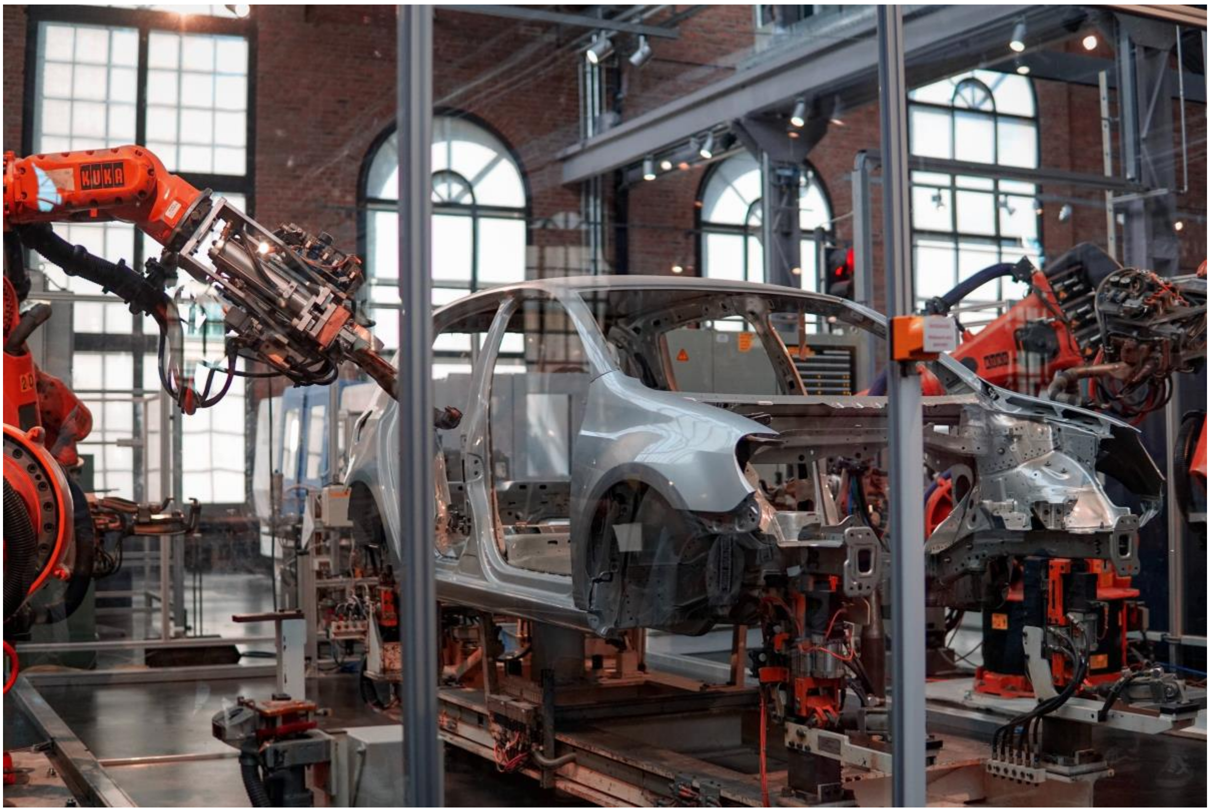

Enabling a just transition in automotive: evidence from the West Midlands and South Australia

Report for the British Academy

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Abstract

Employment in the automotive sector is typically spatially concentrated and hence the impact of the transition to low-carbon technologies will have profound subnational effects. Although there is a rich literature around the spatial impact of automotive plant closures, the novelty of this work lies in its focus on transformation and diversification throughout the supply chain and the impact on workers in the automotive sector. As such, this research study reports on a comparative international piece of research investigating the lessons for supplier firms and workers arising from the West Midlands and South Australia in facilitating a 'Just Transition' in the automotive sector. The research consisted of mixed methods, and entailed interviews with stakeholders (management, workforce/union representatives and policymakers) throughout the supply chain, coupled with a workforce survey in the UK of members of the Unite union (automotive section). This project is ground-breaking through its explicit examination of the potentials of supplier firms to reorient toward the 'green' automotive production economy

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Executive Summary

This report presents the key findings and policy recommendations of a study examining the issues pertaining to a 'just transition'[1] *to zero/low-carbon vehicles for the automotive sector, drawing on case study research from the West Midlands region in the UK, and the North Adelaide area of South Australia.*

The research drew upon interviews with stakeholders (business, policymaker etc.) pertaining to the automotive supply chain – in the West Midlands this focussed on the capacity (or rather, lack of) of supplier firms to transition to EV; whilst in South Australia, the focus was a retrospective one on the cessation of ICE vehicle manufacturing in Australia in 2017, whether suppliers had diversified into other sectors, and what nascent moves were underway to try and build a domestic EV or hydrogen-powered vehicle industry. This work was augmented with a survey of Unite union members working in automotive in the West Midlands, seeking to assess worker perceptions and concerns underpinning transition.

Key themes explored in the interviews were participants' views on the current state of the EV industry in their region, the dependency on Vehicle Manufacturers (VMs; typically multinational firms) as being key to whether they could transition, what skills mix would be required and where skills gaps were, what the role of government should be to facilitate transition, and any issues pertaining to underpinning infrastructure (namely, the EV charging network). The (UK) survey of workers sought to assess how confident they were of transitioning, whether they had the requisite skills, how secure they felt in their jobs, their expectations of future work, and what government could do to assist them transition successfully.

Findings

Our findings *(which focus on the West Midlands, whilst the Australian experience is used to help inform current policy debate) suggest that the automotive value chain in the West Midlands has marked gaps in terms of being able to supply key parts and components for EV production; particularly in EV powertrain systems and all battery components, which will hinder attempts to capture value-added in securing domestic EV production. In this context, the current mania for "gigafactories" in the UK obscures the fact that VMs will determine which aspects of EV production they will conduct in the UK, and where they will source the supplies of components from. In particular, we find that firms in the automotive supply chain in the West Midlands:*

- ***are particularly exposed to the operations of Jaguar Land Rover (JLR), given its dominance in the region (accounting for approx. 50% of automotive employment in the West Midlands), and the continued uncertainty (at the time of writing) as to JLR's EV strategy;***
- ***lack the capacity or the specialist equipment needed to undertake production of batteries, high value battery components (especially anodes and cathodes) and key components for electric motors (e.g., severe lack of domestic capacity to produce laminations for electric motors);***
- ***are hindered by a lack of non-grain-oriented (NGO) electrical steel produced in the UK to support production of EV components, for batteries and motors, following the decision by Tata Steel to consolidate production of NGO steel in Sweden;***

[1] A 'just transition' can be defined as "*securing the future and livelihoods of workers and their communities in the transition to a low-carbon economy. It is based on social dialogue between workers and their unions, employers, and government, and consultation with communities and civil society*" (Emden et al., 2021).

- ***suffers from uncompetitive energy prices relative to other European countries, which will hinder production in the UK of energy-intensive parts and components such as battery cells;***

In this context, the exposure of the regional supply chain to JLR is critical, given that in contrast to other UK-based manufacturers, who focus on assembly, JLR conducts substantial R&D operations and value-added in the UK.

Policy recommendations

As such, our analysis strongly suggests that policy needs to focus on two areas: ***general support and improvements to the area's infrastructure and general business environment (transport links, potential help with energy costs etc.)*** *and more significantly* ***assisting with the transition to an electric vehicle manufacturing focus for West Midlands automotive****. Specifically, helping to secure a battery plant, either an assembly plant or a fully vertically integrated factory which encompasses cell production plant as well as battery assembly, should be top of the local and regional policy makers' objectives – and this has to start with a clear understanding of the needs and intents of VMs in the region.* ***If production of cells is to take place at a UK gigafactory, then this will in all likelihood need to be presaged by a UK Government 'deal' on a reduced tariff for electricity****. This is because as much as 2/3 of the embedded energy consumed in the production a battery is in the cell production phase; most of the rest is incurred in the raw material mining phase. There is a strong case to be made for cell production to receive support as an energy intensive industry.*

Hence, current talk of a establishing a 'gigafactory' obscures the problems we have identified in securing as much value-added as possible in the West Midlands. ***Helping the region's existing supply chain firms to assess what they need to do re-orientate themselves towards the new EV or zero carbon economy is essential.*** *There is a case for reinstating a regional service akin the MAS (Manufacturing Advisory Service), which was discontinued in 2016.* ***It is also essential that a Skills Strategy is developed to ensure that both VMs and supply chain firms can recruit as well as train and retrain workers so that they have the skills needed for electric vehicle production****.*

Broadly speaking, there are policies that could be actioned at a regional level (e.g., in the UK by the West Midlands Combined Authority in concert with local government and other regional agencies), whilst others above would require action at a national level. In terms of regional actions (our specific recommendations focus on the West Midlands, also having drawn on the Australian experience), to augment current efforts to maximise domestic value-added in EV production, these should include:

- *Establishing a Register of firms in the supply chain who want to work with VMs in transitioning to EV production, by developing a Capacity Directory which lists what products and processes firms can provide;*

- *Appointing a Supply Chain Champion to assist in delivering on-shoring and growing local supply chain capacity;*

- *Working with the major VMs to understand which UK firms they actually wish to work with in the transition to EV component supply;*

- *Funding for training provision to assist suppliers to retrain and reskill their workers for the transition to EV production (and related areas such as the green energy supply chain).*[2] *This should include provision of training in digital skills and expertise;*

- *Establish a Skills Taskforce consisting of VMs, supply chain firms, universities and colleges as well as private training providers to commission research and intelligence gathering on skills requirements and skills shortages to enable the design of training and degree programmes that will meet skills requirements. The VW experience in Germany demonstrates that it is essential that this is done in a collaborative basis;*

- *VMs and supply chain firms to work together on skills requirements; supply chain firms to be integrated into training programmes of VMs. This is essential to ensure coordination of skills training in order to improve quality assurance and productivity to achieve competitiveness in the emerging EV production system (the German term is 'ecosystem') (Herrman, 2020a).*

- *Shore up the supply chain by measures (subsidies/tax relief/equity stakes etc.) to make domestic production of NGO steel and key powertrain components such as motor laminations viable;*

- *Improve information sharing across the supply chain to enhance the potential for innovation;*

- *Suppliers should be able to access a loan fund to assist with restructuring their operations. This has been a key policy response used in previous plant closures such as that of MG Rover and also in response to the 2008 Global Financial Crisis (GFC);*

- *Potential business tax/rates holidays – as De Ruyter et al. (2019) identified, business rates have generally been seen as a disproportionate cost burden borne by UK manufacturing companies, especially when compared to equivalent taxes levied in other EU countries;*

- *Provide specific diversification support for firms in the industry. This was significant with individual plant closures such as MG Rover, and in response to the GFC (in this case via the Automotive Response Programme);*

- *Much more investment is needed in increasing the capacity of on-road/car park EV charging infrastructure – this could serve as a key job creation policy as well as augmenting the skills base in green energy workers;*

- *Set up a National Transition Centre for Sustainable Employment. This can be used to raise awareness of the profound changes that are going to occur in the automotive industry. This to include the development of measures to safeguard jobs or to ensure they are reduced in a socially responsible way. The UK can draw on Volkswagen's experience in this regard (Herrman, 2020a);*

- *Prioritise local procurement strategies for the public sector, in accordance with the UK's obligations under international trade agreements;*

- *Establish special enterprise zones with excellent connectivity and a range of tax incentives. These should be centred on existing areas of automotive specialisation, building on existing*

[2] This will also be critical for successful adoption of 'Industry 4.0' (see De Propris and Bailey, 2021; for a discussion).

clusters of expertise and support the growth of cutting-edge technologies in the region. Incubation of scale-up firms is another important area of focus;

- *Producing a Green Industrial Strategy prioritising accessible low-cost green energy;*
- *Developing a Green Business Hub to promote regional buying, selling, sourcing and best practice exchange, and;*
- *Launching a Green Skills Hub involving West Midlands' schools, colleges, universities and businesses prioritised in light of skills shortages already evident in preparing and readying for the transitional skills required (McCabe and Nielsen, 2021).*

1. Introduction

The coming decade will see some of the most far-reaching changes the global automotive industry has experienced. In just over a decade, by 2035, significant major world markets anticipate phasing out the sale of new vehicles powered by internal combustion engines (ICEs) with a number hoping to do so even sooner. The imperative to move to low-carbon production is now clear and industry is responding. However, existing supply chains are predicated upon the internal combustion engine as a mode of propulsion and the move to low-carbon technologies is likely to have uneven outcomes, varying across different socio-economic groups and spatially among places. These effects may exacerbate existing inequities. The challenge of ensuring a just transition to new low-carbon technologies is thus profound and comes on top of other (not unrelated) challenges relating to the Fourth Industrial Revolution and the consequent impact of 'Industry 4.0' and attendant digitalisation on the automotive sector (Sehgal, 2020).

As such, the literature surveyed in this report has demonstrated that the shift to electric vehicles, low emission public transport and renewable energy sources creates opportunities to expand the industrial reorientation component of Just Transition (Newell and Mulvaney, 2013) and to integrate it with scholarship on industrial 'path creation' to revitalise affected local economies (Dawley et al., 2014). In this context, Emden et al. (2021) define a Just Transition as:

"*securing the future and livelihoods of workers and their communities in the transition to a low-carbon economy. It is based on social dialogue between workers and their unions, employers, and government, and consultation with communities and civil society*" (ibid.).

However, there remains much uncertainty around how affected local economies might take advantage of these opportunities. As such, this research sets out to systematically evaluate these issues, and the attendant opportunities and constraints. The central questions addressed in this research are:

1. What lessons – positive and negative – can be learnt from recent experiences of automotive plant closures?

2. What are the optimal policy settings to manage plant closures, preserve skilled employment, and promote retraining and reskilling into emerging industries?

3. What are the potentials of smaller supplier firms to diversify to viable new specialisations, especially those created by the greening of the automotive sector globally?

4. How can the industrial transition to new forms of transport be optimally coordinated with the labour market transition of automotive workforces?

In the sections that follow, we first frame the issues at stake in terms of understanding just what constitutes a 'just transition'. We do this explicitly in terms of reviewing and analysing the factors that underpin successful labour market adjustment for workers caught up in plant closures and other disruptive economic influences. Drawing on the framework of Standing (1997) and the wider literature on labour market precariousness, we seek to assess how relative labour insecurity at the macro, meso and micro level impacts on the likelihood of a successful transition and draw on previous studies examining the impact of plant closure on workers' employment prospects in Australia, the UK and elsewhere (e.g., Germany). This literature is necessarily accompanied by a spatial focus on how issues of scale and regional disparities impact on successful adjustment.

This is then followed by an analysis that details the nature and evolution of the passenger vehicle sector in Australia and the UK, focussing on South Australia and the West Midlands. The case study of the Australian passenger vehicle sector demonstrates, with the prospect of the demise of ICE vehicle production system in Australia, that attempts made to transition to an electric vehicle production system, to safeguard both the industry and jobs, failed. The transition was not secured, nor a 'just transition'. The case study of the West Midlands automotive industry cluster explores the scope for a transition to an electric vehicle production system to ensure that a transition and a just transition is secured. It outlines the state of the industry and then the challenges to the industry of a transition to an electric vehicle production system. It highlights that the development of an EV supply chain system is imperative and that a skills training system is needed to support it, in order to sustain employment, given that jobs will be lost in the ICE production system, and in order to ensure workers have the skills to work in firms in the electric vehicle production system. It draws on primary and secondary data findings and analysis, from interviews with stakeholders and a survey of workers in the UK automotive sector. The final sections consider the implications for policy and best practice in ensuring not only a successful but also a just transition.

2. Framing the issue: understanding a 'Just Transition'

In this chapter, we outline a conceptual approach that is explicitly subnational, looking to build upon both prior experiences of industrial transition and current work in the area, before turning to the empirical material on the West Midlands and South Australia; areas which have experienced multiple major automotive plant closures and hence faced significant challenges in terms of labour market adjustment. In both places a range of interventions have sought to alleviate the negative personal, social, economic and community repercussions of closures. These responses, which have been framed by the notion of a Just Transition (Newell and Mulvaney, 2013), have included strategies for transitioning the workforce for new employment, strategies to rebuild local economies and generate new employment opportunities, interventions to maintain social cohesion, and initiatives that commemorate the contribution of earlier forms of industrialisation. In the material that follows, we critically explore these issues.

2.1 Transition and labour market precariousness

The concept of a 'just transition' emerged in the academic literature around 2005 with the publication of work such as that of Geels (2005) and Geels and Schott (2007), which explicitly framed it in terms of "socio-technical transitions", whereby this was defined as:

"*deep structural changes in systems, such as energy, that involve long-term and complex reconfigurations of landscapes with technology, policy, infrastructure, scientific knowledge, and social and cultural practices towards sustainable ends*" (Newell and Mulvaney, 2013, p.2).

Central to such transitions of course, is that they should be effected in an equitable manner amongst the stakeholder communities affected by change – raising issues of distribution and justice, in both their environmental ("climate justice") and social aspects (Snell, 2018). As such, trade unions and their confederations have been key proponents of the need to ameliorate the adverse impacts of a shift to a zero/low carbon future on their constituents (going right back to the 1980s with the US trade union movement in their efforts to promote the plight of workers displaced by the enacting of clean air and water laws which led to closures of polluting plants (Newell and Mulvaney, 2013). However, it is essentially government that is seen as the key agency to effect change, and moreover that governments of a "free market" persuasion are incapable or unwilling to deliver the "just" outcomes necessary, be it those epitomised in a "Green New Deal" or some other extant variant of "Green Keynesianism" (Snell, 2018, p.553). This in turn raises wider issues around vested interests, the political complexion of governments and their willingness to effect change (ibid.) – a theme we return to below.

A discussion of a just transition, of course, entails understanding the factors that enable successful labour market adjustment, into "decent" forms of work – i.e., those that pay a living ("decent") wage, reduce the gender pay gap and provide employment and skills opportunity to all, particularly "*those who need them most, including people who have been out of work for a number of years, those who lack higher level skills and people living in deprived areas*" (Bird and Lawton, 2009, p.24). This last point, of course, introduces a distinct *spatial* element to the analysis of decent work (central to our own analysis), a point we return to in subsequent sections. Such forms of work are epitomised in the International Labour Organization's (ILO) Decent Work Agenda for a Just Transition (ILO, 2015), which seeks to embed the "four pillars" of the Decent Work Agenda – *"social dialogue, social* *protection, rights at work and employment*" into a wider transition programme of inclusive, sustainable development (economic, social and environmental).[3]

As such, pivotal to this inclusive transitioning agenda is a policy environment that enables *labour security*, in all its aspects (Standing, 1997; De Ruyter and Burgess, 2003), and thereby alleviating the increased labour market *precariousness* that a non-just transition would entail (Sehgal, 2020). Amidst a context of requiring *progressive, redistributive* action by government and trade unions (our emphasis) to promote wider workforce well-being and security, Standing's (1997) framework, detailing seven aspects of labour security[4] (reproduced in Table 1 below), was developed to illustrate his concern in comparing the shift from the post-Second World War (WW2) Keynesian welfare state consensus of promoting full employment to the current era of what he termed 'market regulation' and flexibility (ibid. 11).

Table 1: Dimensions of labour security

Dimension	*Explanation*
Labour market	Adequate employment opportunity – state support of full employment
Employment	Protection against arbitrary dismissal; regulations governing hiring and firing
Job	Designated occupation or career; barriers to skill dilution; craft demarcation
Work	Protection against accident and illness at work; limits on working time and unsociable hours
Skill reproduction	Access to skills; skill retention and upgrading; apprenticeships, on the job training
Income	Minimum wages; wage indexation; progressive taxation; comprehensive social security
Representation	Protection of collective voice; independent trade unions; rights to collectivise, strike etc.

Source: Standing (1986, p.114, 1997, pp. 8-9).

For Standing, labour security during the 25 years or so after the Second World War was the outcome of an enforced recognition (brought about by the sobering experiences of the Great Depression and the consequent challenges of Fascism and Communism to western liberal democracies) to rebalance the capital–labour relationship to promote a more equitable society. As such, in return for interventionist policies to narrow economic and social inequalities, the "managerial right to manage was left broadly intact and private ownership of capital was largely preserved" (1997, p.9).

Conversely, labour flexibility was the antithesis of labour security and hence increased labour market flexibility post-1970s across mature industrial economies was synonymous with increasing labour market precariousness (Standing, 2011; 2014). This period was characterised by structural shifts from manufacturing to services, increased female participation in the workforce, elimination of

[3] The ILO Labour Standards and resolutions that could be relevant to a Just Transition programme (ibid. 18) come under the aegis of: *Conventions on fundamental principles and rights at work* (including Freedom of Association and Right to Organise, and Equal Remuneration); *Governance conventions* (including Labour Inspection), and; *Other technical conventions* (including Paid Educational Leave and Social Security Minimum Standards).

[4] A criticism of Standing's framework is its complexity. There are also issues of cumulative causation, for example, whereby rising labour market insecurity could lead to rising income insecurity through the dampening effect that a rise in unemployment could have on wage bargaining (see Bailey and De Ruyter, 2015, for a discussion). However, Standing's typology provides a comprehensive framework to analyse changes in the objective conditions of employment, which is important in assessing labour market transition (ibid.).

trade barriers, liberalisation of financial, labour and product markets and the erosion of trade union densities. As such, there has been a shift in government focus from the promotion of ‘full employment’ to one of minimising state involvement in managing the economy and shifting the burden of taxation away from wealth towards income and consumption – particularly since the global financial crisis of 2008 (typified in the UK by the policies of the Conservative Party led governments since 2010). It is only the current Covid-19 pandemic that has forced the state in many countries to take a more pro-active fiscal stance in preserving lives and livelihoods (and these programs are now being scaled back).

Hence, in this context, labour market precariousness entails the increased prospect that workers displaced from traditional (manufacturing) sector jobs could find themselves ending up in “forms of work involving limited social benefits or statutory entitlements, job insecurity, low wages and high risks of ill health” (Vosko, 2006, p.3); that is, labour market precariousness is characterised by patterns of work that are otherwise typified by “uncertainty, instability, and insecurity” (Kalleberg and Hewison, 2013: 273). Hence, avoiding the labour market precariousness that often accompanies job losses arising from plant closure (Bailey and De Ruyter, 2015) is an important part of the ‘decent work’ agenda encapsulated by the International Labour Organization (ILO, 2015) that is core to the framework of a just transition.

However, much of the growth in employment over the past 40 years has been in jobs that are relatively low-paid and low-skilled (Arnold and Bongiovi, 2013), which in turn has contributed to rising earnings inequalities (Atkinson, 2007). The last decade in particular has been notable for seeing the most stagnant period in wages growth in the UK since the Napoleonic wars (REF) and the growth of highly precarious forms of work such as zero-hours contracts, which are associated with the ‘gig economy’ (De Ruyter and Brown, 2019). Such is the prevalence of precarious work in the UK that contemporary estimates now put the incidence of such forms of work as comprising about one quarter of the labour force. Analysis by John Philpott for the Resolution Foundation (as reported in the Guardian) suggested that over 7 million workers, or some 22.2% of the workforce in 2016 (up from 18.1% in 2006) were in precarious forms of employment (Booth, 2016), a situation that has scarcely changed since.[5]

As such, the overriding labour market policy emphasis in the UK has been a raw focus on transition into ‘any job’, with ‘quantity over quality’ (Berry, 2014). However, we would argue that a ‘just’ labour market transition requires that the issue of labour security should be addressed. As the acute pressure of Covid-19 begins to abate on the workforce, the longer-term challenges posed by climate change and automation will leave many workers in sectors such as automotive brutally exposed if they are simply allowed to be left to ‘market forces’.

These issues are particularly pressing for displaced workers who might be able only to obtain forms of work which are insecure, or precarious, in nature. Previous research on plant closure in the automotive sector has suggested that lower age, higher skill, and a willingness to travel further afield to find work are all factors that increase one’s ability to secure a successful labour market transition (Armstrong et al., 2008; Bailey et al., 2012). In contrast, there is evidence to suggest that individuals who subsequently obtain precarious forms of work risk becoming ‘trapped’ in precarious cycles of intermittent work and unemployment (Westin, 1990), even more so during periods of economic

[5] Of the 22.2% of the workforce defined as being in precarious work in 2016, 15.1% were “self-employed”, 4.3% on a temporary contract, and 2.9% on “zero hours” contracts (which only comprised 0.5% of the workforce in 2006). Of the self-employed category, Philpott’s analysis suggested that half were low paid and took home less than two-thirds of median earnings and that 2 million self-employed workers were earning less than £8 per hour (ibid.).

downturn – further adding to their sense of exclusion and deprivation (Yates and Leach, 2006). These dilemmas serve only to reiterate the importance of an analysis of transition that extends beyond an overtly simplistic view of 'success' being measured by entry into a job of any sort. As Bailey and De Ruyter (2015, p.364) note, "the consequences of closure for job quality and security of employment are considerable".

However, whilst much of the discourse on labour market precariousness has stemmed from the labour law literature that assesses precariousness in terms of exclusion from protective regulation and social benefits at a national level, it is also important to recognise the geography of precariousness. As Vosko (2006, p.3) pointedly reminds us, labour market precariousness is "shaped by […] geography". As such, it is important that any analysis of precariousness and transition must be able to "connect with the emergent local spaces of the contemporary service economy" (Cumbers et al., 2010, p.129). The traditional focus of industrial relations and labour law researchers on the implementation of national policies and agendas (ibid.) has been poorly placed to deal with these developments. In this sense, a substantive criticism of Standing's (1997) framework is that it lacks an explicit spatial or multi-level governance dimension (Bailey and De Ruyter, 2015). This is important, as developments in insecurity at the national level can compromise the effectiveness of policy measures tailored at the local and regional level - e.g., the 'Task Force' approach used to ameliorate the adverse impacts of the closure of MG Rover in Birmingham in 2005 on workers and the supply chain (ibid.), was limited as to what it could propose as it had to apply nationally derived policies, a point which we return to when framing recommendations for policy.

However, this is not to understate the impact of national factors on regional and local developments. The key point to consider is that the various factors shaping the degree of precariousness faced by workers in a particular locality (and thereby the ability to entail a just transition) will necessarily involve interaction between local, regional and national (and indeed international) influences, which in turn reiterates the need for a subnational focus on policies more suited to the subnational scale, that we adopt in this study.

2.2 Just transition as engagement with stakeholders – adding a regional dimension

Evident from the discussion above is that any just transition will require a multi-scalar approach to policy-making, in which the interaction between national and regional policies are key. However, regional policy in the UK has been subject to considerable variation over the past 30 years, with varying degrees of place-based focus and much institutional 'chopping and changing'. The formation of a Conservative-Liberal Democrat coalition government in 2010 marked an abrupt change in English regional development policy, with the abolition of English Regional Development Agencies (with the exception of London). As a substitution for these, 'Local Enterprise Partnerships' (LEPs) emerged, which operate at the sub-regional scale (Bentley et al., 2010b) These were later augmented with the creation of Mayoral metropolitan authorities in key cities. However, this more recent institutional set up seems less well positioned in terms of availability of resources and in terms of being able to make judgements about how best to offer support and to which sectors and ecosystems. Reflecting on such experience, Bailey and Berkeley (2014) argued that there remains a key role for regional-level coordination and policy and thereby bring stakeholders together.

Hence, regional institutions can have a key role in fostering a just transition by supporting the adaptation of regional industries to continuous changing environments (Martin, 2011). Indeed, the current period of discontent that manifests unevenly across regions (De Ruyter et al., 2021b), necessitates that those regions that feel far removed from the socio-spatial concentrations of power are offered some meaningful devolution in terms of power and control over resources (De Ruyter et al., 2021a; Martin et al., 2021).

2.3 Just transition in automotive: considering the supply chain

In addition, in considering a just transition for the automotive sector, we need to give explicit consideration to the supply chain. The UK automotive supply chain for the production of ICE vehicles comprises a broad range of companies, ranging from small specialist firms to large multinationals. The supply chain for the as yet to be developed for the production of electric vehicles will be substantially different in so far that electric vehicle production will involve working with electrical components and not mechanical/metal-based components. Statistics from the Interdepartmental Business Register (ONS, 2020) reveal that in 2020 a total of 3480 businesses were directly involved in the production of vehicles or vehicle parts. Similarly, the SMMT notes that there are over 30 manufacturers of vehicles based in the UK, although many of these are smaller specialist manufacturers, including of commercial vehicles (SMMT, 2020). However, this is only part of the picture; many companies who provide inputs for the automotive industry categorise their business in terms of the materials they work with, and many of these suppliers will be further upstream, primarily selling to tier-one suppliers rather than vehicle producers themselves. UK tier-one companies import a large proportion of their inputs, including metals, plastics, glass and other products that are categorised elsewhere in trade statistics. Some 80% of imported parts and components are from the EU (ibid.) with much of the remainder coming from Japan, China and other Asian markets.

In this context, the conventional approach to supporting the supply chain to adapt to economic shocks has been that of emphasising increased supply-chain resilience, the literature of which has proliferated over the past decade (Pournader et al., 2020). This was evident in the policy response to the MG Rover closure, for example, by which considerable funding was used to facilitate supplier diversification as a means to enhance resilience. However, such responses by government tend to be ad-hoc and reactive. In this context, the conspicuous absence of any active industrial policy, which is a hallmark of 'neo-liberal' market capitalism in the UK and Australia, renders their suppliers considerably more vulnerable than many of their European counterparts to the negative fallout arising from a shift to zero-carbon technologies. More coordinated market economies – however unsatisfactory such a broad label may be (Dicken, 2015, p.181) – in which representatives of employees and (often subnational) government play a more active role in the industry typically exhibit greater willingness and ability to intervene in order to protect their supply chains.

More generally, in contrast to larger firms which enjoy greater 'resource slack', the smaller firms that typically characterise the supply chain have fewer intangible resources such as the knowledge generated by dedicated corporate units operating in business intelligence, HR or R&D (Surroca et al., 2010) which can be used to anticipate and avoid disruption (Braunscheidel and Suresh, 2009), which is certainly inherent in a shift to zero-carbon technologies. They are therefore are at greater need of policy assistance in ensuring a successful transition.

2.4 Just transition in automotive: considering job loss and the skills challenge

The transition to an electric vehicle production system from an ICE production system will result in firms in the ICE supply chain gradually losing business and potentially closing down with attendant job losses unless they can secure alternative sources of revenue in or outside the automotive sector. Support systems need to be developed which assist redundant workers adjust to job loss so that they are not faced with entering into precarious employment. This must include the scope for re-training for workers to work in the firms in the EV production system. However, it is clear that many components in electric vehicles are different to those used in ICE vehicles. The nature of EV-specific components means that the production processes for EV components require different skills-sets. The development of an EV supply chain system requires that a skills training system be developed to ensure workers have the skills to work in firms in the electric vehicle production system. We explore this issue in more detail below in Section 7.2.

2.5 Summary

The discussion above emphasises that by a just transition is meant that transitioning the workforce and supply chain firms in the automotive industry, as the result of deep structural change from the production of ICE powered vehicles to the production of low-carbon and electric vehicle production, so that it does not result in the needless loss of firms in the industry and in the creation of precarious employment. It highlights that effective subnational industrial policy and subnational governance structures is imperative to support effective transition in regions where a few embedded industries comprise a disproportionate share of employment and value-added (Kitsos et al., 2019). In the chapters that follow, we draw on evidence from the South Australian and West Midlands experience to further articulate a policy agenda to enable a just transition.

3. Methodology

In this chapter we outline the research methodology underpinning this study. The research adopted a mixed-methods approach, operating within the broad ASID (agency, structure, institutions, discourse) heuristic of Moulaert et al. (2016) in undertaking two (comparative) case studies of the West Midlands region and the North Adelaide area of South Australia. Given its explicit focus on spatio-temporal constraints and opportunities, the Moulert et al. framework has proven useful in the field of economic geography (Beer et al., 2021). The methodology was posited in a context where flows of best practice knowledge within firms, labour organisations and regional policy communities meant that the three groups are in a dynamic conversation with one another around transitioning issues. Hence, in so doing, we sought to answer the following research questions:

1. What lessons – positive and negative – can be learnt from recent experiences of automotive plant closures?

2. What are the optimal policy settings to manage plant closures, preserve skilled employment, and promote retraining and reskilling into emerging industries?

3. What are the potentials of smaller supplier firms to diversify to viable new specialisations, especially those created by the greening of the automotive sector globally?

4. How best can the industrial transition to new forms of transport be coordinated with the labour market transition of automotive workforces?

The analysis presented in this report thus drew upon four complementary sets of data collection and analysis.

First, an overview of the automotive sector in the West Midlands (with comparisons to other NUTS1 regions of the UK) and the Australian situation, using a variety of secondary data sources. In so doing, the analysis demonstrated both that the West Midlands as a key automotive region is closely connected with international supply chains (particularly in Europe) and that there are real gaps in our knowledge based on aggregate data. The Australian situation demonstrates that an indigenous automotive industry was always reliant on a modicum of government support and subsidy (historically provided by a protective tariff regime). With the advent of more neoliberal policy regimes from 1983 onwards the industry was progressively exposed to more international competition, which gradually undermined it in the absence of any proactive government support in both the UK and Australia, for transitioning.

Second, a review of the academic literature pertaining to a just transition (Weller, 2018), the green restructuring of the automotive sector (Goods, 2014), and on the potentials for industrial diversification in the 'related variety' mode (Frenken et al., 2007). Accompanying this was a review of policy documents and policy settings, the 'grey' literature on the industries in each place, and reports on transition activities already undertaken.

Third, a series of semi-structured interviews with key regional stakeholders in the West Midlands and South Australia between late November 2021 and February 2022. For each area, 15/16 interviews, of approximately 30-60 minutes duration were undertaken. These individuals consisted of a mix of: business owners/senior managers; union representatives; local and regional policymakers (including MPs), universities and; representatives of wider industry bodies. However, the key criterion for interview selection was that these people in some sense "owned" the issues around transitioning to zero-carbon technologies in their organisational unit. In conducting the interviews with businesses, we specifically sought a mix of respondents across different tiers of the supply chain, ranging from Tier 1 to lower tiers. In so doing, the research explicitly sought to situate upstream suppliers within a wider value chain (De Marchi et al., 2017). Key summary statistics pertaining to the respondents in Australia and the UK are detailed in Tables 2 and 3 respectively.

Table 2: Australian interview participants

Pseudonym	Sector	Location	Role
Interview 8	Federal	Adelaide	National Energy Research Agency (ex-GMH)
Interview 10	Private	Melbourne	Former Supplier Firm Manager
Interview 11	Private	Geelong	Automotive Supplier with EV links
Interview 1	University	Melbourne	Research on post-automotive diversification
Interview 5	University	Perth	Green economy/EV Research
Interview 2	Private	Adelaide	Former Manager, Automotive Supplier
Interview 12	Private	Adelaide	Former Manager, Automotive Supplier
Interview 16	University	Adelaide	UNISA Auto Follow-up Project Manager
Interview 15	Private	Adelaide	Former General Motors HR manager
Interview 14	Lobby	Adelaide	Electric Vehicle Association of South Australia
Interview 3	Federal	Canberra	Member of Federal Parliament
Interview 6	State	Geelong	Industry Diversification Program delivery
Interview 7	Federal/State	Adelaide	Industry Diversification Program delivery (ex-GMH)
Interview 9	University	Adelaide	Energy Transition Research
Interview 4	Private	Adelaide	EV Entrepreneur (ACE)
Interview 13	Union	Adelaide	Automotive Sector Union Official

The interviews were conducted in a semi-structured format and questions focussed on understanding the extent of supply chain exposure to vehicle manufacturers, what sectors they operated within, their understanding of the EV industry and potential to operate within it, skills gaps and requirements, the nature of the EV charging network and other infrastructure issues. Additionally, more general questions were asked to explore the utility of a number of potential government interventions such as physical and digital infrastructure expenditure, tackling skills gaps, grants for R&D or changes in the tax system, and the efficacy (or otherwise) of other policy interventions at various levels of government (national/federal; state/regional) in order to establish what the "optimal policy mix" should be.

