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Capturing the economic benefits of a transformative shift to low carbon automobility: a case study of the West Midlands, UK

Nigel Berkeley[1], David Jarvis
[1] *The Applied Research Centre in Sustainable Regeneration (SURGE), Futures Institute*
10, Coventry Innovation Village, Cheetah Road, Coventry, UK
n.berkeley@coventry.ac.uk

Abstract

Whilst traditional automotive manufacturing regions continue to face tremendous competitive pressures new opportunities are emerging with strong governmental support to encourage the manufacture and adoption of low carbon vehicles (LCV). This paper examines such opportunities in the West Midlands region of the UK, where the automotive 'cluster' remains one of the largest in the country and where failure to adapt to changing markets could prove economically and socially damaging. It suggests that the Region should build on its strengths at the upper end of the technology spectrum and establish itself as a leader in the area of LCV technologies. In doing so it is recognised that a co-ordinated and holistic approach is required, involving multiple layers of government, backed up by a strong and supportive policy framework. As such, the abolition of regional government in England presents a serious challenge. It remains to be seen whether the new Local Enterprise Partnerships in the Region can overcome constraints of funding, capacity, co-ordination and remit to fill the void left by the abolition of the Regional Development Agency. Failure to do so would mean that the economic development opportunities presented by low carbon vehicles may not be fully realised.

Keywords: Electric Vehicle, Infrastructure, Market, Policy

1 Introduction

The automotive industry continues to face tremendous competitive pressures, an issue brought into sharp focus during the recent economic downturn. However, new opportunities are emerging with national and regional governments globally encouraging the manufacture and adoption of low carbon vehicles (LCV) through a combination of supply and demand sided policy instruments. These are shaped by both environmental and economic drivers, including the challenge of meeting the demands of the climate change agenda and reducing CO2 emissions from road transport, and economic opportunities arising from the emergence and exploitation of new niche green technologies. Failure to respond to these challenges could prove economically and socially damaging especially to those local economies with traditional automotive manufacturing clusters, which in many cases continue to contract in the face of global competitive pressures. A case in point is the West Midlands region of the UK, well-served by a strong automotive design and engineering base, and where the automotive cluster contributes 15% of UK car production, 28% of its market value and 28% of all automotive jobs nationally. Here, the embracing of low carbon automobility by both local policy makers and manufacturers presents opportunities to diversify into new market niches and prevent further hollowing out of the cluster.

Whilst early engagement with low carbon technologies offers the potential to provide a significant boost to the West Midlands automotive cluster, this type of transformative shift requires a significant push from government both on the supply and demand sides. In particular, the lack of a clear winner in terms of competing alternative fuel solutions and the requirement for consumers to invest in more expensive, poorer performing vehicles have stalled the rate of market penetration of LCVs and are challenges that the 'market' will not meet without public intervention and investment. This is itself potentially hampered by significant restructuring of sub-national economic development policy delivery in the UK since 2010. As such, this paper seeks to examine the extent to which the UK automotive sector, and the West Midlands region in particular, is positioned to exploit opportunities provided by the shift low carbon automobility, and in doing so, draw out wider lessons for automotive clusters in other developed market economies. The paper is structured in four further sections. First, a review of existing literature; second, an analysis of UK government strategy and policy relating to the low carbon vehicles sector; third, an examination of the readiness of the West Midlands region to take advantage of economic opportunities presented by low carbon vehicle automobility; and finally, some concluding remarks are presented.

