuels and developing "energy-, environment-, and resource-efficient production" based on a democratic process. In comparison to JT policies effectuated or envisaged in Germany, it is remarkable that not only support and compensation programmes, e.g. retraining and aid in finding new jobs, for workers are demanded but that the authors call for a redefinition of work and redistribution of working time (Arbeiterkammer Wien et al., 2019). A JT of this kind goes beyond the isolated, employee centred JTs achieved by German unions, wherefore the paper is a promising entry point for further discussion on JT in the country. Moreover, the focus on roadmaps for firms and just transition funds tailored to regional and sectoral needs shows the authors' bottom up understanding of JT.

3 Employment trends in the automotive industry

Expectations and trends regarding employment in the automotive industry are widely researched in Germany due to the industry's elevated position in the country's production structure. Research for Austria is somewhat more limited but recent research (Wissen et al., forthcoming) offers in-depth insights. The estimates found in the quantitative studies inform the scenario analysis in chapter five. This section reviews studies concerning employment trends in the automotive industry published from 2015 onwards concerned with medium-term employment effects induced by vehicle electrification. Please note that these studies, especially quantitative estimates, are often commissioned by industry, interest groups or political institutions. The study by Cacilo and Haag (2018) was included despite focusing on digitalization instead of vehicle electrification only since both developments happen simultaneously. Qualitative studies were analysed with a focus on the authors' theoretical framework, study participants' expectations regarding employment and perspectives on the future of work in the industry. Quantitative studies, in turn, were summarized with regards to expected employment effects and envisaged timeframes. For all studies, methodologies and sectoral trends as stipulated by the authors were considered. The results are summarized in the tables below. With a view to understanding changes for suppliers, one limitation of available empirical research is that "the impacts of the shift towards electric mobility on engine component suppliers have, so far, not been systematically examined" (Krzywdzinski, 2019, p. 220).

In general terms, the comparison shows noteworthy differences in approaches. While quantitative studies were based largely on assumptions wedded to the macroeconomic status quo, e.g. growth of the global automotive market, qualitative research focuses on potentials and challenges in the transformation of the industry and the functioning of the economy, for example by employing a wide understanding of transformation and discussing the potential for conversion of firms. Quantitative studies employed different time frames, different methodological approaches, and regional foci. For example, ELAB 2.0, a study realized by the Fraunhofer Institute (cf. Bauer et al., 2018) has a higher degree of differentiation, thereby allowing for more dynamism in results, than the model employed by e.g. Kleebinder (2019). This partially explains diverging results and aggravates inter-study comparison. Even though numerical estimates found in each quantitative study suggest a degree of certainty coupled with a margin of error, a comparative glance shows how in an uncertain and complex world, mathematical models need to make simplifying assumptions and can by no means be treated as predictions. Instead, it is crucial to understand the axiomatic underpinnings and weight them against each other.

The differences in the estimations offered by the eight quantitative analyses considered here are illustrative of the high degree of uncertainty associated with the medium-term employment effects of sectoral transition. Indeed, positive net developments in employment, albeit being less likely and less discussed, are possible. For example, the study by Mönnig et al. (2018) concludes that positive growth- and employment effects in the longer term could be reached if battery production were moved to Germany. Studies finding a positive effect in at least one scenario are: AMZ/CATI (2019), Frieske et al. (2019), Cacilo and Haag (2018), and Kleebinder (2019). Negative (net) effects range from -0.3% by 2025 (AMZ/CATI, 2019) to -53% by 2030 (Bauer et al., 2018). Moreover, only the study by Blanck et al. (2017) considers changes to the mobility system as a whole in its scenario analysis, inquiring into changed forms and patterns of mobility, including changes induced by automation and digitization, rather than just the electrification of vehicle production, which makes it a valuable contribution for the inquiry into the employment effects of social-ecological transformation. The study by Cacilo and Haag (2018) does also consider changes in the mobility system induced by digitization and automation but stays short of the degree of complexity and interaction considered by Blanck et al. (2017). The diversity of results requires careful weighting in the decision for a specific scenario considered in my analysis, which will be given in chapter five.

The results of the five qualitative studies examined provide the necessary insights into employees' perspective on the transformation, potentials for conversion and specificities to be considered in the development of JT strategies. Especially the regional analyses by Blöcker et al. (2020) and the study by Wissen et al. (forthcoming), who offer plant-level insights are useful for an analysis of transformation dynamics on the ground, the understanding of which is crucial to JT, the success of which relies on the context-specific suitability of such programmes. Therefore, both studies are central to my elaboration on accompanying measures for a JT in section 5.2 and the discussion of my results in chapter six. The firm structure in German federal states formerly belonging to the GDR is, somewhat akin to the Austrian firm structure, characterized by suppliers, wherefore the perspectives of employees will be given special consideration by way of comparison. One remarkable difference is that Austrian firms are often relatively innovative and dispose of own r&d departments, inducive to a sense of pride for the own skills amongst employees. Meanwhile the negative transformation experiences after German reunification coupled with firms' low degree of preparedness for changes in production explain widespread pessimism amongst employees working in the Thuringian automotive industry. However, employees throughout the industry expect a reduction in employment as the results of IG Metall's *Transformationsatlas* show (IG Metall Vorstand, 2019). Finally, the expert discussions realized in Petschow et al. (2018) and Bormann et al. (2018) give an insight into policy-level debates, thereby complementing the insights gained in sections 2.3-2.5.

I will pick up on the quantitative studies reviewed here in the development of my scenario analysis in chapter five while the qualitative studies will be crucial to section 5.2 and chapter six. Before delving into the future of employment, chapter four gives an overview about the current employment structure in the sector.

3.1 Quantitative studies

	Region/ Sample	Methodology	Trends in the sector	Year	Scenarios	Employment effects
	AMZ/CATI (2019):Transformationsprozess in der sächsischen Automobilzulieferindustrie aufgrund der Umstellung auf die Produktion von Elektrofahrzeugen					
Germany	Saxony	Estimation basis: changed personnel needs in production + automotive industry's production plans (microeconomic data of 197 firms)		2025	15% BEV	Negative: - 3,6 % Balance: + 1,7%
					30% BEV	Negative: -- 7,3% Balance: - 0,3%
					40% BEV	Negative: - 10,2% Balance: - 1,7%
	Frieske et al. (2019): Strukturstudie BW^{e} mobil 2019					
	Baden-Wurttemberg	Estimation basis: Baden-Wurttemberg's automotive clusters, assume global growth of the market, only look at employees in powertrain production	Electrification, Digitalisation, autonomous driving, automobile-production 4.0	2030	Business as usual (15% BEV)	+2,4%
					Progressiv (51% BEV)	-7,8%
	Bauer et al. (2018): ELAB 2.0 Wirkungen der Fahrzeugelektrifizierung auf die Beschäftigung am Standort Deutschland					
	Direct employees in production, indirect employees close to production, indirect employees	Estimation basis: personnel needs in power train production, scenario elements: increases in productivity + different options for production of PHEV	Globalisation, digitalization, decarbonisation	2025	25% BEV by 2030 40% BEV by 2030 80 % BEV by 2030	-7% to -23% -9% to -24% -20% to – 33%
				2030	25% BEV 40% BEV 80 % BEV	-11% to -37% -18% to -40% - 35% to -53%
					Jobs lost assuming productivity increases: 25% BEV:74 000 - 80 000 40% BEV: 80 000 - 90 000 80 % BEV: 107 000 - 125 000	
	Cacilo and Haag (2018): Beschäftigungsauswirkungen der Fahrzeugdigitalisierung					
	NACE-29 and NACE-62 firms	Estimation basis: changes in market volume and net pricing of each of the three trends assume growing automobile sector + growing passenger traffic by car for scenario 1 & 2	Autonomous vehicles (AV), connected driving (CD), mobility as a service (MaaS)	2030	MaaS and automation additive mobility elements	+ 458878 jobs (16534 CD,127503 AV, 53311 MaaS, 261530 sectoral growth)
					50% substitution of autonomous driving, partial substitution of conventional traffic by MaaS-sevices	+142210 jobs (13245 CD,105217 AV, 53311 MaaS, -34196 substitution effect, 4632 sectoral growth)

					Full substitution by MaaS traffic (more likely than scenario 1, further shrinking expected)	-117819 jobs (10474 CD, 86441 AV, 53311 MaaS, -56186 substitution effect, -211858 sectoral growth)
	Mönnig et al. (2018): Elektromobilität 2035: Effekte auf Wirtschaft und Erwerbstätigkeit durch die Elektrifizierung des Antriebsstrangs von Personenkraftwagen					
	Sectoral cluster (see model)	Macroeconometric Input-Output Model QINFORGE	n.a.	2035	23% Electrification	-83 000 jobs
	Blanck et al. (2017): Mobiles Baden-Württemberg- Wege der Transformation zu einer nachhaltigen Mobilität					
	Baden-Wurttemberg	Mixed methods, interdisciplinary team, transdisciplinary approach including workshops with stakeholders, scenarios consider all trends	Climate change, electrification, renewable energies, digitalization	2030	New individualized mobility	- 8,5%
					New services	- 20%
					New mobility culture	- 25%
	Falck et al. (2017): Auswirkungen eines Zulassungsverbots für Personenkraftwagen und leichte Nutzfahrzeuge mit Verbrennungsmotor					
	WZ 29 + suppliers	Extrapolation based on production data of German statistical services, including suppliers, in 2015	-	2030	Prohibition of ICEVs by 2030	470 500 / 57,5% of Jobs in WZ 29 affected; 31 000 jobs at SMEs esp. in danger
Austria	**Kleebinder (2019): Auf der Siegerstraße bleiben: Automotive Cluster der Zukunft bauen**					
	Satellite account automotive industry + Input-Output-Table	Input-Output Analysis (direct effects, indirect effects, induced effects); per capita employment effects given here for automotive industry only (ÖNACE-C29)	Decarbonisation (electrification, global emission regulations), autonomous driving and alternative concepts of mobility	2030	26% BEV	- 1,2 %
					15% BEV	+ 0,7%
					42% BEV	- 5,9%
					68% BEV	- 13 %

