A Regional Energy Strategy for the West Midlands

November 2018

Black Country LEP

CWLEP Coventry & Warwickshire Local Enterprise Partnership

Greater Birmingham & Solihull Local Enterprise Partnership

ENERGY CAPITAL

West Midlands Combined Authority

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Executive Summary

Between 2018 and 2030, more than £15bn will be invested in local energy projects across the three LEPs of the West Midlands, and £74bn will be spent on products and services (like cars and homes) where the quality of local energy systems will make the difference between global competitiveness and economic failure for our local industries, and between lives dominated by energy poverty or supported by comfortable and efficiently heated homes for our citizens. A further £80bn will be spent on fuel and power to drive our industry and to power those same homes and cars.

Vision

This strategy is about influencing these financial flows to deliver a vision for energy across the region by 2030 which includes:

- reducing energy costs for our strategic industrial sectors to at least match those of our international competitors;
- reducing the incidence of fuel poverty across our region by hitting current government targets for energy efficient housing five years ahead of schedule;
- delivering the West Midlands' share of national and global carbon budgets by reducing regional carbon emissions;
- creating a regional energy infrastructure that adds £1bn to GVA by 2025 by putting the region at the leading edge of the global energy and transport systems transition.

Specific, measurable targets for each of these objectives are set out in section 5.

Innovative and selective delivery mechanisms

We will deliver these targets through highly selective investment of public and private capital, working through a framework of Energy Innovation Zones (EIZs) developed alongside this strategy.

EIZs create local partnerships which bring together the right stakeholders for each locality and are thus collectively able to manage energy investment risk efficiently (particularly when innovative technologies are being commercialised or require strategic infrastructure investment).

Unique regional ambitions and history

This idea was developed in the West Midlands and is designed to work for the particular diversity, strengths and heritage of our region. The West Midlands would simply not exist as a population and industrial centre if it were not for the world-class energy infrastructure and assets uniquely available here and matched to our industrial and innovative capabilities from 1750 onwards.

The West Midlands of today is very different from that of the 18th to 20th centuries, but energy remains critical to our key sectors and to our citizens. This energy strategy is a key element underpinning a local industrial strategy focused on the digital, health and life sciences, and clean growth opportunities of the future. It targets a massive global clean growth opportunity which is aligned with national industrial strategy and which this region is particularly well-positioned to exploit.

We have specific regional issues around fuel poverty (the quality of our housing stock); diversifying and creating new markets for our exceptional industrial and manufacturing base; and making best

use of the imagination and creativity of our innovators and academic institutions. This strategy recognises and responds to all these issues.

Contributing to national challenges and needs

However, this strategy has been developed against the backdrop of a fundamental transition in global energy systems which is widely recognised and is creating challenges and opportunities at both global and national level. Effective regional leadership in energy is key to responding to these challenges. This strategy sees the West Midlands contributing constructively to changing the way energy is regulated and managed nationally, working with other devolved regions and authorities across the UK.

Financial implications and approach

Four pilot EIZs have been identified and preliminary investment cases developed for this strategy. These EIZs will act as a focus for energy systems investment of between £270M and £490M over the next 15 years and deliver the first £200M of the £1bn GVA target. The remaining £800M will be delivered through a range of initiatives including:

- additional Energy Innovation Zones;
- strategic infrastructure support for accelerated new market development of locally sourced products such as electric vehicles and smart connected and low carbon housing;
- seeking to establish a legacy bank to cover sunk costs of stranded and legacy energy infrastructure assets, using this to reduce energy costs for innovative and competitive manufacturers;
- energy efficiency programmes for manufacturing and residential sectors;
- simplifying access to and improving transparency of energy markets for business customers;
- more rigorous and targeted new build housing energy efficiency standards;
- large-scale retrofit programmes for fuel poor households and energy-inefficient housing;
- a focused cluster support programme including incubation of clean technology businesses and specialist energy support for established businesses, working with regional and international partners.

We propose to establish a £500M specialist regional investment fund to support these initiatives.

The strategy will be delivered through Energy Capital, established with a governance structure shown in Figure 1 (also see section 5). Individual EIZs will be controlled and run by their local authorities.

Detailed delivery plans and timescales are set out in accompanying reports covering EIZs, including *Energy as an Enabler of Industrial Strategy* across the region and which is summarised in section 7. The immediate priorities are:

1. To establish an initial Energy Capital executive team within the WMCA to support the Board and funding commitments made by partners. This will be done in two stages: an interim development team will be put in place for 2018-19, and permanent resource will be recruited into the WMCA from 2019-20 onwards.
2. To follow through on the recommendations of the Regional Energy Policy Commission, particularly around working with government and regulators to detail the legal implications and requirements for EIZs.

