Seizing sustainable growth opportunities from zero emission passenger vehicles in the UK

SUMMARY

Special report for the

LSE Growth Commission

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This report summary is intended to inform decision-makers in the public, private and third sectors. It has been reviewed by internal and external referees before publication.

Foreword by Nicholas Stern

The UK government has a long-term commitment to improving productivity and achieving sustainable and inclusive growth. Concurrently, the UK has become the first major economy to enter a commitment into law to achieve net-zero annual emissions of greenhouse gases by 2050. The combination of these long-term commitments creates a whole-economy opportunity to drive growth through sustainable investment, innovation and creativity, while demonstrating the UK's international leadership on climate change.

By orienting the economy towards zero-carbon products and services, the UK can seize economic opportunities from the global transition as demand rises for zero-carbon activities. Market forces combined with rising government and societal ambitions across the globe are unleashing demand for zero-carbon goods and services. The costs of technologies such as lithium-ion batteries has fallen by more than 75 per cent over the past 10 years. The zero-carbon transition is the growth story of the 21st century, and a race is now on between economies to become cleaner, smarter and more efficient.

The UK's commitment to sustainable and inclusive growth to date has been increasingly embedded in policies and plans through, for example, the Industrial Strategy and Clean Growth Strategy. The combination of urgency and opportunity implies that the Government should now make a step change, both in the amount of investment and in the package of policies and institutions that can achieve effective impact at scale. Strong institutions and sound policies can unlock further investments in infrastructure, innovation, skills and cities, driving productivity improvements and sustainable growth across the nation.

In many parts of the country, employment in automotive manufacturing and related sectors is interwoven with local communities and their sense of identity, and the zero-carbon transition must be carefully managed to minimise displacement and ensure its benefits are spread. Well-planned policies for sustainable investment can strengthen local cohesion and pride by building local capacity, generating economic opportunities and improving labour market resilience.

In 2018, the LSE Growth Commission released a special report on sustainable growth in the UK, setting out how the country can seize opportunities from technological change and the transition to a low-carbon economy. The report presented the institutional and policy frameworks required to stimulate investments in innovation, infrastructure, skills and cities and to return the UK to long-run and inclusive growth. These principles must underpin the Government's approach to policymaking in the coming years.

The transition towards sustainable growth needs to take place across the entire economy. The Committee on Climate Change's advice to government on net zero shows that substantial structural shifts are required simultaneously across different parts of the economy if the UK is to achieve this ambition and legislative target. These include, but are not limited to: electricity, hydrogen, buildings, road transport, industry, land use, agriculture, aviation, shipping, waste, F-gases, greenhouse gas removals and infrastructure. Road transport is just one of many parts of the economy that are undergoing a significant transition, and that could present growth opportunities for the UK. But it is one of great importance. The UK government's recent decision to move the ban on sales of internal combustion engines forward to 2035 is welcomed. Strong, long-term policy sends a clear signal to both business and consumers, thereby reducing uncertainty and the cost of capital and allowing commitment at the scale that can reduce costs. This report unpacks how the UK can derive balanced and inclusive growth opportunities from a shift towards zero emission passenger vehicles.

***Nicholas Stern**, February 2020*

IG Patel Professor of Economics and Government, and Chair, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science

Key findings

- The rise of zero emission and autonomous vehicles offers a pathway to decarbonise road transport in the UK and provides growth opportunities for the country, part of the whole economy opportunity that sustainable growth presents.
- Despite the UK losing competitiveness in comparison with market leaders, our analysis suggests it could still have a manufacturing opportunity if it steps up incentives to support production in regions across the UK, spurs demand for zero emission vehicles and secures close alignment with the European Single Market and EU emissions regulations.
- The UK could sustain nearly 80,000 jobs in 2030 in the production of electric vehicle powertrain components, charge points, fuel cell powertrain components and autonomous vehicle hardware and software – if the UK is globally competitive in these technologies.
- In this scenario there would be significant additional employment upstream and downstream of component production. For instance, upstream, EV component production would likely be underpinned by a competitive domestic chemicals supply chain. Downstream, car manufacturers would likely be more inclined to assemble vehicles in the UK if the country is manufacturing high value components for zero emission vehicles.
- Related growth opportunities are diverse in nature and extend beyond the automotive supply chain as it is traditionally considered, including areas such as the testing of connected and autonomous vehicles, the production of chemical inputs for batteries, and software platforms for mobility services. Future supply chains could look very different from today's.
- In terms of innovation, the UK's competitiveness varies across technologies and supply chain stages. The UK has a comparatively lower share of global innovation in clean and autonomous car technologies relative to other countries and is lagging behind on EV component innovation; there is still innovation activity in dirty car technologies.
- However, looking at specific technologies within the clean and autonomous car category, the UK has a comparatively greater share of global innovation in connected and autonomous vehicle technologies, and regions such as the West Midlands and Eastern Scotland are hotbeds of zero emission and autonomous vehicle innovation.
- Innovation policy can also be informed by new measures of the social returns from innovation, which include private returns on innovation as well as direct and indirect knowledge spillovers. Such measures can highlight areas where the UK returns to R&D are high.
- To meet this diverse range of opportunities and given varying levels of competitiveness, the UK should adopt a portfolio approach to incentive design, targeting a wide range of goods and services that can contribute to zero emission, connected and autonomous road transport.