Table 1 Quantitative studies employment trends

3.2 *Qualitative studies*

	Region/ type of firms	**Methodology**	**Theoretical Framework**	**Trends in the (sub) sector; influencing factors**	**Expectations regarding employment**	**Strategies/expectations employees, unionists; recommendations**
Germany	**Blöcker et al. (2020): Auto- und Zulieferindustrie in der Transformation**					
	Berlin, Brandenburg, Saxony, Saxony-Anhalt (OEM plants, suppliers of different size), not limited to WZ29	Mixed methods: qualitative interviews, expert talks, brief surveys, group interviews, secondary analysis of results of IG Metall questionnaire	Social-ecological and democratic transformation; industrial conversion	**Fields of transformation**: Electrification, automation and digitalization, mobility as a service **Fields of conversion:** alternative products **Conversion requirements**: fair working conditions	Short- medium term mostly constant or positive expectations, expected reductions in employment lower than in the West, growing confidence in potentials of electrification (Saxony), belief in capabilities for conversion if allowed for by management, trust in own qualifications as high transformational competence, unfair working conditions barrier to change	**Dominant perceptions amongst employees**: fear of rationalization and being excluded from innovations at OEMs, no strategies for conversion to e-mobility **Recommendations for conversion policy:** Comprehensive employee qualification, develop positive transformation motive, accompany digital transformation, discuss conversion within firms
	Thuringia (mainly SMEs), not limited to WZ29	Mixed methods: problem centred interviews, secondary analysis of data from earlier research projects		Economic and ecologic dual crisis, decarbonisation, structural dependencies towards OEMs, insecurity of future employment	Depending on firm's firms dependence on conventional power train and strategic possibilities, fragmented picture characterized by uncertainty, many firms not equipped for transformation/conversion	**Recommendations:** Advance discussions on conversion on the firm level, participatory policy processes, model region sustainable mobility
	IG Metall Vorstand (2019): Transformationsatlas- wesentliche Ergebnisse					
	Germany, employees from all IGM branches; only results for automotive industry given	Survey amongst employee representatives (Betriebsrät:innen)	-	As seen by employees: productivity increase, outsourcing, decarbonization	Medium term (2-4 years): 54% expect reduction, 8 % increase, overall negative trend	-
	Bormann et al. (2018): Die Zukunft der deutschen Automobilindustrie					
	No specification	Expert discussion, published by foundation close to social democrats	Not explicit, narrow understanding of transformation (cf.	**Megatrends changing mobility**: Sustainability, urbanization,	Change of every third job in the sector	**Recommendation:** Covenant for the future of the automotive industry(electronic vehicles, technological advancements,

			p.12), ecological modernization (c.f. p 25)	individualization, digitalization **Mobility trends changing automobility**: Electrification, connectivity and new competitors, automation, mobility as a service		communal laboratories for new mobility, restructuring infrastructure policy, support for research, initiative for employment and qualification, initiatives for infrastructure)
	Petschow et al. (2018): Mobilitätswende- Die deutsche Automobilindustrie im Umbruch					
	No specification	Discussion paper by IÖW (institute for ecological economy)	Social-ecological transition: turnaround in mobility, replacement of motorized individual traffic	**Mobility system:** Climate change, digitalization, autonomous driving **Car industry:** electrification, mobility as a service, digitalization, autonomous vehicles	Based on 2017 ifo study (Falck et al., see above)y: up to 620 000 jobs affected (including indirect jobs); examined expect balanced or positive net effect of electrification, authors conclude that net effects on employment cannot be determined at present	Unspecific call for far-reaching measures and turnaround in mobility (*Mobilitätswende*)
Austria	**Wissen et al. (forthcoming): Zwischen Modernisierung und sozial-ökologischer Konversion: Konflikte um die Zukunft der österreichischen Autoindustrie**					
	Firms which are part of the Austrian automotive clusters, including KTM (two-wheel manufacturer)	Open, guided interviews and focus groups with members of work councils, union representatives at the firm level, ministry representatives, managers	Social-ecological conversion Austrian automotive industry	Ecological modernization of combustion engine, electronic mobility, social – ecological transformation	Reference to Kleebinder et al. (2019), see above; depth of crisis underestimated by employees	**Employees' perspective:** Little reflection on role in mobility transformation, perceived agency in change processes depends on firms' ownership structure: insecurity in firms dependent on OEMs abroad; high trust in own skills and capabilities for conversion **Recommendations:** Politicizing tension between ecological awareness and own work, economic democracy/ nationalization of firms,

Table 2 Qualitative studies employment trends

4 The structure of employment in the automotive industry

4.1 Data and methodology

It is important to understand the current structure of employment in order to be able to develop well informed estimates and discussions regarding future developments. Employment in the automotive industry is regionally clustered in Germany and Austria. The data analysed here is on the state level and applies to Economic Division (WZ) 29 (Germany) and ÖNACE-C29 (Austria). While the labels differ, both are based on the European Classification of Economic Activities (NACE) which, in turn, is based on the International Standard Industrial Classification of All Economic Activities (ISIC Rev.4) of the United Nations (Destatis, 2008). Therefore, it only includes direct employment in the automotive industry. Firms which directly produce for the automotive industry but are not listed in the sector are excluded. This applies, for example, to firms producing covers for car seats and other textiles (Wissen et al., forthcoming).

Data was requested for WZ/ÖNACEC-2711, production of electric motors, generators, and transformers, as well. However, since this sector is more likely to benefit from a shift towards electric vehicles in the medium-term analysed in this thesis, I decided against its inclusion for greater stringency. However, for future research it is recommendable to assess employment in this sector, possibly as part of regionally specified automotive clusters, in order to get a more complete picture of the industry. For both countries, data was gathered with the aim of maximizing depth. Consequently, occupations are classified differently. For Germany, the Federal Agency of Labour (*Bundesagentur für Arbeit,* BA), provides cross-tabulated data for employees in ten-year age groups and 37 occupational groups (*Berufshauptgruppen*) sorted by occupational similarity (*berufsfachliche Ähnlichkeit*) ("Klassifikation der Berufe", 2011, p.17) according to the agency's own classification system KLDB 2010. A translation of the labels for occupational groups from English to German can be found in the appendix. Empty cells in the tables indicate that data cannot be displayed due to possible personal identification of employees. In the original dataset, these cells have an asterisk. The asterisk was removed to allow for easier calculation in Microsoft Excel. Anonymization explains possible differences between the sum of employees and the sum of numbers in the table.

In contrast, Austrian data is not available in cross-tabulated form from the national statistical service (*Statistik Austria*) or the Public Employment Service (*Arbeitsmarktservice,* AMS), which was verified in email communication with each of the institutions. The best available data is thus non-cross tabulated data of employees in five-year age groups provided by the AMS for ÖNACE C-29 on the state level. A second dataset provided by the Austrian Statistical Office (*Statistik Austria*) is based on 2019 micro-census data giving employees' occupation classified according to ISCO 08, the ILO's International Standard Classification of Occupations, major groups. Already at this comparatively coarse level, the estimated values are strongly influenced by chance due to the sample size of the micro-census, wherefore the depth found for German data cannot be provided for Austria. The five -year age groups in AMS data were maintained for higher precision. Please note that differences in both data sets arise from different data collection methods. The main classificatory difference between both countries' data on occupational groups is that Austrian data is structured hierarchically while German data is structured according to the kind of activity employees engage in. For example, both an assembly-line worker and an engineer working in 'technical occupations in machine-building and automotive industry' are clustered in occupational group 25 according to KLDB 2010, while they fall in group 8 and two, respectively, in ISCO 08.

A descriptive evaluation of the obtained data can be found below, which allows for first insights into the employment structure currently found in the industry. In chapter five, this data will be used to develop a demographically enriched scenario for the mid-term future of employment in the automotive industry. The analysis is done for each country separately due to the differences in data. As any scenario, this is not a prediction. Rather, my aim is to inquire who will be affected by jobs lost in the sector by 2025 and 2030 based on the estimations of employment changes as found in the literature (see chapter three).

4.2 Regional distribution

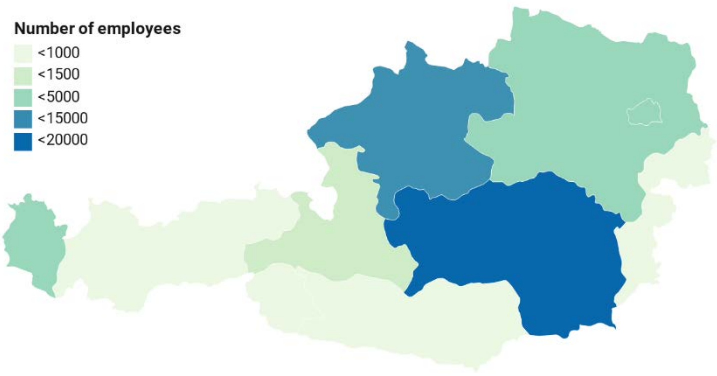

Figure 1 Employees ÖNACE-C29, Austria 2019

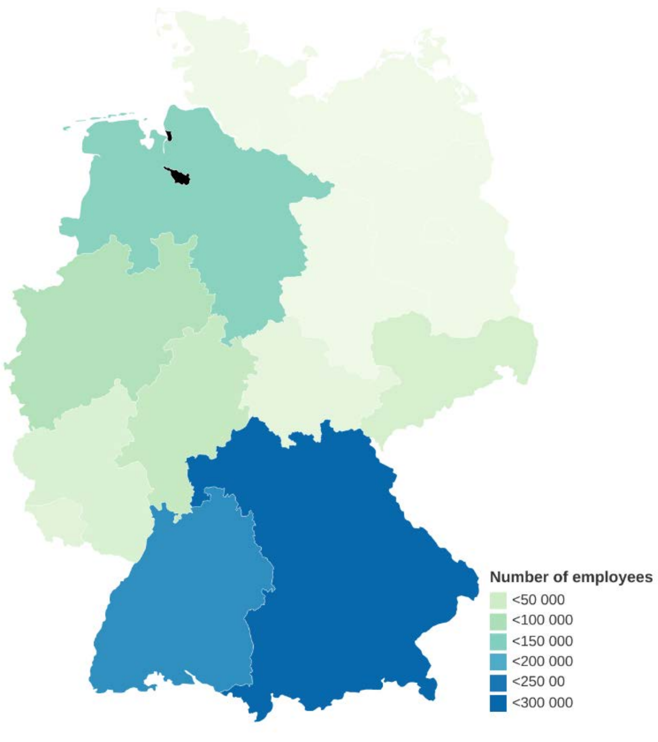

Figure 2 Employees WZ29, Germany 2019

As figures one and two show, employment in the automotive industry can be found in all German states, with data being anonymized for Bremen, and all Austrian states, with the highest number of employees in Bavaria, Baden-Wurttemberg, and Saxony and respectively in Upper Austria and Styria. However, the sheer number of employees is not the only indicator of importance, especially not for comparative analysis. In Germany, the states with highest regional importance of the automotive industry are those in which OEMs are located: BMW in Bavaria, VW in Lower Saxony and Daimler, Audi and Porsche in Baden Wurttemberg. These states are thus highly dependent on car manufacturing. At the same time, these are the locations where unions are relatively strong and have already achieved certain successes for securing employment. For example, Daimler's new electric powertrain will be manufactured in Untertürkheim, which is seen as a success by local unionists. Of course, firms' decisions regarding production sites are not predictable, but there is a trend towards insourcing, i.e. relocating production processes from suppliers to own production sites in order to secure employment (Götz & Hahne, 2019). In contrast, regions characterized by suppliers such as Thuringia are expected to come under severe strain in the medium term as firms in the state are badly equipped for the changes ahead (cf. Holzschuh et al., 2020, p. 98). The Austrian automotive industry, in turn, is made up of suppliers, many family-led, highly specialized SMEs producing tailor-made solution for OEMs and plants belonging directly to mainly German OEMs (Wissen et al., forthcoming). From the perspective of transformation, it is therefore crucial to better understand the demographic profiles and regional distribution of employees in the sector.