Table 3: UK interview participants

Pseudonym	Sector	Location	Role
Interview 1 (RC)	Private	Birmingham	CEO, Metal Fabricator
Interview 2	Private	Sandwell	CEO, Metal Fabricator
Interview 3	Private	Herefordshire	CEO, Engineering Services (Design)
Interview 4 (LB)	Public	Birmingham	Local Authority Economic Development Unit
Interview 5	Private	Sandwell	CEO, Metal Fabricator
Interview 6	Private	Birmingham	CEO, Green Economy firm
Interview 7	Private	Birmingham	CFO, Green Economy firm
Interview 8	Public	Birmingham	Member of Parliament
Interview 9	Private	Birmingham	Automotive industry consultant
Interview 10	Private	Worcestershire	CEO, Green Economy firm
Interview 11	Public	Coventry	Local Authority Economic Development Unit
Interview 12	Private		Consultant, Green Economy
Interview 13	Union	London	Sector union official
Interview 14	Private	Loughborough	Consultant, Green Economy
Interview 15	Private	Coventry	Chamber of Commerce

Finally, an online survey of workers (members of Unite, the key sector trade union) in automotive and related industries in the West Midlands was conducted in January - February 2022, in order to ascertain workers' preferences and intentions towards transitioning as the automotive sector shifts towards zero-carbon emissions and the cessation of ICE vehicle production in the UK after 2030. The questions here sought to explore: worker perceptions on whether their employer would survive or manage the transition to low emissions vehicles; whether their skill-set was transferable to the production of zero-carbon vehicles and whether they expected to stay in the sector; what types of support they needed to cope with the shift to EV; issues around retraining (if they felt it was needed); and what 'fair' government policies to facilitate a just transition would consist of.

Research participants were provided with prior information about the purpose of the research, so as to ensure that they had given fully-informed consent, and the survey questionnaire and interviews were conducted in accordance with the strict ethical tenets of voluntary participation, anonymity, confidentiality, the right to withdraw from the research at any stage, and non-disclosure where requested. The interviews were recorded online via a secure digital recording platform (MS Teams) and transcribed in an anonymised manner. The UK survey questionnaire was disseminated on our behalf by the Unite trade union to their members and participants completed the questionnaire anonymously, online on Unite's own secure survey platform. All data was kept on secure servers and all personal identifiers were destroyed upon the conclusion of the research.

As such, the analysis sought to undertake systematic comparisons across sites, in order to discern how similar policy initiatives played out differently in each location, and how similar policy ambitions could be interpreted differently, depending on a particular context (Weller, 2018). In the material that follows, we detail the findings of the analysis and consequent policy recommendations.

4. The (Former) Australian Passenger Motor Vehicle Production Sector

In this section we examine the trajectory (and ultimate demise) of the passenger motor vehicle production sector in Australia, with a view to informing the policy debate on just transition in the UK automotive sector later in this report.

4.1 The Fordist Phase

The Australian Passenger Motor Vehicle production industry was established after World War 1 at the instigation of a nation-building government committed to developing a local industrial base. Australia's then Keynesian accumulation strategy was supported by the three pillars of trade protection, regulated wages and high migration intakes. In this classically 'Fordist'[6] regime, the relatively high wages earned by ordinary workers ensured their ability to purchase consumer goods. Australia's dispersed settlement made a motor vehicle an essential household purchase. The assemblers established in Adelaide, South Australia, and Geelong and Broadmeadows in Victoria, locations where State governments provided supportive infrastructure.

Initially two international car makers – US firms Ford and General Motors – set up operations in Australia. The Ford Motor Company of Australia was formed in 1925 and production commenced in Geelong in that year (with other sites following in Adelaide, Sydney, Brisbane and Fremantle), originally producing the famous Model T.[7] Domestic production was a necessity to supply the Australian market, as the Australian Government had banned the import of luxury goods (including car bodies) in 1917 during the First World war in order to promote domestic industries – and provide new employment for its (horse-drawn) carriage-makers. Following the Second World War, expansion of the domestic industry in 1948 saw the emergence of the rival iconic Holden brand (an Australian subsidiary of General Motors, also known as GMH), which soon dominated the domestic market.

These firms were joined later by Japanese firms – Toyota, Nissan and Mitsubishi (who took over Chrysler's operations in Australia). The regulatory system protected the local assemblers from overseas competition behind a tariff wall and required that, wherever possible, vehicle components would be sourced locally. In the years to 1972 the local industry grew with the population, and by the early 1970s cars were designed locally for local conditions and marketed as 'Australian' products. The supplier industry comprised locally owned firms that were small in global terms and that produced only for the local market. Thus, car production in Australia peaked in the 1970s (475,000 in 1970, which ranked Australia tenth in the world at the time) and declined more or less from there on[8]. The industry was supported by government policy settings, but these were isolated and lacked economies of scale.

Fortunes began to change with the global fiscal crisis that led to the United States abandoning the Bretton Woods international currency stabilisation in 1972. The Vietnam War was reshaping politics, culminating in the election of the radical Whitlam Labor[9] government in late 1972. Whitlam

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[6] A production regime typified by the mass assembly line, standardised job tasks with a high division and specialisation of labour, accompanied by a social relations system of unionised labour, collective bargaining and a protective state macro-economic regime (REF).

[7] https://www.abc.net.au/news/2016-10-07/timeline-ford-australia-ceases-production/7911742

[8] https://en.wikipedia.org/wiki/Automotive_industry_in_Australia

[9] Labor, formally known as *the Australian Labor Party*, or ALP (American spelling convention used). The conservative parties in Australia have had various manifestations over the years, namely; *Free Trade Party*, *Nationalist Party*, *United Australia Party* and *Liberal Party*, generally as a coalition with the *Country Party* (now *National Party*).

responded to the global crisis by devaluing the Australian currency and reducing tariff protection by 25% across-the-board. This was the first time the government had acted contrary to the interests of the automotive sector, and there were strong protests including, for the overseas-owned carmakers, threats to withdraw from Australia. As such, fierce opposition from domestic producers (notably GMH, which stood down 5,000 workers in response) saw this cut reduced to 15 per cent, but it was notable at the time that the industry, which at its peak employed 100,000 people, was seen as being characterised by:

"*Too many producers with extensive operations in multiple states, resulting in product proliferation, scale inefficiencies, and components industries that were forced into exceptionally short production runs, together with excessive and costly parts inventories.*"[10]

The immediate effect of the change in protection policy was a flood of small and inexpensive Japanese-made imports compromising the budget end of the local market. The crisis produced the first round of automotive job losses and impelled the local industry towards specialising in larger, more powerful vehicles. During the 1970s, despite the fact that federal policy encouraged the carmakers to develop a presence in export markets, the local industry did not integrate itself into then-emerging global automotive production networks. This outcome reflected factor-cost disadvantages (wages), distance disadvantages (from northern hemisphere transnational trade corridors), and inwardly focused policy settings that discouraged transnational intra-industry trade. The Federal Government was forced repeatedly to increase tariff and other border protection measures merely to maintain local production. Policy critics insisted that these arrangements were unsustainable.

4.2 Restructuring for International Competitiveness

The Hawke Labor government was elected in March 1983 with a mandate to internationalise the economy. With an economic agenda negotiated with industry and union interests over the preceding years, it was in a position to implement a radical program of internationalisation and marketisation (see Bell, 1993). At the time the architects of change sought to replicate the Scandinavian social democracy model, but in retrospect the Hawke reforms have been depicted as shift to 'neoliberalism' (Humphrys and Cahill, 2017). The Hawke reforms began with floating the Australian currency and deregulating the banking sector. A social pact – the 'Wages and Incomes Accord' – maintained industrial cooperation as a series of 'flexibilising' and productivity enhancing workplace reforms rolled out. Then border protections began to be dismantled progressively.

In the automotive sector, and industry policy strategy known as the Button Plan (after the Industry Minister John Button) established at the microscale the combinations of technical and workplace change required to lift productivity and competitiveness. This had multiple components including technological upgrading of plant and equipment, government-funded introduction of EDI (electronic data interchange) technologies, to facilitate the introduction of just-in-time production (this also necessitated the computerisation of supplier offices), a reduction of the number of vehicle models produced locally, the introduction of cooperative arrangements between firms to maximise the scale of component production, and an 'award restructuring' process that saw union amalgamations, the elimination of work demarcations, and the introduction of productivity-based wage negotiations. The aim was to make Australian automotive production 'internationally competitive' enough to survive in a low tariff environment. These changes led to large numbers of job losses, both directly through assembler reorganisation and indirectly through the rationalisation of suppliers. Just-in-time

[10] http://theconversation.com/whitlam-made-the-case-for-reform-an-enduring-economic-legacy-33226

further encouraged the industry to concentrate in particular locations, such as the northern suburbs of Adelaide.

Industry policy settings were adjusted after the 1991-92 recession to promote exporting, but policy concentrated on the export of entire locally made vehicles rather than the integration of the local industry into global production networks. In the early 2000s, before the global financial crisis and with the Australian currency trading at a low (export-promoting) value, this strategy was relatively successful. The local industry had found a niche, specialising in 'muscle cars' designed for long-range driving, most notably that of the Holden 'Commodore' and the Ford 'Falcon' (De Ruyter, 2020). However, the vulnerability was that these tended to be high emissions vehicles. The local industry had improved productivity and quality, but still lacked economies of scale and remained isolated from the automotive sector's global production networks. Imported vehicles were whittling away the local share of sales.

4.3 Labor's New Car Plan 2009-2012

The return of a Federal Labor Government in 2007 after 11 years of conservative rule saw the imposition of the 'New Car Plan' in 2009. The Plan focused on reorienting the existing production system, especially the three remaining lead firms, rather than introducing new enterprises into the system. Kevin Rudd's Labor Government had gone into the 2007 election promising to revitalise manufacturing and to revitalise the automotive sector. Its 'A New Car Plan for a Greener Future', announced soon after, rekindled the restructuring ambitions of the Button era. The incoming Prime Minister pledged that "we do not just want a green car; we want a green car industry", and to achieve that the industry would have to "reinvent itself once more" (Rudd 2008, pp.4695-6). It comprised three subprograms:

- An *Automotive Transformation Scheme* (ATS) to stimulate local innovation, research and development. It was allocated $3.4 billion over the years 2011 to 2020. The scheme was basically a continuation of an arrangement established by the previous government allowing firms claim import duty credits on local research and development and production investments. In its revised form the program would provide the assistance as grants rather than duty credits and required the development of skills and capabilities that would lead to better environment outcomes (DIIS, 2008; Goods, 2012, p.184). This scheme was the central mechanism through which the government sought to encourage local firms integrate into global production networks. Gruen (2016) suggests its design lacked mechanisms to encourage intra-industry trade.
- A *Green Car Innovation Fund* (GCIF) to support a more environmentally sustainable industry.
- An *Automotive Industry Structural Adjustment Program* (AISAP) to facilitate the restructuring of the automotive labour force. It was allocated a $116.3 million to assist workers displaced in the anticipated the consolidation of the industry after tariff reductions (DIISR, 2008).

This report is concerned mainly with the GCIF and AISAP, as discussed in detail below. Three months later, Mitsubishi announced its withdrawal from Australian production. In 2008, Ford Motor Company also announced the intention to withdraw from Australian production, but additional funding from the Victorian and Federal governments convinced it to remain. The government responded by commissioning an independent review of the Automotive Sector led by former Labor Premier of the state of Victoria, Steve Bracks (Bracks, 2008). The report provided a positive assessment of the industry's potentials, in contrast to the negative assessments from Australia's principal industry advisory body, the Productivity Commission. The review led to the government resolving to reduce automotive tariffs from 10% to 5%, but to offset the effects with a revised package of industry policy interventions costed at $6.2 billion over a 13- year horizon (Rudd and Carr, 2008). As it happened, the programs outlived both the Rudd government and the automotive industry. Further detail on the Green Car Innovation Fund is provided below.

4.3.1 The Green Car Innovation Fund

The Green Car Innovation Fund was essentially an innovation fund and the central mechanism for encouraging the restructuring of the existing automotive industry. Innovation funds are not considered industry subsidies under WTO rules, so they constitute one of the few industry policy levers still available to the Australian government. The scheme was important at the time. Goods (2012) reports Minister Carr asserting in 2012 that “without the GCIF, the (automotive) industry would not be here today”.

The outline of the initial $500 million Green Car Innovation Fund (GCIF) was announced in March 2007 (Peatling, 2007) but revamped after the Bracks Review. Commencing in 2011, it provided grants for projects would lead to the local manufacture of world-leading low-emission vehicles and/or technologies. It adopted a co-investment funding model that required industry to commit $3 for every $1 provided by the government and that. The program accepted proposals to reduce the emissions of ICE vehicles and proposals for more radical innovations. The Federal Government – keen to avoid the accusation that it was ‘picking winners’, welcomed competition among technologies:

“*We are agnostic about the technology – hybrid, hydrogen combustion, hydrogen fuel cell, flexible fuel (petrol-ethanol), clean diesel, LPG – they are all on the table. So are technologies to make vehicles lighter and more aerodynamic. Technologies to make vehicles operate more efficiently – such as cylinder deactivation, dual-clutch transmissions, common axles and drive-chain improvements. Even technologies to help vehicles get through traffic more smoothly, such as intelligent transport systems and telematics.*

Any idea with a serious chance of reducing the carbon and other environmental impacts of Australia’s vehicle fleet will get a hearing. I’ve already made it clear that we will not be putting the entire fund into one vehicle, company or technology. We welcome the contest of ideas and we are ready to support a variety of solutions. We are especially keen to develop solutions that will find markets overseas. This is an international industry and Australia needs to become an integral link in the global supply chain”. (Carr, 2008, cited in Priestley, 2010).

After the Bracks review, the GCIF was expanded into a $1.3 billion program spanning ten years 2009-19. Its funding criteria were also relaxed to allow a wider range of applicants (Taylor and Uren, 2010, p.118). The GCIF comprised a ‘Stream A’ funds for the lead automotive firms and ‘Stream B’ funds for other firms. In the first tranche, more than 80% of the GCIF funding was allocated to the lead firms, with much of the funding concerned with reducing emissions from ICE vehicles. The largest allocations were to Toyota (to develop a Hybrid version of the Camry,) to Ford (for the efficient ECO-boost engine), and to Holden (to establish local production of the Cruze model). The Cruze used the same (Delta) platform as the all-electric Volt, made in the USA until 2019, and so stimulated hope that EVs could be manufactured in South Australia. This did not eventuate.

Table 4 shows the allocations under the program to 2011. It shows that there was some significant support in Stream 2 for EV-related technologies, in particular the grant of more than $3.5 million to EV Engineering for electric vehicle proof of concept, $3.3 million to Nissan Casting Australia to produce EV components, and $2.0 million to the Very Small Particle Company develop Lithium-ion batteries. Priestley (2010) reports that a proposal to develop an Australian-made Bolwell Nagari electric sports car was rejected (see also Motor Report, 2010). Other unsuccessful applications include Mitsubishi seeking support for amendments to enable importing its electric i-MiEV, which did not comply with Australian Design Rules, and a consortium led by Macquarie Bank seeking funding to build an Electric Vehicle Network (Priestley, 2010). There had been calls for a third stream of funding – to support early-stage-innovation, start-ups and the local-retrofit industry, but these too were rejected (Simpson, 2009). Smaller firms were eligible to apply for mainstream innovation grants. For example, a less onerous grant scheme, COMET, provided a $64,000 grant for local company Blade Electric Technology (BET) to commercialise its battery management system which allows smaller cars to be converted to electric power (Priestley, 2010).

Table 4: GCIF Funding Agreements

Company	**Grant**	**Technology**
Ford Australia	$42,000,000	Fuel efficient ECO---boost engine
Toyota Australia	$35,000,000	Hybrid Camry
Toyota Australia	$63,000,000	New engine line for next gen efficient engines
GM Holden	$149,000,000	Build a fuel---efficient, low---emission small car (Cruze)
GM Holden	$39,800,000	Lightweight Commodore body panels
Century Yuasa Batteries	$966,327	Efficient vehicle battery
Orbital Australia	$440,413	Direct injection engine technology
Very Small Particle Company	$2,090,000	Lithium---ion phosphate for batteries in electric vehicles
SMR Automotive Australia	$2,422,190	Development of lightweight automotive mirror
Toyoda Gosei Australia	$2,367,616	Component weight loss program
Alternative Fuel Innovations	$3,540,477	Develop LPG liquid injection system
EV Engineering	$3,550,202	Large electric vehicle proof of concept and capability
Nissan Casting Australia	$3,348,250	Re-tooling to produce electric vehicle components
CFusion	$1,393,130	Commercialisation of one-piece carbon fibre wheel
Composite Materials Engineering	$797,399	Development of light weight load floors
Hirotec Australia	$1,666,559	Production of technology for aluminium alloy
Nexteer Automotive	$63,000,000	Production of lightweight technologies

Source: (Goods 2012, p.187 from AusIndustry 2011; Carr 2011a)

Goods (2012) criticised the expenditures on the grounds that most of money was spent on improving the efficiency of ICE engines and because the developments funded in the lead firms were at odds with the firms' global strategies.

The GCIF provided funds to firms with already well-developed ('shovel-ready') investment plans and funding sources. As the global financial crisis unfolded, the US parent companies of two of Australia's three remaining assemblers – Ford and General Motors – were thrown into severe financial difficulty. The 'bailout' of the parent companies by the United States' government – in policies known as 'reshoring' – was conditional on their concentrating company resources to support local (USA) jobs. As the financial crisis deepened, Australian vehicle sales fell by 20 per cent and the local lead firms began reducing shifts and downsizing their workforces (Lansbury and Dommerson, 2010, p.92). The contraction meant that 9000 jobs in the automotive industry were lost in the four years of the 2008-2012. In the depressed local market the local assembler firms were not generating surplus for reinvestment, while reshoring meant the lead firm head offices were not able to provide their Australian branches with funds for research and development activities in Australia. As a result, GCIF applications dried up.

In the 2010 budget, the Rudd Government reduced the funding for GCIF – a cut of $200 million over 4 years (DIISR, 2010). Goods (2012) attributes the cut to weak industry interest. Then, in 2011, the new Labor Prime Minister Gillard reallocated the remaining $400 million of the GGIF's funds and discontinued the scheme (Kelly, 2011). The industry's anger was summed up by GM Holden Chairman Mike Devereux (2011), who complained that governments:

"… *can't establish long-term co-investment plans only to pull the rug out from under companies half way through decade long product development and investment cycles*".

Goods (2012: 191) reported that the firms, industry association and unions were all "bitterly disappointed" by the government breaking its promises to the industry.

Industry Minister Senator Carr included himself amongst those disappointed by the decision (Interview 4). He visited US head offices at the end of 2011 and, and in January 2012 announced a $103 million package to ensure Ford maintained production in Australia through to 2016 - $34 million came from the Federal government with the remaining funding provided by the Victorian Government and Ford (Gillard et al., 2012). Holden was allocated a similar package the following month, with both the Victorian and South Australian governments contributing (Gillard, 2012). In 2012, $25 million of the New Car Plan funding was directed to the establishment of an Automotive New Markets Initiative (ANMI) to assist supply chain firms expand their operations. The Victorian and SA Governments co-funded the Automotive New Markets Program (ANMP) component of this scheme, which provided merit-based grants for companies to expand, enhance capabilities, markets and product range (DIIS, 2020).

However, these inducements were not sufficient to maintain the industry, and Ford was the first to announce its closure in May 2013. Contributing to that decision were policy uncertainty, the increasing value of the Australian currency relative to the US dollar (which reduced the competitiveness of Australian exports), and escalating energy costs associated with the failures of Australian climate policies.

4.4 Managing Industry Closure

The Labor Party lost government in the November 2013 election. The incoming Abbott conservative (Liberal-National) administration was market-oriented and openly contemptuous of what it saw as supporting uncompetitive industries. Support to the automotive sector was soon reduced by AUD$500 million and in October 2013 a Productivity Commission review of the sector was commissioned. Its terms of reference were ominous. As the industry lobbied for the restoration of funds, the government's Joe Hockey challenged the firms' commitment to Australian production -

“Either you’re here or you’re not.” he taunted on 11 December 2013 (Coorey and Potter, 2013).[11] In response Holden announced its closure, and Toyota followed suit soon after.

As expected, the Productivity Commission found that Australia would be better off without an automotive industry. The key finding of its August 2014 Report (PC, 2014) were:

“*The policy rationales for industry-specific assistance to automotive manufacturing firms are weak and the economy-wide costs of such assistance outweigh the benefits.*

The Automotive Transformation Scheme should be closed after Ford, Holden and Toyota have ceased manufacturing motor vehicles in Australia.

Component manufacturing firms are currently set to receive over $300 million in industry-specific assistance between 2014 and 2017. There are both efficiency and industry equity arguments against extending assistance beyond that already committed, or introducing new assistance programs that would advantage component manufacturers ahead of other firms that face adjustment pressures.”

The recommendations recognised that much of the remaining New Car Plan funding was locked in by legislation. However, the implementation of the ATS and AISAP were now reoriented for closure management. Ford ceased production in September 2016; Holden and Toyota in October 2017.

Table 5 provides a summary of the main plant closure events, noting that both assemblers and supply chain firms were downsizing continuously from about 2007 (Interview 11).

Table 5: Summary of Closure Events in Australia

Closure Event	Jobs Lost	Date
Ford Production Plant, Broadmeadows, Victoria	450	7 October 2016
Ford Engine, Stamping and Casting Plant, Geelong, Victoria	170	7 October 2016
Ford Broadmeadows and Geelong Plants, Victoria	110	July 2017
GM Port Melbourne Victoria and Elizabeth South Australia (phased)	1,168	Dec 2014 - Oct 2017
GM Holden Cruze Production, Elizabeth, South Australia	280	7 October 2016
GM Holden Engine Plant, Port Melbourne, Victoria	177	29 November 2016
Toyota Production Plant, Altona, Victoria	2,700	3 October 2017
GM Holden Production Plant, Elizabeth, South Australia	805	20 October 2017

Source: DESE (2020) from Information provided by Ford Australia, GM Holden and Toyota

The DESE (2020) estimated that by 2018, 20 of the 75 companies in South Australia’s automotive supply chain had closed, and in Victoria 26 of the 140 automotive supply chain companies had closed and around 25 downsized.

4.4.1 Pre-Closure Assistance Measures

The Federal Government announced a suite of measures to manage the transition, and formed a high steering group, with the South Australian and Victorian state governments, to coordinate the response (McFarlane, 2013). The Federal Government also instigated reviews of the South Australian and Victorian economies to access likely impacts in affected local government areas (DIIS, 2014). DIIS (2020) estimates that total assistance to the automotive sector in the pre-closure years 2013-2017 exceeded $2.5 billion (total industry value adding in that period exceeded $15 billion).

[11] An article in the *Wall Street Journal* had suggested that GM has already made the decision to close Australian production, which contradicted the public position of local management.

The ATS and AISAP programs were extended to manage the impending closure of the industry. The ATS reoriented to promote the industry diversification of supplier firms while the AISAP re-focused on retraining and job placement. Funds committed to programs supporting the closure process totalled about $380 million (Australian Government, 2019), shared between federal and State governments and the assembler firms. The programs can be divided in programs supporting firms, programs supporting the workforce transition, and programs supporting regional economies.

4.4.1.1 Programs Supporting Firms

In the three years between the announcement of the closures and the final cars leaving the assembly lines, component firms were assisted to diversify their products and product markets with outreach workers helping firms to work through options and craft funding applications. There were multiple programmes for firms, and they were oriented to ensuring an 'orderly exit' of the industry (Interview 15). The programs included:

- The Next Generation Manufacturing Investment Programme was a $94 million fund included $12 million each from the Victorian and South Australian governments. This fund was a government co-investment fund, supporting firms diversifying into "high value non-automotive manufacturing sectors" (DIIS, 2020). It generated $222 million in private sector investment (DIIS, 2020).
- The Automotive Diversification Programme provided funding for firms to diversify out of domestic motor vehicle manufacturing, therefore precluding any activity in the EV passenger vehicle space. This $20 million program supported 26 businesses and generated an additional $49 million in investment.
- An Automotive New Markets Program (ANMP), co-funded by the South Australian and Victoria Governments, supported "early-stage commercialisation; pre-production development activities; re-tooling; proof-of-concept activities; and embedding of Australian design and engineering employees." It was undersubscribed and terminated early (DIIS, 2020).
- The Business Capability Support Program provided intensive assistance to firms to "develop new capabilities; improve their productivity; and apply current capabilities in new ways" (DIIS, 2020).
- The Advanced Manufacturing Growth Fund was a $47.5 million program announced in May 2017 focused on capital upgrades. It supported 32 businesses from Victoria and South Australia with grants to "transition from traditional to advanced manufacturing of higher value products". The funding leveraged investment of $144 million.
- South Australia Automotive Supplier Diversification Program and the Victorian Automotive Supply Chain Transition Program, and the Victorian Local Industry Fund for Transition Program, all State funded, provided additional support to suppliers, in particular bringing in consultants to examine the potential for the business.

Automotive firms could access other general Innovation and Investment Funds at both State and Federal levels.

In South Australia, The Automotive Supplier Diversification Program (ASDP) was an $11.65 million initiative to assist South Australian companies operating within the automotive supply chain to diversify and secure alternate revenue streams "to drive sustainable growth, long term employment and potential for export revenues". Funding was available for five years 2013–14 to 2017–18. The ASDP was delivered by an Automotive Transformation Taskforce within the South Australian

Department of State Development. Appendix 1 lists its objective and eligibility criteria. In practice these interventions worked in partnership with firms to identify opportunities:

"*Well, sometimes it wasn't so much that the companies didn't know what they didn't know, but it was worthwhile to look. We engaged. We certainly weren't experts in understanding the true depth. We engaged independent consultants for the companies, so that way they could take an arms-length review of the business - take the emotion out of it and really understand what the gaps were in terms of them having a successful future. Sometimes I, I think you need that*" (Interview 15).

"…yeah, I suppose domestically owned companies. For them it was, I suppose, working closely with them to understand what they needed. And part of that was not only sort of asking them what they needed, but also … undertaking a review of their operations. So that way we could somewhere in between identify what the gaps were to them having a successful future". (Interview 7)

These programs are considered to have been very successful. The Federal Government's Department of Industry, Innovation and Science undertook a national evaluation of the federal scheme in 2019 (DIIS, 2020), tracing the destinations to January 2018 of the 144 firms that received Federal Government assistance in 2013. Table 6 shows the summary data.

Table 6: Supplier Survival Rate by Business Type (Up To January 2018)

Business Status	Australian Owned	Multinational	Unknown	Totals
In Business	78[1]	36[2]	-	114[3]
Ceased Trading	10	14	-	24
Unknown	2	2	2	6
Totals	90	52	2	144

[0] 1 to close in 2018; [2] 6 to close in 2018.

Although the guidelines for the assistance encouraged firms to diversify outside automotive, Table 7 suggests that diversification activities did not branch far from the firms' original activities. It suggests that the loss of jobs in motor vehicle manufacturing was almost entirely offset by an increase in activity in related automotive sectors.

Table 7: Change in Employment Levels between Motor Vehicle Manufacturing Categories

ANZSIC sector	**2014-15**	**2015-16**	**2016-17**	**2017-18**
231 Motor vehicle and motor vehicle part manufacturing	40,642	39,271	39,037	37,537
2311 Motor vehicle manufacturing	12,434	11,706	9,619	6,545
2312 Motor vehicle body and trailer manufacturing	14,016	13,340	14,613	15,936
2313 Automotive electrical component manufacturing	2,601	2,606	2,758	2,546
2319 Other motor vehicle parts manufacturing	11,592	11,619	12,047	12,510

Source: ABS Cat No. 8155

The DIIS (2020) estimated that firms in receipt of government assistance shed fewer employees than firms not accessing government assistance. The DIIS concludes from Table 8 that firms accessing assistance increased levels of diversification. The report shows that firms accessing assistance considerably reduced their 'automotive exposure', defined as the ratio of automotive sales to total sales. Australian owned firms were more likely to diversify away from automotive activities.

Table 8: Count of Businesses Engaged in Non-Auto Diversification and Exporting

Support Program	Number of Participants	Diversified Outside of Auto (2013)	Diversified Outside of Auto (2017)	Evidence of Increasing Diversification between 2013 - 2017	Exporting (2013)	Exporting (2017)
ANMP	23	13	19	14	9	9
ADP	23	15	22	19	6	12
BCSP	28	17	22	16	13	12
Only ATS	98	52	59	43	22	25

Source: Reproduced from DIIS (2020, Table 9).

DIIS (2020) also provided a number of vignettes on successful diversification – mostly in heavy vehicle manufacture – none of which mention electric vehicles. EV was simply not 'on the radar' at the time:

"At the time, not to electric vehicles. I don't think at the time there was as much opportunity in terms of what companies could diversify into. Certainly we didn't preclude that [EV] *as an activity, but certainly I suppose the intent [of the programme] was companies diversifying out of the automotive sector".* (Interview 15)

The 2019 Senate Inquiry into manufacturing identified on firm diversifying to EV. Precision Buses in North Adelaide transitioned from a Level 1 components supplier to Holden and Ford to manufacturing electric buses. The transformation was achieved with the support of the ATS. The firm explained that:

"*By setting that up in a local condition, we're able to bring economic benefit to suppliers and manufacturers locally. We use the existing capability that was available with OEM manufacturers in the passenger car space to engineer for us today*". (Christian Reynolds of Precision Buses, cited in Commonwealth of Australia, 2019, p.20)

This project has not identified any additional examples of suppliers firms diversifying to EV-related activities.

4.4.1.2 Programs supporting the workforce

Support for the workforce was funded by topping up the Automotive Industry Structural Adjustment Programme (AISAP) with an additional $15 million. The Ford closure response was organised in the last months of the Labor administration, while the Holden and Toyota provisions were established under a Liberal government. There were enduring differences in the programs. The Ford Transition Program was organised through Auto Skills Australia, with active cooperation of the unions, and complemented by a series of State government research efforts such as the 'Skilling the Bay" initiative. For Ford and Toyota, the Skills and Training Initiative funded the Holden Transition Centres and the Toyota DRIVE program. The assistance was organised and delivered by firms. The Toyota program set aside $3 million to assist workers in its supply chain. The State Governments in South Australia and Victoria complemented these with programs focused on affected supply chain firms and workers:

- South Australian Automotive Workers in Transition Program
- South Australian Government 'Beyond Auto' wellbeing and resilience counselling support

- Victorian Automotive Supply Chain Training Initiative

The lead firms established comprehensive individualised programs to support worker transition. These included careers advice, financial counselling, personal counselling if required, job search assistance, retraining opportunities to a value of $2000 per worker, and ‘recognition of prior learning’ assessments to ensure that workers had full accreditation for their existing skills (Interview 13). In the lead firms, workers skills were fully accredited, and work resumes fully updated before they finished work with their automotive employer. The lead firms usually made these programs available to workers’ family members and support continued well after individual workers had finished their automotive employment. The response included assistance to redeploy to new roles within the employing company.

Redundancy provisions were crucial to the orderly exit of the industry. Permanent workers in the lead firms qualified for generous redundancy payments based on years of service. The provision of redundancy payments varied in the component sector depending on workplace-level industrial agreements (and tended to be less generous than the lead firms). In the lead firms, the gold standard was 6 weeks’ pay for each year of service, uncapped, and the full payout of all annual leave and sick leave entitlements. This meant that the most vulnerable workers in the labour market – long serving auto workers over the age of 50 – left their jobs with payouts in the range of $250,000, usually enough more to ensure their financial security. These payments secured worker cooperation through the closure process. Some of the firms agreed to release non-essential workers who found new jobs, without loss of redundancy entitlements. They also organised redundancy payments to minimise tax liabilities. Superannuation balances – superannuation is compulsory in Australia – were unaffected, so workers taking early retirement were doubly secure. Some firms had initially not paid out sick leave entitlements, but this position was reversed to stem absenteeism in the pre-closure period. Theses redundancy provisions appeared in workplace agreements in 2008 and 2009, around the time of the Carr ‘New Car Plan’, as a part of the then plan to retain the industry in Australia. High exit costs encourage firms to continue.

Firms changed their management styles in the period between announcements and closure and relied more on interpersonal relationships to secure cooperation. Industrial relations also reoriented to ensuring workers maximised their access to support. Holden in Adelaide, for example, conducted tours of its plant during the last year of operation to explain to prospective employers how the (Toyota) quality system worked and to demonstrate its culture of continuous improvement. This, it was argued (Interview 15), changed the perception of Holden workers among prospective employers. The lead firms also made a considerable effort to stage-manage the final closures – and to control media reporting of the closures – to make them a celebration of achievement rather than a final defeat (Interview 15). These strategies were well-received by the workforce.

The assistance to workers was also adjudged a success. A government-sponsored evaluation of the diversification effort (ACIL-Allen, 2019) found that job losses in the supply sector had not been as large as anticipated, and that many firms had continued to operate by providing products to through the automotive-aftermarket and expanding into truck, trailer, and caravan markets. ACIL-Allen (Australia, 2019) found that larger (Tier 1) suppliers, most of which were by 2013 overseas owned, tended to close down completely, as they remained in Australia to service the local assemblers. The firms likely to diversify and survive were smaller Australian-owned (Tier 2) suppliers. These firms continue to face cost disadvantages on global markets, so it is unclear how they will fare in the longer term.

The ACIL-Allen study found that in 2019, for many workers about six months after leaving the automotive sector, employment outcomes were positive. Table 7 reproduces ACIL-Allen's conclusions regarding best practice plant closure. Overall, 85% were working and 15% were retired (6%), taking a break (6%) or studying. Of those in the labour force and 82% of were working and 18% were unemployed. Of those who were working, 53% were fulltime, 6% were part-time, and 41% were casual or 'other' work categories. A further 4% were self-employed. Table 9 reproduces ACIL-Allen's conclusions regarding best practice plant closure.

Table 9: Best Practice Plant Closure

	BEST PRACTICE SUPPORT	BENEFITS & OUTCOMES
TRANSITIONING WORKERS	• Early notification to workers allows support to be communicated early and often • Tailored career advice and local labour market information via case managers • Transferable skills recognition and training support including funding • Resume, interview and digital job search assistance • Health and wellbeing support, financial counselling • Dedicated transition hubs or information centres	• Time to mentally process information, change • Time to consider career options • Quicker transitions to new jobs • Ability to upskill or retrain into new careers • Easy access to information from a central location
COMPANIES / INDUSTRY	• Early notification / long lead time of closure or restructure • Transition support demonstrates a caring employer • Access to support and training in paid work time • Proactive engagement with the media • Dedicated transition hubs or information centres, staffed by case managers, to deliver tailored support services	• Continued engagement of employees • Maintain production productivity, quality • Companies who support their workers maintain their good reputation and loyalty of customers • Maintain staff attendance levels until end of production • Shape the narrative around the closure/ restructure in the media
GOVERNMENT & COMMUNITY	• Provide a clear single access point for information on all existing support and how to access them • Close collaboration with all stakeholders for communications, data collection • Flexible support available outside of work hours • Access to information for the whole family / support network • Long lead time allows for focus on industry diversification and worker skills development • Support for supply chain businesses and workers	• Quicker transition to new employment, study, focus on future • Increased financial literacy improves financial security, reduces reliance on government income support • Maintain skills in economy as workers transfer to new employers • Family engagement supports mental health and other outcomes • Services enhanced by data and user feedback • Industry diversification

The three main industries of employment were manufacturing (35%), transport, postal and warehousing (13%) and construction (9%). Given that many automotive sector workers had worked in warehousing and transport occupations, their figures suggest that about half of the displaced automotive worker found work in similar occupations to their work in the automotive sector. Most (85%) reported that they were 'satisfied' with their pay scale. Overall, at the 12-month follow-up, the 82% of those in the workforce who had any employment compares favourably to the 60% average estimated by the Australian Bureau of Statistic for displaced workers across the economy. Interviews conducted within the Future Work Future Communities project (Beer et al., 2020; Irving et al., 2022) suggest that the skills of former middle managers from the Internal Combustion Engine (ICE) sector – especially those associated with the quality systems and the Toyota organisational model – were highly attractive to employers in manufacturing and other sectors.

There is some evidence of individuals from within the ICE automotive sector transferring to occupations associated with EV sector. The firm Carbon Revolution, for example, supplies global EV markets and employs a number of former ICE workers. Three of the fifteen interviewees for this project were (incidentally) former ICE sector employees now working in industry policy roles in the public sector.