Summary

Seizing opportunities from goods and services related to passenger vehicles can be part of a strategic approach to achieving net-zero in the UK

The transition to a zero-carbon economy is the growth story of the 21st century. The UK's recent commitment to achieve net-zero annual emissions of greenhouse gases by 2050 presents an opportunity to drive sustainable growth in the country through investment, innovation and creativity. By being at the forefront of the development of zero-carbon products and services, the UK can seize economic opportunities from the worldwide transition that is already underway, and the markets that are growing around the world.

An economy-wide approach to supporting decarbonisation presents the UK with significant opportunities to harness and exploit innovation in transformational technologies such as digitisation, artificial intelligence (AI) and robotics. However, to realise this potential, the UK needs to adopt a strategic approach to decarbonisation and the transition to net-zero economic growth. This will require consistent and long-term policy across government, R&D funded directly by government, and incentives for businesses to invest in innovation for zero-carbon goods and services. Clear signals will also be needed to demonstrate the direction of travel to consumers, and to incentivise and accelerate the switch to zero-carbon alternatives across all sectors of the economy, including transport. This report focuses on how the UK can seize opportunities from goods and services related to passenger vehicles.[1]

Despite the UK losing competitiveness in vehicle manufacturing in comparison with market leaders such as China and Germany, our analysis suggests the country could still have a manufacturing opportunity if it steps up incentives and maintains its focus on driving domestic demand for zero emission vehicles. Furthermore, the areas related to passenger vehicle mobility in which the UK could be competitive extend beyond manufacturing of components to diverse goods and services across value chains and stages of innovation.

Passenger vehicles – an area of opportunity

The UK automotive industry, including both automotive manufacturing and jobs reliant on automotive jobs, accounts for the employment of nearly 450,000 people. In 2019, 1.3 million cars were built in the UK, 1.1 million of which were exported, according to the Society of Motor Manufacturers and Traders. What combination of passenger vehicle technologies takes root in the future remains to be seen – full deployment of individual technologies and trends such as autonomous driving are not yet guaranteed, and there are uncertainties over the speed of take-up. However, the UK government recently signalled its commitment to the domestic uptake of zero emission vehicles by moving a ban on new sales of internal combustion engine (ICE) and hybrid vehicles forward from 2040 to 2035. Furthermore, global technology trends, passenger behaviours and policy signals are gradually steering innovation away from vehicles powered by internal combustion engines, owned by individuals and driven by humans, and towards a number of cleaner and smarter technologies and innovations. Along with unanticipated future innovation related to zero emission passenger vehicles, these are the focuses of our analysis:

- Electric vehicles (EVs), charging infrastructure and supporting services
- Connected and autonomous vehicle (CAV) hardware and software
- Fuel cell vehicles and infrastructure
- Mobility-as-a-service (e.g. digitally-enabled ride-hailing)

[1] This is the first in a series of reports by the LSE's Grantham Research Institute on Climate Change and the Environment and the Centre for Economic Performance that will identify how the UK can maintain a focus on sustainable and inclusive growth in different parts of the economy as the country seeks to redefine its place in the world and achieve net-zero emissions.

Expected technology trends and drivers in road transport

The main developing technologies expected to penetrate further in the 2020s, to differing degrees, are:

- *Electric vehicles (EVs):* EV sales are expected to increase significantly through the 2020s, both domestically and globally. The 2019 Battery Price Survey by Bloomberg New Energy Finance (BNEF) predicts that EVs will start to reach price parity with internal combustion engine vehicles globally in 2024, after which sales will gather pace. This will be accompanied by improvements in performance and resultant reductions in anxiety over range.
- *Connected and autonomous vehicle (CAV) hardware and software:* Many vehicles sold today are already equipped with some autonomous functionality. Sales of CAVs with fully autonomous capabilities (e.g. L4–5) are expected to gradually increase through the 2020s but fully autonomous vehicles are not expected by BNEF to have a meaningful impact on transport patterns until the 2030s. Autonomous driving will be enabled by regulatory frameworks which allow L4–5 autonomous vehicles to drive on roads and growing consumer confidence in the technologies.
- *Fuel cell vehicles and infrastructure:* Fuel cells are not anticipated to have a material impact up to 2030 for passenger vehicles as there is not yet a supply of hydrogen available at scale or a demonstrated infrastructure network that can safely carry it to vehicles. The 2020s are likely to provide an opportunity for testing, refining and demonstrating the technology, with it being most viable for heavy goods vehicles.
- *Mobility-as-a-service*: With a proliferation of ride-sharing applications and car clubs, mobility-as-a-service is likely to increase significantly through the 2020s, driven by factors including shifts in vehicle ownership behaviours and the disrupting force of technologies such as artificial intelligence and the internet of things working together. The impact on car sales and ownership is not clear but the market for technologies which enable mobility as a service is set to increase.