4.3 Age groups

First, the age groups of employees in the sector merit attention. In the appendix, you can find the full tables for both countries, disaggregated on the state level. The tables are colourized as heatmaps, showing the distribution throughout age groups for each state with green indicating the lowest and red indicating the highest number of employees. Figure three shows the age distribution for Austria, disaggregated by state and for the whole country. From a transition perspective, one crucial aspect is that nearly 25% of employees in ÖNACE-C29, the sector likely to be most affected by electrification, are 50 or older. For these 9722 persons, early retirement provisions may well be a feasible option in a just transition scenario. The states with the highest number of employees in the sector

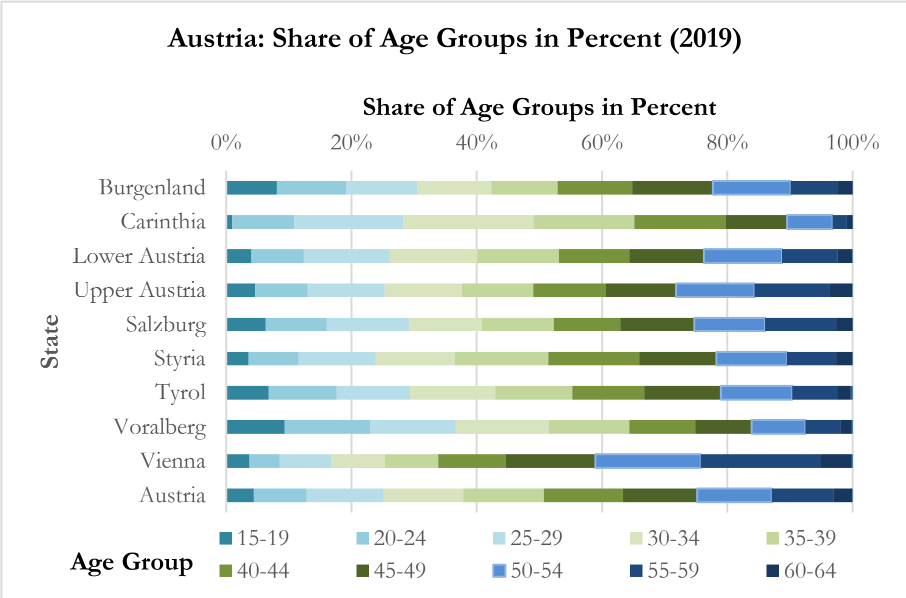

Figure 3 Age groups ÖNACE-C29, Austria 2019

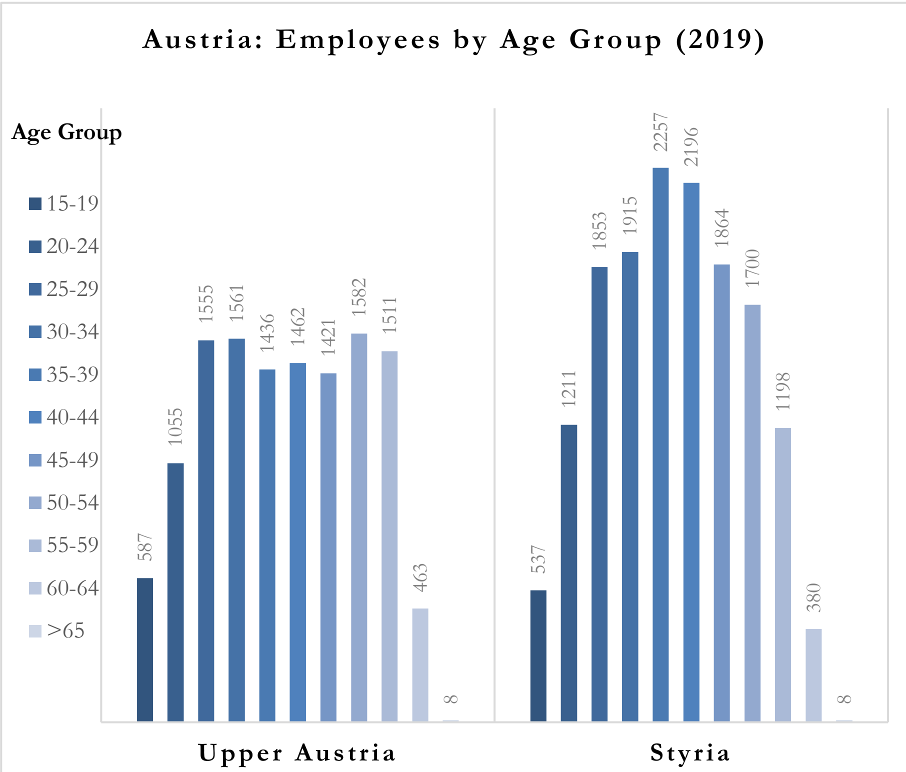

Figure 4 Age distribution Upper Austria and Styria, 2019

merit further attention, since regional clustering needs to be accounted for in the development of JT programmes. As visualized in greater detail in figure four, the relative weight of employees in this age group is even stronger in Upper Austria, the region with the second highest number of employees overall (28%) and somewhat lower in Styria (22%), pointing towards differences in employees' needs when designing transformation strategies.

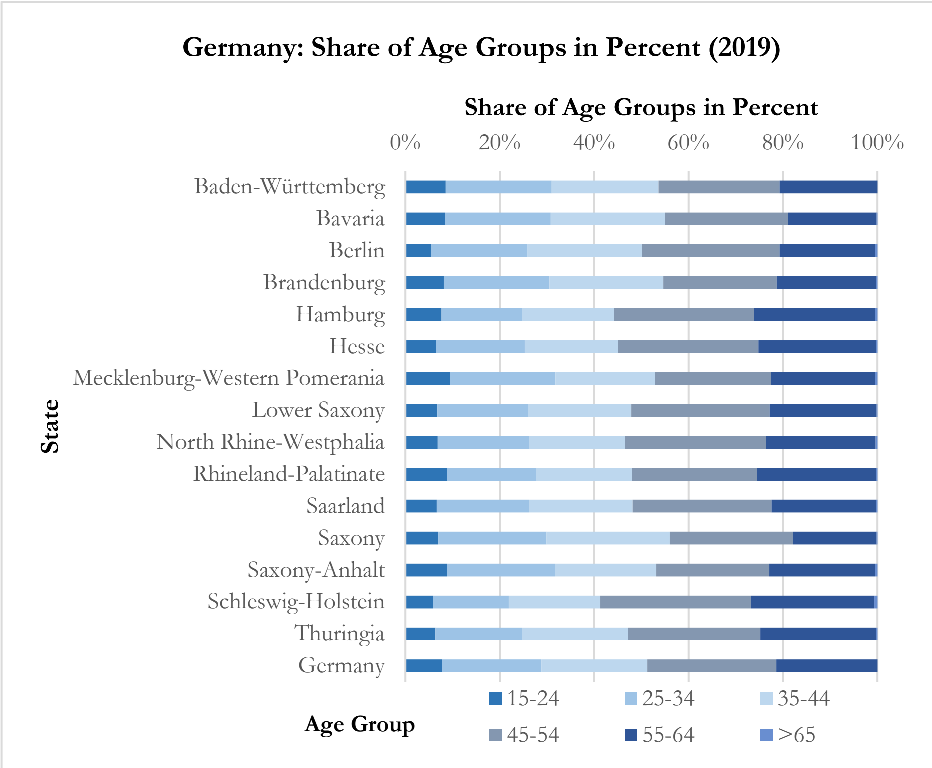

Figure 5 Age groups WZ29, Germany 2019

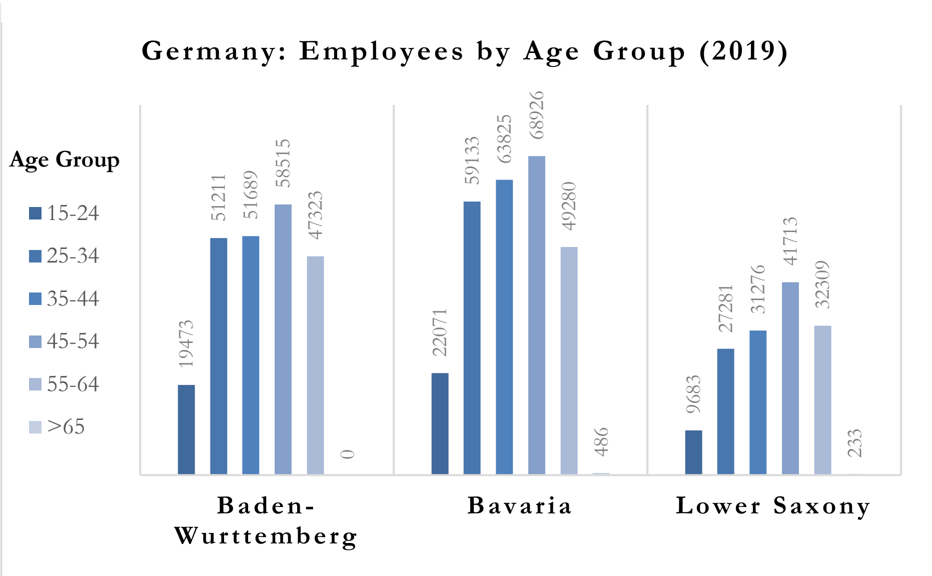

Figure 6 Age distribution Baden-Wurttemberg, Bavaria, Lower Saxony, 2019

For Germany, as visualized in figure five, the picture is somewhat similar although, due to differences in data, less precise. For WZ 29 around 49% of employees (insecurity of exact value due to anonymisation of data) are 45 or older. Under the condition of uniform distribution in age groups, one can estimate that approximately 35% are 50 or older. Again, the age distribution for the states with highest employment in the sector are examined separately. For Baden-Württemberg, rates are at 46% and 33%, respectively. In Bavaria it is 45% or 31% and in Lower-Saxonly 52% of employees are 45 or older while approximately 37% are over fifty. For these three states, the distribution of workers amongst age groups is given in figure five. Overall, employees in Germany are, on average, older than in Austria, with pronounced differences in the regions employing most people in the sector.