2 Literature Review

Low carbon automobilty has stimulated wide ranging academic debate in recent years. However, this debate has taken place primarily from engineering, scientific and policy perspectives. For example, authors have considered: the contribution of LCVs to sustainable transport systems (Moriarty and Honnery [1], Gilbert and Perl [2] and Wootton [3]); the development of propulsion technologies (Lee et al. [4] and Duke et al. [5]); the role of government (Marsden and Rye [6] and Cousins et al. [7]); the CO2 substitution effect (Brady and O'Mahony [8], Smith [9] and Bristow et al [10]); the potential of different types of propulsion to meet various different duty cycles (Offer et al. [11,12] and van Bree et al. [13]) and the challenges posed by the widespread production and uptake of LCVs, including development of refuelling infrastructure, battery production and range (Ogden and Nicholas [14] and Sentance [15]). At the same time, some consideration has been given to consumer attitudes to new technologies, focusing particularly of the barriers presented by substantial medium-term price differentials when compared to existing petrol and diesel driven vehicles (Lane and Potter [16], Potoglou and Kanaroglou [17] and Mourato et al. [18]).

In essence, literature has tended to focus on the challenges presented by LCV technologies rather than potential new economic opportunities which such developments present for manufacturers and their suppliers in established automotive manufacturing regions. Leaver and Gillingham [19] have analysed the economic impact of LCVs in New Zealand, but the comparative lack of attention concerning impacts on traditional manufacturing regions is surprising on two counts; first, given, albeit optimistic, forecasts which suggest that LCVs will account for one third of all cars manufactured globally by 2025 [20], and; second, recognition by national governments of their potential to help satisfy a number of policy objectives. Research presented here seeks to bridge this gap, providing an analysis of the picture in the UK, with a specific focus on the West Midlands region, profiling the emergent LCV sector and forecasting its potential to stimulate future economic growth. As a precursor to this analysis, the next section of the paper provides the context within which this transformative shift is currently situated.

2.1 The state of the UK automotive industry

Over the past decade, the UK automotive industry has been in relative decline, leading to a situation where it is no longer considered a natural environment for volume car production. This decline has been manifest in a number of high-profile plant closures over the past decade, most notably those of MG Rover in Birmingham, Peugeot in Coventry, GM in Luton and Ford in Dagenham. Currently, volume production is limited to a handful of overseas owned assembly facilities, most notably those operated by Japanese firms Toyota, Honda and Nissan. Despite such relative decline, the UK car industry remains an integral component of the national economy, concentrated particularly in the West Midlands, the South East and the North West regions. In terms of its profile, the automotive industry in the UK: contributes £8.5bn added value to the economy;

manufactures over one million cars and commercial vehicles and over two million engines annually; contributes over 10% of total UK exports, covering some 100 markets worldwide and delivering an average annual export value of more than £25bn over the last five years; had the fourth highest R&D spend in Europe and represented a fifth of core global R&D activity in 2010; employs over 700,000 people from manufacturing to retailing and; features the largest number of specialist sports car manufacturers in the world and 19 of the world's top 20 suppliers [21].

Despite the apparent health of the industry it is beset by a number of problems. While it remains Britain's largest exporter of manufactured goods, is an even greater importer with a deficit of £16.75 billion recorded in 2007, the largest in any UK trade sector. As the assembly industry is contracting, so too is component manufacturing as production shifts to Eastern Europe and elsewhere. Both vehicle manufacturers and suppliers, therefore, are suffering from hollowing out and an inevitable weakening of the supply-chain. Parallel to the overall contraction of the industry has been a relative fall in R&D expenditure, a key component in promoting industrial growth and expansion. This is underpinned by Britain's lack of a viable domestically owned volume car industry, with foreign owned interests concentrating R&D expenditure in their home markets. The conclusion drawn is that in comparison with other countries, the UK is in a relatively weak position, with the over-reliance on overseas investors to provide new technologies a potential barrier to realising future economic development benefits from low carbon automobility [22].