Passenger vehicles (even if self-driving or under shared ownership) are expected to continue to play a role in future transport systems in 2030, alongside other mobility modes such as cycling. Therefore, opportunities in the design and manufacture of passenger vehicles as well as auxiliary services can be created by an ambitious vision for sustainable growth in the UK.

Sizing up the future growth opportunity for the UK

A broad range of growth opportunities exist for the UK in relation to passenger vehicles, from early stage innovation through to diffusion, across the value chain. Automobile value chains themselves are expected to change shape in the coming years as they are upgraded due to rising wage costs in emerging economies, the digitisation of production and the bundling of goods and services together. These factors will potentially create opportunities for advanced economies, including the UK, to regain international competitiveness in the passenger vehicle industry. Production may also become more distributed and closer to markets for consumption.

There is increasing awareness of the strong linkages between manufacturing and services, with business services able to provide inputs into manufacturing processes. The Government should think strategically about where the UK could have advantage across innovation and value chains, given the competition it faces from other economies.

Below we outline how competitive the UK is in different areas across the value chain and where employment opportunities may lie:

- *Raw material production:* The UK is exploring lithium mining opportunities in Cornwall, but this is early stage research and it is not clear whether production can be cost-competitive with imports. Currently, cobalt production is dominated by Democratic Republic of Congo while China has significant lithium production and secondary processing of cobalt. The UK has an established and mature chemical industry that could benefit from increased demand for chemical inputs from a UK-focused battery industry.
- *Manufacturing of components:* The UK's production of batteries has remained small at around 2GWh per annum (powering 60,000 vehicles) at the Nissan Leaf factory. Battery production remains dominated by China (73 per cent of global capacity), followed by the United States and many Chinese and Korean companies are siting production in Europe. It is likely that much of the CAV-related hardware (in particular, sensing and mapping hardware) would be imported to the UK from abroad. Our innovation analysis indicates the UK has a good record for vehicle-to-everything technologies and smart charging technologies.
- *Assembly of components:* The number of UK-based developers of EV charging infrastructure is growing – developing turnkey charging products, by purchasing components from overseas and then assembling them under different configurations – e.g. Jaguar Land Rover recently announced plans to assemble an EV. However, established automotive companies in countries such as China, the United States and Germany (such as Volkswagen) are dominating investment into both EV assembly and charging infrastructure. Large-scale conventional vehicle assembly in the UK is dominated by foreign companies.
- *Sale and usage (including maintenance):* The UK is one of the fastest growing markets for EVs and could be well placed to test the usage of future vehicle technologies such as CAVs – it is already one of the major global centres with four CAV testbeds and internationally active companies testing the technology e.g. Horiba Mira. China remains the world's largest market, accounting for almost half of the global stock. Norway is the global leader in terms of EV market share as a proportion of total vehicles, at 46 per cent of new sales in 2018. A recent survey by KPMG found the Netherlands to be the country most prepared for CAVs, followed by Singapore, Norway and the United States.
- *Services across the supply chain:* A wide range of services play a role in current and likely future supply chains. This includes software and computer services that enable autonomous mobility via passenger vehicles (dominated by Silicon Valley firms); and strategy, management consulting and technical services (e.g. engineering – spread throughout the world but with concentrations of revenue in the United States, China and Canada) related to production of passenger vehicles. The UK is a world-leading green finance centre and financial services continued to be the largest service exported globally by UK businesses in 2017. However, to date the UK's capabilities in, and availability of, green finance have not translated into an advantage for the country's zero emission vehicle industry. The UK has a significant number of major engineering firms, including Mott McDonald, and examples of businesses working on mobility services such as Oxbotica.