3. To work with regional and wider partners to develop a cross-sectoral and place-based 'Deal' for the West Midlands' new energy economy[1]. This will act as the initial focus for securing the required investment funding.

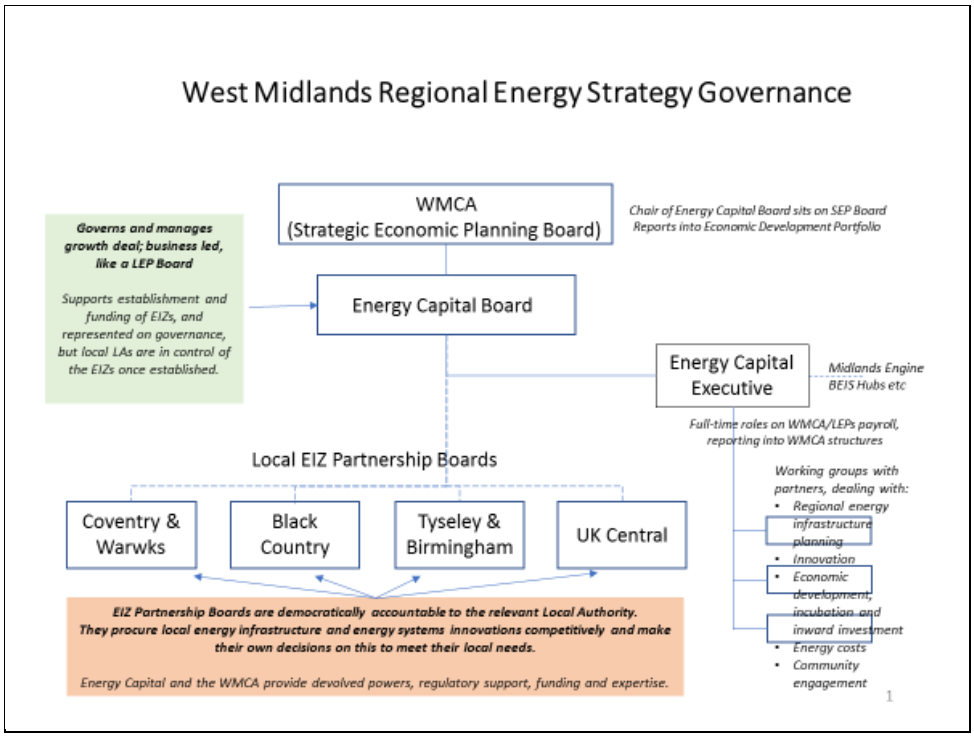


Figure 1 West Midlands Regional Energy Strategy governance

[1] This is being taken forward as part of the Local Industrial Strategy.

1. Introduction

This strategy is a consolidation of more than a year's work across the West Midlands to bring together existing energy mapping and strategy work, fill in gaps and develop a strategic framework to support delivery of the region's ambitions and needs. It is intended as a response to BEIS's request that the three LEPs within the West Midlands Combined Authority (WMCA) produce a single high-level strategy summarising how they will work together through Energy Capital to deliver shared objectives.

Throughout the work we have maintained a fundamental principle that the strategy will not lead to replication or duplication of existing work, initiatives or institutions. The intention is to create a strategy which builds on and supports these activities where they are already underway and makes it easier for local leaders and projects to deliver their specific objectives around energy. This point is expanded on in later sections.

This document should be read as an overview document and strategic framework. It does not attempt detailed energy mapping and street-by-street analysis of housing energy performance across our major conurbations, nor contain maps of energy distribution networks, for example. This is for three reasons: firstly because this would have been very costly and time consuming and potentially prevented us completing this strategy (and carried the risk of losing sight of the wood for the trees); secondly because for a region the size of the West Midlands it would have almost certainly been out-of-date by the time it was finished and impossible to maintain at regional level without considerable ongoing resourcing; and thirdly because most of this data is already held and maintained effectively at local level by different organisations who are typically best placed to maintain the datasets efficiently and cost-effectively. The strategic challenge is not collating the data centrally, it is putting in place effective and strong local partnerships and governance structures to ensure that the data are used and available as effectively and efficiently as needed. This is the approach we are taking in the West Midlands.