4.4.1.3 Programs Supporting Affected Regions

In South Australia, where the automotive industry was located, State level industry programs were effectively located in the affected locations. The South Australian government has (since 2013) embarked on a radical industry modernisation programme in which the State has sought to position itself as Australia's high-tech innovation hub. Important components have been the State government's commitment to move to zero emissions, through large renewable energy investments and the 2017 installation of a large battery to stabilise the State's electric supplies. South Australia is the epicentre of Australia's defence-related innovations and was the site for the manufacture of submarines in an agreement where French contractor agreed to maximise the use of local inputs. The State has set up innovation precincts – in particular at Tonsley on the former Mitsubishi production site – to house advanced technology firms. There have been attempts to convert the former Holden site (Lionsgate) into a similar hub. The State has marketed itself in the media as a node in global high-tech networks.

In Victoria, programs were established to revitalise the regional economies in the areas previously dominate by employed in Ford plants in Geelong and Broadmeadows.

- Melbourne's North Innovation and Investment Fund committed $24.5 million to support new jobs and investment by businesses in Melbourne's Northern suburbs.
- Geelong Region Innovation and Investment Fund $29.5 million to support new jobs and investment by businesses in Geelong.

As documented in Johnston et al. (2020), Geelong was identified in the early 2000s as a growth city that would relieve population pressures in nearby Melbourne. Consequently, in addition to these defined automotive sector programs, there has been considerable infrastructure-related investment in Geelong provided with the support of other government departments and agencies. The location of the federal National Disability Service in Geelong consolidates its position as a medical and insurance centre. Deakin University and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) research capacity in Geelong have facilitated innovate private sector initiatives such as Carbon Revolution, a firm that manufacturers carbon fibre wheels. There has not been equivalent activity in Melbourne's Northern suburbs, where there is no university and little private sector interest.

Finally, in considering labour adjustment, government policy assumed that, in the absence of intervention, workers outcomes would be poor, given the mature age of the workforce, the dearth of local jobs in their areas of skill and experience, and their long tenure with one employer, with is expected to narrow their skills – especially in organisational matters – and indicate inexperience in engaging with the labour market and recruitment processes, which was commented on by our respondents:

"*And then with that, obviously looking after the workers are given that the whole sector was going down. Potentially there was a supposed perceived limited opportunity for a lot of the workers*" (Interview 7).

"*Yeah well I've come out of it. I worked for Holden for 15 years, in manufacturing here, in production management. So you know I watched the whole industry wind down to nowhere. I worked at Hills Industries back in my earlier career, when they made everything here on South Road as well. I worked at Kimberly-Clark Australia as well. They're still going, which is good. But yeah, it's a tough road for industry*" (Interview 8).

4.5 Summary

This chapter has demonstrated that the Australian experience of car production in the 20th century emphasised the primacy of the state in fostering industrial policy and industrialisation. In this sense, the availability of abundant, cheap raw materials (a 'location-specific advantage' as economist John Dunning would have called it in his 'eclectic paradigm' of explaining foreign direct investment) combined with a protectionist state regime that offered incentives such as land packages meant domestic production was the only feasible way to supply the Australian market. However, Australia did not have a large or integrated domestic market, being subject to a historical legacy of varying jurisdictions across the different states.

As such, when subsequent governments (ALP and conservative) embarked on trade liberalisation and integration policies with the Asia-Pacific post-1975, it made more economic sense for companies such as Ford and Toyota to produce in the geographically proximate countries of Indonesia and Thailand and export complete vehicles to Australia (not helped by a mining boom in the 2000s that raised the value of the Australian dollar and eroded export competitiveness) and hence car production in Australia collapsed, ending in 2017. As such, the Australian experience also points to the transformative role of the state at various spatial levels as a key driver of the structural changes that can be all too readily solely attributed to globalisation (see Beer, 2018; for a discussion)[12]. In the following chapter, we explore efforts to engender an EV industry in Australia and critically assess the issues and challenges to date that have mitigated against this thus far.

[12] Beer (ibid.) argues convincingly that this process has been typified by the Federal Government in Australia prioritising overall growth and competitiveness over regional well-being, with state governments and local authorities being left to deal with the "negative consequences of economic change".

5. The Electric Vehicle Industry in Australia and Supply-chain transition

The previous chapter has shown that clearly the Australian automotive sector did not transform into an EV production industry. However, in this chapter we ask has EV manufacturing emerged from the ashes, independently of the organised interventions described in the previous chapter? A number of submissions to the 2019 Senate Committee Inquiry on Electric Vehicles in Australia pointed to the residual value of Australia's car-making skills and experience. The South Australian state Government, for example, put forward the view that:

"*The state also retains an automotive sector following the closure of Holden with many component suppliers, a strong research base and a remnant pool of skilled workers*" (p. 51).

The Electric Vehicle Council of Australia CEO, Behyad Jafari, argued that Australia has a "monumental opportunity" with EVs, "not only in reducing pollution, but creating an innovative industry in manufacturing, technology and services" (EVC, 2021). The Council has branches in every State including South Australia. Other contributions to the Inquiry suggested that the same issues that defeated local ICE manufacturing would prohibit the development of an EV industry:

"*On the question of manufacturing in the future, obviously we ceased [vehicle] manufacturing late last year* [2017]. *In the future, if we were to look at manufacturing being realistic, we'd have to examine the fact that, despite Australia having a market of 1.2 million vehicles a year, no vehicle sells at 50,000 units per year in Australia. Fifty thousand units is not considered to be the scale required for a factory anywhere in the world, and therefore you would need extensive export markets, in conjunction with a very successful product in the domestic market, before it was viable. One of the substantial issues with manufacturing in Australia is lack of real access to markets outside of Australia, especially in the Asian region, because of tariffs and non-tariff barriers*". (Mr Tony Weber, Chief Executive Officer of the Federal Chamber of Automotive Industries, cited in Australian Senate (2020, p.50).

5.1 EV Policy Settings

In January 2019 an Australian Senate Select Committee published a report on Electric Vehicles (EV) (Commonwealth of Australia 2019). It pointed to the importance of government intervention, or the lack of it, in determining the future take-up of EVs:

"*In the absence of appropriate regulatory settings, Australia's near-term EV uptake is likely to be modest. Slow uptake will continue to result in EV manufacturers not prioritising the Australian market and fewer EV models being available to Australian motorists. It will also delay the realisation of substantial economic, environmental and health benefits, and risk seeing opportunities for economic development pass by*" (p. xvi).

The report considered EV and EV component manufacturing; battery manufacturing and commodity value-adding; and charging infrastructure. The report was cautiously optimistic about the future of, and wider economic potential of an EV industry in Australia. In November 2021 the Federal government unveiled its $250 million Future Fuels and Vehicles Strategy, consistent with the object of reducing transport emissions to reach the Glasgow target of net zero emissions by 2050.[13] The new policy settings have not committed the government to vehicle emissions standards, or changes

[13] Australia's ruling conservative Liberal-National coalition changed policy direction in October 2021, in the aftermath of the Glasgow climate conference, announcing its 'commitment' to act on climate change. This dramatic policy shift followed a shift in the position of the rural-oriented National Party.

to depreciation allowances, asset write-offs, tax deductions for home charging, or any other incentives for the take-up of EVs or disincentives for use of ICEs (see Kraal, 2021). The Prime Minister emphasised the freedom of consumer choice: "We will not be forcing Australians out of the car they want to drive or penalising those who can least afford it through bans or taxes," (PM Morrison, cited in Gailberger, 2021).

Rather, the Future Fuels Strategy focussed on improving the charging infrastructure, for both batteries (BEV) and hydrogen fuel cell (HEV) vehicles with the expectation that EVs will make up 29% of new car sales by 2030. "Our plan to reach net zero by 2050 is … focused on technology not taxes, and this fund backs in Australian companies to find new solutions" (cited in Armstrong, 2021). The federal opposition party – the Australian Labor Party – has promised relatively modest financial incentives to encourage EV take up. It intends to waive import tariffs on EVs, waive the luxury car tax on high value imported EVs, remove fringe benefits tax for EV fleet vehicles, and favour procurement of EVs for Commonwealth vehicles. It commissioned econometric modelling predicting that under these policy proposals, EVs would constitute 89% of new car sales by 2030 (Brown, 2021). The influential think-tank, the Grattan Institute, disputed these estimates and argued for stronger incentives for the take-up of electric vehicles (Wood et al., 2020). The lack of a policy from the Federal government to promote EV take-up was not lost on our interview respondents, for example:

"… there's no overarching Federal [Government] *policy to even transition, let alone how we do it. And that, I think, that's like the worst thing. Like you can say so much about South Australia: got a Liberal state government, but at least they've tried a little bit. Yeah. But, it's not enough. It's not quite what we want, and it took so long to develop the policy. It was a bit out of date by the time it came out, but it's better than nothing"* (Interview 7).

The consequence of Federal inaction is more vigorous regulatory intervention at the State level. Most States now have incentives for EV take-up (Gutwein, 2020; Perrottet et al., 2021). Like other States, South Australia as a policy position supporting electrification of the transport system. It has a notional target for EV take-up, currently that all new vehicles sold will be 'fully electric' by 2035. The total package was allocated $22.7 million. There plans for amendments for EV-ready building regulations. In April 2021 the South Australian government announced a $13.4 million allocation to install 530 fast-charging stations in locations across the State. The announcement included the intention to introduce an electric vehicle user charge to pay for EV-related infrastructure program. The details of this new tax were not available, which drew criticism from the opposition (Sutton 2021). In December 2021 South Australia introduced assistance with EV capital costs (a $3,000 vehicle purchase subsidy for vehicles priced up to $68,750, and $2000 subsidy for home charging equipment), and a three-year motor registration fee exemption (Henson, 2021).

The current Federal Government's support package for manufacturing has identified six priority areas for funding, none of which encompass EV-related manufacturing. The funding program also favours established, capital-rich firms by continuing with the co-investment model used in the GCIF. In the first round of funding, 34 projects were supported from 765 applications, generating private sector investment of $340 million topped up with $200 million of government investment (Chambers, 2021). Only one of the funded projects was EV-related, supporting battery manufacturing in Darwin.

5.2 EV Manufacturing

In this section, we look at what attempts were made to enable EV manufacturing in Australia. Evident is that there have been sporadic gestures – from industry entrepreneurs and the manufacturing-oriented factions of the Australian Labor Party to establish electric vehicle production in Australia. For example:

- The Geelong-based wheelmaker Carbon Revolution produces a lightweight wheel suitable for EVs. In 2020 it embarked on a $92 million capital raising to expand its production to serve a growing EV-based market (Interview 11). However, this firm is exceptional in that it is the product of 15 years of research and development collaboration by the CSIRO and Deakin University advanced materials research. Carbon Revolution employs a number of former ICE component supplier managers and former automotive labour (Interview 12).
- Prospective EV manufacturer, Australian Clean Energy Electric Vehicle Group (ACE-EV) had attempted to access the Automotive Transition Scheme (ATS) funds but was unable to meet the fund's eligibility criteria. The criteria – to be producing 30,000 units per annum – effectively limited the fund to the three lead firms of the ICE sector and excluded start-up manufacturers (p 53). The firm ACE vigorously pursued the South Australian government for support to establish an EV assembly facility in Adelaide (Interview 4). This idea was lampooned by a former South Australian government official (Interview 8) – who was also a former General Motors Holden manager – on the grounds that the vehicles did not meet Australian safety standards (such as fitted airbags).
- Another example, in Victoria, was a plan for the firm SEA Electric to establish an EV assembly facility in the regional town of Morwell in Victoria's Latrobe Valley, where it could benefit from access to Victoria's transmission system. SEA Electric signed an agreement with the Victorian Government to support the venture. It was estimated that the Morwell plant could build 2 400 four-tonne vans and commuter buses, employ up to 500 workers, and generate about $200 million in economic activity (Commonwealth of Australia, 2019, p 55). SEA Electric abandoned the project a couple of days after the Federal Government's 2020 announcement of the Future Fuels Strategy (which did not offer support to manufacturers).
- Another example, from 2019, is GFG's entrepreneurial CEO Sanjeev Gupta announcing his intention to establish EV manufacturing in Australia. Gupta (2019) flags the repurposing of ICE automotive sites for EV production in a venture involving "business and government working collaboratively". In May 2019, Gupta (2019) promised that:

  > "*GFG will shortly launch its very own EV and is excited about the opportunity to bring vehicle manufacturing back to Australia. We are currently finalising our launch plans (including which state to locate the manufacturing facility in) and will be using technology developed by Gordon Murray Design of UK. We plan to build our first production line in Australia with additional plants to follow in other markets in our global footprint*."

This statement came a year before the GFG empire was compromised by its reliance on the failed financier Greensill Capital and the GFG proposal had seemed to have disappeared subsequently.

In 2019-20, there was one example of a global firm making use of the automotive sector's skill resources. The Vietnamese electric vehicle start-up VinFast established a research and development centre in Melbourne in 2020, adjacent to the old Holden headquarters, and purchased the ex-Holden Lang proving ground in late 2020 for $36.3m.[14] It employed more than 100 Australian former

[14] Vinfast has developed two EVs for export to USA and EU markets in 2022. The design of the VF e35 mid-sized hatchback and large VF e36 wagon (Dowling, 2020; EV Central, 2021).

Holden, Ford and Toyota automotive engineers. A company spokesman explained that the company chose Melbourne as its first offshore satellite because it has been:

"*The 'headquarters' of giant car manufacturers such as Toyota, Ford, Mitsubishi and GM … Melbourne has available facilities, complete supply chains and experienced human resources with profound expertise and knowledge of the auto industry … Not only possessing new proving grounds and a large wind tunnel already available for aerodynamic testing of automakers, Melbourne also has a seaport – the gateway to export cars around the world*" (cited in Dowling, 2020).

The photo below shows the VinFast Melbourne team – looking very much like the teams from Toyota or Holden.

VinFast's Melbourne R&D Centre

VinFast vice-president Roy Flecknell said the Australian engineers:

"*… bring massive talent and experience to the* [Vinfast] *business … We have clearly benefitted from all those OEMs leaving Australia… It is sad that happened, but we have benefitted from it*" (cited in Carsales, 2018).

He added that the VinFast experience had expanded the engineering skills:

"*When you work for Toyota, Ford or GM, it's very global, very regimented and very rigid. They are able to come and use all their experience and think about ways of doing things differently… It's amazing how creative you can be and do things differently and still create good quality products. … They have it refreshing to do something different rather than follow the Ford, GM or Toyota global process, which is very, very rigid*."

Citing Covid-19, VinFast closed the Melbourne R&D Centre in May 2021. Between 50 and 90 employees of were made redundant or offered a position in Vietnam. In August 2021 it put the Lang Lang testing site back on the market. This decision is likely to have been influenced by the signals from the Federal Government that EV manufacturing was not a priority. A comment on a blog added that "one look at the level of compliance and overheads required here and they packed up double time." There are no plans to sell the VinFast models in the Australian market and the situation in terms of domestic producers remains minimal:

"*…There's no one really involved in the EV sector…The landscape in Australia is pretty tragic in terms of EV. We are the only ones really doing what we do. The others are either importing vehicles or doing conversions*" (Interview 4).

5.3 Prospects for EV Sales in Australia

Australia has a large, high income market and car-based culture, with 56 per cent of Australian households owning two or more vehicles (ABS, 2017). However, car use peaked in 1989, and since then, reduced wage incomes for workers and fewer fleet vehicles – associated with the outsourcing of services and the improvement of remote communication – have produced a stagnant market in which the growth of any brand or model will come at the expense of the market share of other models. Compared to other comparable nations Australia has relatively more old cars in use, partly because Australian consumer protection laws restrict car firms from financing purchases, and partly because there are no 'anti-clunker' regulations. Consequently, 44% of new car sales in Australia are fleet vehicles, which are almost always purchased under leasing agreements. The main type of vehicle purchased by businesses are 'workhorse' light trucks (a segment in which there are no local EV options).

Half of Australians say in surveys that they would consider buying an EV, but sales are only 1% of the market. This is because they are unaffordable for ordinary wage-earners. The lack of government action on automotive emissions is making Australia a 'dumping ground' for high emissions ICE (Stegall, 2021). About 17% of Australia's emissions are from automotive. EVs are a 'known and readily deployable' technology ICE (Stegall, 2021). In 2021 there were 26 EV, PHEV and HEV models available in the Australian market. Of these, only three models retailed for less than $50,000 (Wood et al. 2020) To put that in perspective, the average new car spend in Australia was about $40,000. But price is not the only reason why Australia been slow to take up EVs – consumer research reveals anxiety about the range in EV's, the lack of charging infrastructure, and lack of government incentives. Australia accounted for only 0.78% of global EV sales in 2020 (Changarithi, 2020). Many EV models that are available in other countries are not available in Australia because low sales do not make it worth the cost of entry. According to Australian Capital Territory (ACT) Climate Minister, Rattenbury:

"*I understand why manufacturers have been reluctant … when we saw the campaign that the Federal Government ran against electric vehicles, it's not very motivating if you're the importer …. And, of course, in Australia, we haven't seen the incentives that other countries are offering, so that's why our market has been so slow to take off*" (cited in Allen, 2021).

Anxiety about charging and range has led the traditional carmakers to back Hybrids (HEV), which under Australian regulations 'count' as EVs (see Wood et al., 2020). In 2021, 85% of low emissions cars sold in Australia were HEVs (the remaining 15% are mainly Tesla). Toyota is the market leader in HEV technologies. It introduced the Hybrid Prius as early as 2001, and in 2021 it sold 54,335 Hybrid vehicles in Australia, representing almost 30% of its total sales (Toyota, 2021). In August 2021, the Toyota RAV 4 Hybrid was the highest selling vehicle in Australia, the first time a non-ICE vehicle has led sales. Hagan (2021) provides a description of the features of new models on the local market. In the absence of such intervention, the Federal Chamber of Automotive Industries argued that internal combustion engines would remain the dominant source of power in passenger cars for the 2020s and beyond (p. 13). Citing a 'lack of support', one respondent acerbically commented that:

"*I wasted $3-4 million of my time convincing* [the Federal Government] *that this is an opportunity, now we had the land and everything. But they said "No. No, it is too difficult." And at that stage they did not even have a look at our business plan. And there's all sorts of bull shit going on in the media, because the media were asking 'Why aren't you supporting* [firm]*?' And they were putting stories out there "Oh* [firm] *hasn't got a business plan in place" - but they'd never even asked for it, we've offered it. Just political bullsh!t*" (Interview 4).

5.4 Supply Chain Industries

Regardless of whether EVs are imported or manufactured locally, opportunities in downstream and upstream industries also need to be considered.

5.4.1 Downstream Industries

The downstream activity is a contest between hydrogen fuel cell and lithium battery industries, and it will have implications for the types of vehicles that Australians access in the future. This is partly a discursive battle: Tesla's battery entrepreneur Elon Musk has called hydrogen for cars "mind-bogglingly stupid". Australia hydrogen entrepreneur Andrew Forrest responded that "He has every reason to fear them and his description is perhaps better suited, in my view, to someone why peddles a battery technology as green when it turns out it runs on fossil fuel" (both quoted in Kirby 2021). Both technologies have advantages and disadvantages.

The development of hydrogen fuel cell vehicles has been the "long-term goal of the car industry" (Mikler, 2009: 65), and it appeals to ICE manufacturers in part because it adapts the existing production framework rather than replacing it. Most major car manufacturers have had fuel cell research and development programmes since the late 1990s (Paterson, 2007). Australia's 2008 Bracks' Report concluded that hydrogen fuel cells would not be economically unviable until "at least 2030" (Bracks et al., 2008, p.29). Nonetheless, there is considerable support in Australia for the expansion of hydrogen-based fuels, although some commentators see hydrogen as most applicable to heavy vehicles, others see the technology as having the potential to overcome problems of distance and sparse infrastructure (which implies the technology is more suitable in less development contexts). Support for the hydrogen option could be understood as a major impediment to the growth of BEVs. There are a number of reasons for this:

- First, the hydrogen fuel cell technologies developed by Toyota with the support of the ATS funds are nearing commercial application. The former Industry Minister (Kim Carr) is a strong supporter of hydrogen fuel, arguing that it overcomes consumer anxiety about the range of BEV vehicles, as well as not being dependent on scarce earth resources like lithium (Interview 3).
- Second, there is more trust between the government and Toyota than with any other firm in the automotive sector. Prime Minister Morrison marketed his $250 million Future Fuel Strategy by test-driving a hydrogen-powered vehicle at the Toyota Hydrogen Centre in Melbourne. Toyota's research and development centre in Melbourne has been trialling Fuel Cell Electric Vehicles (FCEV) – vehicles that emit only water – since 2018. These vehicles are being tested in cooperation with local government, the CSIRO and university research. Hydrogen or "fuel cell" cars use hydrogen to create electricity which, in turn, charges an on-board battery pack and/or powers an electric motor to drive the wheels. They can be refuelled in five minutes and driven about 600km between stops, much like a petrol car. In March 2021 Toyota announced the opening of the first permanent, commercial grade hydrogen production, storage and refuelling facility in Melbourne. This has the more potential for local value capture than importing BEVs.
- The third reason for supporting hydrogen is that many in the government and industry view it as having the potential to replace coal as Australia's major export industry. In other words, it entices with the promise of providing a new national accumulation strategy. The Bank of America has predicted that hydrogen will supply 25% of global energy by 2025. While not yet fully commercialised, the expectation is that existing gas and coal ports can be repurposed to export hydrogen.

- Fourth, major industry is on board the hydrogen bandwagon. Within 24 hours of the Federal Government shifted to support climate targets, billionaire minerals baron Andrew Forrest announced a new venture, Fortescue Future Industries (FFI), which would ‘lead the transition to the hydrogen era’ (Kirby, 2021). The reorientation would begin with a $US650 million hydrogen plant (Aldoga) in Queensland, with the creation of 380 jobs. It would be developed from an initial $US83 million investment to ‘kick-start’ the manufacture of electrolyser equipment to create hydrogen from water.
- The final reason – at the risk of drawing too long a bow – is that hydrogen can be produced as ‘blue’ (coal based) or ‘green’ (water based) forms, and a hydrogen industry is compatible with existing coal-based networks of power. This produces that suspicion that in Australia powerful coal interests are behind the hydrogen project.

5.4.2 Battery Technologies

EVs need lots of lithium, nickel and cobalt. By 2040, the IEA forecasts that demand for lithium will have increased 42 times relative to 2020 levels. Australia is a major global source of these raw materials, but currently the further processing industry is centred in China. This is potentially a competitive threat to EU and US carmakers. There is currently intensive interest in the lithium mining and battery production industries, and this is a space of innovation as firms seek to develop more efficient and longer-life batteries. There are a number of start-ups in the Lithium space:

- Lithium Australia makes lithium ferro-phosphate batteries but has located production in India.
- Novonix is a battery technology firm owned mainly by veteran coal and electricity sector investor Trevor St Baker (ex ERM Power). Its shares rose by 670% in 2021. St Baker also owns “one the biggest charging station companies in the world”.
- Vulcan in another lithium start-up. Its shares rose 370% in 2021.
- ASX-listed Redflow is a redox flow battery developer. The Redflow battery, developed at University of NSW, uses an electrolyte that doesn’t degrade with use, which suggests applications in remote locations. The electrolyte is made in Australia by Australian Vanadium. The battery is nearing commercialisation, but in April 2021 it was announced that it would be made in Thailand.
- Envirostream (a partner of Redflow) uses CSIRO technologies to recycle lithium-ion batteries, and also imports Chinese made Soluna lithium ion batteries. Roberts (2021) reports it is ‘investigating the feasibility” of manufacturing these battery packs locally.
- Queensland-based subsidiary VSPC has developed lithium ferro phosphate battery cathodes in its Brisbane pilot plant. The new lithium ferro phosphate (LFP) cathode powder plant will be located in India.
- Iron Ore billionaire Gina Rinehart has started building equity investments in ‘future metals” (rare earths and lithium). An initial investment of $669 million had grown to $1.07 billion in 2021 (Stensholt, 2021).

Clearly the supply chains for batteries seem to be following the pattern established for iron ore and bauxite, where minerals are mined in Australia but value adding occurs in places with lower wages and less stringent environmental controls. Roberts (2021) remarks of VSPC:

“…*when a long-talked about Australian technology so readily goes offshore, you have to look at the company’s promise to establish a complete lithium ion supply chain from raw materials to recycling and manufacture by entering the Australian battery market*.”

Lithium is ‘hot’ in the financial markets. In 2021, for example, the most successful ungeared EFT security in the Australian market was the EFT Securities battery-metals focused AC/DC EFT, which made a 63% return. Financial sector interest is flooding the sector with capital. The lithium value chain comprises five steps from mining to battery manufacture:

“*the first step being mining concentrate; the second step being refining and processing; the third step being electrochemical processing; the fourth step being the production of battery cells; and the final step being the assembly of batteries*” (Warren Pearce, Chief Executive Officer of the Association of Mining and Exploration Companies, cited in Commonwealth of Australia, 2019).

In 2019, Australian activity was restricted to the mining the raw materials, but a number of submissions, including one from the University of Adelaide, advocated building involvement in the subsequent stages (p. 63). Subsequently, two battery manufacturers, Sonnen and Alpha ESS, announced that they would manufacture lithium-ion batteries in Adelaide (p 67). However, by 2021, both producers were focussed entirely on home batteries for the thermal energy market. One of the issues for BEV development is the scarcity of the raw materials used in batteries. In October 2021, UK firm S&P Global Analytic warned that increasing prices of the metals used in batteries could constrain the growth of the electric vehicles (England, 2021). The price of lithium had tripled in the previous year, and cobalt by 90% and nickel by 35%. The costs of batteries based on nickel, manganese and cobalt rose sharply. Market leading lithium-iron phosphate batteries have been affected. Global EV estimated that a 5% increase in battery prices would produce a 10% decrease in EV sales. With a sharp increase in the market share of EVs, shortages of lithium and spodumene compounds were to be expected.[15]

Financial markets are likely to determine the outcome of the hydrogen vs lithium debate. Kirby (2021) reports RBC Capital partners as commenting that under current conditions the project is not commercially viable, since hydrogen fuel is more expensive than both fossil fuels and ‘brown’ hydrogen. But he notes that this was also true of LNG in its early days, so cost disadvantages are unlikely to deter investors. And investors are keen. The most successful ungeared EFT security in the Australian market in 2021 was the EFT Securities battery-metals focused AC/DC EFT, which made a 63% return in 2021. EFT Securities is backing hydrogen with a new ETFS Hydrogen EFT, thereby aligning with the Bank of America’s prediction that hydrogen will supply 25% of global energy by 2025. It has interests in Plug Power and Bloom Energy and will ‘track’ (meaning?) the Solactive Global Hydrogen ESG Index, which increased 40% in 2021.

5.4.3 Upstream Service Industries

Australia does not yet have the infrastructure in place to support the growth of EVs. The Federal Government’s Future Fuels Strategy (FFS) focuses on remedying this deficiency. The petrol companies are already moving to convert petrol service stations to provide EV and Hydrogen cell charging (Gottliebsen, 2021), presumably funded by the FFS. Gottliebsen (2021) observes that once the petrol distributors start offering EV charging services, they will necessarily become players in the wholesale electricity market. He suggests that this will therefore alter competition in that market as petrol companies leverage their consumer data to compete with the established electricity providers.

The Senate Committee report (Commonwealth of Australia, 2019) projected a net increase of 13,400 jobs as a result of an increased uptake in EVs, most of which would be in sales, servicing,

[15] Global EV sales of 480,000 for the financial year ending 2021 was a three-fold increase over the previous year.

components and charging infrastructure. Nonetheless, it anticipated the paradigm shift away from an oil-based logistics, parts and servicing transportation system will result in job losses and negatively affect some businesses in these sectors. It noted that:

"*One submitter described a 'seismic shift in the fuel distribution network in Australia' arguing that major fuel retailers will be significantly affected: Fuel retailers will have difficulty competing with the convenience and cost of cheap home charging even if they install DC charging stations in local service stations. Most local service stations will disappear because electric cars will charge in homes*" (p. 47).

Noting the risk of job losses, the City of Adelaide highlighted the importance of supporting and encouraging the 'motor trades sector to transition to electric vehicle sales, servicing and potentially business models, such as car share and mobility as a service, which may result in lower levels of private car ownership' There is also considerable activity in niche industries to, especially in retrofitting old cars: "*We are pretty much all booked until sometime next year, so it's definitely a growth grassroots cottage industry that's going to go 'wow' very soon I feel*" (retrofitter Mr Gibb; cited in Allen, 2021).

The rollout of infrastructure is slow relative to Europe. In December 2021 there were only 395 fast-charging points nationally. Like other States, South Australia as a notional target for EV take-up, currently that all new vehicles sold will be 'fully electric' by 2035. The total package was allocated $22.7 million. There plans for amendments for EV-ready building regulations. In April 2021 the South Australian government announced a $13.4 million allocation to install 530 fast-charging stations in locations across the State. The announcement included the intention to introduce an electric vehicle user charge to pay for EV-related infrastructure program. The details of this new tax were not available, which drew criticism from the opposition (Sutton, 2021). In December 2021 South Australia introduced assistance with EV capital costs (a $3000 vehicle purchase subsidy for vehicles priced up to $68,750, and $2000 subsidy for home charging equipment), and a three-year motor registration fee exemption (Henson, 2021). Some other States have more ambitious plans for the EV rollout (Gutwein, 2020; Perrottet et al., 2021).

The firm doing most of the installations, Brisbane-based XXXX, is unable to meet demand. The petrol companies are already moving to convert petrol service stations to provide EV charging (Gottliebsen, 2021). To do that they have to enter the wholesale electricity market, which means that they will be positioned to leverage their extensive consumer data bases to compete with the established electricity providers.

5.5 Conclusions

This chapter has described a situation where, despite there being strong consumer support for the transition away from ICE vehicles, the direction of the transition – whether to EVs, or hydrogen fuel cells – in Australia is not settled. Furthermore, the pace of the transition is slow compared to other advanced economy contexts.

Again, the policy context and the transformative (or lack thereof) role of the state is pivotal in this regard. In this context, the lack of regulations to discourage high emissions vehicles, or to encourage the take-up of zero emissions vehicles, is an important cause. Further impediments to zero-emissions vehicles arise from price constraints, in that Australia is a price-taker on world markets. As outlined in the previous chapter, Australia no longer produces cars locally, so price and model range issues will be a continuing impediment to EV take-up.

Additionally, Australia's dispersed space-economy has a comparatively under-developed public transport system, making governments (state and federal) wary of introducing regulations that would make it harder for workers to get to work. The most promising developments then are in battery and hydrogen technologies, where Australian industry might have the potential to find a global niche.

6. The West Midlands and UK automotive industry in transition

In this chapter we explore the evolution of the West Midlands auto industry. In the first section, we briefly examine the history of production in the sector, particularly noting the volume-based manufacturing of the 20th century that led to the West Midlands being an epicentre for automotive production in the UK. We then examine the subsequent period of plant closures over the past 30 years that resulted in the sector reorienting itself to one integrated within European supply chains and also exporting to the US and China, before turning to issues surrounding the transition to electric vehicle production.

6.1 Volume-based manufacturing in the 20th century

Car production in the region began 125 years ago in 1897 when Daimler made its first car in Coventry. Before World War 1 had begun, in 1913 there reportedly 20 vehicle companies in the UK, most in the Midlands, employing 12,000, but turning out only a little over 9,000 vehicles a year. As well as being home to Daimler, other well-known names in Coventry included Standard, Triumph, Alvis, Rootes, Hillman, Morris and Jaguar. Only the latter survives today, albeit not in Coventry. Austin meanwhile had opened a plant at Longbridge in Birmingham in 1905, with Herbert Austin himself having previously worked for another grand name of the UK motor industry, Wolseley (Bell, 2015).

These companies survived, albeit without building much scale, nor making much in the way of profits, through beyond World War II; post-war the companies undertook some merger activity in the search for scale and economic efficiency. Standard bought Triumph, while Austin and Morris merged in in 1952, creating the British Motor Corporation; in 1968 BMC was taken over by Leyland (essentially a truck company) to create British Leyland. This period saw vehicle manufacturing's peak in Birmingham and the wider West Midlands, with manufacturing comprising some 65% of total employment in the region by 1961 (Bryson et al., cited in Barber and Hall, 2008, p.283).

In the 1960s the UK government implemented its *Distribution of Industry* Policy and prevented existing vehicle companies from expanding in the West Midlands and allowed only limited expansion by Ford in east London and Essex in exchange for Ford opening a plant at Halewood on Merseyside. Vauxhall was allowed to expand in Luton if it also opened a plant on Merseyside, this time on the south side, at Ellesmere Port in Cheshire. Rootes also opened a short-lived plant at Linwood in Scotland, and Triumph opened a sports car plant at Speke in north Liverpool). During the 1960s, the pre-eminence of the West Midlands as the centre of the UK automotive manufacturing sector was lost, partly at least as a direct result of the government's industrial policy.

Come the 1970s and the oil price shock, general economic decline, labour problems and widespread industrial conflict, the West Midlands automotive industry declined further (Law, 1985). The creation of British Leyland in 1968 – which at one point had more than 100 factories – and its progressive rationalisation, alliance formation and break-up failed to reverse this process (ibid.). Indeed, the conglomerate was unsuccessful, being characterised by low trust between units, poor industrial relations, the lack of economies of scale and scope, and an inability to recover the rising costs of product development (Bailey et al., 2008). As such, British Leyland finally collapsed in 1975 - it was rescued by the government and underwent further rationalisation and change, including of a change of name.

In 1986, the surviving Austin Rover was renamed Rover Group, the Austin badge itself disappearing in 1987. Rover was sold to British Aerospace (for some reason the government thought there were synergies between aerospace and automotive, but none materialised); Rover (which included Land

Rover) was sold onto BMW in 1994; Land Rover was sold to Ford for nearly UK£2bn in 2000 (Bentley, 2000). By this time Ford had acquired Jaguar and Aston Martin and set up the Premier Automotive Group. Tata took over Jaguar Land Rover in 2008, just before the financial crash. Meanwhile MG Rover was sold to local investors, mostly ex Rover employees in the guise of the 'Phoenix Four', in 2000. However, this failed in 2005 with some degree of rancour when it was discovered that the directors had utilised a 'value extraction' approach to the firm's assets and they were subsequently struck off the Business Register by the then Labour Government (Bailey et al., 2010). The MG Rover name was sold to SAIC of China and manufacturing on site virtually ceased; today a modest number of Chinese-made electric MG SUVs are sold in the UK. Longbridge was finally closed soon after and the land taken over for housing and retail use.

Earlier, Chrysler bought the Rootes plant in Coventry and in turn this was bought by Peugeot; somehow this plant struggled on, essentially as an assembly plant using French-sourced components, but finally closed in 2006 when the replacement model for the Peugeot 206, the 207, was allocated to Peugeot's new factory at in Slovakia. As a sign of how the industry never stops evolving, Trnava now shares production of the successor to the 207, the 208, with a plant in Morocco.

6.2 Policy interventions to tackle prior plant closures

The plant closures detailed above elicited a number of responses from the UK Government over the period in question (a period which saw a Labour government incumbent in Westminster) (see table 10 for a summary of the closures). Accordingly, in this section, we detail the policy responses and the agencies that delivered the policy responses. It is notable that during this period Regional Development Agencies were in operation. These bodies had the necessary degree of coordinating powers to bring stakeholders together under the auspices of the 'Task Force' approach (Bentley et al., 2010a; Bentley, 2018).