In focus: UK jobs from manufacturing of passenger vehicle components in 2030

It is challenging to make accurate estimates for the number of individuals that might be employed in the future value chain for passenger vehicles. This is due both to the diverse range of potential employment opportunities as well as to uncertainties about future business models, technology penetration levels, vehicle sales and UK market share. In contrast, fewer

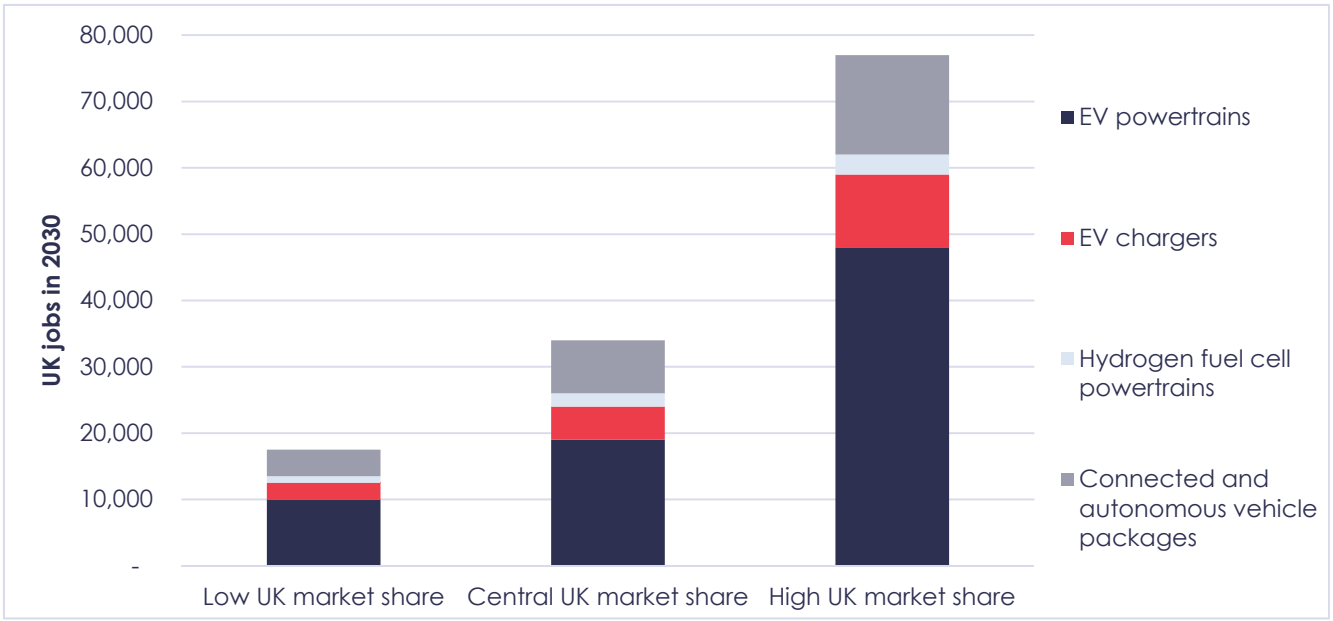
assumptions are required to make high level estimates for the jobs that could be directly supported by the manufacture of future goods, based on the value of components if they were manufactured in the UK. We have taken the latter approach but we highlight the fact that the total numbers across the value chain would be much bigger.

To estimate the jobs directly supported by the manufacture of future goods, we project the 2030 sales for different technologies, using a range of sources including the International Energy Agency, Transport Systems Catapult and Frost & Sullivan. Figure 1 outlines the possible number of jobs in 2030 if the UK gains or loses market share relative to the status quo. If the UK can attain the 'high market share' scenario (growing its global market share from 2017 to the level of its close European competitors), the passenger vehicle industry could sustain nearly 80,000 jobs in the direct manufacture of zero emission vehicle powertrain (the mechanism that transmits the drive from the engine of a vehicle to its axle) components and connected/autonomous passenger vehicle components. This does not include broader employment opportunities in the supply chain or remaining jobs in component production for vehicles powered by internal combustion engines. The global market for selected zero emission and autonomous vehicle components made in the UK could be worth £16.8bn in 2030, with EV powertrains making up the bulk of this value, under a 'high UK market share' scenario.

There are currently 168,000 people directly employed in the manufacturing of all types of vehicle in the UK. Many of these jobs are not powertrain-specific (e.g. chassis production) and thus in theory are transferable to zero emission vehicles. However, securing UK jobs in the manufacture of zero emission and autonomous vehicle components could be particularly important to anchor the manufacture of a broader range of components in the UK. A strong backbone of next-generation component production in the UK could encourage businesses to continue – or move – production of other vehicle components and assembly to the UK.

However, it is also clear that the UK needs to improve its competitiveness in these technologies if it wants to support a number of workers in manufacturing zero emission vehicle components comparable to the amount currently employed in the manufacture of components for vehicles powered by internal combustion engines.