4.2 Occupations

Employees in WZ 29 by occupation, Germany 2019	
Occupation (KLDB 2010)	**WZ 29**
25 Technical occupations in machine-building and automotive industry	273.721
27 Occupations in technical research and development, construction, and production planning and scheduling	181.697
24 Occupations in metal-making and -working, and in metal construction	122.899
71 Occupations in business management and organisation	104.546
51 Occupations in traffic and logistics (without vehicle driving)	59.020
26 Occupations in mechatronics, energy electronics and electrical engineering	47.583
22 Occupations in plastic-making and -processing, and wood-working and -processing	36.781
61 Occupations in purchasing, sales and trading	23.049
43 Occupations in computer science, information and communication technology	21.902
72 Occupations in financial services, accounting and tax consultancy	14.821
28 Occupations in textile- and leather-making and -processing	7.522
34 Occupations in building services engineering and technical building services	6.529
92 Occupations in advertising and marketing, in commercial and editorial media design	6.433
52 Drivers and operators of vehicles and transport equipment	5.904
63 Occupations in tourism, hotels and restaurants	5.759
41 Occupations in mathematics, biology, chemistry and physics	5.497
53 Occupations in safety and health protection, security and surveillance	5.268
62 Sales occupations in retail trade	3.661
73 Occupations in law and public administration	2.942
54 Occupations in cleaning services	2.251
91 Occupations in in philology, literature, humanities, social sciences, and economics.	2.222
84 Occupations in teaching and training	2.183
93 Occupations in product design, artisan craftwork, fine arts and the making of musical instruments	1.966
23 Occupations in paper-making and -processing, printing, and in technical media design.	1.133
Other	4.282
Total	949.621

Table 4 Employees by occupation, Germany 2019

Employees in ÖNACE C-29 by occupation (in 1000s), Austria 2019	
ISCO08 major groups	**C29**
1 Managers	(x)
2 Professionals	(5.5)
3 Technicians and Associate Professionals	8.1
4 Clerical Support Workers	(x)
5 Services and Sales Workers	(x)
6 Skilled Agricultural, Forestry and Fishery Workers	(x)
7 Craft and Related Trades Workers	17.2
8 Plant and Machine Operators and Assemblers	6.2
9 Elementary Occupations	(x)
Total	**45.1**

Table 3 Employees by occupation, Austria 2019

As table one shows, the majority of employees in the Austrian automotive industry work in groups 3 (technicians and associate professionals) and 7 (craft and related trades workers). Together, these groups make up 56% of employees in ÖNACE-C29. Values in () are strongly influenced by chance due to sample size, (x) indicates that there is no value that can be statistically interpreted.

For Germany, more disaggregated data is available. In table two occupations in which less than 1000 people were employed in 2019 were aggregated as 'others' to allow more concise display of data. Occupations are listed by number of employees in descending order. For WZ29 48%, of employees fall in category 25, technical occupations in machine-building and automotive industry, and 27, occupations in technical research and development, construction, and production planning and scheduling, hence most employees are found, as might be expected, in jobs directly linked to vehicle production. The tables give first insights into the groups of workers which need to be considered in JT retraining measures. Both groups include workers who are relatively highly qualified due to the Austrian and German apprenticeship system, which is reflected in a high degree of self-esteem and trust in their own competences (Strötzel & Brunkhorst, 2019; Wissen et al., forthcoming). If the JT is supposed to function similar to the JT for German hard coal miners, new jobs should correspond to their skill level and offer similar renumeration (cf. Abraham, 2017)

4.5 Cross tabulation age and occupation in Germany

Data availability in Germany allows for a detailed analysis of the employment structure along the lines of age and occupation, which is invaluable information from a JT perspective as it allows for the design of tailormade-solutions fitting regional contexts. This data is available for all occupational groups in all states, unless employee numbers are very small. It is therefore possible to provide very detailed analyses. However, since this study has a comparative, macro-oriented focus, age- and occupational distribution will be given for the whole of Germany, following the same aggregation method as above. Should you need information on the state level, please contact me for the original data set. Table three provides an overview of employees by age group in descending order. The table is colourized as a heatmap, with green indicating lowest and red indicating the highest numbers in the dataset (not per group!). The occupational group with most employees; technical occupations in machine-building and automotive industry, accounts for 28% of employees in the sector and disposes of 50% of employees at age 45 or older. An estimated 37% are 50 years or older. Again, the occupational distribution highlights the high skill level amongst employees which characterizes the sector, while from a JT perspective the relatively high share of employees aged 50 or older in the biggest occupational groups points towards the potentials of early retirement strategies and partial retirement plans (cf. Galgóczi, 2019).

Employees in WZ29 by age and occupation, Germany 2019							
Age/ Occupation	Total	15-24	25-34	35-44	45-54	55-64	>65
25 Technical occupations in machine-building and automotive industry	273.721	25.419	55.116	56.751	72.841	63.047	*
27 Occupations in technical research and development, construction, and production planning and scheduling	181.697	5.083	41.245	46.775	51.118	37.127	349
24 Occupations in metal-making and -working, and in metal construction	122.899	10.867	23.206	25.757	34.679	28.036	354
71 Occupations in business management and organisation	104.546	9.913	22.174	23.577	29.334	19.209	339
51 Occupations in traffic and logistics (without vehicle driving)	59.020	3.153	9.843	11.600	17.539	16.764	121
26 Occupations in mechatronics, energy electronics and electrical engineering	47.583	9.088	11.707	9.543	10.500	6.676	69
22 Occupations in plastic-making and -processing, and wood-working and -processing	36.781	2.745	7.562	7.733	10.169	8.478	94
61 Occupations in purchasing, sales and trading	23.049	622	6.297	6.266	6.111	3.681	72
43 Occupations in computer science, information and communication technology	21.902	1.088	5.559	6.244	5.618	3.348	45
72 Occupations in financial services, accounting and tax consultancy	14.821	301	4.096	4.393	3.763	2.225	43
28 Occupations in textile- and leather-making and -processing	7.522	452	1.802	2.075	1.803	1.369	21

34 Occupations in building services engineering and technical building services	6.529	265	1.064	1.339	2.096	1.751	14
92 Occupations in advertising and marketing, in commercial and editorial media design	6.433	166	1.766	2.101	1.624	765	11
52 Drivers and operators of vehicles and transport equipment	5.904	85	642	1.068	1.896	2.114	99
63 Occupations in tourism, hotels and restaurants	5.759	2.777	987	*	829	675	*
41 Occupations in mathematics, biology, chemistry and physics	5.497	468	1.219	1.111	1.468	1.215	16
53 Occupations in safety and health protection, security and surveillance	5.268	547	918	1.002	1.390	1.401	10
62 Sales occupations in retail trade	3.661	87	540	733	1.346	936	19
73 Occupations in law and public administration	2.942	40	588	940	896	471	7
54 Occupations in cleaning services	2.251	90	225	362	735	821	18
91 Occupations in in philology, literature, humanities, social sciences, and economics.	2.222	*	618	734	567	270	*
84 Occupations in teaching and training	2.183	96	373	468	670	570	6
93 Occupations in product design, artisan craftwork, fine arts and the making of musical instruments	1.966	*	553	636	473	229	*
23 Occupations in paper-making and -processing, printing, and in technical media design.	1.133	*	207	214	350	281	*
Other	4.282	45	748	1.019	1.323	1.062	-
Total	949.621	73.668	199.059	212.935	259.149	202.521	*

Table 5 Employees by age and occupation, Germany 2019

5 Scenario analysis: employment reduction until 2030

After analysing the current employment structure of the industry in chapter four, I enquire into the pathways of future employment. The quantitative studies reviewed in chapter three form the basis of my own scenario analysis realized in this chapter. The wide range of estimates requires weighing different research interests and possible future developments against each other. The following criteria inform my decision. First, I decided to use studies which at least give estimates until 2030, since I am interested in medium-term effects wherefore a ten-year timeframe is preferable. The studies by Frieske et al. (2019), Cacilo and Haag (2018), Bauer et al. (2018), Blanck et al. (2017), Falck et al. (2017), and Kleebinder (2019) are compatible with this criterion. The study by Bauer et al. (2018) has the additional advantage of offering a two-step estimation for 2025 and 2030, allowing for more nuanced analysis.

Second, the studies should inquire into the employment effects of jobs found in WZ29/ÖNACE-C29, either induced by electrification, corresponding to this study's research question, and/or wider changes in the mobility system, corresponding to the study's wider interest to research strategies for the social-ecological transformation of employment. Sections 4.3. and 4.4. gave insights into the occupations found in the sector. In 2016, an estimated 30% of employees in the German automotive industry could be found in occupations connected with powertrain production (Blanck et al., 2017). Therefore, the study by Bauer et al. (2018) proofs important since it examines the employment effects of electrification based on changed personnel needs in powertrain production, including direct, close and indirect employees in its estimates. Only one study, by Blanck et al. (2017), develops scenarios for a mobility transformation and explicitly addresses the necessity to reconciliate mobility with the goals of the Paris Agreement while incorporating other mobility trends, notably digitalization and automation. Therefore, the estimates provided in this study, albeit given for the whole 'mobility economy' (*Mobilitätswirtschaft*) and specifically tailored to the situation in Baden-Wurttemberg are of interest.

Third, given the necessity for a social-ecological transformation of the economy as a whole and the interest in developing JT scenarios compatible with that goal, as discussed in chapter two, it makes sense to include scenarios that assume changes into that direction rather than those that may look less dramatic because comparatively little jobs are presumed to be lost. For these reasons I decided to realize a scenario analysis for job losses that are considerably higher than those found in studies specifically tailored to automotive suppliers, i.e. the studies by AMZ/CATI (2019) and Kleebinder (2017). Thus, the scenario developed here assumes changes that, especially in the Austrian context where industry is mainly made up of suppliers, are rather stark in the medium term. Exploring such a scenario also makes sense from a JT perspective since it gives more profound insights into the potentials of cushioning drastic changes.