Table 10: Summary of main Auto Industry firm Closures in the UK

Closure	Jobs Lost	Date
Vauxhall, Luton	2000	March 2002
Ford Dagenham, Essex	1,100	May 2002
MG Rover, Longbridge, Birmingham	6,000	April 2005
Jaguar, Coventry	2,500*	July 2005
Peugeot, Ryton-upon-Dunsmore plant near Coventry	2,300	January 2007
LDV, Washwood Heath, Birmingham	850 + 3,000#	June 2009
GKN Driveline plant, Erdington, Birmingham	519	2021 - ongoing

* Some workers moved to the Castle Bromwich Jaguar factory in Birmingham
# Dealers and suppliers

6.2.1 The Task Force Model

Task Forces have long been utilised in policy making and implementation exercises in the UK. Essentially, a task force, which has a military connotation, is a group of people bought together to work on a single defined task or activity in a time limited way, especially where a rapid response is required to deal with a crisis situation. In a public policy context, task forces can enable the state to formulate and implement policy with the participation of actors inside and outside the state. Drawing on specialised expertise, task forces can investigate and recommend new policies and practical means of implementing them (Jessop, 1997; Barker et al., 1999). As Pike (2002) points out, this is different from routine and consultation exercises commonly carried out by governments.

Criticised as lacking in accountability and transparency, as well as for limited inclusivity and tokenistic participation, Pike (2001) found over 295 examples of Task forces being set up in the UK between 1997 and 1999. This is some measure of their usefulness as a means of governance in a policy making and implementation process, since they can focus attention on particular problems that require solutions.

As a means of effective governance, an assessment of the MGRover task force showed that a task force can be successful (Bentley et al., 2010a). It involved *multi-level working* across different territorial boundaries and tiers of government, as well as *community engagement*, and produced *tailored policy designs* which better addressed the issues resulting from the closure of MG Rover. While the agencies at sub-national scale participating in the Task Force were given *devolved responsibility*, to implement policy, it can be argued that British 'new centrism' meant they were mediated by national policy and funding regimes (Bentley, et al., 2017).

An area for concern is *legitimacy*; to meet the need to be politically acceptable, public accountability requires that the outputs of Task Forces need to be visible and open to question by the polity. Despite all of the good work by the MG Rover Task Force, in devising appropriate policy solutions to deal with the effects of closure, a survey of redundant workers at MG Rover found that most ex-workers felt more supported by family and friends than by government organisations (Bailey et al., 2008). However, it can be argued that the Task Force and its policy outputs were simply invisible to the ex-workers, such was their plight at being made redundant.

In each case of the closures detailed below, policy responses included different forms of assistance for those made redundant. A Task Force was not set up in all cases. However, the assistance given to those being made redundant included help with job seeking; finding training courses; help with financial problems; with claiming benefits and, in some cases, with emotional problems. They represent a modicum of an attempt to secure a just transition in the case of a closure and the job loss experienced by the workers. Other interests in the closures are property developers and venture capitalists, who gained from the closures. The question arises of whether a just transition was secured for those who were made redundant.

6.2.2 Vauxhall Luton (March 2002)

Vauxhall Luton was closed in March 2002. The Luton Vauxhall Partnership (LVP) was set up, comprised of the public and private sector, including the Vauxhall Company, trade unions, the Employment Service, the regional supply network, local authorities and local University, chaired by the East of England Development Agency (Wood, 2006). A Gateway Multi-Media Agency and 'Learning for Life' Team, based at the plant, was set up. Funding came from national government as well as the European Union (European Social Fund).

Policy interventions saw the following assistance being given to those made redundant:

- Job seeking: Advice and Guidance interviews; Interview techniques; CV writing.
- Training/re-training courses: Accreditation of prior leaning (APL) scheme developed.
- Job Fairs.
- JobCentre Plus Service: help with claiming unemployment benefits.
- Help with financial problems: Money advice surgeries.
- Counselling services: Health and lifestyle.

The closure meant the direct loss of jobs for just over 2000 employees.

6.2.3 Ford Dagenham (May 2002)

Ford Dagenham was closed in May 2002. The closure did not lead to the establishment of a Task Force to discuss and devise ways of dealing with the redundancies, possibly because the redundancies were voluntary rather than forced, something Ford was proud of.

Policy interventions were straightforward in so far as the ex-workers went through normal Jobcentre channels when they were made redundant.

The closure saw the loss of 1,100 jobs (BBC News Online, 2002). Redundancy packages offered by the company saw ex-workers walk off with pay-offs of up to £50,000; others took early retirement. A management strategy had also seen the company operating a short-time working policy to keep workers on the books to ensure they were employable.

Regeneration was sought for the site, including urban and environmental projects; trees were planted and an on-site lake restored. A new educational campus including a £25m centre for engineering excellence, billed as the UK's first "seamless" university, was built, paid for through a partnership between Ford and the public sector, to provide apprenticeships, post-graduate research, and business management.

6.2.4 Jaguar (2005)

Production at Jaguar’s Browns Lane site in Coventry ended in July 2005 (Bentley, 2007). Policy interventions were developed without a Task Force being set up. Jaguar, however, collaborated with the agencies providing services to the ex-workers.

The public sector response was:

- Job seeking: JobCentre Plus Service set up on site
- Talks about self-employment opportunities
- Training/re-training courses: Advice Service set up on the site
- Welfare: advice about unemployment benefit claims

The closure led to the loss of 2,500 jobs on the Brown’s Lane site (BBC News Online, 2004). Vehicle assembly was switched to Jaguar’s plant at Castle Bromwich in Birmingham, and with it, half the employees. Those made redundant were given generous redundancy packages; many took early retirement.

The Browns Lane site was sold in March 2007. Macquarie Goodman, an Australian developer, planned to turn the 100-acre site into an office and warehousing park, to create 1500 jobs. Jaguar kept its wood veneering facility in the remaining 17 acres of the site and about 400 staff.

6.2.5 MG Rover (2005)

MG Rover at Longbridge Birmingham closed in April 2005 (Bentley, 2007). The MG Rover Task Force, involving national, regional and local public sector agencies, trade unions and employers’ organisations and automotive industry companies, as well as local MPs was set up. Community groups were not involved, but were influential in shaping policy. Its budget was £150m, extended by nearly £70m of European Social Fund money. Some £40m was set aside for schemes to help ex-workers. Some £60m was available to help supply chain companies.

The public policy response to dealing with the redundancies was as follows. It was more extensive than in other cases:

- Job seeking: Job Fairs; a telephone ‘help line’; an advice pack. Advice on self-employment.

- Advice on Training/re-training courses: free places; free travel.
- JobCentre Plus Service: unemployment and other benefits.
- Help with financial problems: Money advice surgeries; on lower child support agency payments; on mortgages and loan payments.
- Counselling services: Health and lifestyle.

Assistance for firms in the supply chain:

- Wage Subsidy Scheme: firms taking on MGRover ex-workers given payment to send workers on courses; £50 induction support allowance for each eligible worker recruited.
- 'Advantage Transition Bridge Fund' of £20m to make loans of £50,000 and up to half a million, to suppliers who were owed money and who were facing financial difficulties as a result.
- A 'cash breathing space'. VAT, PAYE and national insurance payments could be deferred.
- Help to formulate a business plan to find new business and develop new products.
- Accelerate, an ongoing scheme to help supply chain companies modernise and diversify.

The MG Rover site, owned by property development company St Modwen, saw the development of a £100m Technology Park. Development also included plans for a new site for a Further Education college, a food store, shops and a nursery and pub, to regenerate the area and to provide 2,500 jobs.

A politically sensitive situation, there was some discussion about whether the company ought to be taken into public ownership. It was bought by the Nanjing Automobile Group, which shipped the machinery to China. Taken over subsequently by the Shanghai Automotive Industry Corporation, their plan to use part of the factory to assemble sports cars did not materialise.

Some 6,000 jobs were lost (BBC News Online, 2007). Workers received a reported average of £5,000 in redundancy money. They also expected to receive a compensation payment, this for not being properly consulted and forewarned about the closure. MG Rover workers and campaigners were hoping for £10m-30m to be paid into a trust fund, set up when the assets from within the Phoenix group of companies that owned MG Rover and its businesses were to be liquidated (Guardian, 2012). However, as noted above, given the 'Phoenix Four', utilised a 'value extraction' approach to the firm's assets, creditors were paid first, with the result that only £22,000 was left in the fund, which amounted to £3 compensation per redundant worker. The Phoenix Four were reported as paying themselves £42m (Guardian, 2012).

A study of the closure showed that 90% of the ex-workers had found jobs by the end of 2008 (Armstrong, 2006). However, the jobs paid much lower salaries than workers had earned at MG Rover, as much as £5,600 pa, for those working full-time (Bailey, et al., 2008). The study also found that workers felt more helped by their family and friends to find other work than through the measures introduced by local or national government agencies. We can ask, to what extent a just transition following the closure was achieved for the ex-workers.

6.2.6 Peugeot (2006/7)

Peugeot closed the Ryton-upon-Dunsmore plant near Coventry in January 2007 (BBC News Online, 2006a; Bentley, 2007). The DTI (Department of Trade and Industry) offered a £14.1m grant in an attempt to save the plant but Peugeot received EU assistance to set up a factory in Slovakia.

The 'Peugeot Partnership', under the auspices of the Coventry, Solihull and Warwickshire Partnership, involving Warwickshire County Council, Rugby District Council, Coventry City Council, Advantage West Midlands, (the Regional Development Agency), the Chamber of Commerce, the LSC

(Learning and Skills Council) and Alan Johnson, who at the time, was Minister for Industry, was set up (CSWP Ltd, 2006). This spawned a Jobs and Training Group. Some £18m was allocated to the initiatives (BBC News Online, 2006b).

In response to the closure, interventions included:

Assistance for workers through the on-site Peugeot Resource Centre:

- Job seeking: Information on vacancies and self-employment.
- Training/re-training: Advice on courses.
- JobCentre Plus Service: unemployment benefits.

Assistance for firms in the supply chain:

- Accelerate and Diversification, two long standing business support schemes, run through the Chambers of Commerce, and utilised by the Manufacturing Advisory Service[16] (MAS), set up in 1996 and extended in 2005, provided funds to help firms to modernise and diversify (Bentley et al., 2007).

Consideration was given to the use of the site to generate new employment. Assisted area status was sought which could enable grants to be given to new businesses. Sold in March 2007 to Trenport Investments Ltd, for an undisclosed sum, it was emerging that possible uses for the plant were for a warehousing and distribution centre.

However, some 2,300 workers lost their jobs. It was said that 6,000 job opportunities were offered to the workers, including jobs within the company in Coventry. By August 2006, of the 877 leaving the company at that time, 277 had found jobs, 45 had had retired, with 33 opting for self-employment (CSWP Ltd, 2006). It can be asked whether this was a just transition.

6.2.7 LDV (2009)

Van maker LDV (Leyland Daf Vans), based in Washwood Heath in Birmingham went into administration in June 2009 (Guardian, 2009a). LDV sought buyers. It might also have been expected that with a Labour Government, support would available to keep the factory open; but it was only prepared to offer £5m to help fund a potential takeover (Guardian, 2009a).

The response was steered by the LDV Task Force. Members included national and local government agencies, trade unions, company management, the regional development agency, Advantage West Midlands (AWM), Birmingham City Council, Solihull Metropolitan Borough Council (MBC), the Learning and Skills Council (LSC), the Pensions Service and HMRC (Her Majesty's Revenue and Customs).

Assistance for workers through the on-site Peugeot Resource Centre took the form of help with:

- Job seeking: help on writing CVs; Jobs Fair; Information on vacancies and self-employment.
- Training/re-training: Advice on courses; 'Rapid Response Fund' to provide individual funding of up to £10,500 for training. Learning and Skills Centre used 'Better West Midlands' (a fund

[16] The Manufacturing Advisory Service was set up by government in April 2002. Regionalised, it was launched with a budget of £27m to help improve productivity in SMEs. Its success in assisting companies was due to its use of specialist advisors, who could 'troubleshoot' a firm and give advice on course of action to be taken. Abolished in 2015, as part of the Conservative Government's austerity programme, it was revised as a private sector company in 2017 to help firms grow and improve, by conducting Business Reviews. It also provides help for SMEs to diversify into advanced manufacturing supply chains and to develop better relations with OEMs. Its status is unclear, because it had funding support from the EU. The UK is no longer a member of the EU.

of £12m set up in 2011 to aid all sectors and individuals in the West Midlands) (Dudley, 2015).
- Advice on unemployment benefits; information on state pensions and tax credits advice via a JobCentre Service on site: (Dudley, 2015).
- Welfare: Debt counselling

Assistance for firms in the supply chain:

- Accelerate and Diversification, two long standing business support schemes, provided funds to help firms to modernise and diversify.

It is worth noting that LDV had been seeking loans from lenders and government for at least 5 months, including calling for a £50m loan from the European Investment Bank and for a loan of £60million from the UK government but not forthcoming (Financial Times, 2009a). In contrast, the exchequer cost of closure was higher; LDV calculated that the cost to the government of its own collapse would be £53m in the first year alone in benefits payments and lost tax revenues (Financial Times, 2009b).

In October 2009, Eco Concept, owned by China Ventures and backed by Dr Li, who was involved in the takeover of MG Rover, bought LDV assets for an undisclosed sum (Guardian, 2009b).

About 850 workers were made redundant with some 3,000 jobs in dealers and suppliers being put at risk. It can be argued that the UK lost a capacity to produce the electric vans. The automotive production cluster in the West Midlands was weakened, and skilled workers lost their jobs. The closure of LDV demonstrates the potential dangers of relying on overseas venture capitalists to fund investment in innovation to develop production capability which is then relocated overseas, as is in the case of GKN, which we turn to look at next.

6.2.8 GKN Driveline (2021-present)

It was planned to close the GKN Driveline plant in Erdington Birmingham by January 2022 (Autocar, 2021). It will eventually close in May 2022, Driveshaft assembly is to be shifted to Poland and France (Autocar, 2021). Workers have been offered a favourable redundancy package (BBC Online, 2021).

It was reported that a Task Force was being set up (Interview with respondent 8). Business Secretary Kwasi Kwarteng has said that he would work closely with Unite (the trade union), the Government, the Mayor of the West Midlands and the Leader of Birmingham City Council to explore options to assist workers and to find a use for the site (Birmingham Mail, 2021b).

"*we've established a taskforce bringing together all of the key players, including the company, DWP, City Council, a raft of key players from the industry around alternative employment for those 519 workers. Secondly, what we've also done is to commence a process the Metro mayor for the West Midlands and history to myself of the search for alternative use of the GKN factory, and in particular, alternative use as part of the transformation of the industry and industries more generally, around green productions*" (Interview 8).

Assistance for workers being made redundant, it is understood, includes:

- Job seeking: Jobs Fair with recruiters showcasing available jobs; CV writing.
- Training and re-training: help with finding courses

The closure of this factory has been controversial, not least because GKN was taken over by Melrose Industries in its successful £8.1bn bid for the company in 2018, which sent GKN's share price rising over 6% to 450p (BBC Online, 2018a). In addition, a considerable amount of public money has been used to support Melrose/GKN to develop a new e-drive, at its Oxfordshire research facility (Unite, 2021). It is clear that the Erdington Factory will not be used for its production (Kellaway, 2021). The loss of the factory also leaves a hole in the ICE automotive industry supply chain in the West Midlands. Jaguar and Land Rover, the main customers of GKN, will have to import the components, which might be subject to EU tariffs. It is delivering what the late Jack Dromey MP said was a 'hammer blow' to a deprived area in Birmingham and as representing a loss of jobs and the loss of an extremely skilled and experienced engineering workforce (Birmingham Mail, 2021b).

Melrose Industries specialises in turning round troubled manufacturing businesses and selling them on. And, given that the government will not help keep the factory open, it can be argued that the closure represents 'putting the interests of City speculators over people's jobs'. Some 519 jobs will be lost and, it is expected, a further 1,000 jobs in supply chain firms (Birmingham Live, 2021a). It can be argued that this is hardly a just transition.

6.3 The Industry today: key trends in employment, turnover and value-added

The above sections described a situation in which the West Midlands went from accounting for around 60% of UK car production in the 1970s (despite the distribution of industry policy resulting in the growth of the automotive industry on Merseyside and briefly in Scotland) to less than 20% by 2008, i.e., at the onset of the Global Financial Crisis. Before COVID changed things further, and with Nissan, Toyota, Honda (since closed) and Mini all present, the West Midlands still accounted for 20% of UK car production. The decline has at least been stayed, relatively speaking, with the Indian parent company Tata providing JLR with a period of stability. Despite undoubted strategic mistakes by JLR management and the many global challenges it faces, JLR is operating and appears to have an owner willing to let current management develop and implement a strategy for transforming the company as the transition to electric vehicles accelerates.

As such, creating and sustaining an environment in which JLR can remain active and indeed grow (a recurrent theme in this report) has to be the key priority for local, regional and national policy makers, if the last major automotive company in the West Midlands is to survive. Overseas investors, from the US, France, Germany and Japan (indirectly when Honda licensed technology to Rover) have all failed to keep the automobile industry alive in the West Midlands when domestic owners had also failed (Donnelly et al., 2016). In the following sections, we look at the current state of the automotive sector in the West Midlands in terms of employment, turnover and GVA, before turning specifically to a situational analysis of the electric vehicle (EV) market and its potential in the region.

For this section we have analysed official UK government data from various ONS data sets on labour force trends and economic activity by region in the automotive industry, highlighting the significance of the West Midlands to the UK's automotive manufacturing sector.

The key datasets used are:

- **Employment**: the source used is https://www.nomisweb.co.uk/datasets/newbres6pub. This data comes from the Annual Labour Force survey and shows UK and WM employment as per the two-digit code for automotive vehicles and components (29). This data set covers 2015-2020.

  We have used employment category 29 because this is consistent with the data used for employment trend analysis by the UK's automotive trade association, the SMMT. There is also some automotive employment within category 25 (metal fabrication) and 22 (rubber, including tyres), but this is not readily available at the regional level so has been excluded (for now)[17]. Furthermore, companies reporting in these categories work for a range of end-use sectors and not just automotive); isolating the pure automotive employment for these sectors is impractical.

- **Turnover by region**: the source used here is https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveyregionalresultssectionsas. This comes from the UK's Annual Business Survey, with data available from 2008 through to 2019; data for 2020 has not yet been released (this will come out in May 2022); moreover, given the economic disruption in 2020 due to COVID, the data for 2020 will not be as representative as earlier years for trend analysis purposes.

- **Gross value added by region**: the source used here is https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry and it covers the years 2009-2019. Data for 2020 has not yet been released.

- And **exports by region**: the source used here is https://www.uktradeinfo.com/trade-data/rts-custom-table/; this covers 2013-2020 and H1/2021. We have extracted data for SITC code 78 which covers the automotive sector.

6.3.1 Employment

Much of the change in geographic employment patterns within the region is due to changes in employment policy by Jaguar Land Rover and its supplier base. Recent years have seen employment at JLR sites at Castle Bromwich (north Birmingham), Solihull and indeed Whitely (within Coventry) decline; this is partly because of JLR's reduction in the number of temporary or contract staff employed at all its sites; meanwhile, employment at Gaydon in "rural" Warwickshire has risen.[18] In addition, employment at a number of tier 1 suppliers – for example Faurecia at Lichfield and Fradley, Webasto and Multimatic in Coleshill – has increased over the period concerned. There will have been some ups and downs in employment in component suppliers in line with increases or decreases in production volumes by Jaguar Land Rover. In addition employment has grown at suppliers located at and near to at the MIRA automotive research park at Rugby.[19]

In summary:

- Employment in GB[20] automotive (vehicle) manufacturing has been in the range c153-166,000 in recent years but was higher, at c174,000 in 2008[21], i.e., before the financial crash.

[17] Regional breakdowns for categories 22 and 25 may be accessible in due course upon request from the ONS, although the timing for this and the level of coverage is unknown

[18] As an example see: https://www.theguardian.com/business/2020/jul/07/thousands-of-jaguar-land-rover-logistics-workers-to-lose-jobs#:~:text=The%20news%20come%20just%20weeks,production%20and%20closed%20car%20showrooms. This refers to 1,100 agency jobs being cut by JLR in June 2020, with a further 2,200 jobs at DHL being cut as DHL Logistics support for JLR was significantly reduced in July 2020. In early 2021, as the financial impact of COVID-19 and the chip shortage hit JLR severely a further round of job cuts, covering 2,000 people, was announced: https://www.coventrytelegraph.net/news/coventry-news/jaguar-land-rover-worker-tells-19867362

[19] For example, see: https://www.coventrytelegraph.net/news/business/manufacturing/electric-vehicle-start-up-firm-19847476 which covers the recent announcement of Israeli company REE creating 200 jobs at MIRA to develop its electric vehicle platform to an industrial scale

[20] This extract used for this analysis excludes Northern Ireland because of data suppression by the ONS, although this will make only a minor difference given the modest size of the automotive sector in Northern Ireland.

[21] Source: private information from SMMT

- West Midlands automotive employment (that is, employment in Vehicle Manufacturers) has been between c50-54,000 between 2015 and 2020, i.e., around 33% of the national total.

In the employment dataset there are some apparent inconsistencies between annual national totals and totals derived from regional sub-totals – this is because the ONS deliberately suppresses some data when provided at regional or smaller geographic levels for reasons of confidentiality, especially where one company accounts for an especially large proportion of employment in a specific postcode or town. This output shows rounded employment by local authority area within the region.

Looking the West Midlands specifically, key employment highlights are:

- The proportion of West Midlands' automotive manufacturing employment in Birmingham, Coventry and Solihull has declined steadily since 2015.
- Birmingham automotive employment fell from 16.7% in 2015 to 12% in 2020, while Solihull (containing the JLR plant) fell from nearly 21% to 18% and Coventry (which includes the JLR Whitely site and its special vehicles operations) fell from nearly 19% to 16% over the same period.
- The key winner has been Warwickshire in which automotive manufacturing has risen from 25% to 32% of regional automotive employment.
- These percentage changes are reflected in the decline in the number of automotive jobs between 2015 and 2020 as follows:
    - Birmingham fell from 8,000 to 6,000.
    - Coventry fell from 9,000 to 8,000 and
    - Solihull fell from 10,000 to 9,000 .
- Meanwhile Warwickshire's auto employment rose from 12,000 to 16,000.

These trends are shown in the following tables and figures.[22]

Table 11: Automotive employment by authority area within the West Midlands

	2015	2016	2017	2018	2019	2020
Birmingham	8,000	8000	6,000	7,000	7,000	6,000
Coventry	9,000	9000	9,000	8,000	8,000	8,000
Dudley	0	0	0	0	0	1,000
Herefordshire	0	0	1,000	1,000	0	0
Sandwell	2,000	2000	1,000	2,000	1,000	2,000
Shropshire	0	0	0	0	0	0
Solihull	10,000	10000	10,000	10,000	11,000	9,000
Staffordshire	3,000	3000	3,000	3,000	3,000	4,000
Stoke-on-Trent	0	0	0	0	0	0
Telford and Wrekin	2,000	2000	2,000	2,000	2,000	2,000
Walsall	0	1000	0	0	0	0
Warwickshire	12,000	12000	12,000	14,000	14,000	16,000
Wolverhampton	0	0	0	0	0	0
Worcestershire	2,000	2000	2,000	2,000	2,000	2,000
Total	**48,000**	**49,000**	**46,000**	**49,000**	**48,000**	**50,000**

[22] Note that the JLR factory at i54 (often referred to as JLR Wolverhampton is actually located in Staffordshire)

Figure 1: Automotive employment by authority area within the West Midlands

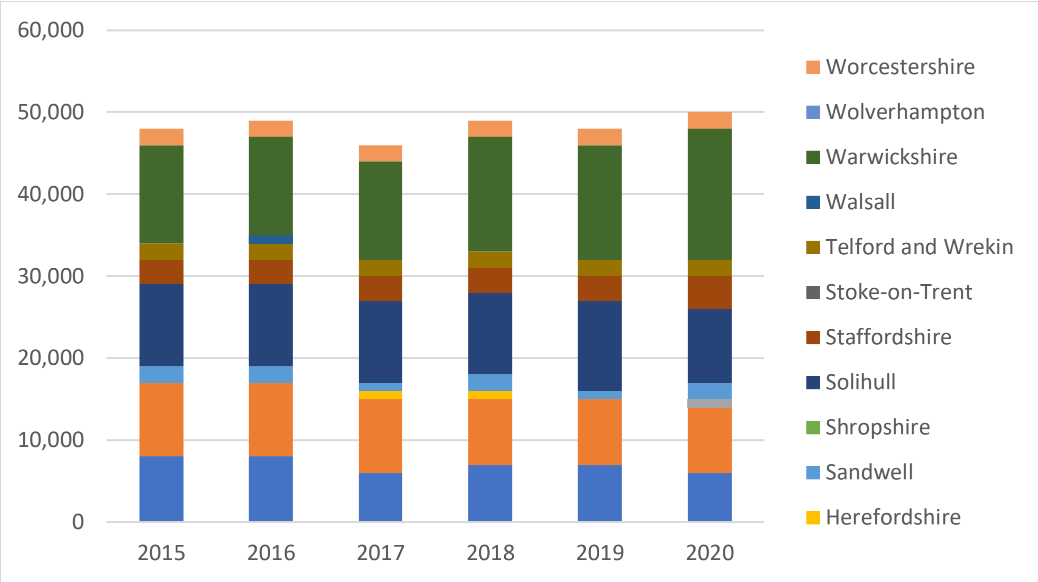
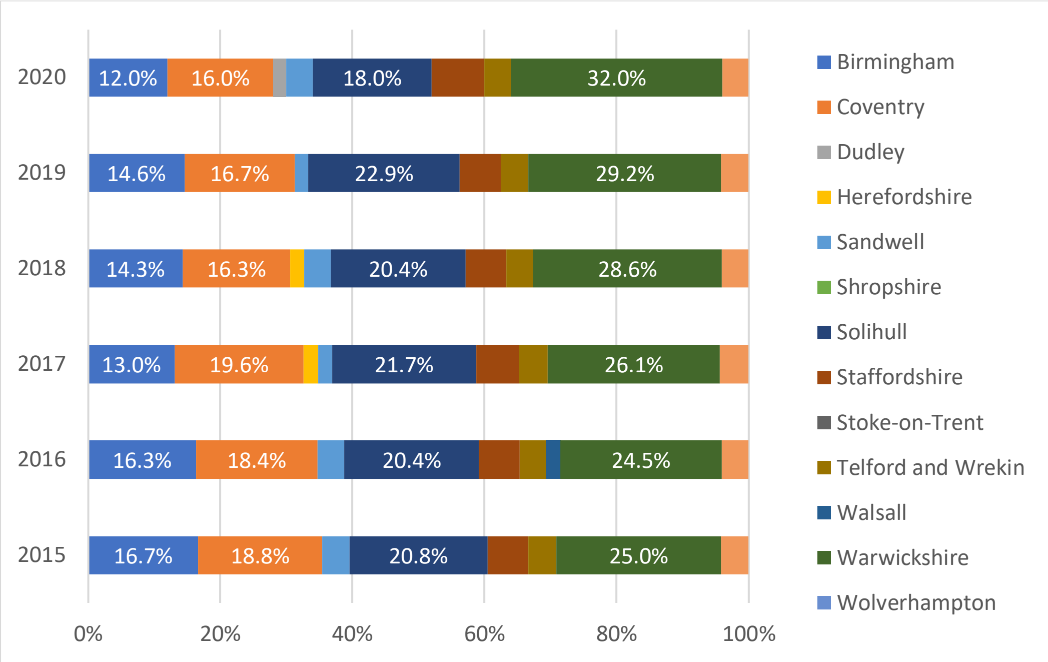


Table 12: Automotive employment by authority area within the West Midlands. %

	2015	2016	2017	2018	2019	2020
Birmingham	16.7%	16.3%	13.0%	14.3%	14.6%	12.0%
Coventry	18.8%	18.4%	19.6%	16.3%	16.7%	16.0%
Dudley	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%
Herefordshire	0.0%	0.0%	2.2%	2.0%	0.0%	0.0%
Sandwell	4.2%	4.1%	2.2%	4.1%	2.1%	4.0%
Shropshire	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Solihull	20.8%	20.4%	21.7%	20.4%	22.9%	18.0%
Staffordshire	6.3%	6.1%	6.5%	6.1%	6.3%	8.0%
Stoke-on-Trent	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Telford and Wrekin	4.2%	4.1%	4.3%	4.1%	4.2%	4.0%
Walsall	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%
Warwickshire	25.0%	24.5%	26.1%	28.6%	29.2%	32.0%
Wolverhampton	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Worcestershire	4.2%	4.1%	4.3%	4.1%	4.2%	4.0%

Figure 2: Automotive employment by authority area within the West Midlands, %



Between 2015 and 2020, automotive employment in the West Midlands fluctuated between 48,000 and 50,000 persons. This has represented a little over 33% of total automotive employment in the UK in each year, except 2018 when it accounted for 32.6%. This is around 2-2.5 times the percentage accounted for by the second ranked region, the North West (which includes JLR at Halewood, Bentley and Vauxhall Ellesmere Port). It is also c3.5 times the percentage accounted for by the North East, i.e., the area including Nissan in Sunderland.

Figures comparing the West Midlands and other regions are shown in the following table and figure:

Table 13: Automotive (vehicle manufacture) employment by GB region

	2015	2016	2017	2018	2019	2020
East	8,300	8,675	4,565	7,295	5,405	5,910
East Midlands	8,925	8,060	8,735	9,775	8,725	8,400
London	4,410	5,085	3,930	3,910	3,200	3,395
North East	14,445	15,430	15,655	17,115	15,710	14,660
North West	19,900	23,800	23,450	24,300	19,000	20,850
Scotland	3,695	3,825	3,320	3,325	3,065	3,400
South East	13,050	15,350	14,020	14,575	17,475	15,975
South West	8,475	10,475	8,400	8,050	8,100	10,575
Wales	10,150	8,965	11,280	10,000	10,510	10,910
West Midlands	51,985	53,545	50,120	53,980	52,890	54,025
Yorkshire and The Humber	11,650	7,545	9,750	13,425	12,825	13,350
Total	154,985	160,755	153,225	165,750	156,905	161,450

Table 14: Automotive employment by GB region, %

	2015	2016	2017	2018	2019	2020
East	5.4%	5.4%	3.0%	4.4%	3.4%	3.7%
East Midlands	5.8%	5.0%	5.7%	5.9%	5.6%	5.2%
London	2.8%	3.2%	2.6%	2.4%	2.0%	2.1%
North East	9.3%	9.6%	10.2%	10.3%	10.0%	9.1%
North West	12.8%	14.8%	15.3%	14.7%	12.1%	12.9%
Scotland	2.4%	2.4%	2.2%	2.0%	2.0%	2.1%
South East	8.4%	9.5%	9.1%	8.8%	11.1%	9.9%
South West	5.5%	6.5%	5.5%	4.9%	5.2%	6.6%
Wales	6.5%	5.6%	7.4%	6.0%	6.7%	6.8%
West Midlands	33.5%	33.3%	32.7%	32.6%	33.7%	33.5%
Yorkshire and The Humber	7.5%	4.7%	6.4%	8.1%	8.2%	8.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

6.3.2 Regional Turnover

Data from the Annual Business Survey for 2008-2019 shows, at the 2-digit SIC level (for category 29), that the UK automotive manufacturing sector, including vehicles and components, had an aggregate turnover of £48.5bn in 2008, rising to over £70bn in 2017-2019. This is shown in the following tables[23]:

Table 15: Automotive (vehicle manufacture) turnover by UK region, £m

Region	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
East Midlands	3,397	2,639	2,875	2,875	2,482	3,161	3,311	3,469	3,462	3,327	3,305	3,742
East of England	4,658	*4,575*	*4,475*	*4,350*	*4,290*	4,254	2,769	2,614	2,449	2,612	2,529	2,420
London	0	0	0	0	0	0	0	0	0	0	0	0
North East	5,352	4,579	5,943	6,813	6,263	6,839	6,595	6,484	8,127	9,051	8,803	7,410
North West	6,119	4,197	5,069	6,711	7,525	9,085	9,545	9,428	9,321	*9,150*	8,220	8,635
South East	*4,750*	4,946	4,086	4,367	4,620	*4,750*	*4,835*	*4,880*	*4,925*	*4,950*	*4,850*	*4,800*
South West	2,882	2,268	2,888	2,625	3,459	2,787	2,535	2,689	*2,900*	*3,175*	3,439	2,938
West Midlands	10,146	7,944	11,368	14,510	15,057	17,768	20,441	21,757	25,040	26,452	27,584	25,582
Yorkshire and The Humber	1,900	1,316	1,340	1,524	1,663	1,638	1,574	1,673	1,776	*1,850*	1,948	1,886
Northern Ireland	424	403	377	399	453	539	621	848	756	609	706	500
Scotland	619	401	357	466	441	506	846	694	719	715	641	651
Wales	3,075	2,205	2,682	2,928	2,516	2,875	3,935	4,303	3,839	4,041	4,217	4,235
Unknown (England)	*5,218*	*2,710*	*3,340*	*4,237*	*3,763*	*4,446*	*4,728*	*5,000*	*6,078*	*7,297*	*7,833*	*8,830*
Total	**48,540**	**38,183**	**44,800**	**51,805**	**52,532**	**58,648**	**61,735**	**63,839**	**69,392**	**73,229**	**74,075**	**71,629**

[23] The total UK figures in the ABS dataset differ slightly from the total derived from figures for English regions in the same dataset. For some regions, data is missing for certain years, e.g., the South West (which included Honda Swindon until its closure in July 2021) is shown as zero turnover for 2016 and 2017; the North West (including JLR Halewood, Vauxhall Ellesmere Port and Bentley) had zero turnover recorded for 2017 and the South East (which includes Mini Oxford, Rolls Royce and McLaren especially) was zero for 2013-2019. We have "allocated" the unallocated total to these regions on the basis of rising or declining turnover in adjacent years for which data is available.

Table 16: automotive (vehicle manufacture) turnover by UK region, %

Region	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
East Midlands	7.0%	6.9%	6.4%	5.5%	4.7%	5.4%	5.4%	5.4%	5.0%	4.5%	4.5%	5.2%
East of England	9.6%	12.0%	10.0%	8.4%	8.2%	7.3%	4.5%	4.1%	3.5%	3.6%	3.4%	3.4%
London	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
North East	11.0%	12.0%	13.3%	13.2%	11.9%	11.7%	10.7%	10.2%	11.7%	12.4%	11.9%	10.3%
North West	12.6%	11.0%	11.3%	13.0%	14.3%	15.5%	15.5%	14.8%	13.4%	12.5%	11.1%	12.1%
South East	9.8%	13.0%	9.1%	8.4%	8.8%	8.1%	7.8%	7.6%	7.1%	6.8%	6.5%	6.7%
South West	5.9%	5.9%	6.4%	5.1%	6.6%	4.8%	4.1%	4.2%	4.2%	4.3%	4.6%	4.1%
West Midlands	20.9%	20.8%	25.4%	28.0%	28.7%	30.3%	33.1%	34.1%	36.1%	36.1%	37.2%	35.7%
Yorkshire and The Humber	3.9%	3.4%	3.0%	2.9%	3.2%	2.8%	2.5%	2.6%	2.6%	2.5%	2.6%	2.6%
Northern Ireland	0.9%	1.1%	0.8%	0.8%	0.9%	0.9%	1.0%	1.3%	1.1%	0.8%	1.0%	0.7%
Scotland	1.3%	1.1%	0.8%	0.9%	0.8%	0.9%	1.4%	1.1%	1.0%	1.0%	0.9%	0.9%
Wales	6.3%	5.8%	6.0%	5.7%	4.8%	4.9%	6.4%	6.7%	5.5%	5.5%	5.7%	5.9%
Unknown (England)	10.7%	7.1%	7.5%	8.2%	7.2%	7.6%	7.7%	7.8%	8.8%	10.0%	10.6%	12.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

These tables show how from 2008 to 2019 the West Midlands has consistently been the largest contributor to national turnover in automotive manufacturing; the region's total rose from just over £10.1bn in 2008 to just under £28bn in 2018 and nearly £27bn in 2019; this period coincided with JLR production at Solihull rising and remaining strong throughout on the back of the Range Rover, Range Rover Sport and Range Rover Velar models. Subsequently, JLR has experienced significant falls in production in 2020 and 2021 owing to COVID-19 and the disruption caused by the semi-conductor (chips) crisis. It is likely that this value will have fallen to around £20bn in both years.