Figure 1. UK jobs related to selected vehicle and charger components under varied scenarios



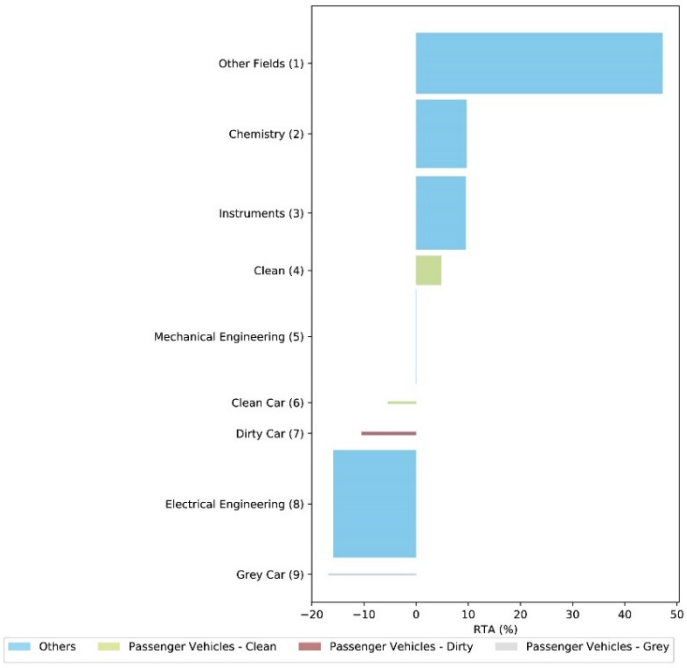
Note: each scenario assumes consistent vehicle sales, technology deployment and a sales ban in the UK in 2030 on vehicles powered by the internal combustion engine. Source: Authors' analysis based on multiple sources

In focus: the UK's innovative strengths

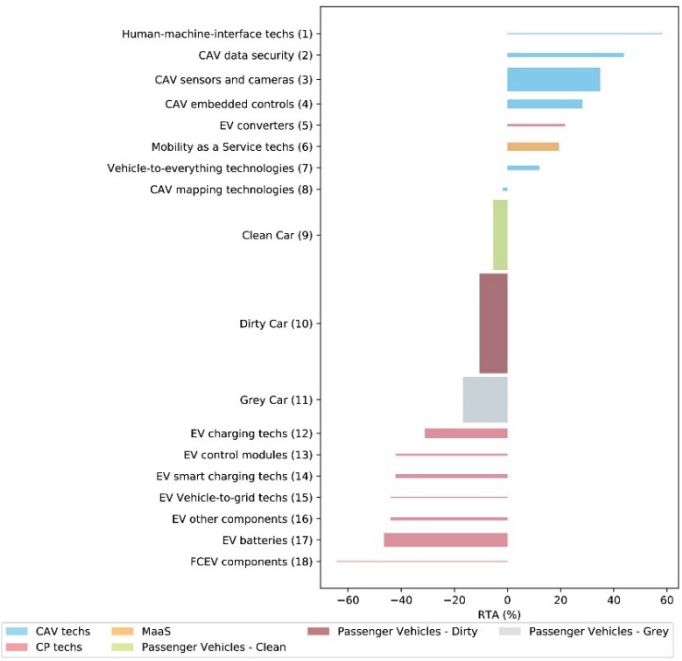
While there is significant uncertainty over future UK competitiveness in goods and services related to zero emission passenger vehicles, tracking innovation activity can give an indication of areas in which the UK might enjoy comparative advantage. A useful measure to consider is Revealed Technological Advantage (RTA), which gives the share of an economy's patents in a particular technology field relative to the share of patents in that field around the world. This gives an indication of the relative specialisation of a given country in selected domains of technological innovation. Figure 2, Panel A shows the UK's RTA in clean car innovation compared with the rest of world between 2005 and 2014. This reveals that at a broad, economy-wide level, the UK is doing comparatively worse in clean car innovation compared with other countries – in contrast with other broad categories of the economy (including cleantech as a whole), in which the UK has a greater share of innovation than other countries.

Figure 2. Revealed technological advantage (RTA) of the UK in clean car innovation compared with the rest of world (2005–14)

A. Share of clean car innovations in the UK compared with rest of world



B. UK innovation in clean cars compared with broader innovation



Notes: The x-axis (width of the bar) shows the RTA; the depth of the bar on the y-axis is proportional to the number of patents in each category. Source: Authors' estimates based on PATSTAT

Panel B shows UK innovation at a more granular level within the clean car category, compared to broader categories of car innovation. This analysis suggests that within the category of clean cars, the UK is outperforming the rest of the world for CAV technologies (labelled CAV techs, coloured blue) and doing worse relative to other countries in clean powertrain technologies (labelled CP techs, coloured pink). While in absolute terms a large number of innovations related to EV batteries have been registered, the UK has a considerably lower share of total innovation than other countries.