2.2 The West Midlands automotive cluster

Despite high profile closures, the West Midlands region remains the engine room of the UK automotive industry, with around 15% of car production, 28% of market value, and 28% of the UK jobs in the sector. This concentration of activity is placed into context when the number of automotive firms and employees in the region are benchmarked against Great Britain. This produces location quotients of 1.97 and 2.86 respectively. When employment in the regional automotive cluster is disaggregated by firm size, the industry is shown to be dominated numerically by SMEs, which account for 92% of all automotive firms in the region. Yet these same firms provide just 34% of sectoral employment, with the remaining 66% of jobs provided by just 42 large firms. Automotive firms with workforces greater than 50 are far more prevalent in the West Midlands than the country as a whole, with a location quotient of over 3. Indeed, 30% of such firms are located in the West Midlands [23].

The West Midlands automotive cluster is in a state of maturity with many companies dependant upon traditional low value-added manufacturing and the sourcing decisions of foreign-owned volume manufacturers. At the same time, the region is underperforming in terms of productivity and competitiveness when compared to competitor regions elsewhere in Europe [24, 25]. However, there are exemplar organisations and networks of expertise within the region that are driving the transformation of the cluster through design-led production in niche vehicles and technologies. These are helping to push the competitiveness of the cluster and provide a platform for the wider exploitation of low carbon automobility solutions [26]. Key points to note in this regard are: vehicle makers in the premium and upper premium market segments; a cluster of first and second tier suppliers; the presence of niche vehicle manufacturers; and a concentration of design, R&D and engineering consultancies (Table 1).

3 The Policy Framework for Low Carbon Automobility

Government strategy for facilitating a transformative shift to LCVs articulated by the previous Labour administration is structured around five key themes [27]. These comprise: supporting the automotive industry through economic recession for a successful transition to a low carbon future; enhancing the UK's reputation as a leading location for research, development and demonstration of LCV technology; promoting the adoption of LCVs in lead cities and regions, including investment in the skills base; making LCV solutions competitive for consumers by helping to reduce the upfront costs of new technologies; and providing leadership through smarter coordination of public sector activity. Despite a change of government in 2010, these priorities remain the same, albeit within a more austere financial climate.

Table 1: The West Midlands automotive cluster: key strengths

Premium/upper-premium producers: • Jaguar (Castle Bromwich) • Land Rover (Solihull) • Aston Martin (Gaydon) • BMW engines (Hams Hall) • Jaguar Land Rover engines *(in development at Wolverhampton)*	**Sports cars and niche vehicle manufacturers:** • MG Motor (Longbridge, Birmingham) • Morgan (Malvern Link, Worcestershire) • Spyker (Coventry) • Westfield (Dudley) • London Taxis International (Coventry) • Dennis-Eagle public service vehicles (Warwick) • JCB (Desford, Staffordshire) • Alvis Fighting Vehicles (Coventry) • Tata EV *(in development at Coventry)*
First tier suppliers, including: • GKN (Redditch): drive shafts, universal joints, chassis manufacture and other products • Wagon (Walsall): body manufacturing and engineering, doors and door systems • Denso (Sutton Coalfield): starters and alternators • Delphi (Coventry): engine management and injection systems • Valeo (Birmingham): suspension systems • Lear Corporation (Coventry): seats and interiors • Unipart Group (Coventry): exhaust systems and fuel tanks • Rockwell (Sutton Coalfield): body/chassis systems and brakes • Dana (Birmingham): axles • Siemens-VDO (Birmingham): electronics • Pirelli (Burton-on-Trent): tyres	**Design, research and development and engineering consultancies** • Pro-Drive (Kenilworth) • Zytek (Lichfield) • Ricardo (Leamington Spa) • ARUP (Solihull) • Motor Industry Research Association [MIRA] (Nuneaton) • Manufacturing Technology Centre (Coventry) • Warwick Manufacturing Group (University of Warwick, Coventry)

These policy goals are delivered through a package of supply and demand stimuli designed to encourage consumer uptake of alternatively fuelled vehicles, as well as their development and manufacture in the UK. Whilst the balance of these measures can be questioned, there is little doubt that the government is committed to promoting the low carbon automobilty agenda.