My analysis merges the effects found in two different studies: the 'middle of the road' scenario by Bauer et al. (2018), assuming 40% of BEV production by 2030, and the 'new mobility culture' scenario by Blanck et al (2017), based on changes in overall mobility system. Both studies find similar effects, albeit based on different assumptions. A strength of building a scenario based on these two studies is that the 'middle of the road' scenario is found to be most realistic by Bauer et al. (2018), while the net effects found by Blanck et al. (2017) give insights into the reduction in employment that needs to be cushioned even if new employment in other parts of the mobility sector is considered. This is especially relevant for Austrian industry, where conversion potential is already discussed amongst employees (c.f. Wissen et al., forthcoming). I therefore assume a 16,5% reduction in employment by 2025, the mean effect of scenario 2 in Bauer et al. (2018), and a 25% reduction of employment by 2030, which is the net effect found by Blanck et al. (2017) for the 'new mobility culture' scenario and compatible with the range given for scenario two by Bauer et al. (2018).

5.1 Employment reduction and early retirement as JT strategy

To estimate the employment structure for 2025 and 2030 respectively, I extrapolate from the demographic structure of employees in 2019. I assume ceteris paribus conditions: a constant net employment in the sector, i.e. no net growth of employment (total and per age group), uniform distribution of employees within age groups, no shocks to employment apart from the ones expected as a result of electrification, and unchanged part-time rates. For employees aged 65 or above, it is assumed that they retire. For Germany, which has an official retirement age of 67 for people born after 1964 as of 2024, with a gradual transition since 2012 starting with the cohort of 1947, the same is assumed for reasons of analytical simplicity as the clustering in ten-year age groups does not allow precise prediction of employees' retirement age. Moreover, there are at present special provisions for early retirement at 63 at full pension in place for people who have worked 45 years or longer while many people accept pension cuts to retire earlier, for example due to health reasons. Consequently, the average retirement age was at 64,2 years in 2018 for West Germany and 63,7 years in East Germany (Meyer, 2019). In Austria, where men's regular retirement age is at 65 while women's is at 60 and only gradually increased to 65, the average age at retirement in 2018 was 61,3 for men and 59 for women ("Pensionsantrittsalter", 2019).

Employees in the group 55-64 are all considered active employees for this analysis, without consideration of retirements earlier than 65 be that due to specific provisions, legislative changes only applying from a certain cohort onwards or voluntary choice of earlier retirement. The assumption of employees staying in the workforce until 65 is thus a rather conservative one for both countries and likely to overestimate the number of people 60 or above who are still part of the workforce. Of course, a more complex model accounting for the specificities of each country's retirement system and real retirement age is desirable for higher accuracy. However, given the explorative character of the extrapolation and the strong reliance on ceteris paribus assumptions, the analysis offered here is in any case not to be taken as a prediction of absolute numbers but as an exploration of possible trends in employment. Please note that anonymised values, marked with an asterisk in the original data, were set to 0 for the extrapolation, which explains differing totals in employees considered for 2019 and the following years. Full tables of the extrapolated data by state for both countries and the age-occupational cross tabulation for Germany can be found in the appendix and will not be reproduced here. In a second step, the conditions for early retirement amongst employees in each country, a central part of JT strategies, will be examined, as age is the central variable in its design. In section 5.2, the potentials of other JT measures currently discussed or used in the past, e.g. retraining, working time reductions, and regional development programmes, will be examined.

By 2025, the share of employees aged 50 or older is estimated at 36% for Austria, 38% for Upper Austria, and 34% for Styria. Another five years later, in 2030, the shares have increased to 43% nationwide, 43% in Upper Austria and 44% in Styria. Relative to 2019, by 2025 a reduction of employees in the sector by 5% for Austria, 6% for Upper Austria and 4% for Styria due to demographic change alone is expected, growing to 15%, 18% and 13% respectively in 2030. If we assume a 16,5% reduction in employment by 2025, this will mean that 11,5% of employees in Austria, 10,5% in Upper Austria and 12,5% in Styria need a JT solution. By 2030, with a 25% reduction in employment relative to 2019, JT proposals for 10%, 7% and 12% of employees would need to be developed. One common strategy is the option for early retirement, as realized in the German exit from hard coal and lignite mining, available for employees starting at the age of 58 (cf. section 2.5). In 2025, 15% of Austrian, 18% of Upper Austrian and 14% of Styrian employees would be eligible for such a policy, by 2030 it would be 20%, 21% and 19% respectively. Taking into consideration the estimated reduction in employees due to demographic change, this policy alone could be apt to fully cushion the expected reduction in employment in the next years.

For the German case, the share of employees aged 50 or older will be even higher at 43% nationwide, 41% in Baden-Wurttemberg, 40% in Bavaria and 45% in Lower Saxony by 2025. For 2030, shares are estimated at 50%,48%, 48% and 53% respectively. Relative to 2019, the demographically induced reduction in employees by 2025 is at 13% for Germany as a whole and Baden-Wurttemberg, while being slightly lower at 11% in Bavaria and the highest in Lower Saxony at 14%. By 2030, estimates go up to 24% in the first two cases, and 21% respectively 26% for the latter states. Again, eligibility for early retirement at 58 as JT strategy was estimated. Corresponding to the difference in age structure, eligibility for early retirement is higher than in Austria at 20% nationwide by 2025, 19% for Baden Wurttemberg, 18% for Bavaria and 21% for Lower Saxony. The respective estimates for 2030 are 25%,23%, 23% and 27%. As in the Austrian case, given the demographically induced reduction in employees an early retirement program analogous to the one achieved for lignite miners could be sufficient to cushion the reduction in employment in the scenario under consideration.

Year	Region	Employees ≥50	Demographically induced reduction in employees	Eligibility retirement at 58
2025	Austria	36%	5%	15%
	Upper Austria	38%	6%	18%
	Styria	34%	4%	14%
	Germany	43%	13%	20%
	Baden-Wurttemberg	41%	13%	19%
	Bavaria	40%	11%	18%
	Lower-Saxony	45%	14%	21%
	Germany (group 24)	44%	14%	20%
	Germany (group 25	43%	14%	21%
	Germany (group 27)	44%	12%	20%
2030	Austria	43%	15%	20%
	Upper Austria	43%	18%	21%
	Styria	44%	13%	19%
	Germany	50%	24%	25%
	Baden-Wurttemberg	48%	24%	23%
	Bavaria	48%	21%	23%
	Lower-Saxony	53%	26%	27%
	Germany (group 24)	51%	26%	26%
	Germany (group 25	49%	26%	25%
	Germany (group 27)	53/	23%	26%

Table 6 Summary of estimates in section 5.2

Finally, the employment effects by occupation shall be considered for Germany. It is to be expected that not all occupations will be evenly affected, hence only the three groups most important from an employment perspective by number of employers (making up around 60% of the total) will be considered. The first and third group can be expected to be strongly affected by a change in powertrain technology. The age distribution in the three groups is similar to the German total, with 43% of employees in '25 technical occupations in machine-building and automotive industry' being fifty or older, 44% of employees in '27 occupations in technical research and development, construction, and production planning and scheduling' and 44% of employees in '24 occupations in metal-making and -working, and in metal construction' belonging in that group by 2025. Rates are going up to 49%,53% and 51% respectively by 2030. The demographically induced reduction in employees, assuming a retirement age of 65, is estimated at 14% for group 25, 12% for group 27 and 14% for group 24 by 2025, going up to 26%, 23% and 26% by 2030 respectively. Finally, eligibility for early retirement at 58 of employees still belonging to the workforce in 2025, i.e. those between 58-65 years of age, is at 21% for group 25, 20% for group 27 and 20% for group 24, increasing to 25%, 26% and 26% respectively by 2030. Eligibility for early retirement alone, not including demographically induced reduction in employment, is higher or equal to the reduction in employment estimated in the scenario under consideration, showing the high suitability of this policy for the employees in occupational groups likely to be most affected by the sectoral transformation.

5.2 JT: more than a retirement programme

Early retirement analogous to past and present JT policies in the German mining sector can, as shown above, be an effective tool to cushion the negative effects of employment reduction in the automotive industry as induced by vehicle electrification. Analytically, the approach clearly falls within a narrow, status quo type of JT strategy according to the typology offered by the Just Transition Research Collective (Morena et al., 2018). It is clearly part of an EM strategy if we assume that jobs are lost in the process of powertrain electrification, as in ELAB 2.0 (cf. Kreinin, 2020). However, if we consider the assumptions stipulated in scenario three of Blanck et al. (2017), it can also be part of a SET-type of JT, since the study's estimates consider a change towards more collective, less fossil fuel based mobility patterns. In this profound change of the mobility system, early retirement policies can only be part of the solution and need to be accompanied by other, comprehensive measures tailored towards regional needs as opposed to only employees.

For present employees in the sector, several accompanying measures are already discussed or being implemented. First, retraining programmes for younger employees who need to find a new job are part of the compromise reached for hard coal miners (Abraham, 2017). Similar policies are likely to be needed in the automotive industry as well, especially in the medium to long term as the transformation will not end by 2030 but instead is likely to pick up pace as the climate crisis worsens and policy pressure increases. Second, partial retirement could cushion stronger than expected reduction or locally clustered reduction in employment on the plant level. These agreements are already in place for a number of German plants, which shows that they can be a realistic goal (Strötzel & Brunkhorst, 2019). Workers councils in other affected plants may strive for similar programmes. Third, a general working time reduction is gradually moving from being an often-heard demand by ecological economists pointing out potential social and ecological benefits to a real policy option (Pullinger, 2014). In the wake of the COVID 19 crisis it has been proposed as a measure to tackle the crisis by Austrian social democrats, receiving positive feedback from unions (Weißensteiner, 2020). With a view towards the medium term, the chairman of IG Metall proposed demanding an optional four-day workweek in the next round of collective bargaining for the automotive industry as part of their transformation strategy, thereby going beyond proposals focusing on the acute crisis (Hagelüken & Peters, 2020). This clearly shows that the topic is moving from the ivory tower to the policy arena and sits well with the findings of qualitative studies who find acceptance for working time reductions amongst employees (see, for example, Blöcker et al., 2020, p.130 ff.).

Equally, regional programmes need to accompany these narrow measures to arrive at a JT in the wider/comprehensive sense as outlined by the JTRC. The JT experience of the Ruhr region, in which miners got a good deal while the regional effects are far from rosy, illustrates the necessity for such programmes (Morena et al., 2018). The scenario analysis' assumption of no new net employment in the sector just proofs the case in point that there needs to be practical training and employment for young people who could presently find employment in the automotive industry. Evidently, this is far from an easy task and links to the necessity for a SET-type transformation challenging the functioning of the capitalist economy (Kreinin,2020). However, delaying these debates, be it on the policy, union, or workers council level will in all likelihood only lead to another lost decade both from the field of climate policy and JT, which is precisely what happened in the exit from hard coal mining (JTRC, 2018).