Another significant finding is that during the period in question, the UK was still registering more 'dirty' vehicle innovations than 'clean' innovations. This piece of analysis finishes in 2014 given lags in data availability and we note that the shares of innovation are likely to have changed since then, given the significant amounts of R&D funding directed towards clean powertrain technologies (e.g. via the Advanced Propulsion Centre and the Faraday battery challenge).

While RTA gives an indication of the areas in which the UK has specialised, it does not give an indication of the value that the UK – or the rest of the world – might gain from a particular type of innovation. Nor does it give an indication about the ability of governments to promote further innovation in specific areas. Innovation policy can also be informed by measures of the social returns from innovations, which vary considerably in nature and between different technologies and across countries. The 'IStra-X' industrial strategy index methodology allows for the computation of the social return on potential government R&D subsidies to different technology areas, taking into account variation in the private returns on innovation, as well as direct and indirect knowledge spillovers. It also allows for differential responses to government subsidies across technology areas.

The IStra-X analysis shows that in the UK, car related technologies as a whole tend to deliver lower social returns than most other technology fields. Furthermore, public R&D investments in clean cars appear to deliver comparatively lower social returns to the UK than 'dirty' and 'grey' car technologies, relative to the cost and likelihood of innovation. This may be explained by the enduring incumbency of the ICE vehicle and the corresponding firms innovating incrementally.

Nonetheless, as with relative technological advantage, there is a high level of heterogeneity between specific vehicle technologies. EV vehicle-to-grid technologies and vehicle-to-everything technologies are the technologies that outperform dirty and grey car technologies when considering both RTA and IStra-X as indicators; the UK outperforms the rest of the world in innovation related to these technologies, and they deliver notable innovation-related social returns for the UK (in excess of 10 per cent on average).

Given the diversity of these results, and the UK government's decision to target passenger vehicles as a strategic priority (for reasons broader than innovation spillovers), this analysis highlights the need for a portfolio approach to policymaking in this area, with incentives at the aggregated, outcome level – e.g. 'zero emission passenger vehicles'. This may help to mitigate the overall impact of certain passenger vehicle technologies receiving government support while delivering comparatively lower returns than others. More generally, this type of analysis can help highlight other clean technologies, for example in clean energy, where further support can be justified from a growth perspective.

Ensuring opportunities contribute towards regionally balanced growth

Growth opportunities related to clean and autonomous vehicles need to be understood at a regional level to ensure goods and services contribute to growth that is well distributed across the UK. Areas outside London and the South East account for a large proportion of employment in vehicle manufacture, and the industry plays a key role in defining regional identities. Motor vehicle production accounts for 18 per cent of total manufacturing jobs in the West Midlands and 15 per cent of manufacturing jobs in the North East.

In areas with high employment in the internal combustion engine supply chain, there should be a focus on worker reskilling programmes and other programmes to attract investment and jobs in zero carbon goods and services. This must recognise that other sectors alongside vehicle production could also foster growth opportunities. Where there is regional capacity to drive growth from clean and autonomous vehicles, it should be nurtured. From a national policy perspective, it is also valuable to share best practice and build linkages between regions.