Policy intervention initially focused on securing the future of the automotive sector which was severely affected by the economic recession of 2008/2009. This included a £2.3 billion package of support under the Automotive Assistance Programme, put in place by the previous Labour government. In addition, it also committed £400 million, a sum which has been cut back by the current coalition government, to facilitate research and development, roll-out supporting vehicle charging infrastructure, and provide consumer incentives to stimulate low carbon vehicle uptake.

Examples of policy initiatives include: a competitive 'Plugged-in-Places' programme to facilitate the installation of vehicle recharging points in streets, car parks, commercial, retail and leisure facilities [28]; a plug-in car grant providing incentives to consumers to purchase LCVs; a public procurement grant designed to encourage public authorities to switch to low carbon commercial fleets; and an ultra low carbon vehicle demonstrator programme, promoting public trials of alternatively fuelled vehicles [29]. In addition to direct funding, a range of tax break incentives have been introduced to encourage the uptake of LCVs. These comprise: zero vehicle excise duty; a five-year exemption from company car tax; allowances for corporate fleet purchases of EVs and hybrids, and; zero congestion charges (in London). At the same time, the government has introduced a range of punitive costs on high-emissions vehicles through differential taxation based on engine size [30].

In terms of a time line for low carbon automobility, it is anticipated that the medium term will comprise improvements to the efficiency of new petrol and diesel cars, wider take-up of new hybrid powered vehicles, further development of national electric vehicle charging infrastructure, and manufacturers entering large scale production of LCVs. Longer term (2020 and beyond), it is envisaged that hybrid vehicles, smaller ICE engine sizes, and lightweight vehicles will become dominant, that the rollout of charging infrastructure will continue apace, and that LCVs will have achieved significant market penetration through mass-production [27]. The extent to which this vision becomes a reality is somewhat uncertain given the lack of clarity concerning the most effective alternative fuel solution and consumer apathy driven by the current high purchase costs of low carbon vehicles. Against this backdrop of uncertainty, the low carbon vehicle sector is developing, albeit slowly, and nowhere is this more evident in the UK than in the West Midlands region.

4 The future of the West Midlands automotive sector: responding to the Low Carbon Challenge

The biggest challenge for manufacturers in developing and manufacturing a new vehicle is producing or buying a vehicle powertrain (engine and transmission). However, for pure electric vehicles, this is relatively unproblematic; with batteries, motors and control units all available as 'off-the-shelf' products from tier one suppliers. The need for 'in house' research and design capability is, therefore, nullified, with off-the-shelf parts enabling fast start-up by niche manufacturers, effectively allowing them to compete with established competitor firms. In this sense, regions that have a strong supplier base in appropriate component segments should be well-placed to exploit opportunities arising from new low carbon automobilities.

The West Midlands automotive sector already benefits from a strong design and engineering base, while premium and niche manufacturers, working in tandem with other key stakeholders, have begun to publically trial low carbon vehicles and supporting infrastructure in the region (see Table 2 below). This offers a distinct advantage to early pioneers and suppliers seeking to move into the niche, and was evidenced in the designation of the region as a Low Carbon Economic Area for advanced automotive engineering in 2010. This designation made government funding available for a Low Carbon Vehicles Technology programme (see below) to provide entrepreneurs with access to leading research into automotive technology and design taking place within the regions Universities. It should be noted, however, that at the same time other parts of the UK are following similar development pathways (especially the North East), and as such there will be considerable competition between areas as they seek to establish degrees of dominance in the LCV sector.

The readiness of the region to embrace low carbon technologies is demonstrated through the range of projects that have engaged key stakeholders drawing upon: a strong automotive supply-chain; recognised engineering skills and a record of innovation; world class public and private sector R&D capabilities; strong support from local policy makers; and a number of manufacturers taking niche products to market. Building upon this platform, Table 2 illustrates how, working within a strongly supportive policy environment, regional vehicle manufacturers, supply-chain companies, technology providers and research institutions have embraced the challenge of developing and bringing to market low carbon vehicle technologies – both individually and through collaborative projects.