In percentage terms, the West Midlands rose from just under 21% of UK automotive turnover in 2008 and 2009 to as high as just over 37% in 2018 and just under 36% in 2019. This reflects the increased production through this period of the Range Rover family at Solihull, plus – at least for a few years – the Jaguar F-PACE which is also made at Solihull. This period also saw the steady growth in production of engines at JLR's i54 site near Wolverhampton, which further increased regional turnover; the engines from the i54 factory replaced engines bought from Ford at Dagenham, and from Ford engine plants in Wales and Mexico, as well as some engines from PSA (now Stellantis) in France.

The West Midlands figures are significantly higher than the turnover values and percentages of other regions; the North West – which encompasses JLR at Halewood, Vauxhall at Ellesmere Port and Bentley at Crewe in particular – is the second ranked region, accounting for 11-12% of UK automotive turnover. The North West actually accounted for a higher ratio, between 14.3% and 15.5% in 2012-2015; this coincided with peak production at JLR Halewood and higher production volumes for the Astra at Ellesmere Port than has been the case in recent years. Vauxhall Ellesmere Port ran at over 100,000 units pa at peak production for Astra but has been running at lower than 35,000 a year recently.

The North East has generally accounted for 10-12% of UK automotive manufacturing turnover, largely accounted for by Nissan and its suppliers; the ratio was slightly higher in 2010-2011 which reflected the wider range of models made by Nissan at that time and its slightly higher relative price points of the vehicles made at that time. Finally, the South East figures reflect Mini at Oxford mainly, plus McLaren and Rolls Royce, while the South West reflects Honda and the turnover ratio there will decline significantly once the impact of the closure of Swindon plant last year is reflected in the figures.

6.3.3 Regional Value-Added

Between 2010 and 2019, the West Midlands has had the highest automotive regional GVA each year, rising from £1,453m in 2019 to £6.706m in 2019 (it was actually £7,018m in 2018). Over this period, the North West has been the second ranked region, just as it has been in automotive employment and other measures discussed here. However, the gap between the West Midlands and the North West has grown over the period. In 2009, the North West had a GVA of £810m, against the £1,453m for the West Midlands, a difference of 80%; by 2019 the North West had reached £2,212m regional GVA, compared to the £6,706m achieved in the West Midlands, i.e., over three times higher than the North West. Total UK GVA in vehicle manufacturing is shown below:

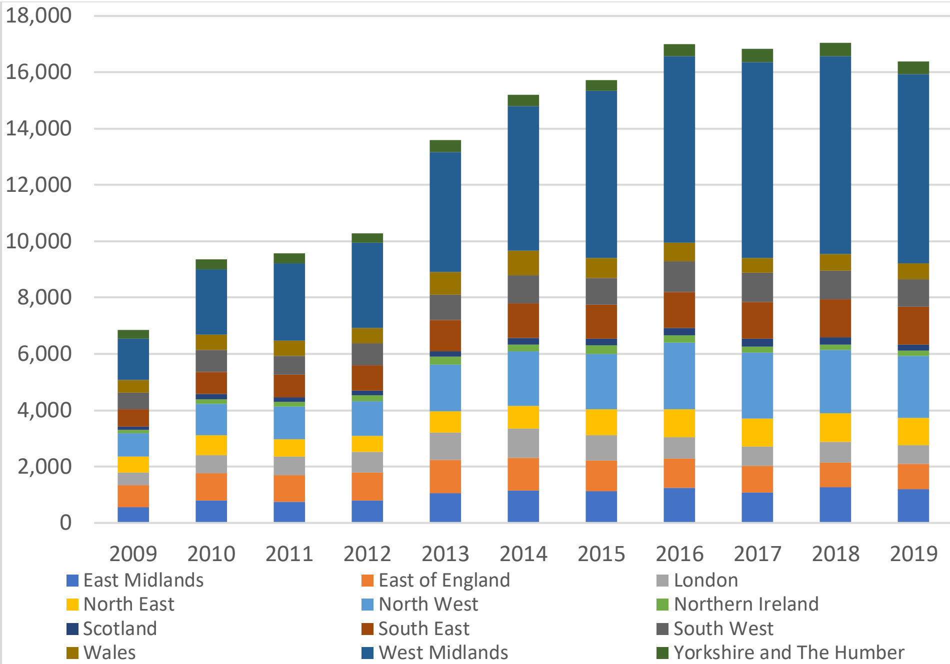
Table 17: Regional vehicle manufacturing GVA, £m

Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
East Midlands	563	796	758	792	1,047	1,155	1,134	1,236	1,078	1,259	1,203
East of England	783	981	927	991	1,186	1,155	1,069	1,041	953	891	889
London	452	627	673	732	966	1,036	919	770	688	719	655
North East	566	712	603	586	755	819	911	985	997	1,034	973
North West	810	1,102	1,174	1,223	1,660	1,927	1,977	2,379	2,327	2,231	2,212
Northern Ireland	134	177	168	213	283	243	296	261	227	196	182
Scotland	123	176	159	152	208	242	236	247	277	251	210
South East	608	781	811	915	1,100	1,215	1,205	1,271	1,306	1,353	1,348
South West	591	778	649	764	908	1,009	940	1,098	1,039	1,027	983
Wales	454	565	549	565	793	868	727	654	514	598	571
West Midlands	1,453	2,300	2,741	3,006	4,261	5,119	5,924	6,620	6,966	7,018	6,706
Yorkshire and The Humber	321	371	369	352	426	408	393	429	452	462	444
Total	**6,858**	**9,366**	**9,581**	**10,291**	**13,593**	**15,196**	**15,731**	**16,991**	**16,824**	**17,039**	**16,376**

Table 18: Regional vehicle manufacturing GVA, %

Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
East Midlands	8.2%	8.5%	7.9%	7.7%	7.7%	7.6%	7.2%	7.3%	6.4%	7.4%	7.3%
East of England	11.4%	10.5%	9.7%	9.6%	8.7%	7.6%	6.8%	6.1%	5.7%	5.2%	5.4%
London	6.6%	6.7%	7.0%	7.1%	7.1%	6.8%	5.8%	4.5%	4.1%	4.2%	4.0%
North East	8.3%	7.6%	6.3%	5.7%	5.6%	5.4%	5.8%	5.8%	5.9%	6.1%	5.9%
North West	11.8%	11.8%	12.3%	11.9%	12.2%	12.7%	12.6%	14.0%	13.8%	13.1%	13.5%
Northern Ireland	2.0%	1.9%	1.8%	2.1%	2.1%	1.6%	1.9%	1.5%	1.3%	1.2%	1.1%
Scotland	1.8%	1.9%	1.7%	1.5%	1.5%	1.6%	1.5%	1.5%	1.6%	1.5%	1.3%
South East	8.9%	8.3%	8.5%	8.9%	8.1%	8.0%	7.7%	7.5%	7.8%	7.9%	8.2%
South West	8.6%	8.3%	6.8%	7.4%	6.7%	6.6%	6.0%	6.5%	6.2%	6.0%	6.0%
Wales	6.6%	6.0%	5.7%	5.5%	5.8%	5.7%	4.6%	3.8%	3.1%	3.5%	3.5%
West Midlands	21.2%	24.6%	28.6%	29.2%	31.3%	33.7%	37.7%	39.0%	41.4%	41.2%	41.0%
Yorkshire and The Humber	4.7%	4.0%	3.9%	3.4%	3.1%	2.7%	2.5%	2.5%	2.7%	2.7%	2.7%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure 3: Regional vehicle manufacturing GVA, £m



The differences shown above – and the primacy of the West Midlands, which these figures clearly show – can almost certainly be attributed to the higher level of transformation and full-scale vehicle manufacturing in the West Midlands compared to activities in the North West; in the North West JLR and Vauxhall vehicles are essentially assembled from locally-made components and those which are "imported" from other locations in the UK, especially for JLR which brings engines, stampings and other parts to Halewood from the Midlands; there are also significant imports from overseas at Vauxhall; at Bentley there is more local value-added than at the other vehicle companies, both within the Bentley plant and from specialist suppliers in the area.

We believe that a large part of the difference between the West Midlands regional GVA in automotive and other regions derives from the supply of parts from JLR in the Midlands to its Halewood plant, plus significance of engine production for Mini (at Hams Hall) and JLR and especially the growth since late 2014 when the JLR engine plant at Wolverhampton opened. Toyota in the East Midlands also uses a number of suppliers in the West Midlands which further increases the level of regional value-added. Nissan also sources around 15% of its UK component needs from the West Midlands.[24] The regional difference also reflects the West Midlands' production of engines for Mini (which are shipped to Oxford and overseas to the Mini plant in the Netherlands) and JLR, as well as other component production and higher vehicle assembly volumes.

6.3.4 Exports

Turning to automotive exports, total UK automotive exports[25] rose from just under £30bn in 2013, to nearly £40bn in 2017, before falling slightly in 2018 (£39.2bn) and fell again in 2019 (to £37.7bn). This was followed by a significant fall to £26.6bn in 2020 (down nearly 30%), due largely to COVID related production and export disruption; the disruption caused by the chip crisis has meant that for H1/2021 exports were just under £14.9bn, potentially indicating a slightly recovery, although the problems with chip supply for JLR and Nissan in particular in H2 mean that when the full year figures are released, they are unlikely to show an increase over 2020. UK car production in 2021 was just

[24] Toyota and Nissan information from proprietary AutoAnalysis data (used with permission from Ian Henry)
[25] Export figures are based on regional trade data from the ONS and analysis at the SITC78 code level for automotive.

under 860,000, down 6.7% from just under 921,000 a year earlier; exports in 2021 were c706,000, or 82% of 2021 production, a slight increase in percentage terms to 82% from the 81% of UK production exported in 2020; export volumes fell from 749,000 to 706,000 despite the slight percentage rise.

As with employment and regional GVA figures, the West Midlands is the largest contributor here; between 2013 and 2018, the region accounted for between 38.3% and nearly 41% of UK automotive exports. This ratio fell to 33.6% in 2019 and to just over 33% in 2020 and H1/2021. This is shown in the following tables:

Table 19: Regional export value for automotive manufacturing (SITC code 78), £m

Region	2013	2014	2015	2016	2017	2018	2019	2020	H1/2021
East	1,365,804,000	1,363,971,000	1,269,070,000	1,729,153,000	1,714,926,000	1,750,023,000	1,539,976,000	1,347,472,000	746,403,000
East Midlands	2,837,255,000	2,558,608,000	2,678,677,000	2,860,987,000	2,679,658,000	2,614,493,000	3,069,217,000	2,429,619,000	1,247,236,000
London	507,164,000	423,231,000	363,692,000	397,393,000	455,142,000	463,004,000	523,332,000	520,600,000	300,244,000
North East	3,101,351,000	3,585,183,000	3,874,239,000	4,285,893,000	4,611,352,000	4,734,025,000	4,238,537,000	2,743,776,000	1,207,776,000
North West	4,059,845,000	4,244,742,000	4,480,407,000	5,327,398,000	5,230,528,000	4,745,493,000	4,739,574,000	3,574,450,000	2,215,314,000
Northern Ireland	313,747,000	325,555,000	347,893,000	329,898,000	380,520,000	430,447,000	453,570,000	344,603,000	148,629,000
Scotland	185,240,000	164,493,000	197,641,000	164,090,000	224,452,000	375,366,000	315,126,000	158,031,000	104,273,000
South East	4,539,016,000	4,489,752,000	4,735,458,000	5,586,444,000	6,390,005,000	6,912,930,000	7,167,170,000	5,194,027,000	3,109,915,000
South West	587,080,000	576,498,000	358,396,000	616,914,000	821,690,000	815,950,000	715,849,000	535,852,000	303,986,000
Wales	394,104,000	335,227,000	350,771,000	497,001,000	571,962,000	593,530,000	586,070,000	455,382,000	290,775,000
West Midlands	11,404,337,000	12,358,603,000	12,265,017,000	14,253,995,000	16,170,904,000	15,214,159,000	13,773,129,000	8,815,240,000	4,936,769,000
Yorkshire and The Humber	510,284,000	451,338,000	446,807,000	430,418,000	497,069,000	536,126,000	542,917,000	431,765,000	240,974,000
Total	**29,805,227,000**	**30,877,201,000**	**31,368,068,000**	**36,479,584,000**	**39,748,208,000**	**39,185,546,000**	**37,664,467,000**	**26,550,817,000**	**14,852,294,000**

Table 20: Regional export value for automotive manufacturing (SITC code 78), %

Region	2013	2014	2015	2016	2017	2018	2019	2020	H1/2021
East	4.6%	4.4%	4.0%	4.7%	4.3%	4.5%	4.1%	5.1%	5.0%
East Midlands	9.5%	8.3%	8.5%	7.8%	6.7%	6.7%	8.1%	9.2%	8.4%
London	1.7%	1.4%	1.2%	1.1%	1.1%	1.2%	1.4%	2.0%	2.0%
North East	10.4%	11.6%	12.4%	11.7%	11.6%	12.1%	11.3%	10.3%	8.1%
North West	13.6%	13.7%	14.3%	14.6%	13.2%	12.1%	12.6%	13.5%	14.9%
Northern Ireland	1.1%	1.1%	1.1%	0.9%	1.0%	1.1%	1.2%	1.3%	1.0%
Scotland	0.6%	0.5%	0.6%	0.4%	0.6%	1.0%	0.8%	0.6%	0.7%
South East	15.2%	14.5%	15.1%	15.3%	16.1%	17.6%	19.0%	19.6%	20.9%
South West	2.0%	1.9%	1.1%	1.7%	2.1%	2.1%	1.9%	2.0%	2.0%
Wales	1.3%	1.1%	1.1%	1.4%	1.4%	1.5%	1.6%	1.7%	2.0%
West Midlands	38.3%	40.0%	39.1%	39.1%	40.7%	38.8%	36.6%	33.2%	33.2%
Yorkshire and The Humber	1.7%	1.5%	1.4%	1.2%	1.3%	1.4%	1.4%	1.6%	1.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

This decline reflects a combination of **reduced** JLR exports (falling Jaguar sales, the loss of Discovery production to Slovakia and therefore the loss of UK exports of this model, and a general decline in Land Rover exports); there has also been a decline in exports of Mini engines as some Mini production has been repatriated from the Netherlands to Oxford. “Exports” of these engines from the West Midlands switch to Mini in the South East; in parallel, with the repatriation of vehicle production from the Netherlands to Oxford, there has been a rise in exports from the South East (which contains the Mini plant in Oxford) from 15% of UK automotive exports in 2013 to nearly 20% in 2020 and nearly 21% in H1/2021. Automotive exports from the West Midlands rose from £11.4bn in 2013 to a peak of nearly £16.2bn in 2017, before falling each year since then. In 2020 exports were just over £8.8bn, a fall of nearly 45% since the peak in 2017. By contrast, the South East’s export value has risen from c£4.5bn in 2013 and 2014 to list more recent peak of nearly £7.2bn in 2019 (the West Midlands’ peak was two years earlier). Although the time period is shorter, the South East’s fall in exports from its peak was just over 27% to £5.2bn in 2020.

7. The Transition to an Electric vehicle Production System

Having considered the key trends in employment, turnover, GVA and exports in the UK and West Midlands automotive sector, we now move on to consider the specifics around a shift to EV production, particularly that of battery production. We also consider the job and skills challenge related to the transition to an electric vehicle production system.

7.1 The UK Battery Challenge

Much is made of the importance of the UK having gigafactories to make batteries for electric vehicles, a view that does seem to be expounded strongly at the highest levels of government in the UK. There is no doubt that having such factories in the UK carrying out some of the battery manufacturing process will make it easier to secure electric vehicle manufacturing in the long run, although exactly which stages in battery production is actually to take place in the UK remains to be confirmed for most vehicle companies.

However, it is not automatically the case that opening a gigafactory in the West Midlands or other region will mean that it will automatically be chosen as the supplier for UK made vehicles, nor lead to an electric vehicle plant opening nor an existing ICE-powered vehicle plant being converted to making electric vehicles. Electric versions of the Mini are made in Oxford and there is no battery factory in the UK for this – the batteries come from Germany (with key parts, the cells, coming from Poland and Asia). Similarly, a new battery plant is being built by Northvolt in Sweden, to supply Volvo, the only car company in Sweden, but first this plant will supply the cells required for Volkswagen and BMW. These cases are worth bearing in mind amidst the clamour for UK battery factories and the assumption – which appears to prevail in the UK Government – that securing battery factories is all that is needed. Customers, i.e., vehicle manufacturers, are also needed. Supplying cells over long distances already takes place and will continue in the future; for example, the distance from Northvolt to BMW in Leipzig, the most northerly BMW Germany factory is at least 1,200kms by road and boat. This suggests that it is not axiomatic that cells especially have to be located close the car plants where they will be used.

Moreover, exactly what future battery factories will actually do could vary significantly. Also, there is no standard definition of what a gigafactory is or means; gigafactories could encompass several possibilities, i.e.:

1. They could be **fully vertically-integrated operations** – as will be the case at Envision for Nissan in the UK – making cells and assembling these into complete batteries.
2. Or it could involve **manufacturing and supplying cells** and/or modules (which are sub-assemblies of a number of cells) to other locations for assembly into finished batteries.
3. Or it could involve **importing cells** for assembly into modules and/or battery packs.
4. Or it could be **a combination of the above**, doing different things for different customers.

An added complication is that there are several different battery cells – cylindrical (the “AA” style cells used by Tesla), pouch or prismatic cells. Each cell type offers different options in terms of packing configuration and the shape and size of the battery pack; the power output and driving ranges required may lead a vehicle company to prefer one cell type over another.[26] The manufacturing process for each cell type is different, i.e., a cell manufacturing line cannot make more than one type of cell, so knowing the requirements of the end customers is essential. In addition, the battery cell market is still evolving technologically and there is no guarantee that the currently favoured types of cells will end up as the long-term dominant technology choice of the industry; BMW, Ford and Toyota for example are especially active in the development of solid-state batteries, which are a different design entirely to cell-based batteries; and a solid-state battery factory would employ very different manufacturing equipment to a cell factory.

There is significant work on battery technologies being undertaken in the UK, much of which is supported by the Advanced Propulsion Centre (APC) in Warwick, a government-funded body. This is undoubtedly providing technical and financial support to new technology companies, as well encouraging co-operation between vehicle companies and suppliers throughout the supply chain. However, converting new technologies developed under the APC umbrella into fully industrialised processes remains a work in progress. In addition, there is little evidence that the key customers for potential UK battery plants – the major car companies – are actively considering emerging battery technology companies for their volume manufacturing needs; companies such as JLR will almost certainly use established battery technologies and companies, whether they are located in the UK or overseas. Others, notably Toyota and Stellantis, are more likely to use future in-house operations within in the EU to supply future battery needs for the UK.

Possible UK gigafactories could carry out any of the work categories described above, or a combination thereof; theoretically such factories could carry out different work for different customers under the same roof. Alternatively, a combination of different activities for a number of VMs, large and small, is possible, but company confidentiality issues will also likely come into play; there is no guarantee that vehicle companies will be happy to share production lines for batteries (they rarely do for other high value components) and will want to protect their uniqueness and technological proprietaries. Clearly the UK Government wants as much local content as possible for any gigafactories it can secure, including cell production, anode and cathode production, electrolyte production, cooling systems assembly and much more.

However, it should not be automatically assumed that the highest value part of the battery, the cells, will be made in the UK in the as yet unconfirmed gigafactories. A key reason for this is the significance of energy costs in cell production; materials extraction, i.e., mining, has been calculated to account for around one-third of the embedded energy in a Nissan Leaf battery, while cell production accounts for close to two-thirds, with the very small balance accounted for by the assembly process. With UK energy prices so high and the energy market in a state of flux, there is a risk that energy costs could undermine the business case of UK cell production. Further details on energy costs are provided later in this report. Analysis of the sourcing options for the UK vehicle companies follows.[27]

In May 2021, the Financial Times suggested that the UK Government was in discussion with several potential gigafactory operators, as follows[28]:

[26] There is also a lot of innovation in battery design, with new batteries – using different combinations of minerals and electrolytes - for longer life and better durability. It is unclear whether any gigafactory proposals could "pick a winner" in terms of battery cell types for example.

[27] The battery company analysis is summarised from a number of private reports undertaken by AutoAnalysis in 2021 for clients; this information is used here with permission of AutoAnalysis.

[28] Add FT May 2021 article ref

1. The Envision plant to support Nissan;
2. Britishvolt which is building a battery plant at Blyth in Northumberland;
3. The proposed plant at Coventry airport;
4. Ford (which would likely be a JV with SKI of Korea were it happen);
5. LG, and;
6. Samsung.

Nissan-Envision

The **Nissan-Envision** plant, which was confirmed in June 2021, involves a significant expansion of the existing battery manufacturing activity at Nissan's Sunderland site. Chinese battery producer Envision, which currently operates a 1.9 GWh plant for the Leaf batteries, will invest £450m to raise annual output to 6 GWh, sufficient to supply batteries for 100,000 vehicles a year. Press reports have suggested this could increase to 18-20 or even 25 GWh per year with another £1.8bn investment. **This investment commitment supports the view that all major gigafactory investment will be at the behest of vehicle companies, and not vice versa**. The new plant will begin as a sole supplier to Nissan. At the time of this announcement there was some speculation that it could supply other UK vehicle companies. However, at this stage we think this is unlikely,[29] especially if Nissan moves rapidly to full BEV production, in which case the additional investment referred to would be required for Nissan alone.

Britishvolt

This is an all-new company with planning approval to build a battery plant at Blyth in the north-east of England, and a stated intent to set up a "global headquarters" in Coventry in 2022.[30] It is a start-up company, and has backing from Glencore and the financial markets, allied to support from local and national UK government bodies.[31] However, **it has no proven technology, nor a production track record, and crucially it has no publicly confirmed customers, although press reports have suggested a memorandum of understanding has been signed with Lotus (although Lotus volumes will not fill this factory at all).** Discussions are also under way for Aston Martin to buy batteries from Britishvolt and while this is welcome, it will also only make a small dent in the plant's capacity.

The company plans to install capacity for 30 GWh (i.e., 5 times the planned capacity at the new Nissan Envision facility) to supply batteries for up to 300,000 vehicles, beginning in 2023. The FT reported on September 15, 2021, that more than two thirds of the initial 10 GWh capacity has already been "signed up for" by three vehicle companies, although who they are is not known.[32]

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[29] Notwithstanding Australia's success at convincing firms to share components (although this would appear to be something of an exception) – the particular policy context here is key.
[30] https://www.britishvolt.com/news/britishvolt-announces-plan-for-new-global-headquarters-in-west-midlands/
[31] https://www.britishvolt.com/news/britishvolt-successfully-develops-production-intent-battery-cells-signs-agreement-to-scale-up-next-generation-cell-technologies-with-uk-battery-industrialisation-centre/
[32] https://www.ft.com/content/9d8a51de-022c-47e7-bc62-da0cb7801f48

However, press reports in January 2022 suggests that the funding round had only just been completed and it is far from clear who would be the actual customers for this factory.[33] It seems unlikely that JLR would source a critical part, i.e., batteries, or even just cells, from a new start-up company without a proven record. Off-the-record discussions with industry contacts suggest that Britishvolt's first customers will actually be truck or bus companies; press reports suggest some low volume sports cars could use Britishvolt batteries, but this is far from certain.

Truck company business would be at much lower volumes than for most car companies, although the batteries themselves would be much bigger, and more powerful and expensive on a per unit basis. Even so, it is not clear how low volume CV companies could account for two thirds of 10 GWh apparently already "ordered".

Coventry Airport

There were reports in 2021 that a new company, InoBat, would build a factory at the site of the former Coventry Airport, although it is clear that such reports were very premature.[34] Like Britishvolt, InoBat is a new company, based in Slovakia. It has been reported as having received advanced or provisional planning permission for a gigafactory at the Coventry Airport site.[35] It has received financial backing from RTZ[36] and Ideanomics, a US electric vehicle group.[37] Based on information on its website and technical press reports, InoBat would appear to be further advanced than Britishvolt in terms of technological development, but it too has no confirmed customers.

Planning permission for the Coventry site has only recently been granted but no firm indication has yet appeared on who will operate the site, nor who the customers of the batteries will be. There is an implicit assumption in the reporting on the Coventry Airport site that JLR will source batteries from this site. This could happen, but it is highly **questionable whether JLR will source batteries from a new, and as yet, unproven company.** Significant (if unspecified) UK Government funding and support has been announced for this site, but there is a risk of this being a case of putting the cart before the horse, as no customers - nor an anchor tenant – at the time of writing, have been confirmed.[38]

Ford

The FT suggested in June 2021 that Ford was considering making batteries in Dagenham. This could replace its current diesel engine activity there which supplies its Transit van factory in Turkey. Instead of delivering diesel engines, the factory could supply batteries made in the UK, using existing supply chain arrangements for diesel engines for the Transit. Ford is in the process of installing capacity to assemble up to 130,000 batteries a year in Turkey for the current electric Transit. The sourcing of the cells for these batteries is not known but initially at least these are likely to come from one of the SKI sites in Hungary. SKI is currently investing heavily in Hungary, where it will have over 70GWh capacity by the mid-2020s.

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33 https://www.ft.com/content/96020ff3-4c01-41f7-9618-894fd65018d2 and https://www.theguardian.com/environment/2022/jan/21/britishvolt-electric-car-battery-uk-gigafactory-blyth-jobs, both January 21, 2022

34 https://www.business-live.co.uk/economic-development/coventry-airport-closes-operations-cease-3936098

35 https://www.electrive.com/2021/06/17/uk-in-talks-to-build-gigafactories-for-ev-batteries/

36 https://www.riotinto.com/en/news/releases/2021/Rio-Tinto-partners-with-InoBat-to-explore-innovative-lithium-battery-initiative

37 Financial Times, January 4, 2022

38 see: https://www.bbc.co.uk/news/uk-england-coventry-warwickshire-60171465

Ford has also indicated that it will make batteries in Europe in a joint venture with SKI of Korea and if the potential Dagenham plan proceeds, it is likely that SKI would be involved in such an investment[39]. SKI is currently investing heavily in Hungary where it will have over 70GWh capacity by the mid-2020s.

LG

As one of the major global battery manufacturers, the South Korean firm LG is being courted by many countries worldwide. It already has a major plant at Wroclaw in Poland; this had 45GWh capacity in 2020, which is in the process of being expanded to reach 70 GWh by 2025. LG will not build a UK battery plant, whether for cells and full battery packs, or simply for final battery assembly, **without a guaranteed contract from a UK vehicle company**. Such demand would realistically have to come from JLR or Mini, as Stellantis, Nissan and Toyota have or would have other preferred suppliers. Given the existing supply arrangements between LG and JLR (for the I-PACE), we think LG is well placed to win this business at JLR.

Samsung

As per LG, Samsung is one of the major global battery manufacturers; it has strong East European presence in Hungary, with two plants, one currently with just 2.5 GWh capacity, which will rise to 20 GWh by 2028; a second Hungarian plant is due to come on stream by the end of 2021 with 7.5 GWh capacity. Again, as per LG, in our opinion Samsung will not build a UK battery plant, without a guaranteed contract from a UK VM.

7.1.1 Potential sources of batteries for VMs

Having reviewed the potential investment by battery companies above, in this section we look at it from the other side, i.e., how the UK VMs might source batteries, taking into account the trend across the industry which sees the major VMs taking increased control of battery manufacturing. The attitudes of major companies, including VW, Mercedes and Stellantis, and their recognition of the value-added which batteries represent, have been made clear regularly in these companies' statements regarding new battery plants, which will either be owned by or directly controlled by the vehicle companies.[40]

The manufacturing of cells, assembly of cells into modules and of modules into complete battery packs and the value of embedded development of battery technology is estimated by major VMs to represent at least one-third (if not half) of the value of a battery – a figure which makes clear why VMs are now taking control of battery production, especially when set alongside the current high level of the total value of the car that a battery represents. The remainder of the value of the battery resides in components and raw materials, which explains:

- Why BMW for example is bringing some non-cell battery component production in-house.
- Why Tesla has begun to take stakes in some mining activities to guarantee lithium supplies.

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[39] https://www.electrive.com/2021/05/21/ford-ski-to-launch-battery-joint-venture/ covers the US plans for Ford and SKI; and https://www.reuters.com/business/autos-transportation/ford-battery-venture-with-sk-innovation-will-extend-into-europe-ford-exec-2021-08-11/ notes that this JV will extend to Europe

[40] https://europe.autonews.com/automakers/vw-stellantis-renault-enter-new-battlefields-ev-race from August 2021 is a very good summary of the situation

- And why VW was, at one point, considering siting a new car plant in Serbia to secure lithium suppliers and may take a stake in another mining company or venture. Other VMs are looking at similar moves and we would expect this to happen in the near future.

Battery cells are also now recognised as potential sources of differentiation in the same way that engines have been product differentiators in the past – and to differentiate high performance versions of even mid-market brands, VMs are beginning to take stakes in specialist battery companies. For example, Renault has taken a 20% stake in high performance battery maker Verkor which will supply batteries for Renault models from a new plant to be built at Dunkirk and also the new Alpine EV range.[41] Porsche has done the same with Varta in high performance cells.[42]

In the volume segment, VMs want to develop standardised cells to maximise cost control; using standardised cells is at heart of VW's battery plans and though using standardised cells, Stellantis expects it can cut battery costs by 40% by 2024; Renault expects to cut battery costs by 60% by doing the same, admittedly by 2030. In addition, battery technology is evolving rapidly, with new chemistries and metals likely to be used in the years ahead, while solid state technology (as opposed to prismatic, pouch or cylindrical cells) will be introduced by the late 2020s.

The above trends need to be borne in mind when looking at the battery and cell sourcing possibilities for the UK VMs. As such, our understanding of the likely or potential sources of batteries for EVs for the major UK vehicle manufacturers is detailed in the following section.

7.1.2 Sourcing potential of UK VMs

In considering sourcing potential, it should be noted that Nissan's sourcing is set and decided. However, for the other volume manufacturers the situation remains fluid. The options open to the other volume manufacturers is set out below:

JLR

This still remains to be confirmed; CEO Thierry Bolloré had suggested that JLR would confirm its battery sourcing plans by the end of 2021. In an interview in the FT in June 2021,[43] Bolloré also said he wanted to secure as much of the battery chain as possible close to JLR's UK plants. At the time of writing there has been no formal announcement of JLR's battery sourcing plans. JLR will likely outsource cell production (it does not have the volumes to justify its own cell production, nor the financial resources to fund this). The key issues at stake are the cell suppliers and their location(s) for the assembly of modules and full battery packs.

Some UK press outlets have suggested that JLR will use Britishvolt, but this is far from certain; the backers of the proposed gigafactory at the former Coventry airport site also hope that JLR will source batteries from this site. JLR already has experience of using LG for the batteries for the I-PACE made in Austria, so LG has a potential advantage here. Battery sourcing for the new Jaguar range will be partly determined by the base platform used for these vehicles; if the base platform for the new Jaguar range is bought-in, then it is highly likely that the cells and possibly complete batteries will be sourced outside the UK from the same supplier(s) as for the base platform.

It is also worth noting that JLR could actually carry out the final assembly of some batteries at Castle Bromwich (it has committed to re-purposing this plant once vehicle assembly stops and battery assembly would be an obvious task for the factory, possibly assembling imported cells). That said,

[41] https://www.uktech.news/news/verkor-funding-signs-partnership-with-renault-20210706
[42] https://www.electrive.com/2021/06/22/varta-finds-first-client-for-new-v4drive-cells-in-porsche/
[43] https://www.ft.com/content/15450fa5-163f-4503-9781-a116edf41839

depending on the volumes involved the first JLR UK-made EV (due in 2024), this could well have a battery which is fully assembled outside the UK, but over time we would expect at least some of the module and battery assembly to take place in the UK, for the UK-made vehicles. JLR will also want to make full use of the Castle Bromwich site and its relative proximity to Solihull – and the lack of space there – means that Castle Bromwich could be used for battery assembly.

Mini

Currently Mini sources a fully assembled battery from BMW's plant at Dingolfing in Germany using cells from the Korean battery supplier LG. This arrangement for the c30-35,000 electric Minis expected to be made annually over the next few years will continue for the current model's life cycle.

The issue at stake is the battery sourcing arrangements for the next Mini. This will become apparent once the next Mini range for Oxford has been confirmed. Future Oxford-made electric Minis will likely use the same supplier as the German-made Mini Countryman. This supplier has not been confirmed, nor if the Countryman will use batteries delivered fully assembled or if BMW will do some or all of the assembly of cells into batteries itself.

At present, expectations are that the next Mini, made on the BMW FAAR platform, will start production in Oxford in 2026, possibly a year earlier, but whether full electric versions will begin at this time, or whether the next Mini will start life as a petrol vehicle remains to be seen. Oxford itself is space-constrained and could not assemble c200,000 batteries annually if the factory switches entirely to BEV output. Equally, BMW Swindon would not have sufficient space, further suggesting that Oxford would use entirely outsourced batteries. BMW Hams Hall will continue making engines for Mini until UK production is fully electric. However, it is unlikely that Hams Hall could accommodate battery assembly at present.

Stellantis

Stellantis is in the process of readying the production start-up of its own cell producer, ACC, a joint venture with Total and SAFT. In September 2021 it was confirmed that Daimler will become a partner in this project. Battery cells and assembly of batteries will begin at two Stellantis sites, Douvrin in northern France (currently a PSA engine plant) and Kaiserslautern in Germany (currently an Opel transmission factory), from 2023-24.

Stellantis will also build a battery plant at a Fiat engine plant at Termoli in Italy, in a JV with a new supplier SVolt, as well as continuing to source some batteries from external suppliers, namely CATL and BYD (both from China) and LG (from Korea). A battery plant in Spain is also expected. Cells will also be made by Daimler for use on Mercedes models. Having relied entirely on external battery suppliers until now, Stellantis is now looking to take increased control of the battery supply chain and will (like VW) gradually reduce its use of external suppliers. **This is in line with industry trends in which the vehicle companies are taking control of the battery supply chain**.

The electric van to be made in Ellesmere Port from late 2022 will be an updated version of the electric version of the Berlingo/Rifter currently made in Vigo, Spain; these currently use cells from CATL in China with assembly into batteries taking place in Spain. The ACC factories in Germany or France will **not** be ready to supply cells or modules by the time UK EV production begins. Initially, therefore, we expect that CATL will continue to supply cells as now, from China into Spain and then – as assembled batteries – on to the UK. Once ACC is up and running and volumes coming out of Ellesmere Port have increased, we expect cells will be supplied from one of the ACC plants to

Ellesmere Port. Furthermore, given the likely initial volumes for the electric van, a maximum of 50,000 a year, there is no serious likelihood of a dedicated UK gigafactory for this project.

Toyota

Currently Toyota sources batteries for its hybrid vehicles from Japan. This will not change for the current model and is unlikely to change for the likely second version of Corolla from 2026.

Sourcing arrangements for hybrids or potential BEVs from the 2030s will depend on model and market allocations for the UK plant and Toyota's broader battery plans for Europe. Toyota has yet to confirm when it will make BEVs in Europe, where these will be made and where the associated battery supply point would be located. We do not expect any firm commitments on any of these issues for a couple of years at least. However, looking at what Toyota is doing elsewhere in the world, we expect that Toyota will almost certainly build its own battery factory in Europe, and it is also possible that Toyota could "jump" technologies and use solid-state batteries in its European-made cars. This would likely make existing cell-based gigafactories incompatible with Toyota technology.

7.2 The UK Jobs and Skills Challenge

The production of electric vehicles will see a change in shift in skills requirements in the automotive industry. Bauer et al. (2018), in their study for the Fraunhofer Institute found that increases in the production of electric vehicles will result in a move away from traditional M/M (metals and mechanics) professions to E/E (electrical, electronics, mechatronics) professions. An earlier study for the Fraunhofer Institute (Spath et al., 2012) forecast that in the transition to electro-mobility in the short term, in favour of (highly automated) assembly processes, metal working activities, especially stamping and cutting (turning, milling, drilling, grinding) are declining in importance (ibid.). In contrast, skills such as setting up, operating, monitoring and maintaining automated production facilities, as well as testing, checking and quality assurance are becoming increasingly important.