6 Discussion

The scenario analysis realized above shows the potential of early retirement and complementary JT strategies for cushioning employment reductions in the automotive sector. However, since policy is rarely a straightforward matter, this chapter is dedicated to discussing limitations of my results and specific issues to be considered in moving from analysis to policy making. The model developed above stays on a macro-level as it considers sectoral reductions in employment on a state or federal level, in the case of Germany partially extended to occupational groups. It is static, assuming age as the only changing variable for employees in the sector, considers employment reduction in five-year steps, and uses the same reduction rates for both countries under consideration. Simplifications like these are part of any modelling process and precisely what makes a model. At the same time, it is crucial to be clear that reality is more complex in order to avoid the pitfall of seemingly straightforward conclusions. First, a matter not touched upon in chapter five is the issue of financing the policy. Early retirement is a burden to the fiscal coffin, the exact cost of which would need to be determined in the policy-making process. However, the JT examples in Germany show that it may still provide a possible solution. Depending on one's perspective, it could even be argued a relatively inexpensive solution. The early retirement plan for lignite miners comes at half the cost of the 'Corona-Aid' for German airline Lufthansa (dw, 2020).

Second, the sectoral structure of Austria and Germany differs which is likely to influence the speed and effects of sectoral transformation. Germany hosts many OEMs, wherefore German plants are likely to profit from insourcing parts of the supply chain in order to maintain employment, a dynamic that is already unfolding (Götz & Hahne, 2019). Austrian industry, in turn, is characterized by suppliers amongst whom the tendency of insourcing is cause for legitimate concern. At the same time, however, the country's highly innovative SMEs already show some potential for product conversion, which posits these firms in an advantageous position with regards to the development of new products (Wissen et al., forthcoming). Hence, change may come about slower than expected in Germany and sooner than expected in Austria, with the employment effects being highly dependent on firms' ability to adapt to changing circumstances.

Third, and related to the different sectoral structures in the countries analysed here, OEMs and suppliers are facing different challenges as the position in the hierarchical supply chain influences firms' preparedness to adapt towards more climate-friendly production. On a global level, suppliers are prepared worse (Damert & Baumgartner, 2018). However, there is a high degree of diversity amongst suppliers in both countries. In Germany, suppliers are generally found to be well prepared and highly competitive (Krzywdzinski, 2019), while there is regional clustering of firms who either are already facing severe challenges or expect to do so in the near future, notably in Thuringia (Blöcker et al., 2020). Austrian suppliers, in turn, are seldom extended workbenches like in Thuringia, but highly dependent on exports to Germany. Nonetheless, employees' trust in their own qualifications and the innovativeness of the country's so-called 'hidden champions' highlight the transformative potential of the country's automotive sector (Wissen et al., forthcoming).

This differentiation gives rise to the fourth point, which is the necessarily context-dependent nature of a JT process. This cannot be adequately displayed in a macro-level analysis, even though a macro-level analysis is a necessary first step. The accompanying JT measures introduced in section 5.2 will partially need to be developed on the plant level. This is not only to account for the specific needs of firms and regions affected by the transformation. It connects to a core requirement in the design of a JT, which ideally integrates employees' and affected communities' needs in a democratic, bottom-up process in which both groups can contribute their knowledge and are involved in the decision making (Morena et al., 2018). In Germany and Austria, the conditions for such a process are, formally, very good in global comparison as unions have a strong legal standing and political leverage (Morena et al., 2018; Soder et al., 2018). However, unions in both countries will likely need to come up with participatory processes on the shop floor for a JT in which justice refers to more than the number of jobs being saved.

As already alluded to in section 3.2 and chapter 5, the analysis presented above only enquires into one possible scenario and possible set of JT policies. There is no way to predict the future. Indeed, there are good reasons why changes might be less pronounced than assumed. First, the uptake of electric vehicles has in the past been comparatively slow. This seems to be changing, but the 40% BEV by 2030 assumed in ELAB 2.0 are highly dependent on political measures being taken. In Germany, 3% of newly registered vehicles in 2019 had a BEV or hybrid powertrain (kba, n.d.). In Austria, the rate for alternative powertrains is at 8% (*Statistik Austria*, 2020). A higher uptake is highly dependent on political will, not only via a buyers' premium but by providing the necessary infrastructure (Bauer et al., 2018). Of course, global electrification will be of decisive importance, too, since both countries' industries are highly export dependent. At the same time, many employees are affected by changes in the sector. In the past examples of JT in Germany, unions largely tried to slow down the dismantling of the lignite and hard coal industries, thereby siding with capital and against climate (Morena et al., 2018), a pattern also observable in Austria (Soder et al., 2018). As discourses regarding the labour-nature nexus are changing within unions and surrounding institutes, it remains to be seen whether unions will become socially and ecologically progressive societal actors pushing for ecologically sustainably work (Barth, Jochum, & Littig, 2019). Both the assumptions for electrification and for union's roles may thus go too far given current political realities.

At the same time, the changes envisaged here do not go far enough to stop the climate crisis and can at best be considered a first step towards a degrowth economy in which a solidarity mode of living prevails. The JT policies discussed in section 5.2 stay short of a reconceptualization of work, as envisaged in the position paper published by Austrian unions, the Viennese Chamber of Labour and civil society actors (Arbeiterkammer Wien et al., 2019). At the same time, it only lays out policies for one sector and does not consider transformation dynamics in the whole economy which are demanded for a turn towards a degrowth or post-growth economy. Measures like a permanent working time reduction (going beyond the automotive industry) and regional development programmes can be useful tools in this wider transformation, too. However, other policies needed for an economy characterized by private sufficiency and public riches, notably tax reform, the redistribution of wealth, changes in ownership structure of firms and democratization of production processes were not touched upon, even though they can be part of a JT strategy, as the example of the South African Food Sovereignty Campaign shows (Hickel, 2019; Kreinin, 2020).

7 Conclusion

My research set out to shed light on the challenges and opportunities in the social-ecological tranformation of labour in the German and Austrian automotive industry. As labour is the central mechanism turning nature into commodities "the creation of employment that promotes labour rights and improves working conditions while also encompassing gender and racial equality, democratic participation and social justice" (Morena et al., 2018, p. 4) is at the core of the transformation towards social-ecologically sustainable economies. A first step on this way is to exit from employment in ecologically unsustainable industries with a clear view towards doing so in a socially just manner. This concern is at the heart of JT discourses and roadmaps amongst trade unions, although the depth of ecological commitment varies greatly and often leaves much to be desired from the perspective of ecological sustainability (Kreinin, 2020).

Jobs in the automotive industry, especially those directly connected to the manufacturing of combustion engines, are one economically and socially important kind of ecologically unsustainable employment. However, "[u]nlike coal, future employment changes in the automobile sector are much less straightforward and much harder to forecast. The only certainty is that the changes will be massive and that almost all jobs in the industry will be affected to some extent" (Galgóczi, 2019, p. 20). This uncertainty is reflected in the empirical studies reviewed in chapter three. Qualitative studies found varying expectations and concerns amongst employees in the sector which, e.g. in the case of Blöcker et al. (2020) did not necessarily correspond to their employers' situation- either under- or overestimating the pace and depth of the changes ahead. Quantitative studies, in turn, yielded very different results based on differences in assumptions and modelling techniques. The scenario decided upon for my own analysis in chapter five combines two of the quantitative estimates which foresee relatively stark effects on employment.

In 2019, employment in WZ29 was at approximately 40 000 in Austria and 950 000 in Germany, with regional concentration in Styria and Upper Austria, respectively Bavaria, Baden-Wurttemberg, and Lower Saxony. Amongst Austrian employees, 25% were fifty or older, while an estimated 35% of German employees fall into this age group. In the five federal states analysed additionally to the national average, rates diverged from the national average by 4% maximum. In Austria, 56% of employees are in ISCO groups three ('technicians and associate professionals') and 7 ('craft and related trade workers'). For Germany, the two strongest occupational groups are 25 and 27, both directly linked to vehicle production (as opposed to, e.g., clerks or sales agents), accounting for 48% of employees. This shows that both by share in overall employees and given the changes brought about by electrification, employees working in production and, specifically, in powertrain production are of core interest to JT strategies. For Germany, data allows to assess the age distribution of these employees, which in the biggest groups is older than the German average with 37% of employees in occupational group 25 being 50 or older.

Based on the current employment structure, I estimated the employment structure by 2025 and 2030 and the demographically induced reduction in employees for both countries, the five states with the highest number of employees in WZ29/ ÖNACE C-29, and the biggest occupational groups in Germany. Subsequently, eligibility amongst remaining employees by 2025 and 2030 for early retirement at 58, analogous to the JT agreement in the German exit from lignite mining, was estimated. I found that, given the reduction in the number of employees due to ageing, the option for retirement at age 58 would, mathematically, be apt to fully cushion a 16,5% reduction in employment by 2025, and a 25% reduction in employment by 2030, both relative to employment in 2019 for all regions and occupational groups considered. This this is an important finding pointing towards the policy's suitability as part of a JT. Yet, one has to keep in mind that the static nature of the model and the five-year steps make the estimate more coarse than desirable from a policy perspective. It does not allow understanding the process through which the 16.5% reduction in jobs within the next five years comes about, neither its exact timing nor the exact jobs affected.

For this reason and because of the high regional importance of the automotive industry, clustered not only in certain federal states but metropolitan regions, e.g. around Wolfsburg in Germany, it is necessary to develop an encompassing JT programme which early retirement forms part of. Notably, retraining programmes, support in finding new high-quality employment and a working time reduction can be suitable tools to achieve a JT. In light of past experiences with the JT in the Ruhr region, it is important to not only consider the future of employees in the sector, but overall regional development. The last two measures connect my analysis of the options for an isolated, status-quo type JT, which is oriented to what appears politically feasible, to calls for a SET (Kreinin, 2020) or transformation-type (Morena et al., 2018) of JT. These forms of JT are characterized by encompassing changes to the functioning of the capitalist economy, which is imperative from an ecological perspective as well as, arguably, for the advancement of global justice. To this end, working time reduction and programmes to develop industrial regions away from carbon-intense production can be first steps.