Collectively, it is anticipated that this collaborative approach, with a concentration on advanced automotive engineering, has the potential to stimulate the competitiveness of the regional economy. In particular, it aims to create new and safeguard existing automotive jobs through transition to LCV manufacturing, support existing supply chain businesses to meet the changing requirements of vehicle manufacturers, and upskill employees through application of new technologies and a knowledge exchange platform for low carbon skills. Activity of this scale and scope has been made possible through the co-ordinating role of the RDA, and although funded projects will be completed, the recent abolition of RDAs (March 2011) means that future funding is uncertain. At the same time, the RDA's co-ordinating role has passed from the regional to local level through emerging Local Enterprise Partnerships (LEPs). Whilst LEPs have the advantage of significant private sector involvement, they lack the human and financial

resources to invest in economic development and, therefore, must develop new and creative ways of encouraging and supporting the types of low carbon automobility projects noted above. Moreover, given the reach of the automotive cluster, the lack of a co-ordinated regional approach to support is a concern. The added value of regional stakeholders working together is evident in initiatives such as the Niche Vehicle Network. Clearly, therefore, in order to maintain momentum gained through funding of collaborative regional LCV projects, LEPs across the West Midlands will need to work together to achieve common goals.

Table 2: Bringing low carbon vehicle technologies to market in the West Midlands

Low carbon vehicle companies: • Jaguar Land Rover: Hybrid Range Rover and application of micro-turbine range extending technology to hybrid Jaguar sports cars • London Taxis International: development of all-electric London Taxi • Microcab industries: Development of hydrogen powered urban taxi cabs • Morgan Motor Company: Green sports car powered by a QinetiQ made PEM fuel cell • Tata Motors: Manufacturing facility for Invicta EV	**Collaborative low carbon technology projects:** • A £38m Low Carbon Vehicles Technology (LCVT) programme involving collaboratively funded R&D across 16 key technology platforms and providing solutions in areas such as motors, batteries and aerodynamics • A £14.5m ultra low carbon vehicle demonstrator project (CABLED) funded by the UK Technology Strategy Board and involving the installation of 36 public charging points and the trialling of 110 electric, hybrid and hydrogen fuelled vehicles by members of the public over a twelve month period • A £4.5m Niche Vehicle Research and Development programme (the Niche Vehicle Network) involving niche vehicle manufacturers, system suppliers, automotive technology companies and academic institutions collaborating on the application of new technologies in low-volume vehicle production • A £6.3m Midlands Plugged-in-Places scheme bringing together energy companies, manufacturers, public authorities and academia to roll-out the installation of over 500 public charging posts
Supply-chain and technology providers: • Arup: Project managers for West Midlands CABLED LCV trial • Potenza Technology: Development of powertrains for electric, hybrid-electric and fuel cell vehicles • Ricardo: Low carbon technology centre • Zytek: Electric powertrain for Smart EV	
Research excellence: • Coventry University: Low carbon vehicle 'Grand Challenge' research group bringing together engineering, design and business disciplines. On-campus hydrogen fuel station • University of Warwick: Warwick Manufacturing Group (WMG) and the International Automotive Research Centre • University of Birmingham: Institute for Energy Research and Policy. Operates a fleet of 5 hydrogen fuel cell powered vehicles that can be refuelled on-campus.	

The importance of a 'joined-up' collaborative approach is brought into focus when viewed against estimates of LCV penetration of the UK market. These range between 2 and 10 per cent over the medium-term, making significant the potential longer-term value of the emerging sector to the West Midlands. For example, research conducted by GfK Automotive [31] suggests that new low carbon automotive technologies could boost Britain's economy by as much as £7.2 billion as early as 2014. This forecast is based on survey data from November 2010 which revealed 1.8 per cent of respondents would 'definitely' buy an electric car within 3 years. Given the relative share of overall UK automotive sector activity situated in the West Midlands, the region can expect to gain significant economic benefits, both

in output and employment, from forecast levels of growth. However, the extent to which these potential benefits are captured will depend upon a number of factors. These include: the pace of development of low carbon vehicle technology vis-a-vis traditional petrol and diesel technologies; the degree of consumer acceptance; and the maintenance of a conducive policy environment.