In regard to battery production, a study by the Faraday Institute examines employment activities for different job types in a gigafactory (Faraday, 2020). Employment activities are not the same as *skills* requirements, but the analysis in the report does give the opportunity to discuss and debate what skillsets will be required to carry out employment activities for each job type. It is essential that further work be carried out to reach a thorough understanding of electric vehicle production processes, job structures and the tasks to be carried out. Intelligence gathering would lead to a better definition of *skills* requirements, better design of training programmes and enable the codification of qualifications. In addition, there will be the opportunity to learn from other UK and overseas experience of the operation of gigafactories, as they develop. Lessons could certainly be learned from the Nissan experience in Sunderland.

Table 21 gives some indication of the employment activity profile for different job types. The report suggests that there will be two predominate job types in gigafactories and which will account for 75% of jobs. Firstly, 'Production Operators', those who perform manual tasks which cannot be automated and who will principally be trained on the job. Second, 'Equipment Technicians' who, with the Production Operators, will be responsible for the efficient operation of the automated part of the manufacturing process. Both groups will have to be educated to level 2 or 3 qualifications and, in particular, will have to take a course in Advanced Manufacturing Engineering. The report suggests that recruits to these roles could come from other sectors, such as the processed food or pharmaceutical industries, where large scale automated production is highly developed. These groups of workers would also need training in specialised skills such as the risks associated with handling chemicals and hazardous materials used in the production of electric vehicles.

Table 21: Employment activities and level of qualification by job types in a typical gigafactory

Job Type	Employment Activity Profile	% Jobs & level of Qualification
Production Operators	Material handling, machine loading, machine unloading, pack assembly, logistics, module/pack assembly, inspection	60% Level 1-3
Equipment Technicians	Machine Service, machine maintenance, optimising machine performance, quality control, reviewing cost & delivery	15% Level 3-5
Engineers & Senior Staff	Facility Engineers, process/production engineers, IT and data management, achievement of KPIs, legislation checks	10% Level 6 & up
Quality Technicians	In-process controls, confirmation of specifications (parts and supply), performance evaluation, assessment of defects	5% Level 4
Quality Engineers	In process controls, confirmation of part/supply specification, performance evaluation, defect analysis	5% Level 6
Management & HQ functions	HR, Finance, purchasing, IT and data management	5% Level 6 and up

Faraday Institution, (2020).

Engineers & Senior Staff and Quality Engineers, on the other hand, who carry out highly skilled activities, require higher level qualifications (See table 25). Systems Engineers, Database Development Engineers and Thermal Management Engineers, for example, require the highest level of academic qualifications (a PhD). The report also highlights that the technical nature of cell manufacture in general begs the need for higher level skills. It also highlights that management roles would entail the carrying out of tasks such as monitoring advances in production technology, for example, the 'Industrial internet of Things', data-driven production, optimisation, automation, materials analysis, continuous improvement and stimulation, in order for businesses to maintain competitive edge in the global market (Faraday Institution, 2020, p.5). The skills required to carry out such tasks need to be elaborated so that training courses that meet skills needs can be designed.

The Fraunhofer Institute has also carried out a study, for Volkswagen, which elaborates on this analysis and points to the skills, qualification and training requirements of the electric vehicle production system (Herrman et al., 2020a). VW is atypical in the sense that it not only produces vehicles but also produces component parts, employing 600,000 worldwide, with 80,000 working in the Volkswagen Group Component division. This includes the five business areas of Engine & Foundry, Transmissions and E-Drive, Chassis & Battery System, Battery Cell, and Seats.[44] Nonetheless, the Fraunhofer report argues that the findings apply to other case examples and, in general, to the automotive industry.

Similar to the other studies undertaken by the Fraunhofer Institute, this study also models the expected change in the level of employment in different departments (business functions) as well as for occupations, based on assumptions about the numbers of workers needed to carry out tasks in the production of a set number of vehicles in the electric vehicle production system. The quantitative work was coupled with qualitative research involving extensive interviews with main players in Volkswagen and industry experts. Similarly to the Faraday Report, the study serves to generate discussion about the skills, training and qualification requirements of the employment implications of the transition to the production of electric vehicles. Volkswagen's aim in this

[44] It should be noted that the seats unit has been placed in a separate JV with seat frame and mechanism company Brose and the new entity will manufacture seats for other VMs, so this could soon be only a four business area unit.

transition is to “do justice to all three dimensions of sustainability – economic, ecological, and social“(Herrman et al., 2020a, p.18).

Most importantly, the report demonstrates that Volkswagen is well ahead in responding to the changes that will take place in job, skills and qualification requirements in the transition to the production of electric vehicles. The report states that working in a collaborative way among the players in the production system has been vital in developing a response to the challenges in relation to the demand and supply of skills. Its *Transform 2025*, *Future Pact* and *Digital Transformation Roadmap*, have guided the development of its training and higher education programme. In setting up *Faculty 73* it is providing in-house training, in particular in software development (ibid.). This links with external degree programmes being provided in universities.

To assist in assessing the demand for different types of workers, the study presents estimates of the degree of job loss and gain within different business functions (See Table 22).

Table 22: Estimated Upper/Lower Percentage Job Loss/Gain by Business Function

BUSINESS FUNCTION	DEGREE OF JOB LOSS/GAIN
Production	-13% to -5%
Technical Development	+2% to +7%
IT	+4% to +2%
Logistics	-20% to 0%
HR	+3% to +5%
Finance	-2% to -1%
Procurement	-6% to 0%
Marketing	0% to +2%

Herrman et al. (2020a)

The table shows that expected job loss in production is high; albeit, as the report says, this figure is not as high as found in other studies. Job loss is estimated to be high in the Logistics and Procurement departments, this it is argued, due to digitisation. These functions are more likely to be automated (Frey and Osborne, 2013). It is in the area of technical development that employment is expected to grow, due both to electrification and digitisation of the system of production of electric vehicles. The carrying out of each of these functions requires skills in data management and analysis and software engineering.

Further detailed analysis illustrates the possible impact of the transition to an electric vehicle production system on job loss and gain (pessimistic and optimistic views) in occupations in the production and technical development departments (See table 23).

Similarly to the Faraday Institute report, the Fraunhofer study finds that in the transition to EV production, there will still be a demand for skilled workers in the operative production of vehicles and parts, including the supporting and executive tasks, (those workers with 2 year vocational training). However, nevertheless, many of this type of skilled jobs found in ICE vehicle production systems will disappear (-10% to -30% of jobs). Workers and their skills will become redundant. VW appears to be conscious of this. It has agreed to secure all jobs to 2029 (Herrman et al, 2020a: 19). It has also said it will create jobs in other business activities and will re-train workers to do the jobs in new business areas. In addition, it has said that it will guide employees through the transition and will offer help to workers to gain qualifications to enhance their employability (Herrman et al., 2020, p.72).

Table 23: Estimated impact of electrification and digitisation on occupations/job types in production and technical development departments

Job impact within production and technical development departments	Pessimistic Assumption	Optimistic Assumption
Operative production of vehicles and parts, supporting and executive tasks	-30%	-10%
Supply chain coordinator	-10%	0%
Production coordinator	-10%	0%
Machinery supervisor	-5%	0%
Project Managers	-4%	0%
Production Planner	-3%	0%
Developer	0%	5%
Electrotechnical worker	0%	10%
Software developer	5%	30%
Data Analyst	250%	350%

Herrman et. al. (2020a, p.93ff)

The report makes it clear that there will be a large increase in demand for data analysts (250%-350%) and software developers (5% to 30%). It argues that there is a particular need for engineers with software and digital skills. The report moreover argues that in general all workers will need to have software and digital skills and, at the same time, that jobs in the electric vehicle production system will require workers with a higher level of education and training (to a first degree level and higher). Alongside this, the report argues that the industry needs workers who can think and act in an interdisciplinary manner (Herrman et al., 2020b, p.u7).

In more detail, in the production of electric vehicles, the installation of interior components or the laying of cable harnesses, requires a knowledge of electrics, electronics, and IT, as well as the handling of high voltage systems. It demands a basic knowledge of electric vehicles, which requires high voltage awareness training, the knowledge of networking, data management, and process planning. It is worth noting that Volkswagen has already developed a training programme leading to a qualification in these fields. Some 7,700 workers at its Zwickau plant have been trained in the production of electric cars (Herrman et al, 2020a: 26).

The transition to electric vehicle production also has implications for the production of components, Volkswagen having its own components division (Volkswagen Group Components) as noted above. The Fraunhofer report notes that the production of components for electric vehicles requires at least 60% fewer workers than for the production of components for ICE vehicles. (Herrman et al, 2020a, p.29). This will lead to job loss and workers with redundant skills. Volkswagen has taken the view that the workers in ICE component production can be retrained to work on the production of components for electric vehicles, including the production of batteries.

In general, skills requirements for the production of batteries include knowledge about working with high-voltage components as well as the operation and servicing of machines for the production of electrodes and quality management for electrochemical energy storage. Volkswagen has begun setting up training programmes to ensure workers have the required skills. Where redeployment is not possible, Volkswagen, in the effort to ensure a socially responsible transition, through *worker transformation*, as noted above, plans to train workers to produce completely new products (Herrman, 2020a: 33). At the same time, the company acknowledges that job cuts will have to be made (Herrman, 2020a: 28). It has offered the option of partial and early retirement to workers, accompanied with generous redundancy packages (Schwartz, 2021).

In a further development in relation to business organisation, Volkswagen is building a Digital Production Platform at Group level in which data from machines, plants and system are bought together with finance and procurement to streamline the production system, from the order through to the sale of a vehicle. It requires workers with the skills in digital technologies, this to enable an efficient and profitable electric vehicle production system to be built. It is here that digitalisation, as an adjunct to electrification, will have a further impact on skills requirements. In particular, not only in the area of technical development but also in administration and management functions.

The application of applied research, for example, on Advanced Systems Engineering (Kubler et al, 2018; Masior, 2020); Simulation-based Product Development (Scheifele, 2019); Virtual Validation (Deicke, 2018) and Software-defined Manufacturing (Lechler, 2017) is meeting the requirements for dealing with complexity, resource optimisation and virtualisation (Herrman et al., 2020a, p.49). In addition, interdisciplinary collaboration (Hertwig et al., 2020) and the introduction of new working methods (e.g., agile development) (Schmidt, et al 2016) is being employed by the company to enhance the utilisation of the new techniques for production (Production Engineering). Clearly this is reflected in the expected increase in demand for data analysts and software developers (See table 27). VW has already taken steps to meet skills requirements in these areas, by setting up on-line training courses, by providing tutors, as well as establishing internal training courses, these to enable workers to develop required skills. Herrman et al (2020a) argue that VW is not doing this quickly enough.

The findings of the study shed further light on skills requirements and training needs. However, it can be argued that they are not detailed enough. It is clear that further work is required to map out more precise requirements for skills; so that courses and qualifications in different occupation groups can be designed which best meet skills requirements. Of course, new job types will emerge as the electric vehicle production system develops. It will require new skills that are not as yet defined and not yet found in the labour market.

This is the challenge that the UK and the West Midlands faces in transitioning to an electric vehicle production system. It will mean that there is a need to gain an understanding of skills requirements for such a production system. New training programmes will have to be designed and new qualifications codified in order that companies will not experience skill shortages, especially in specialist areas, and that workers will be able to obtain what will be high paid, high skilled jobs in the EV production system.[45]

[45] See CLEPA https://clepa.eu/who-and-what-we-represent/suppliers-eu-employment-footprint/skills-dimension/.

8. Understanding the issues of transition for suppliers in the West Midlands: primary data findings and analysis

In this chapter, we now draw upon primary data to look at the impact of a shift to EV on suppliers in the automotive sector in the West Midlands, drawing on comparisons with companies elsewhere in the UK and internationally where appropriate. As the previous material has alluded to, the potential implications for output and employment in the supply chain are significant, with the attendant potential for job loss being particularly concerning. In the discussion that follows, which draws upon primary and secondary data, including the findings from interviews and the survey, we first examine the dependency of suppliers on the key VMs in the region, before turning specifically to issues around electric motor production and battery production. This is then followed by a discussion of skills gaps and infrastructure concerns. In order to assist consequent discussion, the key parts and components of EVs (and hybrid vehicles) are reproduced in Appendix 2.

8.1 Transitioning and the supply chain

As the Australian evidence demonstrates, key to establishing the prospects for the supply chain to undergo a successful transition is to establish the nature of their exposure to key VMs – and thereby to ascertain whether diversification (into related or unrelated sectors)[46] is a viable strategy for those that do not wish to, or cannot, transition to zero-carbon production in supplying automotive. This was commented on by a majority of our respondents, though one pointedly suggested that diversification was something that firms should be doing anyway, irrespective of transition:

"*I think businesses that do go bust as a result of the movement from combustion engine to electric powertrain probably are the ones that should, because they're not diversifying and going with it. However, not everyone is like that. Most companies that I know are actively diversifying and actively taking on business that means they can transition from a price to EV*" (Interview 1).

However, it also means that companies need to assess their own innate capabilities, particularly in terms of the skills base. All of our business respondents stated that they supplied more than one sector, so in that sense they were already diversified (with the necessary caveating about representativeness for the wider sector) – though three commented that automotive accounted for approximately 25% of their business, so any adverse impacts here would have a significant impact on their profitability (at least in the short term). In the West Midlands, dependency on JLR is particularly evident, and thus any adjustment by suppliers will necessarily be strongly influenced by the decisions that JLR make, as articulated in the following section.

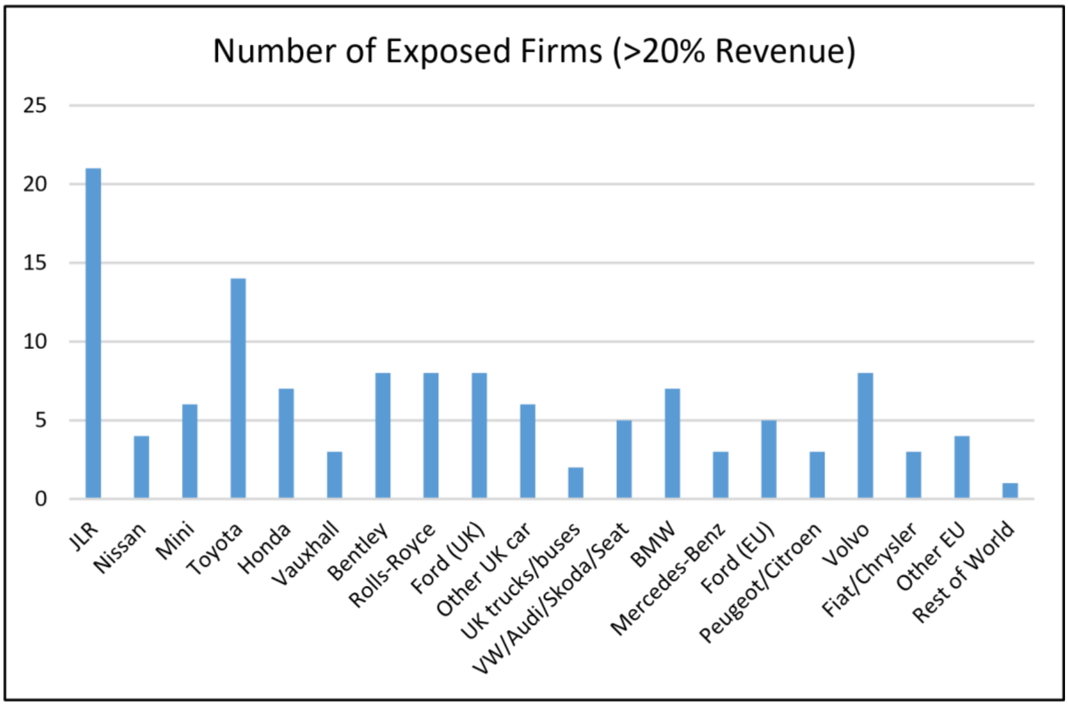
8.1.1 The dependency on vehicle manufacturers

As such, it is evident from our research that the debate on transitioning in automotive cannot be separated from the significance of the global multinational Vehicle Manufacturers (VMs) that dominate the industry in the UK. In the West Midlands, this dominance – as evidenced in our earlier analysis – is particularly stark in that one Vehicle Manufacturer (VM); Jaguar Land Rover, accounts for some 50% of employment in the automotive sector in the region, and an even higher share of value-added. Thus, it is something of a non-sequitur to talk of "transitioning" in automotive, let alone a "just transition" for the workforce, without being cognisant of the corporate strategy of JLR and its parent company, Tata, as any decisions they undertake now will have major ramifications for the workforce, suppliers and the wider region.

[46] The regional studies academic literature refers to this as pursuing "related variety" or "unrelated variety" (e.g., Frenken et al., 2007).

In this context, previous research by the authors (De Ruyter et al., 2019) has demonstrated a high degree of exposure[47] (in terms of revenue dependency) by suppliers in the region to JLR, but also other important VMs such as Toyota. A survey was conducted of 234 firms, involved in transport manufacturing in the Midlands, of which 59 were exclusively automotive and another 27 manufacturing in more than one sector. It found that more than 20 suppliers were significantly exposed to JLR, as reproduced in Figure 4 below, which only reiterates the need to pay particular attention to JLR's plans going forward.

Figure 4: Supplier exposure to Vehicle Manufacturers



Source: De Ruyter et al. (2019, p. 24).

At the time of writing (February 2022), JLR is still in the midst of its latest transformation programme, 'Project Reimagine', which was announced in February 2021.[48] The implications of this, in particular the practical consequences of the switch to producing primarily electric vehicles and where it will source batteries and other components from, are yet to be divulged to the public. The ongoing uncertainty with JLR and the analysis contained within takes the view of what the current state of the industry is in the Region, and what would be needed to be put in place to ensure continued (electric) vehicle production and sourcing within the Region, thus leaves a major cloud over the Region. In the material that follows we assess the issues that will impinge on the ability of suppliers to cope with a shift to EV (drawing on insights derived from our interview participants) and

[47] A measure of suppliers' exposure is the percentage of a supplier's business generated from a particular OEM. A standard accepted measure of exposure is when a particular customer accounts for at least 20 percent of a supplier's revenue, which is a measure accepted across widely read business texts. For example, see: https://www.dummies.com/business/corporate-finance/mergers-and-acquisitions/maoffering-document-recurring-revenue-and-customer-concentration/
https://www.eulerhermes.com/en_US/resources-and-insights/economic-insights/avoid-high-customerconcentration.html
https://www.msn.com/en-sg/money/news/what-you-need-to-know-about-customer-concentration-risk/arBBVmlNk
[48] https://www.jaguarlandrover.com/reimagine

try to identify any actions they are undertaking to adjust, before examining the perspectives of the workforce (drawing on survey data) in Chapter 9.

We therefore build on the analysis in Chapter 7 by assessing the prospects of establishing a viable domestic supply chain for EV in terms of powertrain production (including key components, notably the motor), battery production and stampings and other "supporting" parts needed for batteries. It is evident that UK supplier capability in many of these areas is distinctly patchy, with the lack of domestic supply of electrical steel being a particular supply side gap, following the decision of Tata Steel to close its Orb Electrical Steels plant in Newport (Wales) in 2019 and shift production of this to its plant in Surahammar, Sweden (where the unit costs of energy are also noticeably cheaper – see below).

8.2. Powertrain trends and issues for suppliers

The following table shows AutoAnalysis' latest projections for the powertrain mix at UK vehicle companies over the period 2020 to 2035, as reproduced in Table 24.

Table 24: Projected changes in powertrain mix at UK vehicle manufacturers, 2020-2035 [49]

Powertrain	2020	2025	2030	2035
ICE	82%	50%	9%	<1%
Hybrid	12%	27.5%	36%	22%
PHEV	1.5%	6%	9.5%	7%
BEV	4.5%	16.5%	45.5%	70%
Fuel cells	0%	0%	<0.25%	0.5-0.75%

Source: AutoAnalysis. ICE = Internal Combustion Engine, BEV = Battery Electric Vehicle, PHEV = Plug-in Hybrid Electric Vehicle.

NB. This analysis comes from a model level powertrain forecast developed for clients by AutoAnalysis; this is not available in the public domain. It is reproduced here with the permission of the author (Henry, 2021).

Integral to the viability of a domestic EV supply chain (that is, one where as much value-added as possible is done in the UK, as opposed to just final assembly) is the production of electric motors in the UK. However, these motors are essentially constructed from particular grades of electrical steel – which will need to be imported into the UK (most likely from the EU) given that domestic production has ceased, a point we return to below. JLR has said it plans to make some motors at its i54 site near Wolverhampton as production of internal combustion engines declines, while Ford has said it will make electric motors at Halewood on Merseyside. However, it is not clear – at either company – whether this will be a full manufacturing activity, using UK suppliers, or if the motors will be assembled from imported components.

For UK assembled motors to use UK made parts, a new supply chain needs to be established. This would start with **a viable economic logistics chain from the steel mill (outside the UK) to the UK, to a service centre which can de-coil electrical steel and slit it into strips/blanks ready for stamping**

[49] The projected ratio of hybrids in UK production rises and then falls because as the industry transitions to full electric vehicles, some vehicle companies will transition their own model ranges from pure ICE through hybrid technology before the capacity and capability to make a much higher volumes of battery electric vehicles is installed. Furthermore, some export markets in Europe until 2040 and also beyond Europe will continue to need hybrid vehicles as regulatory environment will not necessarily ban ICE vehicles as quickly as in the UK.

into laminations (a key component) for motors [50]. However, the steel used to make laminations is very thin, as thin as <0.2mm, in order to reduce the eddy current[51] losses that can inhibit the efficiency of the motor. As such, the more 'thin laminations' that can be inserted into a motor, the greater the reduction in eddy current losses, and therefore the more power the motor can generate whilst also becoming smaller. In turn, the smaller and more powerful the motor, the less power is needed from the battery. It is for this reason that VMs generally want to control motor development, engineering and production.

Producing laminations requires dedicated machinery which does not appear to exist in the UK, certainly not at a level capable of making laminations in the volumes required for the automotive industry; moreover, many of the companies which could make such parts, if they had the right equipment installed do not have automotive supplier qualifications; the barriers to entry for a supplier could be significant. This means that a key issue regarding the potential for electric motor production at scale for the automotive sector, then, is whether incumbent UK suppliers have the approval or ability to produce these for UK motor manufacturers or assemblers, either inside the VMs or third party suppliers. At a global level, motor production is dominated by Asian firms, but European production by Bosch and Continental also comprise some of the market. One of our respondents commented that they had latent potential to undertake this, but it was not clear that they could do so at scale:

"*Absolutely, this is an emerging market for us but we are only 5 or so years into our learning, and are still doing lots of R&D. Also the industry is moving from non-precision material gauges 0.4-1mm to precision <0.3mm…. Yes there are 3 who do dabble in this - us probably the most, but it's less than 5% of our business*…." (Interview 1).

Two questions arise from this specifically:

a. Will the region's VMs manufacture laminations themselves in house? As far as the corporate strategies of locally-based VMs are concerned, we have no extant knowledge of relevant investment in production equipment being installed. Moreover, as is evident from the above, very few domestic firms in the region have even the capacity to do this. Particular issues also arise regarding consumables (tooling spares and raw materials). These are the subject of particular needs or precision/special capabilities (unique) locally.
b. Or will they use outside suppliers and if so, from where? There are none in the West Midlands (other than possibly the one identified Tier 2 supplier), so presumably these parts will be imported (Italy and Switzerland are the key locations for this work, but also Germany).

Thus, to reiterate, there are significant capacity and capability issues for UK SMEs to overcome these challenges, and therefore urgent related policy challenges for the UK Government if it really wants

[50] For example, see; https://www.tlclam.net/motor-laminations/. A motor lamination is a part that forms "the core of an electric motor's stator and rotor. They consist of thin metal sheets that are stacked, welded, or bonded together. By making them from individual pieces of metal rather than a solid piece, they experience less eddy current losses" and thus improve engine efficiency and performance. These parts are typically made from metal alloys such as nickel alloys and cobalt-iron alloys (ibid.).
[51] Eddy currents are "closed loops of electric current induced in conductors by changes in magnetic fields, circulating in planes perpendicular to the magnetic fields. According to Lenz's law, eddy currents create their own magnetic fields that oppose changes in the initial magnetic fields that created them," reducing efficiency. See https://www.emobility-engineering.com/motor-laminations/

to maximise the value-added of powertrain production within the UK. We now turn to issues related to battery production.

8.3 Battery production

Whilst there are opportunities for the UK in terms of battery production, as the current policy focus on the establishment of 'gigafactories' - as being a key means by which to secure a successful transition - would attest, there remain a number of significant challenges to overcome. However, all too often the establishment of a gigafactory is almost seen as a fait accompli, with less attention focussed on the practicalities of securing value-added in the region, for example, this statement in the WMCA (2020) Five Year Plan 2021-26 (p. 77): "*Most jobs created in the WMCA will be in manufacturing low emission vehicles, battery packs and modules in gigafactories situated near existing production sites*."

In a similar fashion to the powertrain production chain explained above, the same multi-stage production process applies here (mining, refining, cathode production etc., the production of cells, the assembly of cells into modules and modules into packs). The imperative must be to capture as much value-added in the UK as possible. Indeed, the urgency of securing a gigafactory in the West Midlands was a recurrent theme amongst our respondents, for example, that of this metal fabricator:

"*So, as I said to you before, the battery factories need to be built quickly. The people supplying the electric motors need to boost their production levels, and their development time scales. And we're dealing pretty well, 95% of my inquiry intake at the moment, is about EV…*

I'd like to see more focus for small companies to be directed to the electric vehicle manufacturing supply chain, because what we don't want … these to import it, because all we're doing then is not adding value when we can do it ourselves." (Interview 2).

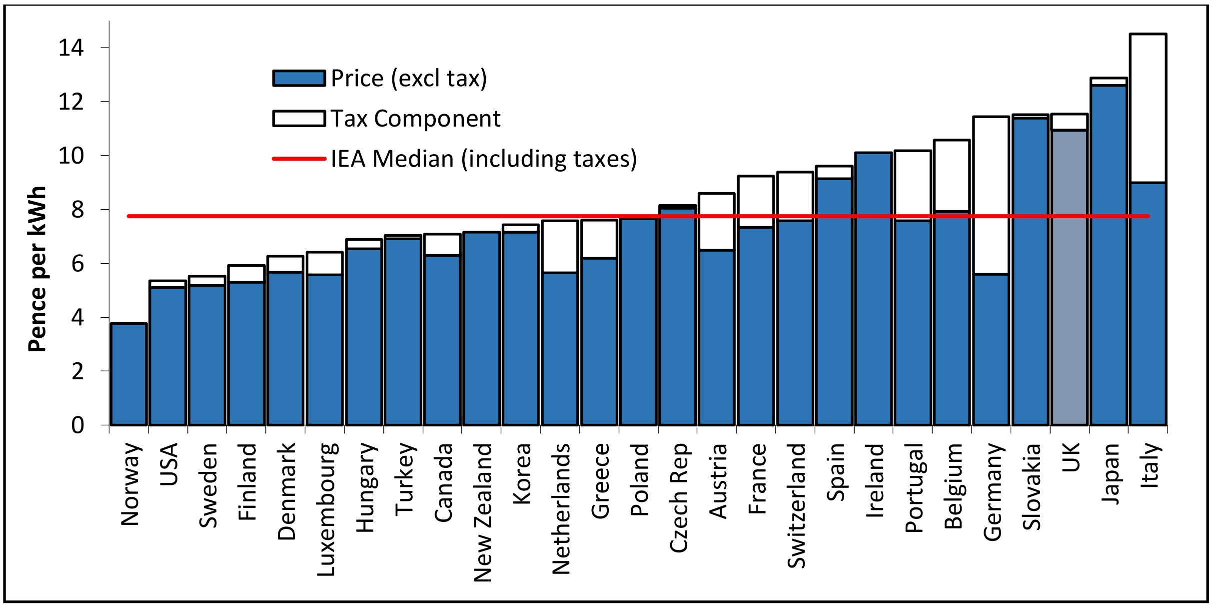
However, the rising cost of electricity will be a major concern for companies seeking to undertake battery production, particularly in components such as cells, which are energy-intensive to produce. There is certainly a strong logic in sourcing batteries close to where EV production takes place (and hence providing a strong logic to the location of gigafactories in the UK, as attested in Chapter 7). However, it could be that only some elements of battery production can economically take place in the UK, as the costs of energy could be a deciding factor in how much value-added is done in the UK. Accordingly, we provide information on the comparative costs of electricity per KwH for IEA countries, as depicted in Table 25 and Figure 5.

Table 25: cost of electricity in pence per KwH for selected IEA countries (excluding and including taxes)

	Electricity													
	Excluding taxes							Including taxes[2]						
	2005	2010	2015	2016	2017	2018	2019	2005	2010	2015	2016	2017	2018	2019
Former EU 15														
Austria	4.24	7.25	5.09	5.36	5.56	6.02	6.50r	5.60	8.86	7.11	7.83	7.94	8.27	8.59r
Belgium	..	7.17	6.89	7.71	7.88	7.64	7.92	..	8.06	8.18	9.69	10.58	10.24	10.58
Denmark	4.39	6.75	4.09	4.76	5.31	5.20	5.67	5.10	7.41	6.27	7.28	7.13	6.97	6.28
Finland	3.56	5.92	4.38	4.83	5.04	5.26	5.30	3.87	6.14	4.89	5.40	5.65	5.88	5.91
France	2.43	6.19	5.80	6.10	6.52r	6.80	7.33	2.74	6.93	7.47	7.84	8.53r	8.72	9.23
Germany	4.62	6.82	5.05	5.52	5.57	5.62	5.61	4.62	8.79	9.49	10.44	11.11	10.90	11.44
Greece	3.69	6.37	6.00	5.91	6.44	6.10	6.18	3.69	7.37	6.89	7.34	8.32	7.83	7.60
Ireland	5.47	8.88	8.66	8.77	9.62	9.64	10.09	5.47	8.88	8.66	8.77	9.62	9.64	10.09
Italy	7.52		7.35	7.92	8.25	8.61	8.99	9.57	12.99	12.32	13.69	13.75	13.07	14.50
Luxembourg	..	6.93	4.08	4.39	5.15	5.43	5.58	..	7.50	4.70	5.10	5.97	6.26	6.40
Netherlands	..	6.58	4.83	5.03	5.23	5.27	5.64	..	7.52	5.86	6.31	6.71	6.97	7.57
Portugal	5.39	7.97	7.22	7.76	7.83	7.06	7.58r	5.39	7.97	8.33	9.25	10.03	10.14	10.18r
Spain	4.36	8.19	7.94	8.16	8.53	9.09	9.14	4.59	8.59	8.24	8.57	8.97	9.56	9.61
Sweden	..	6.19	3.81	4.42	4.81	4.88	5.19	..	6.23	3.85	4.46	4.85	5.23	5.52
United Kingdom	4.56	7.57	9.25	8.93	9.39	10.03	10.93	4.77	7.84	9.50	9.28	9.79	10.43	11.53

Source: BEIS (2022)

Figure 5: Pence per kWh for IEA countries, 2019.



Source: BEIS (2022)

Evident from the above is that the UK faces a significant competitive disadvantage in the production of any battery component that is energy-intensive; especially that of cell production. Indeed, battery cells represent approximately 40% of the value-added in an electric vehicle (EES, 2022). From the table it is apparent that Sweden, Hungary and Poland, plus France to a lesser extent, have much lower energy costs than the UK – and Sweden, Hungary and Poland all feature prominently in the growth in battery cell production over the next few years (ibid.). In this context, the more recent rises in energy prices, which saw inflation rise to a thirty year high of 5.4% in the 12 months leading up to December 2021[52] will only add to the costs of production in the UK. With the lifting of price caps on energy in April 2022 expected to contribute to a 65% increase in energy bills since 2020 for energy-intensive sectors including automotive[53], the severe cost pressures facing any UK-based manufacturer will only be compounded.

As an example for illustrative purposes, this reference (http://dx.doi.org/10.1016/j.cirp.2017.04.109) concludes that making a 24kWh LMO graphite battery pack (e.g., for the Nissan Leaf which has 192 cells) uses approximately 89GJ of energy, of which nearly 30GJ is embedded in battery materials (mining etc.), nearly 59GJ in cell production and 0.3GJ in assembly. However, the crucial finding as far as we can establish is that the overwhelming majority of energy in the production process is used in cell production; so the cost of energy for cell production is crucial. Hence, the rising cost of energy then could compel some to source cells outside the UK and import them for assembly into battery packs. It is within this context that the prospects of battery cell production at the Coventry Airport site, for example (the InoBat proposal detailed earlier), must be critically assessed. A policy implication here is that **if production of cells is to take place at a UK gigafactory, then this may need to presaged by a "deal" on a reduced tariff for electricity – a policy issue for the UK Government to consider**. There is a strong case to be made for cell production to receive government support as an energy intensive industry.

The energy prices rises referenced above have also had an impact on the production of other parts for the sector, for example, that of aluminium casting:

"*in terms of our business, we're a high energy user. Relatively, we only melt aluminium at about 720, whereas the steel and iron buoys are going to be melted at sort of 1300. So, they're going to be bigger energy users, principally, we use, well, at the moment, probably around 50/50 were using gas and electricity. And gas is much cheaper, even though the price increase, is much cheaper than electricity. And notwithstanding the fact that the increases have occurred, if we sort of wind back to six months ago. Electricity was seven times more expensive than gas. So, if I had to change all my furnaces over from gas to electric, I'd have to pay another 850,750 million pounds a year in energy*" (Interview 2).

That competitor countries such as Poland, which have much cheaper energy costs due to a continued reliance on coal was not lost on our respondents, for example for this respondent (a local MP) who was expressing their concerns over the imminent closure of the GKN plant in Erdington, Birmingham, and relocation of production to Eastern Europe:

"*what is absurd is that we're seeing the export of production from this country, which has strong commitments in terms of electrification process to Poland, where in excess of 40% of their energy requirements are being met by the burning of coal, and that cannot be right*" (Interview 8).

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[52] https://www.which.co.uk/news/2022/01/inflation-rises-to-5-4-in-december-2021-can-any-savings-rates-beat-it/

[53] https://www.energylivenews.com/2022/02/01/businesses-warn-of-a-joint-1bn-energy-bill-amid-price-rises/

Thus, the establishment of a gigafactory in the West Midlands cannot be considered to be a panacea in itself, and requires a raft of supporting measures in related sectors. This was recognised by some of our participants, for example, an economic development officer in local government:

"*… it's not just about building the gigafactory, there would need to be an accompanying supply chain support programme to pretty much diversify, or enable large chunks of the sector to diversify accordingly, that would need to come with the gigafactory and there would need to be skilled support alongside that*" (Interview 11).

Hence, in the next section, we consider the implications for the production of other parts needed for the EV sector.

8.4 Stampings and other "supporting" parts needed for batteries

Much of the focus on batteries is on cells and assembly into full battery packs. However, there are many other parts in a battery which could be made by established companies in the metal working sector, especially in stamping and fabricating. Any gigafactory established in the West Midlands would require companies to supply such sub-components, as shown in the table below. These components could be made by UK suppliers, including existing metal stampings suppliers in the West Midlands.

Table 26: Sub-Components required in Battery production

Category	**Part**	**Notes**
Batteries – pack level (fully assembled battery)	Pack Lids	Steel or aluminium stampings; potential for SMC for injection mouldings for complex shapes
	Base plates	Steel or aluminium stampings or extrusions Material choice determined by structural requirements, esp. with respect to crash specifications
	Bus bars	Copper or aluminium; extruded, stamped or stretch-bent; normally with insulation coatings
	Pack frames	Stamped or extruded aluminium or steel, or combination thereof
Batteries – module level (i.e., sub-assemblies delivered to battery assembly plant)	Harnesses	Traditional harness, with flexible PCB or ribbon cable
	Bus bars	Connected directly to cells Made of copper and/or aluminium
	Thermal interface materials	Pastes, pads, foams, or adhesives
	Cooling technology	
	End caps	Injection mouldings, acting as interface between module and pack-level parts

In addition, in the battery cell/chemistry area, the key components are: cathodes, aluminium foil, anodes, copper foil, electrolytes and separators. Many of the key suppliers here are located in China and identifying and assessing potential Chinese investment targets is beyond the scope of this particular study. Outside China, however, the following table lists the major companies which we have been able to identify; many of these already supply the likes of Panasonic, Envision and LG, etc. in Asia and are the sort of companies which LG or similar would need to support it at the Coventry Airport site, if the gigafactory there is to become a reality:

Table 27: Key Components of Batteries and where they are produced

Sector	Company/country
Anodes	Hitachi and Nippon Carbon (both Japan)
Copper foil (for anodes)	Furukawa Electric, Nippon Foil and Nippon Denkai (all Japan); and Doosan of Korea with plants in Hungary and Luxembourg
Cathodes	Umicore (Korea) – which already has a European plant in Poland; Nichia (Japan), Toda Kogyo (also Japan); BASF is also building a cathode plant next to the Tesla EV and battery plants in Germany
Aluminium foil (for cathodes)	Sumitomo Light Metal and Nippon Foil, both from Japan
Electrolytes (medium between anode and cathode)	Mitsui, Mitsubishi Chemical and Ube, all of Japan
Separators (between anodes & cathodes)	Asahi Kasei, Toray Tonen, SKI and UBE of Japan; and Celgard and Entek of the US

This now brings us to a discussion of skills and training, which will be key to any successful (just) transition.