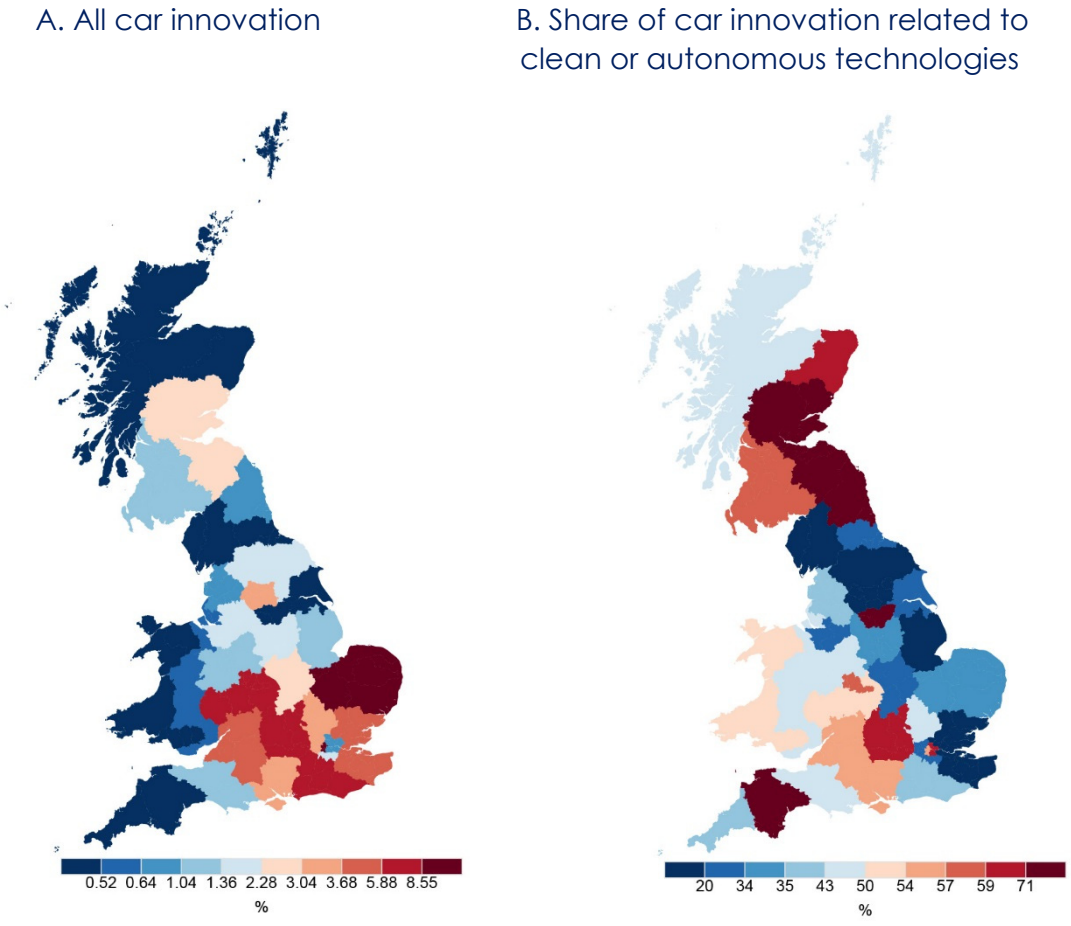
Analysing innovation activity at a regional level can shed light on which parts of the UK could be well positioned to act as R&D hubs for clean and autonomous vehicles in the coming years.

Panel A in Figure 3 below maps the distribution of car innovation (patents) across Great Britain, and includes innovations classed as clean, dirty and grey (e.g. improvements to reduce the emissions of ICE vehicles). Panel B shows the share of total car innovation in each region that is

related to clean or autonomous technologies. The West Midlands has a relatively high share (over 8 per cent) of total car innovation in the UK (Panel A), and more than 50 per cent of this innovation is in clean or autonomous vehicle technologies (Panel B). The statistics are similar for the nearby area encompassing Herefordshire, Worcestershire and Warwickshire. The Warwickshire and Coventry automotive sector has been praised for its investments in R&D and strong links to local universities.

In contrast, a considerably lower proportion of car innovation in East Anglia is related to clean and autonomous, despite being the location for nearly 10 per cent of total car innovations. Eastern Scotland, where just 2.5 per cent of total car innovation takes place, appears to specialise in clean vehicle technologies – more than 75 per cent of its car innovations are in clean and autonomous technologies.

Figure 3. Distribution of car innovation in Great Britain, 2005–14



Notes: The maps give innovation shares (based on patents between 2005 and 2014) at the NUTS2 level. The boundaries marked in the legend for each reflect the deciles of each measure.

Source: Authors' estimates based on PATSTAT

Recommendations for sustainable growth in the UK from passenger vehicles

Current incentive frameworks are not fully optimised to capture the opportunities for sustainable growth that the design and production of zero emission passenger vehicles could present over the next 10 years.[2] There are several gaps and limitations across supply and demand side policies for future passenger vehicles. The recommendations here are structured in response to these gaps and limitations, outlining the changes needed to overcome the barriers to realising the potential of growing demand and markets for zero emission passenger vehicles. Adopting these recommendations can indicate to business that the UK has a strategic commitment to being internationally competitive in these markets, while driving economic growth across the UK.

Issue 1. Demand-side policies are not sufficiently holistic, ambitious or long term to maximise their potential to encourage UK-based suppliers of goods and services.

Recommendations

- 1.1. Implement a non-regression clause which mandates current and future governments to either maintain demand-side vehicle incentives or revise them to be more ambitious and comprehensive, until such a time that the Committee on Climate Change deems them to be no longer necessary.
- 1.2. Explore options to move the ICE and hybrid vehicle sales ban earlier than 2035, while empowering regions to implement further incentives to make the economics of zero emission vehicle purchase more appealing.
- 1.3. Ensure all investment in road infrastructure facilitates charging infrastructure development, with public investment leveraging private investment.
- 1.4. Use demand-side policies, regulation and government procurement in larger vehicle classes to spur UK manufacturing, resulting in technology and knowledge spillovers for passenger vehicle production.
- 1.5. Consult UK businesses to gradually develop the Autonomous and Electric Vehicles Act into a clear regulatory framework while not stymying innovation while there is technological uncertainty

Issue 2. Current innovation and deployment incentives do not integrate zero-carbon systematically.