For future research and policy making, it is desirable to take the macro-level analysis realized in chapter five to the meso level. This allows to better account for the differences between the Austrian and German automotive industry, as well as the different dynamics playing out amongst OEMs, who have the possibility to insource production, and suppliers, for whom conversion might be easier in case there is relative independence in plants' decision-making and on-site r & d. However, the competitiveness and innovativeness of suppliers varies greatly. Therefore and for reasons of democratic participation, it is important to develop JTs in a participatory, bottom-up process in which workers on the shop floor, workers councils and unions work together towards policies that are good for people and not only good on paper. Finally, it has to be kept in mind that my analysis offers but one possibility for future developments in employment and adequate reactions to it. As the future is uncertain and highly dependent on political decisions, it is important not to take my analysis as prediction providing solutions, but to use my findings in the political process. I show that even relatively high losses of employment in the industry can be absorbed in a socially acceptable manner, which opens up room for manoeuvre for unions trying to find courageous strategies for the reconciliation of ecological and social goals, thereby changing their role towards being more progressive actors in the social-ecological transformation.

Indeed, progressive actors are what is needed in order to move from the limited JT discussed in my research towards a social-ecological transformation of the economy. It is not hyperbole to say that this transformation is needed sooner rather than later if climate change is to be stopped on an at least bearable level. What is more, workers, unionists, politicians, and scientists alike need to start to imagine this world to take steps towards it instead of taking an unsustainable status quo as the yardstick for policy-making and political demands. Certainly, the world can change in unsuspected ways. Wilhelm II's prediction about the future of the car was proven so entirely inaccurate by history that one may smirk upon reading it. This was likely not his contemporaries' reaction. Likewise, it is conceivable that Andreas Scheuer's, German minister of transport and infrastructure, 2019 statement that "the diesel engine has a future" (quoted in dpa, AFP, & mbr, 2019, pp., own translation) evokes just the same smirk some years from now.

8 Appendix

8.1. Distribution of employees by age

	Employees in WZ29 in Germany, June 2019								
		< 15	15-24	25-34	35-44	45-54	55-64	>65	Total
WZ 29	Baden-Württemberg	*	19473	51211	51689	58515	47323	*	228863
	Bavaria	0	22071	59133	63825	68926	49280	486	263721
	Berlin	0	274	1022	1219	1464	1018	22	5019
	Brandenburg	0	386	1059	1144	1139	995	16	4739
	Bremen	*	*	*	*	*	*	*	*
	Hamburg	0	237	528	605	921	794	16	3101
	Hesse	0	4105	11855	12465	18804	15764	148	63141
	Mecklenburg-Western Pomerania	0	296	703	663	775	692	14	3143
	Lower Saxony	0	9683	27281	31276	41713	32309	233	142495
	North Rhine-Westphalia	0	6255	17762	18652	27371	21322	354	91716
	Rhineland-Palatinate	0	3077	6476	7042	9135	8729	97	34556
	Saarland	0	1650	4866	5431	7315	5505	56	24823
	Saxony	0	2869	9461	10746	10770	7294	69	41209
	Saxony-Anhalt	0	373	968	905	1012	947	21	4226
	Schleswig-Holstein	0	249	680	820	1351	1110	28	4238
	Thuringia	0	1116	3225	3956	4925	4312	42	17576
	Germany	*****	**73668**	**199059**	**212935**	**259149**	**202521**	*****	**949621**

Table 7 Employees WZ29 by age, Germany 2019

	Employees in ÖNACE08-C29 in Austria by age, July 2019													
	Age/State	< 15	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-54	> 65	Total
WZ 29	Burgenland	0	49	67	69	71	64	72	78	75	46	14	0	605
	Carinthia	0	7	74	130	155	120	109	73	54	17	7	0	746
	Lower Austria	0	136	283	466	471	442	380	404	422	300	79	2	3.385
	Upper Austria	0	587	1.055	1.555	1.561	1.436	1.462	1.421	1.582	1.511	463	8	12.641
	Salzburg	0	85	131	177	156	155	143	159	152	153	35	0	1.346
	Styria	0	537	1.211	1.853	1.915	2.257	2.196	1.864	1.700	1.198	380	8	15.119
	Tyrol	0	68	110	118	137	124	116	123	115	72	22	3	1.008
	Voralberg	0	174	254	255	278	239	196	168	160	106	32	3	1.865
	Vienna	0	90	118	203	207	209	263	350	411	466	122	4	2.443
	Austria	**0**	**1.733**	**3.303**	**4.826**	**4.951**	**5.046**	**4.937**	**4.640**	**4.671**	**3.869**	**1.154**	**28**	**39.158**

Table 8 Employees ÖNACE08-C29 by age, Austria 2019

8.2 Extrapolated age distribution by state for Austria

Year	State	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	>65
2020	Burgenland	39	63	69	71	65	70	77	76	52	20	3
	Carinthia	6	61	119	150	127	111	80	58	24	9	1
	Lower Austria	109	254	429	470	448	392	399	418	324	123	18
	Upper Austria	470	961	1455	1560	1461	1457	1429	1550	1525	673	101
	Salzburg	68	122	168	160	155	145	156	153	153	59	7
	Styria	430	1076	1725	1903	2189	2208	1930	1733	1298	544	84
	Tyrol	54	102	116	133	127	118	122	117	81	32	7
	Voralberg	139	238	255	273	247	205	174	162	117	47	9
	Vienna	72	112	186	206	209	252	333	399	455	191	28
2025	Burgenland	0	39	63	69	71	65	70	77	76	52	23
	Carinthia	0	6	61	119	150	127	111	80	58	24	10
	Lower Austria	0	109	254	429	470	448	392	399	418	324	141
	Upper Austria	0	470	961	1455	1560	1461	1457	1429	1550	1525	773
	Salzburg	0	68	122	168	160	155	145	156	153	153	66
	Styria	0	430	1076	1725	1903	2189	2208	1930	1733	1298	628
	Tyrol	0	54	102	116	133	127	118	122	117	81	39
	Voralberg	0	139	238	255	273	247	205	174	162	117	56
	Vienna	0	72	112	186	206	209	252	333	399	455	219
2030	Burgenland	0	0	39	63	69	71	65	70	77	76	75
	Carinthia	0	0	6	61	119	150	127	111	80	58	35
	Lower Austria	0	0	109	254	429	470	448	392	399	418	465
	Upper Austria	0	0	470	961	1455	1560	1461	1457	1429	1550	2298
	Salzburg	0	0	68	122	168	160	155	145	156	153	218
	Styria	0	0	430	1076	1725	1903	2189	2208	1930	1733	1926
	Tyrol	0	0	54	102	116	133	127	118	122	117	120
	Voralberg	0	0	139	238	255	273	247	205	174	162	173
	Vienna	0	0	72	112	186	206	209	252	333	399	674

Table 9 Extrapolation by state, Austria

8.3 Extrapolated age distribution by state for Germany

Year	State	15-24	25-34	35-44	45-54	55-64	>65
2020	Baden-Württemberg	17526	48037	51641	57832	48442	4732
	Bavaria	19864	55427	63356	68416	51245	5414
	Berlin	247	947	1199	1440	1063	124
	Brandenburg	347	992	1136	1140	1009	116
	Bremen	0	0	0	0	0	0
	Hamburg	213	499	597	889	807	95
	Hesse	3695	11080	12404	18170	16068	1724
	Mecklenburg-Western Pomerania	266	662	667	764	700	83
	Lower Saxony	8715	25521	30877	40669	33249	3464
	North Rhine-Westphalia	5630	16611	18563	26499	21927	2486
	Rhineland-Palatinate	2769	6136	6985	8926	8770	970
	Saarland	1485	4544	5375	7127	5686	607
	Saxony	2582	8802	10618	10768	7642	798
	Saxony-Anhalt	336	909	911	1001	954	116
	Schleswig-Holstein	224	637	806	1298	1134	139
	Thuringia	1004	3014	3883	4828	4373	473
	Germany	66301	186520	211547	254528	208184	20252
2025	Baden-Württemberg	7789	32168	51402	54419	54038	28394
	Bavaria	8828	36896	61010	65865	61068	30054
	Berlin	110	573	1101	1317	1286	633
	Brandenburg	154	655	1093	1142	1081	613
	Bremen	0	0	0	0	0	0
	Hamburg	95	353	559	731	870	492
	Hesse	1642	7205	12099	15001	17588	9606
	Mecklenburg-Western Pomerania	118	459	687	708	742	429
	Lower Saxony	3873	16722	28879	35451	37951	19618
	North Rhine-Westphalia	2502	10858	18118	22140	24951	13147
	Rhineland-Palatinate	1231	4437	6702	7879	8973	5334
	Saarland	660	2936	5092	6185	6591	3359
	Saxony	1148	5506	9975	10756	9380	4445
	Saxony-Anhalt	149	611	943	948	986	589
	Schleswig-Holstein	100	421	736	1032	1255	694
	Thuringia	446	1960	3517	4344	4680	2629
	Germany	29467	123824	204609	231421	236498	121513
2030	Baden-Württemberg	0	17526	48037	51641	57832	53175
	Bavaria	0	19864	55427	63356	68416	56659
	Berlin	0	247	947	1199	1440	1186
	Brandenburg	0	347	992	1136	1140	1125
	Bremen	0	0	0	0	0	0
	Hamburg	0	213	499	597	889	902
	Hesse	0	3695	11080	12404	18170	17792
	Mecklenburg-Western Pomerania	0	266	662	667	764	784
	Lower Saxony	0	8715	25521	30877	40669	36713

	North Rhine-Westphalia	0	5630	16611	18563	26499	24413
	Rhineland-Palatinate	0	2769	6136	6985	8926	9740
	Saarland	0	1485	4544	5375	7127	6293
	Saxony	0	2582	8802	10618	10768	8440
	Saxony-Anhalt	0	336	909	911	1001	1069
	Schleswig-Holstein	0	224	637	806	1298	1273
	Thuringia	0	1004	3014	3883	4828	4847
	Germany	0	66301	186520	211547	254528	228436