8.5 Skills and training gaps

As discussed in chapter 7, having the requisite skillsets for EV production is critical for the development of an electric vehicle production system, particularly in supply chain firms. There is evidence of skills gaps in these areas in the UK.

As one respondent commented:

"*…there's niche skills which exist which we're going to need more of. One of the ones we come across quite often is around power electronics. There isn't enough power electronics experience or skill at the moment, that's a really short supply. And it's clearly necessary in any kind of application that utilises batteries, you need some kind of power electronics. So, I think we need more there depending on the approach on batteries… but also on the battery management side of things…*

So, producing battery management systems that are effective, which requires both in-depth understanding of how lithium ion chemistry batteries work, but also a good understanding of software and the hardware requirements to successfully optimise and control and safely control lithium ion batteries. Those are kind of the areas that we see significant skills shortages at the moment, and not a great deal of trading." (Interview 10)

Even where respondents felt that they had a good incumbent skill set for EV transitioning, it was still felt that the provision of additional training was necessary, for example:

"*we got people with, with quite strong electrical skills, not necessarily totally allied to appropriate motors, perhaps, for example, we have just done a significant autonomous, battery powered device, which we were able to produce, turn our hand to quite quickly. I think we could do some training in that area we're trying to address that certainly isn't allied to specific requirements at the moment. But we are trying to do a little bit on that, certainly*" (Interview 3).

Brexit has also been a factor in the exacerbation of skills gaps, by dint of the end of Freedom of Movement for EU workers into the UK:

"…. *The labour pool, the ease of movement of goods, without politics between Europe and the UK, still is really far from where it needs to be. If that needs to, if we indeed that's how he's going to be for the rest of time, then we got to put a more capability on UK shores to supply what's needed for those customers I've just mentioned…*" (Interview 1).

In considering the implications of skills gaps emerging in the sector, we agree with Bauer et al. (2018), and Herrman et al. (2020b) who argue that it is necessary to develop digital technologies (sic. Industry 4.0) as a core competence in the automotive industry and as a means of value creation and employment; for example, in cell production, mobility services and autonomous driving. This will require more innovation funding and sufficient available venture capital for businesses. Whilst our participants were generally supportive of Government initiatives in this regard, there were some criticisms that bodies such as the Manufacturing Technology Centre (MTC) in Coventry or Innovate UK lacked penetration with smaller businesses further up the supply chain:

"…. *it's sometimes difficult to get the right lead, and the right company who's going to show commercialisation, the stage that we're at, so I think opportunities within Innovate UK type structure to help smaller collections, to innovate would be really great for us, we don't necessarily need to be part of a 2-million-pound consortium, we can do really useful stuff on a smaller budget, or perhaps we just need a bit of help. Being properly introduced, kind of getting those schemes going would be really useful to us*" (Interview 3).

However, there were also criticisms that they were not always "ahead of the curve" in terms of promoting new technology:

"… *it's like, well, how are you* [the MTC] *going to advise us on pieces of kit that we got and had for years that are better than yours? It was never, you know, so there's some elements of it that are flawed. I think generally it's good, the reach of them, but the benefits of them are not well articulated or shouted about at all. Considering I've been in stamping for 15 years, it was only last year that I found out there was an advanced manufacturing catapult in Strathclyde, for metal forming, so that they don't have they don't have a machine anywhere near what mine are*" (Interview 1).

There are thus clear implications for policy and practice in terms of developing an integrated skills strategy, and the need for this to be formulated on a collaborative basis, which we turn to in Chapter 10.

8.6 The current state of EV infrastructure

Finally, turning to the EV charging network side, our findings suggest that the charging network in the UK is in need of a major overhaul and expansion, with a distinct lack of capacity to cope with the expected volumes of EVs on the road after 2030. As at January 27th 2022, there were 48,820 connectors and 29,067 devices at 18,266 locations across the UK (of which, approximately one-third were in the Greater London area, and for which the largest market share in the UK was that of Ubitricity, at 16%). Of these, the number of "rapid charging points" consisted of 11,715 connectors for 5,032 devices at 3,273 locations across the UK, for which Tesla Supercharger held the largest market share, at 15.1% (Zap-Map, 2022). The charging network thus needs to be dramatically expanded if the UK Government's stated target of ceasing ICE vehicle production in 2030 is to be met. These issues can only be met through increased resourcing.

As such, concerns were also expressed about the capacity of the National Grid to supply enough electricity for the expected volume of electric vehicles over the next 20 years:

"*So, it's, for me, it's all about timeframe, you know, to say that we're basically not going to sell any, any cars that are all electric by 2035. You know, that's only like, 14 years away, to actually get enough wind power. You know, I mean, to build a nuclear power station takes probably 20 years from start to finish. You know, I just don't see that it can be done in the timeframe …. it just seems to me that act to actually have the generating capacity to produce enough electricity for all of these vehicles, is quite staggering. So those are the big issues of physical infrastructure and actual generating capacity*" (Interview 6).

Forecasts by the National Grid suggest a 100% increase in electricity generation by 2050, driven largely by a significant expansion in wind power (National Grid, 2021), which would suggest that at a national level, the supply of electricity should not be an issue. Indeed, National Grid argue that if all vehicles in the UK suddenly became electric overnight, then this would only add 10% to electricity demand[54]. Furthermore, the increased take-up by households of renewable energy technology such as solar panels has also served to reduce demand on the Grid and as such, UK peak electricity demand has fallen by 16% since 2002 (ibid.).

However, the nature of the electricity distribution network is such that the high-voltage (HV) National Grid feeds the low-voltage (LV) local electricity networks[55] that supply households. These LV networks have less physical capacity and could struggle to cope with an increased demand if there was a marked increase in EV charging (say at peak usage between 6-10pm), as one EV being charged is basically equivalent to adding another house on to a LV network that may typically only serve 50 houses[56]. Contemplate a 10-fold increase in demand on these LVs as ICE vehicles are phased out after 2030 and "it only needs clustering of a few EV owners in a local area to cause potential problems" – one overload could cause the "lights to go out". This might suggest that (costly) upgrades to LV networks are needed, but in practice "demand-side management" could be sufficient to ensure that EVs are charged at time of low usage of the grid (such as after 10pm and before 6am). Smart meters may enable this shift to take place (ibid.).

Perhaps of more consequence is that much of the UK's housing stock simply lacks the off-road parking to allow for ease of charging of an EV, with the consequence that running a lengthy cable over the footpath and on to street-side parking may expose an EV owner to personal injury claims under the *Highways Act 1980*,[57] should someone trip over their charge wire. According to market research from Andersen, a UK manufacturer of home EV charge points, approximately one-third of UK households lack a driveway or garage to install a home charge point (and this conceals variations between 16% in rural areas to that approaching 60% in cities and town centres), which could discourage the take up of EVs by consumers.[58] Affordability may also be a factor, particularly in poorer neighbourhoods, pointing to the need for government intervention at national and local level. Resourcing such a shift also raises issues for cash-strapped local authorities, as pointed out by one of our respondents, an economic development officer:

"….*you're not going to get a just transition, without cities playing both a formative and leading role in enabling it. But that don't just mean the national policy chapter, but the resources made available for the role out of charging points, for example, you know, just one example. Where does the*

[54] https://www.fuelcardservices.com/uk-energy-grid-and-electric-vehicles/
[55] For example, see that of Western Power Distribution at: https://www.westernpower.co.uk/our-network/network-capacity-map-application
[56] https://www.greencarguide.co.uk/features/can-the-grid-cope-with-electric-vehicles/
[57] https://www.legislation.gov.uk/ukpga/1980/66/contents
[58] https://www.transportxtra.com/publications/parking-review/news/66621/a-third-of-uk-homeowners-don-t-have-a-driveway-or-garage-to-install-a-home-chargepoint/

responsibility lie for making these more accessible, because there'll be a lot of factors? …. *clearly, we're going to be hamstrung by how much resource we have to do it*" (Interview 4).

There are thus significant issues around the expansion of the EV charging network, which we return to in Chapter 10 on policy implications and recommendations.

9. Worker perspectives and experiences on transitioning: preliminary findings

The previous chapter drew on primary data from interviews with suppliers and other stakeholders in the West Midlands to assess the key issues for securing a transition to a viable domestic supply chain to support EV production in the West Midlands. Key was the need to ensure that as much domestic value-added as possible would take place, but that lack of capabilities and capacity by suppliers in areas such as electric motor and battery production could inhibit a successful shift. The other key area identified was in terms of skills gaps in the workforce. This chapter, on the other hand, draws upon primary data gained from the questionnaire survey of automotive industry workers. It elucidates their views on the prospects of successful transition, and what their particular needs and concerns are in this regard. We look first at the evidence from the Australian experience.

9.1 Evidence from Australia

Subsequent to the ACIL-Allen study reported on in the earlier chapters on the Australian experience, a team of researchers led by Andrew Beer at the University of South Australia (and including this project's CI Sally Weller) won an Australian Research Council Grant to examine worker outcomes longitudinally. The automotive firms Holden and Toyota, and the Federal Department of Education, among others, were partner organisations in the project. This enabled the linkage to access the participant data sources that were also used in the ACIL-Allen study, adding to a population of former Ford workers access via the AMWU (Australian Metal Workers Union). The FWFC plans to conduct annual surveys of displaced workers each year for 5 years from 2020 (see Beer et al., 2019).

As with all longitudinal studies, the representativeness of the sample and the retention of participants were crucial issues. The population lists available to the study included workers who had at some point prior to exiting an automotive industry job 'signed up' to participate in the assistance provided to manage the transition. Some may have had attended a job fair or seminar, others may have made intensive use of services over a two or three year period. Those who declined assistance are not included, nor are many of the firms' managerial and office staff. The coverage is weaker among supply chain firms, and especially weak in second and third tier firms that were less involved in the relevant networks.

At the time of writing, only data from the first round (Wave 1) interviews has been analysed (See table 28). In general, it confirms the positive ACIL-Allen story on overall reemployment, but it adds more detailed interrogation of the quality of jobs these workers found after automotive. A recently published article (Irving et al., 2022) provides some basic statistics on outcomes in July 2020. At that time Holden and Toyota workers – who comprised about half the sample – were already almost 3 years post-closure.[59] The data spans South Australian and Victorian locations and was collected during the COVID crisis when both States were experiencing intermittent lockdowns, which may explain the relatively high unemployment rate (more than double the national average).

Employed	65%
Self-Employed	5.3%
Retired	11.3%
Unemployed	14.4%

[59] One of the conditions of the partnership is that firm-level outcomes are not reported publicly.

Australia's social security rules discourage unemployed people from self-employment and community-level provisioning activities.

Of those in employment, most were in permanent work:

Permanent	66.4%
Casual	21.8%
Fixed Term	2.2%
Labour Hire	7.5%
Other	1.4%

This means that a third of those in the workforce were still in precarious jobs three years after retrenchment and reiterates earlier findings from studies in the UK (e.g., Armstrong et al., 2008) that retrenched workers are more likely to fall into precarious forms of work than the wider labour force in general. Moreover, more than half of those in work earned less than in their automotive sector jobs[60].

Less income	51.0%
Same income	15.6%
More income	33.4%

The high-income earners were often skilled workers whose knowledge of the Toyota system was attractive to other employers, especially in manufacturing. Twenty percent (20%) reported that they were still looking for a better job. On self-reported quality of life, the survey respondents were divided fairly evenly into Better (30.9%), Same (34.1%) and Worse (33.4%). These findings, then, reiterate the notion that skill levels will be a key driving factor of the worker experience of transition, and serve to usefully inform the UK experience of pending transition. It is to this material that we now turn.

9.2 Automotive workers in the West Midlands: perspectives on a Just Transition

Accordingly, to explore workers' experience in the West Midlands, a survey of automotive sector workers was conducted between January and February 2022 (Appendix 1 details the survey questionnaire) and in this section we report on the findings. The survey is of Unite the Union members in the union's West Midlands region and automotive industrial sector who provided their email address and permission to be contacted under GDPR provision. The population incudes members in workplace and geographic union branches in the West Midlands and members whose home addresses are in that region. Workplaces included VMs (vehicle manufacturers) such as Jaguar Land Rover, manufacturers in the parts and components supply chain and on-site Third Party Logistics companies.[61]

9.2.1 Profile of respondents

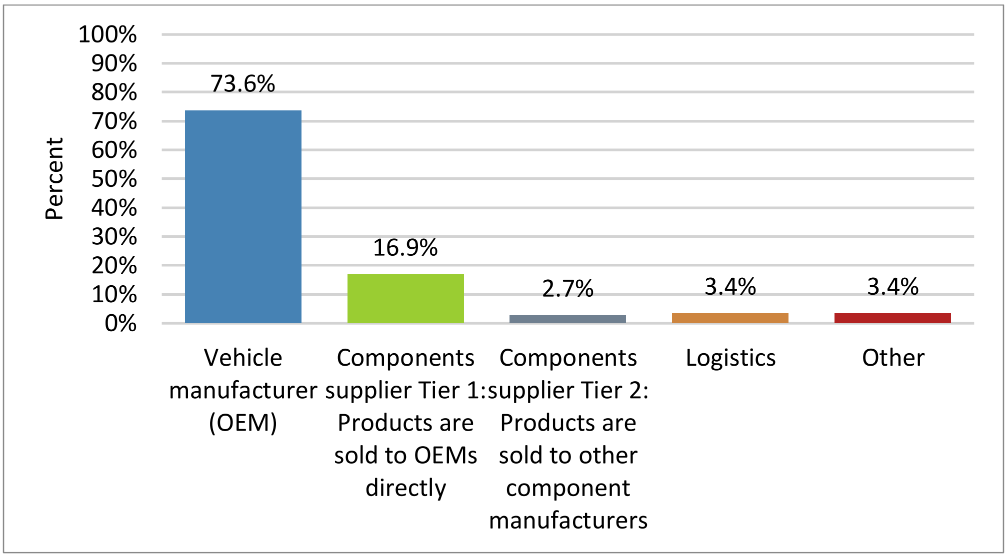
As at February 1st 2022, 148 responses had been obtained, of which 85.8% of respondents identified as male and 79.1% identified as 'white British'. Turning to the type of company they worked for,

[60] A similar trajectory of earnings decline was also evident in workers that had been made redundant with the collapse of MG Rover in the UK – where the overall average earnings fell by £5,000 but which also concealed polarisation of earnings, with a third of respondents reporting higher earnings in subsequent employment (Armstrong et al., 2008; Bailey et al., 2008).

[61] The announced closure of GKN Driveline in Birmingham prior to the survey meant those members were excluded from the distribution. Some individual members choose to participate in the survey.

73.6% of them were employed by a Vehicle Manufacturer (OEM/VM), whilst another 16.9% were employed by a Tier 1 supplier (that is, a firm that directly supplies parts to a VM). This is shown in Figure 6. In terms of employment status, the overwhelming majority of our respondents were in permanent employment with a company, with 96.6% of respondents stating that they were directly employed, and 98.6% stating that they did not have any additional jobs. Turning to hours worked, 56.1% of respondents stated they worked less than 40 hours in a typical working week, 29.1% stated they worked 40 hours (i.e., an eight hour day) and 14.9% reported working more than 40 hours in a typical working week. In terms of *desired* working hours, 45.9% were happy with the working hours that they had, whilst 48.6% desired fewer hours per week. Only 5.5% of respondents desired more hours per week. This suggests that for half of our respondents, work-life balance issues were of some importance.

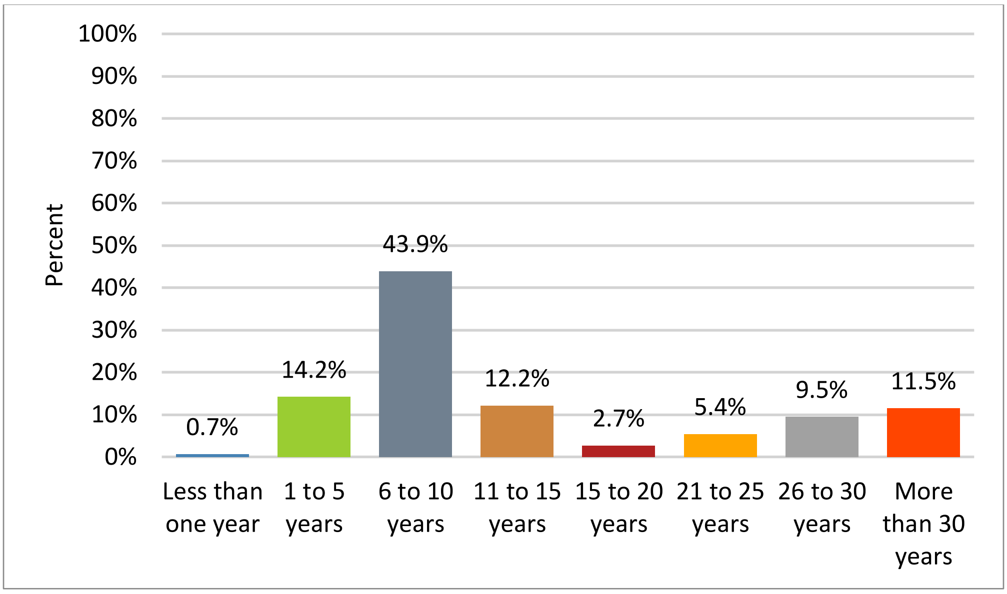
Figure 6: Q1, Which part of the automotive sector do you work in?



Source: Survey.

Turning to employment tenure, a clear majority of our respondents had worked in their current job for at least five years, as shown in Figure 7. Only 14.2% had worked in their current job for 5 years or less, painting a picture of an experienced workforce.

Figure 7: Q9, How long have you worked in your job?

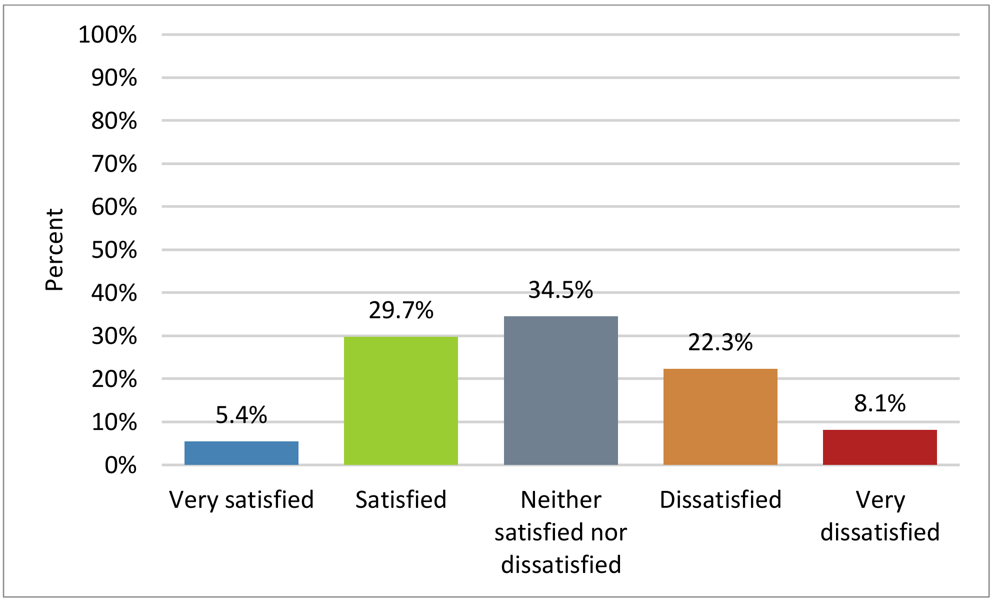


Source: Survey

This is reinforced by the age profile of our respondents, with 48% being aged 36-55, and another 31% being aged 56 or over. In contrast, only 2.1% were aged 25 or under, and 15.5% aged 26-35. As regards travel to work, a majority of respondents lived relatively close to their place of work, with 72.8% of workers reporting a commute time of half-an-hour or less to travel to work. In contrast, only 0.7% (i.e. 1 person) of respondents reported a travel time of two hours or more.

We now turn to an evaluation of job satisfaction, as shown in Figure 8. Evident is that a significant minority were either dissatisfied or very dissatisfied in their job (approximately 30%). Whilst a comprehensive analysis of job satisfaction is beyond the scope of this project, dissatisfaction has been shown to be linked to job insecurity, as the earlier discussion articulated.

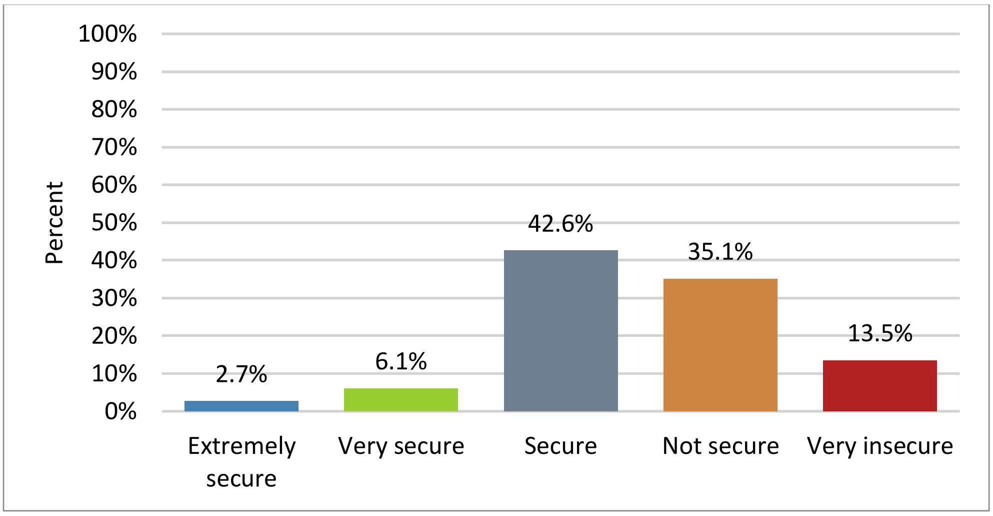
Figure 8: Q13, How satisfied are you in your job?



Source: Survey

The perceptions around job security were even more striking, with nearly half of our respondents either feeling 'insecure' or 'very insecure' in their jobs, as detailed in Figure 9. In contrast, less than 3% felt 'extremely secure' in their job.

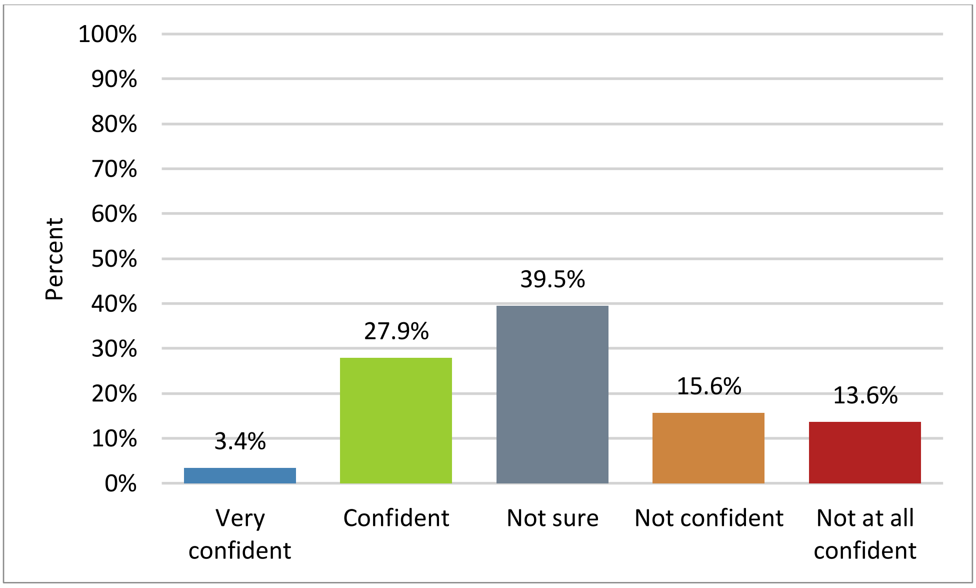
Figure 9: Q14, How secure do you feel in your job?



Source: Survey

Despite this, some 61.5% of respondents stated that they liked their job and expected to stay in it until they retired, whilst another 17.6% said that they liked their job but didn't think that it was likely that they would be able to stay in it for the long-term. However, the sense of relative insecurity is reinforced by Figure 10 below, which seeks to assess how confident workers are that their workplace will successfully transition. Again, only about one third felt 'confident' or 'very confident' that this would be the case. In contrast, nearly 30% were 'not confident' or 'not at all confident' that their workplace would survive.

Figure 10: Q15, How confident are you that your workplace will survive and manage the transition to low emission vehicles?



Source: Survey

As such, in considering their future work trajectories and the age profile of our sample, when asked if they still expected to be working in the automotive industry in 2030 (when the petrol/diesel ban on new vehicles is expected to take place), only 41.9% of respondents said yes. In contrast, 34.5% reported that they will have retired by 2030, whilst 6.8% reported that they would not, as they wanted to leave the industry. Notably, 7.4% stated that they didn't think that they would still be working in the automotive sector, but that they wanted to stay in the industry; whilst 9.5% stated that they did not know, adding to the overall picture of uncertainty.

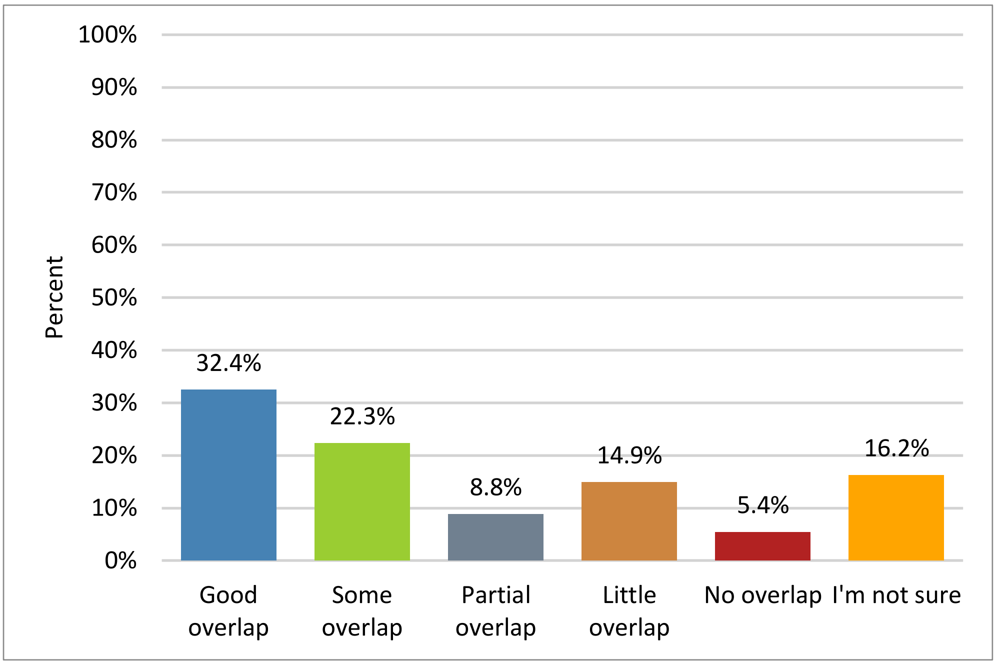
As such, as the discussion on Standing's typology of labour insecurity in Chapter 2 has demonstrated, there are a range of factors that can shape worker perceptions in this regard, but for our purposes in identifying the factors that assist in enabling a 'just transition', the issues around transitioning clearly link to wider concerns around labour market insecurity, employment insecurity and skill reproduction security are pivotal. Accordingly, in the next section, we examine worker perceptions around transitioning, with a particular focus on skills, training and other government policy measures that they feel are necessary to assist them.

9.2.2 Worker perceptions on skills, training and transitioning

In seeking to assess the prospects of successful transitioning for workers, we first sought to assess what their current educational and skills profile was, as previous literature on plant closure and labour market adjustment has highlighted that workers with higher skills and qualifications tend to obtain re-employment quicker (Armstrong et al., 2008). Moreover, as chapter 7 noted, given jobs in the electric vehicle production system require higher level skills and qualifications. In terms of the background qualifications and highest educational attainment of our sample, evident was of a workforce for whom over half lacked any post-secondary school qualifications. Of our sample, the largest proportion (40.7%) had only attained a GCSE/O-level qualification, whilst a further 16.6% had attained A-level or equivalent qualifications. Indeed, some 4% had no formal qualifications at all. In contrast, only 11.7% held a Bachelor's degree or equivalent, and 4.1% a Postgraduate degree or equivalent (although another 22.8% held a Certificate or Diploma). In addition, 52.7% had a technical or trade qualification.

In this context then, it was interesting to note how many workers thought their skillset was suitable for transitioning to the production of zero/low-carbon vehicles. It can be argued that while the respondents might not have a complete knowledge of new skillset requirements, their responses to the question about this are worthy of note. From Figure 11, it is evident that 32.4% thought their skills had a "good overlap" with the skills needed to manufacture low-carbon vehicles. However, another 20.3% thought their skills had "little" or "no overlap" with those needed in the green economy. Others suggested "partial" overlap or that they were unsure. This suggests that for many workers within our sample, the prospect of a shift to a zero-carbon economy could leave them without gainful employment if they are not provided with opportunities and training to adjust. When prompted as to whether they would consider retraining for a new job role in the zero-carbon economy, a clear majority of our respondents (68%) said yes. In this context, it was of some concern that 85% of our respondents reported that they had not been offered any training or upskilling by their employer to help them prepare for the transition to the production of the new vehicles.

Figure 11: Q17, How much do you think your current skills overlap with the skills needed for making low-carbon vehicles? (Electric, Hybrid or Hydrogen.)

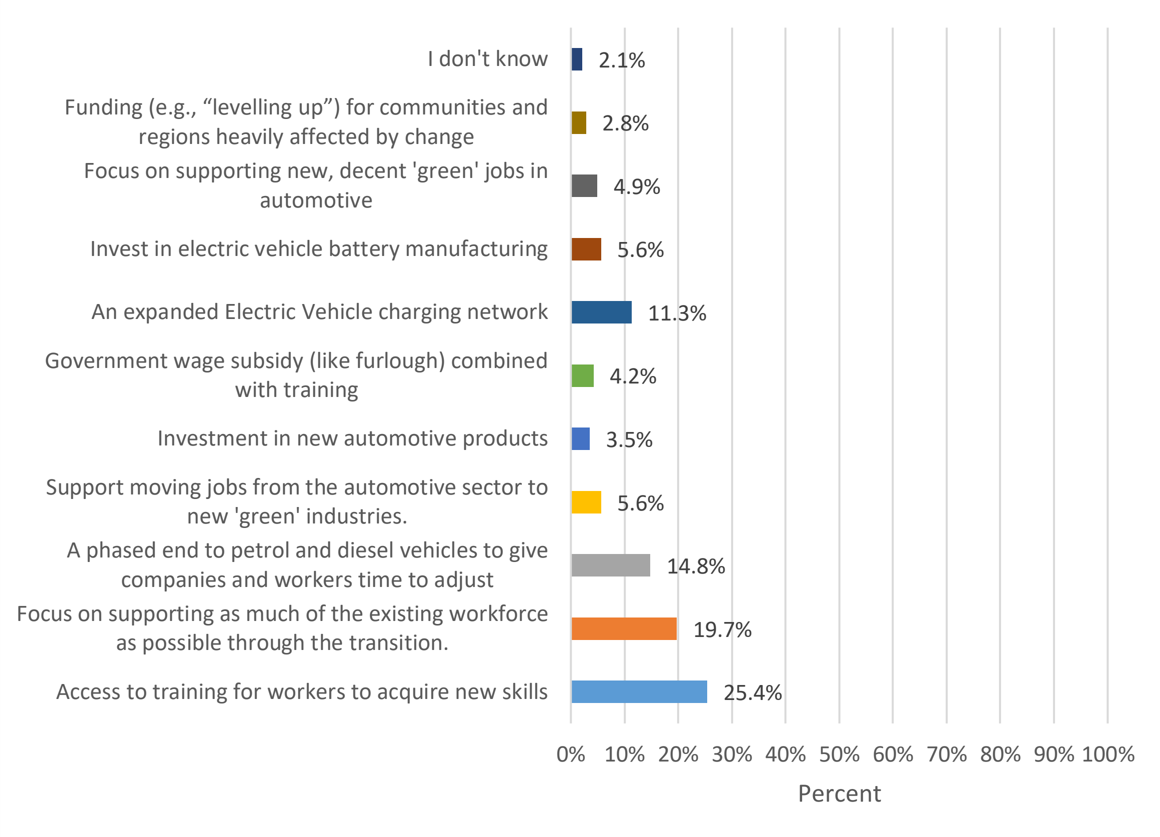


Source: Survey

It can be noted also that not many of our respondents had undertaken any training of their own volition; only 10.8% of our sample had undertaken any training or educational courses outside of work to prepare for the automotive sector's transition. Of those few who did undertake training, two-thirds managed to complete the training or educational course. In terms of what re-skilling support should be available, 74.8% of our respondents identified that their employer should provide training and upskilling opportunities, whilst 49.7% reported that the UK Government should also provide access to training and education for workers (multiple responses were accepted for this question). Only 10.2% of our sample thought that they required no upskilling.

Finally, respondents were asked to rank what they considered the top 3 government policy priorities should be to assist transitioning within the automotive industry. Of the number 1 policy priority, 25.4% reported that this should consist of ‘access to training for workers to acquire new skills’, 19.7% suggested this should consist of focussing on ‘supporting as much of the existing workforce as possible’, whilst 14.8% reported that this should consist of a ‘phased end (i.e., beyond 2030) to petrol and diesel vehicles to give companies and workers time to adjust’. Of the number 2 priority, 23% reported ‘focus on supporting as much of the existing workforce as possible through the transition’, 13.7% reported ‘access to training for workers to acquire new skills’ and 12.9% reported ‘a phased end to petrol and diesel vehicles to give companies and workers time to adjust’. For priority number 3, 12.3% reported ‘support moving jobs from the automotive sector to new 'green' industries’, 12.3% reported ‘focus on supporting as much of the existing workforce as possible through the transition’ and 11.6% called for ‘investment in new automotive products’. Priority 1 is depicted in Figure 12 below, to give an indication for the breadth of responses reported.

Figure 12: Q28, Policy Priority One for the automotive industry



Source: Survey

Somewhat surprisingly, there was little expressed support for policies such as government wage subsidies combined with training along the German 'Kurzarbeit' model,[62] with only 4.2% of respondents thinking this should be a top priority. Nor was there any real support expressed for 'levelling up' funding to communities and regions heavily affected by transition, with only 2.8% of respondents identifying this as a top priority; suggesting that UK Government rhetoric around the 'levelling up' agenda had made little headway with workers.

9.3 Summary

The preliminary evidence from our survey of automotive sector workers suggests that they see the potential to transition into the production of low-carbon vehicles. However, our findings suggest that much more needs to be done to provide effective training and upskilling for workers, with very little evidence of employer engagement in this regard. Accordingly, in the next chapter we consider the implications of our research for policy and practice, with a view to deriving clear recommendations for government policy at a regional and national level.