Recommendations

- 2.1. Establish a new National Investment Bank with a mandate to support zero-carbon goods and services.
- 2.2. Introduce more detailed criteria for the issue of R&D tax credits to ensure that they target R&D projects aligned with zero-carbon transport objectives.
- 2.3. Amend the General Export Facility's mandate to "ensure that no viable UK export fails for lack of finance or insurance" to review the extent to which an export can be considered part of a zero-carbon future.
- 2.4. Scale up funding and lengthen the timeframes for supply chain improvement programmes, with redesign to ensure that the productivity and competitiveness

[2] The Appendix to the full report provides a detailed overview of current supply-side incentives, supported by an assessment of their potential effectiveness, based on ex-post academic analysis of policies, observations of international best practice and consideration of their suitability in relation to the market size and innovation analysis, which is provided in Section 4 of the report. It should be emphasised that not all of these policies specifically target goods and services related to zero emission vehicles at present, and many are economy-wide.

improvements are for components that are either specifically for – or are not incompatible with – usage in zero emission vehicles.

Issue 3. The majority of incentives are finance packages – examples of dynamic policies that are responsive to changes are limited.

Recommendations

- 3.1. Implement an Annual Mobility Services Innovation Prize.
- 3.2. Amend the automotive sector deal to ensure it is a dynamic instrument that responds to changes in the sector.
- 3.3. Build in more robust evaluations of the Catapult centres.

Issue 4. There are comparatively few incentives focusing on skills.

Recommendations

- 4.1. Introduce human capital tax credits for companies that are training staff in skills considered to be of high value for zero emission goods and services including passenger vehicles.
- 4.2. Implement a future skills marketplace that establishes a direct dialogue between skills providers, e.g. further education colleges, and skills demand from companies, enabling skills needs to be tracked and addressed on an ongoing basis.

Issue 5. There are limited policy mechanisms that target balanced growth across the UK, in terms of both communities and workforces.

Recommendations

- 5.1. Ensure that local industrial strategies and long-term sectoral or missions-based policies are consistent in their drive for an inclusive management of the transition in the automotive sector.
- 5.2. Expand and deepen the programme of Science and Innovation audits, which identify areas of strength at the regional level.

Issue 6. Current policies and regulation cannot mitigate the impact of Brexit-related uncertainty for businesses in sectors related to zero emission passenger vehicles.

Recommendations

- 6.1. Secure the UK's connectedness to global automobile value chains by making frictionless trade in the sector a priority for any future UK–EU trade deal.
- 6.2. Ensure UK vehicle sales continue to contribute to EU emissions sales targets.

Issue 7. The UK does not currently have comparative advantage in some technologies receiving government support, and other countries are committing more funding.

Recommendations

- 7.1. Scale up supply-side incentives to values and timescales that are comparable with market-leaders.
- 7.2. Deliver this funding scale-up under a technology 'portfolio' approach, structuring support mechanisms to target economic growth opportunities for the UK in zero emission and autonomous vehicles as an outcome.
- 7.3. Conduct robust assessments of all recipients of the Industrial Strategy Challenge Fund's Faraday battery challenge.
- 7.4. Use the package of incentives recommended in this report as a foundation to negotiate deals with major players in the zero emission and autonomous vehicle supply chain, with a particular focus on a UK gigafactory.

Concluding points

The recommendations in this report seek to make the UK a more attractive location for major foreign companies, as well as create an enabling environment for small and medium sized enterprises (SMEs). For instance the National Investment Bank could provide high value guarantees for chemical companies interested in establishing gigafactories, while also offering smaller packages of working capital for CAV startups. Similarly, human capital tax credits could be employed on a small scale, or could be used to arrange a large, long-term tax break in exchange for a company's commitment to a 10 year programme of targeted worker upskilling. These types of incentives could be used to encourage a major player in the battery cell market to establish a gigafactory in the UK; tax breaks have played a role in incentivising Asian battery manufacturers to establish production in Eastern Europe. Policymakers should keep in mind that those businesses which could secure the future of automotive manufacturing in the UK may not fall within the commonly recognised bounds of the car industry, and will likely include chemicals (including battery cell) manufacturers, semiconductor manufacturers and software developers.

The UK needs sustained, proactive engagement with globally leading companies at the cutting edge of passenger vehicle supply chains. Moreover, it is likely that the UK will need to surpass its international peers in the provision of incentives, given its mixed record of competitiveness and uncertainties over its future trading relationships. Such engagement therefore needs to be underpinned by implementation of the full suite of recommendations in this report. This means stepping up incentives to support innovation and production in regions across the UK; spurring demand for zero emission vehicles; and securing close alignment with the European Single Market and EU emissions regulations. The companies that could anchor long-term car production in the UK may then be considerably more likely to view the country as a favourable place to do business.