Table 10 Extrapolation by state, Germany

8.4 Extrapolated age – and occupational distribution for Germany

Year	Occupation	15-24	25-34	35-44	45-54	55-64	>65
2020	25 Technical occupations in machine-building and automotive industry	22877	52146	56588	71232	64026	6305
	27 Occupations in technical research and development, construction, and production planning and scheduling	4575	37629	46222	50684	38526	4062
	24 Occupations in metal-making and -working, and in metal construction	9780	21972	25502	33787	28700	3158
	71 Occupations in business management and organisation	8922	20948	23437	28758	20222	2260
	51 Occupations in traffic and logistics (without vehicle driving)	2838	9174	11424	16945	16842	1797
	26 Occupations in mechatronics, energy electronics and electrical engineering	8179	11445	9759	10404	7058	737
	22 Occupations in plastic-making and -processing, and wood-working and -processing	2471	7080	7716	9925	8647	942
	61 Occupations in purchasing, sales and trading	560	5730	6269	6127	3924	440
	43 Occupations in computer science, information and communication technology	979	5112	6176	5681	3575	380
	72 Occupations in financial services, accounting and tax consultancy	271	3717	4363	3826	2379	266
	28 Occupations in textile- and leather-making and -processing	407	1667	2048	1830	1412	158
	34 Occupations in building services engineering and technical building services	239	984	1312	2020	1786	189
	92 Occupations in advertising and marketing, in commercial and editorial media design	149	1606	2068	1672	851	88
	52 Drivers and operators of vehicles and transport equipment	77	586	1025	1813	2092	310
	63 Occupations in tourism, hotels and restaurants	2499	1166	99	746	690	68
	41 Occupations in mathematics, biology, chemistry and physics	421	1144	1122	1432	1240	138
	53 Occupations in safety and health protection, security and surveillance	492	881	994	1351	1400	150
	62 Sales occupations in retail trade	78	495	714	1285	977	113
	73 Occupations in law and public administration	36	533	905	900	514	54
	54 Occupations in cleaning services	81	212	348	698	812	100

	91 Occupations in in philology, literature, humanities, social sciences, and economics.	0	556	722	584	300	27
	84 Occupations in teaching and training	86	345	459	650	580	63
	93 Occupations in product design, artisan craftwork, fine arts and the making of musical instruments	0	498	628	489	253	23
	23 Occupations in paper-making and -processing, printing, and in technical media design.	0	186	213	336	288	28
	Other	41	678	992	1293	1088	106
	Total	66301	186520	211547	254528	208184	20252
	25 Technical occupations in machine-building and automotive industry	10168	37298	55770	63187	68923	37828
	27 Occupations in technical research and development, construction, and production planning and scheduling	2033	19548	43457	48512	45522	22625
	24 Occupations in metal-making and -working, and in metal construction	4347	15803	24226	29326	32022	17176
	71 Occupations in business management and organisation	3965	14817	22735	25880	25284	11864
	51 Occupations in traffic and logistics (without vehicle driving)	1261	5829	10546	13976	17229	10179
	26 Occupations in mechatronics, energy electronics and electrical engineering	3635	10136	10841	9926	8970	4075
	22 Occupations in plastic-making and -processing, and wood-working and -processing	1098	4672	7630	8707	9493	5181
	61 Occupations in purchasing, sales and trading	249	2892	6285	6204	5139	2281
	43 Occupations in computer science, information and communication technology	435	2876	5833	5994	4710	2054
	72 Occupations in financial services, accounting and tax consultancy	120	1819	4215	4141	3148	1378
	28 Occupations in textile- and leather-making and -processing	181	992	1911	1966	1629	842
	34 Occupations in building services engineering and technical building services	106	585	1174	1642	1958	1065
	92 Occupations in advertising and marketing, in commercial and editorial media design	66	806	1900	1910	1280	470
	52 Drivers and operators of vehicles and transport equipment	34	308	812	1399	1983	1367
	63 Occupations in tourism, hotels and restaurants	1111	2061	592	332	767	405
	41 Occupations in mathematics, biology, chemistry and physics	187	768	1176	1254	1367	745
	53 Occupations in safety and health protection, security and surveillance	219	695	952	1157	1394	851
	62 Sales occupations in retail trade	35	268	617	978	1182	581
	73 Occupations in law and public administration	16	259	729	922	726	290
	54 Occupations in cleaning services	36	144	280	511	769	511
	91 Occupations in in philology, literature, humanities, social sciences, and economics.	0	247	664	667	448	162
2025	84 Occupations in teaching and training	38	207	411	549	630	348

	93 Occupations in product design, artisan craftwork, fine arts and the making of musical instruments	0	221	586	571	375	137
	23 Occupations in paper-making and -processing, printing, and in technical media design.	0	83	210	268	322	169
	Other	18	326	856	1141	1219	637
	Total	29467	123824	204609	231421	236498	121513
	25 Technical occupations in machine-building and automotive industry	0	22877	52146	56588	71232	70331
	27 Occupations in technical research and development, construction, and production planning and scheduling	0	4575	37629	46222	50684	42588
	24 Occupations in metal-making and -working, and in metal construction	0	9780	21972	25502	33787	31858
	71 Occupations in business management and organisation	0	8922	20948	23437	28758	22481
	51 Occupations in traffic and logistics (without vehicle driving)	0	2838	9174	11424	16945	18639
	26 Occupations in mechatronics, energy electronics and electrical engineering	0	8179	11445	9759	10404	7795
	22 Occupations in plastic-making and -processing, and wood-working and -processing	0	2471	7080	7716	9925	9589
	61 Occupations in purchasing, sales and trading	0	560	5730	6269	6127	4364
	43 Occupations in computer science, information and communication technology	0	979	5112	6176	5681	3955
	72 Occupations in financial services, accounting and tax consultancy	0	271	3717	4363	3826	2644
	28 Occupations in textile- and leather-making and -processing	0	407	1667	2048	1830	1570
	34 Occupations in building services engineering and technical building services	0	239	984	1312	2020	1975
	92 Occupations in advertising and marketing, in commercial and editorial media design	0	149	1606	2068	1672	938
	52 Drivers and operators of vehicles and transport equipment	0	77	586	1025	1813	2403
	63 Occupations in tourism, hotels and restaurants	0	2499	1166	99	746	758
	41 Occupations in mathematics, biology, chemistry and physics	0	421	1144	1122	1432	1378
	53 Occupations in safety and health protection, security and surveillance	0	492	881	994	1351	1550
	62 Sales occupations in retail trade	0	78	495	714	1285	1090
	73 Occupations in law and public administration	0	36	533	905	900	568
	54 Occupations in cleaning services	0	81	212	348	698	913
	91 Occupations in in philology, literature, humanities, social sciences, and economics.	0	0	556	722	584	327
	84 Occupations in teaching and training	0	86	345	459	650	643
	93 Occupations in product design, artisan craftwork, fine arts and the making of musical instruments	0	0	498	628	489	276
2030	23 Occupations in paper-making and -processing, printing, and in technical media design.	0	0	186	213	336	316

	Other	0	41	678	992	1293	1194
	Total	0	66301	186520	211547	254528	228436

Table 11 Extrapolation by occupation, Germany

8.5 Translation of occupational groups

No	*Berufshauptgruppe,* **KLDB 2010**	**Translation**
11	Land-, Tier- und Forstwirtschaftsberufe	Occupations in agriculture, forestry, and farming
12	Gartenbauberufe und Floristik	Occupations in gardening and floristry
21	Rohstoffgewinnung und – aufbereitung, Glas- und Keramikherstellung und -verarbeitung	Occupations in production and processing of raw materials, glass- and ceramic-making and -processing
22	Kunststoffherstellung und -verarbeitung, Holzbe- und -verarbeitung	Occupations in plastic-making and -processing, and wood-working and -processing
23	Papier- und Druckberufe, technische Mediengestaltung	Occupations in paper-making and -processing, printing, and in technical media design
24	Metallerzeugung und -bearbeitung, Metallbauberufe	Occupations in metal-making and -working, and in metal construction
25	Maschinen- und Fahrzeugtechnikberufe	Technical occupations in machine-building and automotive industry
26	Mechatronik-, Energie-, und Elektroberufe	Occupations in mechatronics, energy electronics and electrical engineering
27	Technische Forschungs-, Entwicklungs-, Konstruktions- und Produktionssteuerungsberufe	Occupations in technical research and development, construction, and production planning and scheduling
28	Textil- und Lederberufe	Occupations in textile- and leather-making and -processing
29	Lebensmittelherstellung und -verarbeitung	Occupations in food-production and -processing
31	Bauplanungs-, Architektur- und Vermessungsberufe	Occupations in construction scheduling, architecture and surveying
32	Hoch- und Tiefbauberufe	Occupations in building construction above and below ground
33	(Innen-)Ausbauberufe	Occupations in interior construction
34	Gebäude- und versorgungstechnische Berufe	Occupations in building services engineering and technical building services
41	Mathematik-, Biologie-, Chemie-, und Physikberufe	Occupations in mathematics, biology, chemistry and physics
42	Geologie-, Geografie- und Umweltschutzberufe	Occupations in geology, geography and environmental protection
43	Informatik-, informations- und Kommunikationstechnologieberufe	Occupations in computer science, information and communication technology
51	Verkehrs- und Logistikberufe (außer Fahrzeugführung)	Occupations in traffic and logistics (without vehicle driving)
52	Führer/innen von Fahrzeug- und Transportgeräten	Drivers and operators of vehicles and transport equipment
53	Schutz-, Sicherheits- und Überwachungsberufe	Occupations in safety and health protection, security and surveillance
54	Reinigungsberufe	Occupations in cleaning services
61	Einkaufs-, Vertriebs- und Handelsberufe	Occupations in purchasing, sales and trading
62	Verkaufsberufe	Sales occupations in retail trade
63	Tourismus-, Hotel- und Gaststättenberufe	Occupations in tourism, hotels and restaurants

71	Berufe in Unternehmensführung und Organisation	Occupations in business management and organisation
72	Berufe in Finanzdienstleistungen, Rechnungswesen und Steuerberatung	Occupations in financial services, accounting and tax consultancy
73	Berufe in Recht und Verwaltung	Occupations in law and public administration
81	Medizinische Gesundheitsberufe	Medical and health care occupations
82	Nicht medizinische Gesundheits-, Körperpflege- und Wellnessberufe, Medizintechnik	Occupations in non-medical healthcare, body care, wellness and medical technicians
83	Erziehung, soziale und hauswirtschaftliche Berufe, Theologie	Occupations in education and social work, housekeeping, and theology
84	Lehrende und ausbildende Berufe	Occupations in teaching and training
91	Sprach-, literatur-, geistes-, gesellschafts- und wirtschaftswissenschaftliche Berufe	Occupations in in philology, literature, humanities, social sciences, and economics
92	Werbung, Marketing, kaufmännische und redaktionelle Medienberufe	Occupations in advertising and marketing, in commercial and editorial media design
93	Produktdesign und kunsthandwerkliche Berufe, bildende Kunst, Musikinstrumentenbau	Occupations in product design, artisan craftwork, fine arts and the making of musical instruments
94	Darstellende und unterhaltende Berufe	Occupations in the performing arts and entertainment
01	Angehörige der regulären Streitkräfte	Armed forces personnel

Table 12 Translation occupational groups KLDB10

This translation can be downloaded **here** as a Microsoft Excel Spreadsheet.

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