[62] https://www.econstor.eu/handle/10419/221790

10. Discussion: policy implications

In this study we have sought to analyse the issues pertaining to a Just Transition for the automotive sector, drawing upon primary and secondary data from the UK and Australia, focussing on suppliers and workers. The Australian experience has provided salutary lessons for the UK as to what can happen to the continued existence of an automotive industry if market conditions mitigate against the viability of a domestic production sector in the absence of pro-active industry policy at the heart of government. It highlights that the existing production capability in the industry can disappear, leading to unemployment, and that a new production capability cannot be developed, job creation is lower than it might otherwise be. It follows that Skills-sets held by workers become redundant and, if an electric vehicle production is not developed, workers forego opportunities to retrain and gain new skills. Accordingly, in this chapter we now seek to elucidate the policy implications of our research and thereby draw some wider inferences to understand what enables a successful – and a just transition.

Implicit in our analysis has been the underpinning assumption that the skillsets required within the automotive sector are essential to enable the successful transitioning to a green economy, and therefore that assisting the automotive sector to adjust aids both sectoral and regional resilience in areas heavily dependent on it as a source of employment. In particular, our UK worker survey data suggested that the skills are not wholly available in the West Midlands; only one third of workers felt they had a "good overlap" in terms of having the requisite skills needed to make low-carbon vehicles. This serves to warn that there is a need for urgent action here. The Fraunhofer study of VW shows that skills requirements of electrification need to be fully understood and that a strategy to address skills and qualification requirements needs to be devised. This needs to be done on a collaborative basis, across the industry and public authorities. Moreover, the Fraunhofer study suggests that firms in the supply chain and the VMs need to collaborate in order to ensure that skills needs intersect across the system of production and thus enable a successful low-carbon electric vehicle automotive production system (an ecosystem) to be built (Herrman et al., 2020a).

We thus eschew a "leave it to the market" approach for the UK as such a policy direction is likely to result in the loss of tens of thousands of jobs as the supply chain hollows out in the UK and VMs consolidate production in the wider EU geography of production. We note that, with the requirement in the EU-UK trade agreement that by 2027 all EVs must have batteries made in the EU, or UK to avoid tariffs, and particularly with the new barriers to trade and just-in-time supply chains created by the UK's chosen form of Brexit, having exited the EU Single Market and Customs Union, this makes it more likely that the electric vehicle production system will take place at the spatial scale of the European Union.

The WMCA (2020, p. 80) are all too aware of the prospects of mass redundancies in the sector as EV switching, fuel switching (HGVs/Buses/Taxis), demand reduction due to working from home (WFH) and trips (e.g., more home deliveries), and an anticipated increased use of public transport and vehicle sharing schemes combine to generate job losses in ICE vehicle manufacturing. Whilst a precise figure of probable job losses is not mentioned, the plan (p. 83) does mention that 140,000 jobs will need to "re-skill as result of transition" (11.1% of the WMCA workforce). VW provides lessons in this area. It has agreed to safeguard all jobs to 2029 and has developed a number of ideas to assist workers with redundant skills retain employability both within and without the industry. This is in accordance with the aim of Volkswagen to "do justice to all three dimensions of sustainability – economic, ecological, and social" (Herrman et al, 2020a, p.18).

A pro-active approach thus calls for a regional industrial policy that serves to enhance regional resilience, as we shift to zero-carbon production, accompanied by substantive devolution of power and financial resources (see Bailey and Rajic, 2021). Whilst regional resilience has traditionally been conceived of in terms of economic shocks (Fingleton et al., 2012), notably around the economic notion of 'hysteresis' (Blanchard and Summers, 1987), arguably its bigger potential contribution relates to 'disruption' of existing networks. Disruption, as a concept, encompasses an extremely broad array of events and processes. Where a 'shock' is clearly identifiable, often representing a break in a time series or a specific event, 'disruption' can also refer to an ongoing process which nature and impact evolves over time. This is certainly true of a transition to zero-carbon. It represents a change in a relationship, but the nature of this is likely to change over time and dealing with it will require regional and industrial adaptation to a continuously changing environment, requiring a strong capacity to adapt and create new development paths. Moreover, unlike a typical recessionary shock, the challenges posed by climate change have been clearly signposted for decades in advance.

Therefore a just transition clearly necessitates a need for "reorientation" (Martin, 2011) as a precursor to resilience. This implies that an essential aim of regional policymakers in the West Midlands over the next 10 years has to be to encourage diversification within the automotive supply chain and push for skills reorientation towards EV and other renewables, cognisant of the benefits of agglomeration in taking a place-based approach to regional economic development (Frenken et al., 2007; McCann and Ortega-Argilés, 2015). Bentley and Pugalis (2014) point out that, in contrast to space-neutral/space-blind industrial policies, which do not make a distinction between localities, the place-based narrative in policy spaces affirms that place matters. It involves:

- Focus on functional economic areas;
- Tapping underutilised potential in regions for enhancing regional competitiveness and addressing social exclusion;
- Institutional structures to better account for relational (as well as territorial) geographies;
- Strengthened leadership and collaborative governance capacity; and
- The need to pool resources, including private sector actors as co-creators.

Barca (2009), emphasises that the place-based approach focuses attention on the importance of relational geographies as well as arguing that places are connected in the urban hierarchy, stressing that it is agglomerations that have a position in the international division of labour and provide opportunities for development. Here, the geographies of production and consumption reflect a relational geography and are the space for which policy solutions should be constructed and the space for which a new scale of governance structures could be instituted, to manage the process of development (Bentley and Pugalis, 2014).

In stating this, we are cognisant that current regional bodies lack agency and thus ultimately the stance of the state, in the form of the UK Government in relation to this, will be key in facilitating – or hindering – a successful transition. In the current post-Covid context of seeking to reduce government spending to support the economy, the prospect of substantial resources being devoted to a pro-active industrial policy, and for it to be devolved to regional level, appear particularly slim, especially with avowed free marketeers at the heart of the UK Government. However, we would argue that this is an urgent imperative for the West Midlands, given its particular dependency on one VM (JLR), and it is to this particular issue we next turn.

10.1 The dependency on Jaguar Land Rover and BMW: policy considerations

The importance of the automotive sector to the West Midlands is clear from our analysis in this report. The region is by far the largest employer, turnover generator and value-added creator in the UK automotive industry. Moreover, it is a truism to say that the health of the regional economy depends on the health of JLR especially, and its manufacturing investments in the region. Regional policy makers need to liaise closely with JLR as the decisions regarding the location of JLR battery manufacturing and assembly facilities, which may be operated by suppliers as opposed to JLR, have not yet been made public. This is different from VW, which has its Volkswagen Component Group division and so its production system is highly integrated along the value chain, something which is being reinforced with the establishment of a network of JV or wholly-owned battery cell plants across Europe. The JLR plant at i54 near Wolverhampton will switch to making engines for hybrid powertrains and electric motors for hybrids and full electric EVs. JLR had suggested it would make the relevant announcements on battery sourcing during 2021, but at the time of writing no announcement has been made.

Specifically, employment at JLR's i54 engine manufacturing site near Wolverhampton is currently over 1,000. Additional jobs exist to support this factory, perhaps up to 3 times the number employed there, although not all of these will be in the West Midlands. However, with the ongoing switch to electric vehicles, a steady reduction in employment in the manufacture of conventional engines is inevitable. This reinforces the need to ensure that workers have the skills to compete in emerging sectors, and that suppliers are sufficiently diversified so as to not be over-exposed to the fortunes of one VM. However, the consequences for employment at Wolverhampton and supporting sites are currently unclear, although it should be noted that the switch to full electric vehicles will not be immediate and the transition to EVs will be tempered by some engines continuing to be made in hybrid configurations and by the decision by JLR to make electric motors at Wolverhampton. However, no firm details have been made public on this and the scale and timing of the switch – and specifically what value-added stages in motor manufacturing as opposed to the relatively simple and low value-adding assembly of "imported" components – will ultimately take place at the i54 site remains to be seen.

It is also reasonable to expect that some of the anticipated loss of employment at the JLR i54 site should be replaced by employment in battery production or assembly; it is widely expected that some of this will take place in the West Midlands - but where remains to be confirmed. As such, we strongly recommend monitoring the employment situation at each JLR location – i54, Castle Bromwich, Solihull, Whitley, and Gaydon especially. There is also a JLR site at Hams Hall which assembles batteries for hybrid vehicles. Details on this site remain opaque and limited; it is understood that it could not assemble the much larger and more complex batteries for full electric vehicles, which will require their own new facility and supply chain. Policy makers and local authorities need to maintain close association with both JLR and the unions on employment at all these sites, for early signals on reduction in jobs or indeed the creation of new jobs.

Furthermore, the move of Mini to become an all-electric brand will have profound implications for the activities at BMW's own engine plant at Hams Hall. In addition to Mini engines, this factory is due to make small volumes of the large BMW V8 engine for an unknown period but ultimately this will end. Based on our current understanding of BMW plans in general and for Mini specifically, it seems likely that the Hams Hall engine plant will be gradually run down; this will place the c1,200 jobs at Hams Hall at permanent risk.[63] It is difficult to envisage BMW Hams Hall being converted to

[63] https://www.just-auto.com/news/bmw-to-axe-520-jobs-in-uk/

battery assembly or similar activities given the investment in such facilities in Germany; if BMW decides to assemble batteries in the UK for Mini we expect this to take place nearer Oxford in a dedicated facility (as discussed above in the battery section of this report).

As such, the employment implications of these moves need to be carefully monitored and planned for. It seems likely that there will be some reduction in employment, even if the regional GVA measures remain broadly similar, especially if the batteries for JLR EVs are made or assembled in the region. The production of cells for JLR outside the West Midlands will however lead to a significant fall in regional GVA as production of engines will also decline across the UK. The move of employment from traditional urban areas to more "rural" locations has placed and will likely continue to place increased demands on non-urban transport and other supporting infrastructure. Reallocation of resources for buses and other transport systems may be required to match changing journey to work patterns. This requires further analysis and policy development work. It is clear that the West Midlands is the biggest automotive employing region in the UK and the sector is critical to the region's employment picture. It should be said at the outset that what JLR decides to do regarding the transition from wholly ICE-powered vehicles to various forms of hybrids and ultimately to mainly full electric vehicles will have significant implications for employment in the region (and elsewhere in the UK).

The recent decline in the West Midlands' automotive exports in monetary value terms and in terms of the share of UK automotive exports is significant (see section 6.3 above) and will likely be reflected in the turnover/value added figures when they are released for 2020 and 2021. In order to maintain exports, policy makers need to attend to similar issues as per maintaining employment and manufacturing in general.

10.2 Specific Policy Recommendations

As such, our analysis strongly suggests that policy needs to focus on two areas: **general support and improvements to the area's infrastructure and general business environment (transport links, potential help with energy costs etc.)** and more significantly **assisting with the transition to an electric vehicle manufacturing focus for West Midlands automotive**. Specifically, helping to secure a battery plant, either an assembly plant or a fully vertically integrated factory which encompasses cell production plant as well as battery assembly, should be top of the local and regional policy makers' objectives – and this has to start with a clear understanding of the needs and intents of VMs in the region. **If production of cells is to take place at a UK gigafactory, then this will in all likelihood need to be presaged by a UK Government 'deal' on a reduced tariff for electricity**. This is because as much as 2/3 of the embedded energy consumed in the production a battery is in the cell production phase; most of the rest is incurred in the raw material mining phase. There is a strong case to be made for cell production to receive support as an energy intensive industry.

Hence, current talk of a establishing a 'gigafactory' obscures the problems we have identified in securing as much value-added as possible in the West Midlands. **Helping the region's existing supply chain firms to assess what they need to do re-orientate themselves towards the new EV or zero carbon economy is essential.** There is a case for reinstating a regional service akin the MAS (Manufacturing Advisory Service), which was discontinued in 2016. **It is also essential that a Skills Strategy is developed to ensure that both VMs and supply chain firms can recruit as well as train and retrain workers so that they have the skills needed for electric vehicle production**.

Previous work by the authors (De Ruyter et al., 2019) articulated a range of policy interventions to counteract the adverse impacts of Brexit on the automotive sector, and it is apposite to reproduce them here in terms of specific policy suggestions for the West Midlands, as the impacts of a shift to

EV count as a similarly disruptive process that imparts costs on to business and will necessitate the same mix of policies. Broadly speaking, there are policies that could be actioned at a regional level (i.e., by the West Midlands Combined Authority in concert with local government and other regional agencies), whilst others would require action at a national level. In terms of regional actions, in addition to the current efforts to secure a gigafactory, these should include:

- *Establishing a Register of firms in the supply chain who want to work with VMs in transitioning to EV production, by developing a Capacity Directory which lists what products and processes firms can provide;*
- *Appointing a Supply Chain Champion to assist in delivering on-shoring and growing local supply chain capacity;*
- *Working with the major VMs to understand which UK firms they actually wish to work with in the transition to EV component supply;*
- *Funding for training provision to assist suppliers to retrain and reskill their workers for the transition to EV production (and related areas such as the green energy supply chain).[64] This should include provision of training in digital skills and expertise;*
- *Establish a Skills Taskforce consisting of VMs, supply chain firms, universities and colleges as well as private training providers to commission research and intelligence gathering on skills requirements and skills shortages to enable the design of training and degree programmes that will meet skills requirements. The VW experience in Germany demonstrates that it is essential that this is done in a collaborative basis;*
- *VMs and supply chain firms to work together on skills requirements; supply chain firms to be integrated into training programmes of VMs. This is essential to ensure coordination of skills training in order to improve quality assurance and productivity to achieve competitiveness in the emerging EV production system (the German term is 'ecosystem') (Herrman, 2020a).*
- *Shore up the supply chain by measures (subsidies/tax relief/equity stakes etc.) to make domestic production of NGO steel and key powertrain components such as motor laminations viable;*
- *Improve information sharing across the supply chain to enhance the potential for innovation;*
- *Suppliers should be able to access a loan fund to assist with restructuring their operations. This has been a key policy response used in previous plant closures such as that of MG Rover and also in response to the 2008 Global Financial Crisis (GFC);*
- *Potential business tax/rates holidays – as De Ruyter et al. (2019) identified, business rates have generally been seen as a disproportionate cost burden borne by UK manufacturing companies, especially when compared to equivalent taxes levied in other EU countries;*
- *Provide specific diversification support for firms in the industry. This was significant with individual plant closures such as MG Rover, and in response to the GFC (in this case via the Automotive Response Programme);*

[64] This will also be critical for successful adoption of 'Industry 4.0' (see De Propris and Bailey, 2021; for a discussion).

- *Much more investment is needed in increasing the capacity of on-road/car park EV charging infrastructure – this could serve as a key job creation policy as well as augmenting the skills base in green energy workers;*

- *Set up a National Transition Centre for Sustainable Employment. This can be used to raise awareness of the profound changes that are going to occur in the automotive industry. This to include the development of measures to safeguard jobs or to ensure they are reduced in a socially responsible way. The UK can draw on Volkswagen's experience in this regard (Herrman, 2020a);*

- *Prioritise local procurement strategies for the public sector, in accordance with the UK's obligations under international trade agreements;*

- *Establish special enterprise zones with excellent connectivity and a range of tax incentives. These should be centred on existing areas of automotive specialisation, building on existing clusters of expertise and support the growth of cutting-edge technologies in the region. Incubation of scale-up firms is another important area of focus;*

- *Producing a Green Industrial Strategy prioritising accessible low-cost green energy;*

- *Developing a Green Business Hub to promote regional buying, selling, sourcing and best practice exchange, and;*

- *Launching a Green Skills Hub involving West Midlands' schools, colleges, universities and businesses prioritised in light of skills shortages already evident in preparing and readying for the transitional skills required (McCabe and Nielsen, 2021).*

And whilst we have noted that regional bodies do lack agency in terms of being able to address the challenges posed by transition; that did not mean that they could not learn from one another, either intra-nationally, or internationally. Indeed, it was apparent to some of our participants that local and regional actors could share ideas and build links independently of national governments:

"*I do think that there is a role for what I call city diplomacy. I'll use the term city diplomacy in the context of we need to create in our city, our own narrative, we can't just wait for governments to create the narrative for us, and then us simply hold onto the shirt-tails of what the national governments are leading up, there is a role for us to lead, there is a role for us to challenge there is a role for us to work with other cities and countries around the world to continue to push and challenge on where we need to be quicker*" (Interview 4).

At the very least, the West Midlands needs to work with other regions in the UK with significant presence of automotive industry employment and value-added, like the North West, the North East and the South East. Ideally, it also needs to work with Wolfsberg (VW) and Munich (BMW) in the European theatre of production and consumption, the disruptions caused by Brexit notwithstanding. There is the opportunity to exchange experience and to learn from one another. This is in the interests of enabling a transition to a Green Automotive production system, to meet COP26 targets and to save the planet. More particularly, given that VW was criticised in the Fraunhofer report (Herrman et al., 2020a) for not making changes to its production system quickly enough, collaboration and co-production may help the UK automotive industry transition more quickly to a green automotive production system. This could just help the UK retain its position as an automotive production and not just assembler industry.

11. Conclusions

This report has examined the issues and challenges facing the automotive sector in seeking to attain a just transition to zero/low-carbon technologies, in an Electric Vehicle Production System, drawing on evidence from a region – the West Midlands in the UK – where the sector is still a key employer and generator of regional GVA; and a region – South Australia – where the sector has all but disappeared in the face of increased exposure to international competition. Here and in the UK, the transition appears to lead to anything but a fair transition, firms will close, jobs lost and unemployment will ensue, if nothing is done to address the issues. Key to the fortunes of the automotive sector in both regions has been the stance of government in implementing a pro-active regional industry policy – or lack thereof; in addition to ensuring the workers, and firms up the supply chain have the requisite skills and capacities to secure a successful and just transition. With regard to our initial research questions, there are clearly profound subnational ramifications for both workers in automotive and suppliers from the transition to EV in particular and the adoption of zero/low-carbon technologies in general. Since the automotive industry is spatially concentrated – and the West Midlands automotive cluster is a prime example of this – the regional impact of transition is significant in both the short and longer-term.

As such, the evidence presented here from the West Midlands and South Australia suggests that there are no 'quick fix' industrial policy solutions to the challenges of securing a just transition. For the West Midlands, where there is still "everything to play for" in terms of the continued existence of the sector being a key employer, a key challenge will be to secure as much domestic value-added in electric motor (powertrain) and battery production, as the current focus on securing a gigafactory attests. Hence, the analysis presented in this report points to the need for an appropriate regional industrial policy framework to anticipate and work to mitigate some of these impacts in the short and medium-term and create opportunities for the long-term resilience and sustainability of the regional industrial ecosystem. This would need coordinating with national-level policies but could take a range of approaches in limiting the adverse impacts (resistance) of transition, promoting recovery, and enabling opportunities for renewal and reorientation.

Indeed, this links industrial policy debates with notions of resilience by Martin (2011) in positing a wider agenda around both regional reorientation to secure a just transition – to enable a focus on growth industries in the green economy at a time of disruption – and recovery from a what will be a transformative disruption to production (as the Australian experience shows). As regards the latter, we find that agency is a key concept, noting that the highly centralised administrative governance arrangements within the UK (especially England) have been inimical to coherent regional policymaking at the micro and meso-scales. It is thus imperative that genuine devolution of both financial resources and, crucially, power is necessary (but perhaps not sufficient) to deal with the consequences of often complex disruptive events inherent in a transition to zero-carbon technologies adequately. In this context, further research could usefully explore how the process of transition unfolds by conducting longitudinal studies and follow-up interviews of workers and firms across countries as the shift to zero-carbon technologies unfolds.

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Appendix 1: UK Survey Questionnaire Template

1: Which part of the automotive sector do you work in?

Vehicle manufacturer (OEM) ☐

Components supplier Tier 1: Products are sold to OEMs directly ☐

Components supplier Tier 2: Products are sold to other component manufacturers ☐

Logistics ☐

2: Which company do you work for?

Please state ___________________________________

3: At which site do you work?

Please state ___________________________________

4: Do you have any additional jobs?

Yes ☐ No ☐

5: How many additional jobs do you have?

Please state: ______________

6: What is your job title?

Please state: ______________

7: Does your job contribute to a specific product? (Vehicle or component)

Please state: ______________

8: How long have you worked in your job?

Less than one year	☐	16-20 years	☐
1-5 years	☐	21-25 years	☐
6-10 years	☐	26-30 years	☐
11-15 years	☐	More than 30 years	☐

9: How many hours do you work in this job in a typical week?

More than 40 hours ☐

40 hours ☐

Less than 40 hours ☐

10: Would you prefer:

More hours ☐

Happy with the hours I work ☐

Fewer hours ☐

11: Which of the following best describes your employment arrangement?

Directly employed ☐

Apprentice ☐

Agency worker ☐

Contractor (outsourced) ☐

12: How long does it take you to get to work on a typical day?

Less than half an hour ☐

Half an hour ☐

An hour ☐

Two hours ☐

Over two hours ☐

13: To what extent are you satisfied with your job overall?

Very satisfied ☐

Satisfied ☐

Neither satisfied nor dissatisfied ☐

Dissatisfied ☐

Very dissatisfied ☐

14: How secure do you feel about your job?

Extremely secure ☐

Very secure ☐

Secure ☐

Insecure ☐

Very insecure ☐

15: How confident are you that your workplace will survive and manage the transition to low emission vehicles?

Very confident ☐

Confident ☐

Not sure ☐

Not confident ☐

Not at all confident ☐

16: Have you heard of the phrase: a 'Just Transition'?

Yes ☐

I'm not sure ☐

No ☐

17: How much do you think your current skills overlap with the skills needed for making low-carbon vehicles? (Electric, Hybrid of Hydrogen.)

Good overlap ☐

Partial overlap ☐

Some overlap ☐

Not sure ☐

Little overlap ☐

No overlap ☐

18: How long would you like to work in your current job?

I intend and expect to work here until I retire. ☐

I would like to stay here long term, but that is unlikely to be possible. ☐

I do not intend to work here long term. ☐

I don't know ☐

19: Do you expect to be working in the automotive industry in 2030? (The year the petrol and diesel vehicle ban will begin.)

Yes ☐

I don’t know ☐

No, but I want to stay in the industry ☐

No, I want to leave the industry ☐

No, I will have retired. ☐

20: If not, what sort of work do you hope to find in the post-carbon economy (2030 onwards)?

Other work in the automotive industry ☐

Work outside the automotive sector ☐

I don’t know ☐

Retired ☐

21: Would you consider re-training for a new job role?

Yes ☐

I’m not sure ☐

No ☐

22: What re-skilling support do you think should be available to you? (Tick all that apply.)

Access to training and education from the government ☐

Training and 'upskilling' provided by my employer ☐

I do not need to upskill ☐

I don’t know ☐

23: Has your employer offered new training or upskilling to help you prepare for the transition to new vehicles?

Yes ☐

No ☐

I don’t know ☐

24: Have you undertaken any training or educational courses outside of work to prepare for the automotive sector's transition?

- Yes ☐
- No ☐

25: Did you eventually complete the training or educational course?

- Yes ☐
- No ☐

26: What qualification did you obtain?

Please state ________________________________

27.1: What do you think the government's top three priorities should be to help you and the industry? (Pick 3): Priority One

27.2: What do you think the government's top three priorities should be to help you and the industry? (Pick 3): Priority Two

27.3: What do you think the government's top three priorities should be to help you and the industry? (Pick 3): Priority Three

Scroll-down menu containing the following options:

- Government wage subsidy (like furlough) combined with training.
- A phased end to petrol and diesel vehicles to give companies and workers time to adjust.
- Focus on supporting as much of the existing workforce as possible through the transition.
- Invest in electric vehicle battery manufacturing.
- Focus on supporting new, decent 'green' jobs in automotive.
- Support moving jobs from the automotive sector to new 'green' industries.
- An expanded Electric Vehicle charging network.
- Funding (e.g., “levelling up”) for communities and regions heavily affected by change.
- Access to training for workers to acquire new skills.
- Investment in new automotive products.
- I don’t know.

28: How would you describe your gender?

- Male ☐
- Female ☐
- Prefer not to say ☐

29: How old are you?

18-21 ☐	41-45 ☐
21-25 ☐	46-50 ☐
26-30 ☐	51-55 ☐
31-35 ☐	56-60 ☐
36-40 ☐	over 60 ☐

30: What is your ethnicity?

- White British ☐
- White Irish ☐
- White European ☐
- Black British ☐
- South Asian ☐
- Chinese ☐
- Other East Asian ☐
- Prefer not to say ☐

31: What is your highest level of education you have completed?

- Postgraduate degree or equivalent ☐
- Bachelor degree or equivalent ☐
- Certificate or Diploma ☐
- A-level or equivalent ☐
- GCSE/O-level or below ☐
- No formal schooling ☐

32: Do you have a technical or trade qualification?

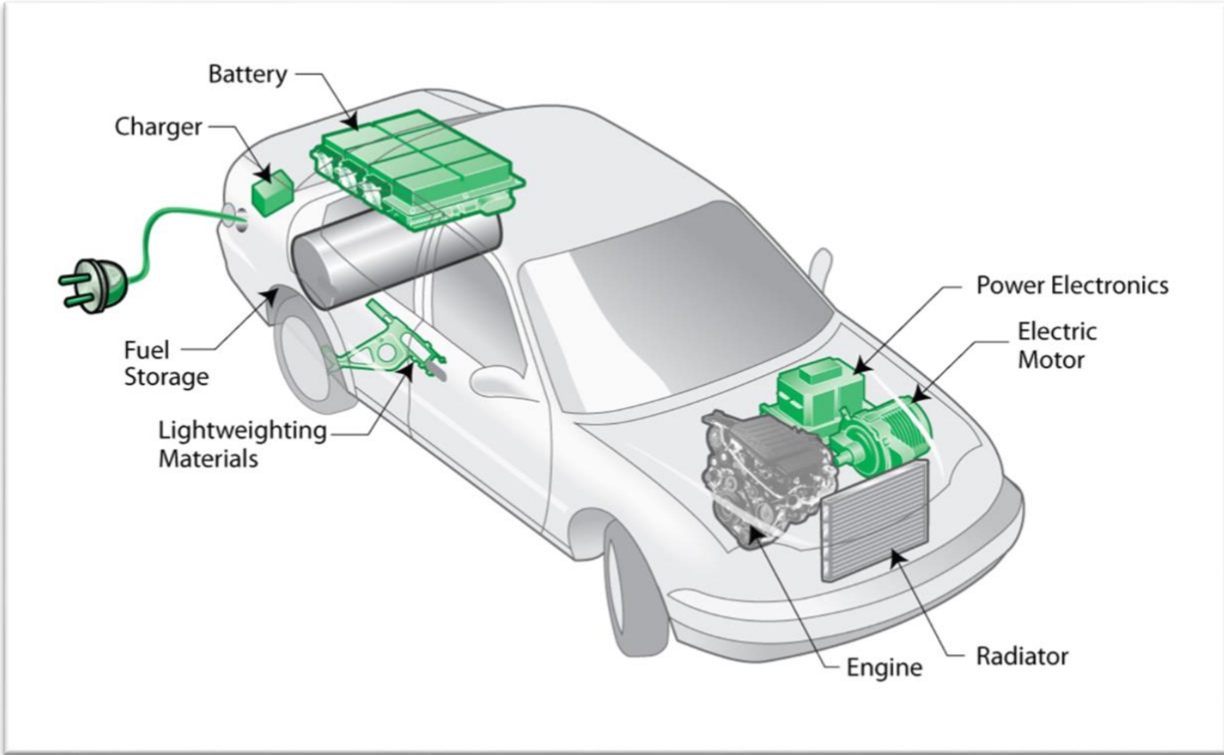
- Yes ☐
- No ☐

33: In general, would you say your health is…?

- Excellent ☐
- Very good ☐
- Good ☐
- Fair ☐
- Poor ☐

Appendix 2: Electric Vehicles, key parts and components

Figure 13: Schematic of the key parts in an electric/hybrid vehicle



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In considering the schema above, it is useful at this stage to provide a recap of the parts and components that go into an Internal Combustion Engine (ICE) vehicle (see Bauer et al., 2018), as opposed to an Electric Vehicle (EV) in order to appreciate the changes that suppliers will face – principally that EVs typically have fewer parts than an ICE vehicle. The production of an ICE involves a considerable number of components and manufacturing processes:

- Flywheel (casting, forging bearings, hardening),
- Engine block (casting, annealing, drilling, milling),
- Piston ring (bending, hardening, coating),
- Crankshaft (casting, forging, polishing, hardening),
- Connecting rods (forging),
- Connecting rod bearings (manufacture),
- Pistons (casting, milling, polishing),
- Oil pan (deep drawing, painting),
- Liners (honing, pressing, polishing),
- Cylinder head (manufacture),
- Cylinder head gasket (punching, gluing),
- Camshaft (casting, hardening, assembling, milling),
- Valve gear (manufacture),
- Valves (guidance, tappets, springs),
- Timing belt (punching, assembling),

- Combustion engine (installation).

There are also components and processes associated with peripherals:

- Charge (Craft),
- Oil supply (manufacture),Air supply (establish, special consideration of suction module, filter, cooler, sensors, clean air line),
- Exhaust system (manufacture, special consideration of sensors, catalytic converter, particle filter, EGR, silencer, SCR),
- Injection system (manufacture, special consideration of control units, injection nozzle, fuel pump),
- Ignition system (manufacture, special consideration of spark plugs, ignition coil, wiring),
- 48 V starter generator (produce),
- Side/PTO shaft (manufacture),
- Tank system (manufacture; special consideration of tank, filter, cap, hoses, pump),
- Assembly of the combustion engine and the peripherals.

Added to this are the components and processes associated with the transmission:

- Dual mass flywheel (pressing, stamping, riveting),
- Multi-plate clutch (stamping, riveting), Gears (casting, hobbing, hardening, grinding),
- Storage (manufacture),
- Shafts (turning, hardening, deburring),
- Hydraulic oil pump (manufacture),
- Mechatronics (manufacture),
- Transmission housing (casting, drilling, milling, grinding),
- Disconnect clutch (manufacture, hybrid only),
- Assemble the electric machine (only hybrid),
- Transmission assembly.

In contrast, the production of EV engines is relatively simple. Fewer parts are needed than for an ICE, which immediately suggests a reduced volume of work for UK suppliers as VMs shift to EVs. The components and production processes are as follows:

- Cell modules (assemble),
- Battery housing (manufacture; form, join, check),
- Battery system (assemble; special consideration of the inserting of the cell modules into the housing, connecting the cell modules),
- Battery management controller (installation).

The following components and manufacturing processes for the production of battery and hybrid electric vehicles also need to be included:

- Rotor (punching and stacking),
- Magnets (assemble; glue, balance, encapsulate),
- Stator (stamping, building up, isolating, winding, painting),
- Bearings (assemble),
- Housing (casting, fine work),
- Bearing and stator (place in housing),
- Rotor (put into stator, check windings, measure),

- Transmission (install, battery-electric vehicle only).

Finally, power electronics control the flow of energy in the electric powertrain with AC/DC and DC/DC converters are generally being used. The following components and manufacturing steps were considered in the Bauer et al. (2018) study:

- Vendor parts: IGBTs, DCB, base plate, housing,
- Power module (assemble),
- Capacitor (manufacture),
- Control electronics (manufacture),
- Housing control electronics (casting),
- Installation of power electronics (fix power module, assemble capacitors and control electronics, close housing).

Appendix 3: The Korean government and batteries for the auto industry

A very good example of how governments can assist with the transition to EVs and batteries comes from Korea. The South Korean government has created an environment in which three global players in the electric vehicle battery sector have emerged to challenge Panasonic of Japan and the many Chinese battery makers (especially CATL). LG, SKI and Samsung have expanded beyond Korea and have a growing network of plants in Europe and North America. Illustrating the co-operation between industry and government, in July 2021, the three Korean companies announced a government-coordinated investment plan worth just over 40 trillion won in what is referred to as the "K-battery strategy". The South Korean president Moon Jae launched the scheme in person, highlighting the commitment of the government. The country will develop and, crucially, commercialise new battery technologies, specifically lithium-sulphur batteries by 2025, solid-state batteries by 2027 and lithium-metal batteries by 2028. Also, a dedicated Battery Park will be operational by 2026 to centralise R&D in next-generation batteries.[65]

The three Korean companies will invest 20.1 trillion won in R&D and 20.5 trillion won in production facilities by 2030. The government will provide tax credits of 20% for investment in production systems and 50% for investments in R&D. In addition, the government, financial companies and the battery makers will set up a significant fund, worth 80 billion won, to fund small and medium-sized companies in strengthening their manufacturing capabilities in battery materials and components. The government will also fund 1,000 battery experts per year.[66] Significantly, the government will also lead plans to secure raw materials for the sector; in August 2021, a plan was announced to double the country's stockpile of strategies inputs for the industry, notably lithium cobalt, nickel and rare earths. The Korean plan is to ensure it has at least 100 days' worth of supplies of each of the 35 critical materials it has identified; this is an increase from the previous average of 57 days' supply.[67] The direct involvement of the Korean government in this crucial industry is clear.

Korean government support for other automotive technology developments

Outside batteries, the South Korean government provides significant support to the automotive sector**.** It committed 145.5 billion won between 2017-22 to support key automotive technology areas, along with appropriate infrastructural support to companies in the region. This support includes specific support as three locations:

- **Daegu**: Intelligent automotive systems, including autonomous vehicles, specifically at:
    - The Gyeongbuk Research Institute of Vehicle Embedded Technology
    - The Gyeongbuk Institute for Advanced of Eco-friendly Auto Parts Technology
    - The Korea Intelligent Automotive Parts Promotion Institute.
- **Ulsan**: Fuel cells and electric vehicle components.
- **Busan**: Quality control systems.

[65] See: https://www.electrive.com/2021/07/09/south-korea-to-invest-in-battery-industry/

[66] See: https://www.kedglobal.com/newsView/ked202107080013

[67] See: https://qz.com/2044472/south-korea-unveils-critical-metals-plan-to-support-battery-goals/

All of the above builds on earlier commitment from the Korean government to the automotive sector, including:

- **KRW150bn** (USD136m) was allocated between 2015-20 to support R&D in battery density; cooling and heating systems; electric power conversion; lightweight bodies; high output power-driving systems; multi-stage transmissions systems.
- **KRW78bn** (USD71m) was allocated between 2015-20 for work in self-driving or autonomous vehicle systems; areas that the government sees a collective weakness for the country being too reliant on imports. Components include high resolution cameras, radar sensors, external communications modules, vehicle position measuring modules, high-precision 3D maps, driver monitoring, self-driving integrated controllers and recording systems for self-driving vehicles
- Following these projects, in early 2020 the Korean government announced that a further KRW385.6 billion (USD350m) will be invested in R&D projects through to 2026, focusing on electric and other clean energy vehicles. This builds on a 2019 government commitment to make Korea into what President Moon Jae-in described as "the leading country for future cars by 2030" which was based around three core strategies:

    1. **Facilitating the use of eco-friendly technology**: the Korean government wants electric and hydrogen vehicles to:
        - account for 33% of the Korean market by 2030
        - achieve a global market share for these vehicles of 10%
        - and take advantage of these developments with the installation of 15,000 rapid chargers for EVs by 2025 and 660 hydrogen fuel stations by 2030 and 1,200 stations by 2040 (Korea already has 171 hydrogen stations).

    2. Becoming **the first country to have the relevant infrastructure for self-driving vehicles** by 2027, although key systems (wireless communications, detailed 3D mapping and integrated traffic control systems and road signs) should be operational by 2024.

    3. And **the development of an ecosystem of suppliers and research institutes for** what the government calls **"future vehicles"** with investment KRW60 trillion (USD54.5bn) led by Hyundai and Kia.

Further to the above, the government supports academic research in the following technology areas and locations, with the specific aim of creating an environment for new companies to spin off from academic research:

Region of South Korea	Location	Technology focus
North-west	Gyeonggi-do	Green car technology
	Chungcheongnam-do	Automotive design, electric components
West	Jeollabuk-do	Green CV technology
South-west	Gwangju	Clean diesel systems
	Jeollanam-do	Micro mobility
	Jeollanam-do	Automotive tuning
East	Daegu	Intelligent vehicles
		Green car technology
		“Auto convergence” parts
South-east	Ulsan	EV parts

Source: KOTRA (Korean Overseas Trade Promotion Agency)