At present, market penetration of LCV technology is being slowed by improvements to traditional petrol and diesel powered vehicles, including through increased engine efficiency, lower emissions levels and more lightweight structures. Indeed, many petrol and diesel powered models now produce emissions well within the 130g/Km target sought by the EU. This is evidenced by the fact that in 2000 the UK market share for new cars with emissions of 130g/KM or less was just 0.8%, whereas by 2010 it had reached 38.1% [21]. At the same time, the current trend towards purchases of smaller, less costly and more efficient cars has fuelled demand for such technological development. Data from SMMT [21] show that the market share of the small car segment ('mini' and 'supermini' vehicles) has grown from 33% in 2000 to 39% in 2010, whilst the medium car segment has declined from 50% of new car sales to 39%.

A key issue underpinning forecasts of market penetration is the willingness of consumers to switch to low carbon automobility. Whilst government policy includes a commitment to subsidise electric transport, this is yet to convince the public with just 786 people taking up the £5,000 incentive to purchase between 01st January and 30th September 2011 [32]. Worryingly, the rate of uptake of the grant has declined significantly over the period, with quarter three sales in 2011 less than 25 per cent of those realised in quarter one. Moreover, funding for the grant scheme has been dramatically scaled back from £230m to just £43m, and is under review in 2012.

Two thirds of people report being put off by the comparatively high-costs of new LCVs [31], with just 8% being prepared to spend more than £20,000 on one [33]. The range of LCVs currently available is a further impediment on sales, with some commentators arguing that the stringent eligibility criteria applied to the plug-in grant in the UK is restricting market choice [34]. The effect of such issues is that whilst production capacity of LCVs is likely to reach some 4 million worldwide by 2015, demand may lag significantly behind [35]. This provides evidence of the need for a demand push, and is further illustrated in data which suggest that consumers are dissuaded from purchasing alternatively fuelled vehicles by perceptions of poor performance and limited supporting infrastructure. Indeed, in research conducted by GfK Automotive [31], 68 per cent of respondents suffer range anxiety relating to the distances that electric vehicles can travel between charges; the same proportion expressed fears about limited charging infrastructure, and 54 per cent expressed reservations about the time taken to recharge vehicle batteries.

This suggests in the short-term that overcoming consumer anxieties is critical to the sustainable growth of the LCV sector as a whole, and to the potential economic benefits that flow from it. Trials of electric vehicles, such as through the CABLED project noted earlier, are vital in this respect. Data from drivers participating in CABLED in 2010/2011 show a significant trend towards users of electric vehicles travelling longer journeys over time, indicating increased confidence and reduced range anxiety. Moreover, trial data reveal limited use of public charging infrastructure, suggesting driver confidence in the range capability of their vehicle based on home-charging alone [36]. Dissemination of such information is critical in order to raise public awareness of viability of electric vehicles as an urban transport solution.

On the basis of the above analysis, it is clear that the West Midlands region has a sound platform upon which to maximise economic benefits arising from the application of low carbon technologies within the vehicle sector. However, a number of barriers have been shown to be slowing the rate at which these are accrued. In order to mitigate these and enable potential benefits to be more fully realised in the medium to long-term, LCV stakeholders should consider the following key factors in shaping future activity. First, it must be recognised that continued public sector stimulation of the LCV sector within the region is vital over the medium-term given the relatively low volumes of vehicles involved and the current prevalence of negative consumer perceptions highlighted earlier in this paper. In particular, it will be vital to maintain regional momentum built up through projects supported by the former

RDA, something that will require the new more fragmented West Midlands LEP network to work collaboratively. In this respect, there is much to build upon as the area has established collaborative working practices through the existing cluster of niche producers, supply-chain firms and R&D infrastructure noted above. Second, the West Midlands faces much competition in seeking to gain economically from the emergent LCV sector. However, the notion of regional competition presents opportunities as well as threats, with the possibility for regions to collaborate and co-ordinate activity in order to develop particular product niches or technological specialisations. LTI in Coventry provides one example of this type of 'co-operation' whereby Taxis will be assembled in Coventry before being transported to Washington in the North East region for the installation of an electric powertrain. Third, there needs to be continuous investment in upgrading and maintaining the right mix of skills in the area. Again, the region is well-placed in this respect, but requires continued and increased cooperation with universities and research institutes in order to maximise the benefits achieved. Fourth, the need for a more effective and sustained demand push is evident throughout much of the analysis presented in this paper. Without a suitable supporting policy framework to accomplish this, consumers are unlikely to adopt low carbon vehicles in the quantity necessary to persuade manufacturers to bring vehicles to market in the volumes currently anticipated by government.

5 Conclusions

Findings here suggest that the West Midlands is extremely well placed to build upon a strong automotive supply-chain; recognised engineering skills and a record of innovation; world class R&D capabilities; a supportive policy environment; and a number of niche manufacturers in bringing low carbon vehicle technologies to market. Indeed, there are numerous examples of good practice in bringing forward products, supporting infrastructure and giving members of the public in the region an opportunity to trial alternatively fuelled vehicles (see table 2 above).

Notwithstanding this conducive platform, driving forward innovation and economic development in a new emerging technology sector requires a co-ordinated and holistic approach, involving multiple layers of government, backed up a strong a supportive policy framework, encompassing sustainable demand and supply-side policies. Such a context has been apparent through the actions of the former regional development agency, and strong momentum has been gained over recent years through numerous publically supported projects. However, the abolition of regional government in England presents a serious challenge, which will require the new LEPs across the region to work collaboratively and innovatively in order to attract funding and to ensure that the regional economic development benefits arising from future growth of the market for LCVs are fully realised.

In drawing lessons that might be applied to automotive clusters elsewhere, the UK experience demonstrates some good practice as well as areas where policy has not worked so well. A positive lesson to be drawn is the effectiveness of joined-up solutions and partnership working which engages industry, government at all levels, research institutions and energy suppliers collaboratively. Alongside this, the automotive industry itself has played a key role in forming, leading and delivering solutions. At a regional level, the West Midlands has benefited (and potentially will continue to benefit) from building upon key historical strengths and an established cluster rather than attempting to develop new industries from a position of weakness. At the same time, whilst the government should be applauded for the package of supply and demand initiatives introduced to support development, application and consumption of LCV technologies, the balance of these is considerably out of step. Much more attention needs to be paid in these early years to a demand push if potential economic benefits are to be maximised.

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Authors

Dr Nigel Berkeley is Director of the Research Centre in Sustainable Regeneration (SURGE), at Coventry University. Key research interests include local and regional economic development, especially the restructuring and competitiveness of traditional industries and economies. He has particular expertise in clothing and automotive industries. Recent work includes: an evaluation of the West Midlands Task Force a regional programme of intervention to respond to recession in the UK; and a pilot programme to trial low carbon vehicles in the West Midlands Region of the UK.

David Jarvis is Deputy Director of SURGE at Coventry University. David's research experience spans the Higher Education and commercial consultancy sectors, working collaboratively with organisations across the public, private and voluntary sectors, providing clients with research-led intelligence in order to inform policy, strategy and practice. Recent research includes a suite of reports for the Local Authority in Coventry examining economic opportunities for the city in emerging transformation technology sectors, including low Carbon Vehicles.