Energy Capital itself inherited a strong partnership from the Birmingham Green Commission led by Councillor Lisa Trickett and the work of its energy group, chaired by Professor Martin Freer. The strategy has been made possible by the willingness of this group to combine with the strong sense of purpose coming from the Black Country LEP, where energy is championed by Tom Westley, and the vision of Coventry and Warwickshire, who are engaging creatively with the energy challenge as their traditional core transport and manufacturing businesses see new global opportunities rapidly opening in front of them.

The strategy should be read in conjunction with other key documents produced alongside or as part of the regional energy strategy, specifically:

- Powering Growth: Black Country Energy Strategy Final Report (Aecom, February 2018)
- Business Cases for Energy Innovation Zones in the West Midlands (Arup, March 2018)
- Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation (Regional Policy Commission on Energy, March 2018)
- Energy as an Enabler: Linkages between regional energy strategy, productivity and growth (Black Country LEP and Matthew Rhodes, March 2018)
- Distributed generation and demand study. Technology growth scenarios to 2030, Regen for WPD (January 2018)[i]

Several sections of this strategy draw heavily on the work done for these reports and the reports themselves. The work of their authors and the conversations and events surrounding their preparation is much appreciated and recognised. Links to these documents and others relevant to the strategy are provided in appendices I and II and in the References section.

The project has been governed by a steering group consisting of a representative from each of the three LEPs. Figure 2 below shows how the various workstreams came together. The red diamonds indicate consultation events with stakeholders. A full list of participants in the main stakeholder engagement event on 6 March is provided as Appendix IV.

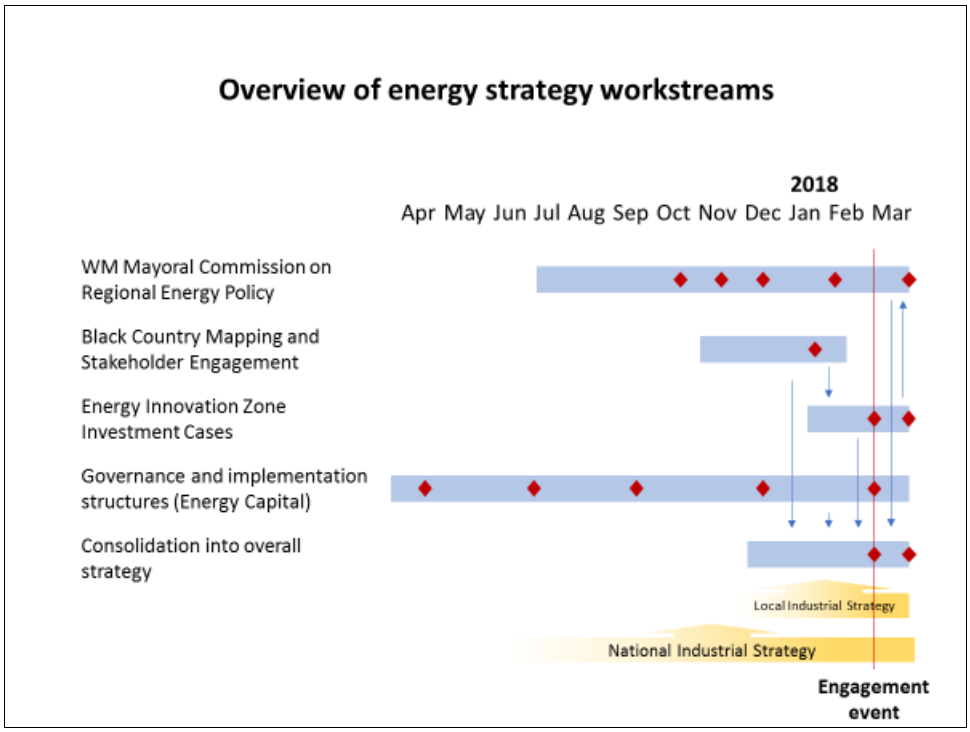


Figure 2 Overview of energy strategy workstreams

An open consultation process was run during April and May 2018, and responses received from corporate, local authority and individual respondents have all been recognised and incorporated in this final version. The responses were overwhelmingly positive supportive, and the main requests were for greater detail, particularly on housing and resourcing. This point has been addressed as far as possible.

The strategy starts by summarising the specific regional context that is the West Midlands. It then discusses the economic opportunities in energy seen from this perspective and the challenges and constraints faced by the region in seeking to maximise economic outcomes from investments in energy systems. These sections set the scene for the regional energy strategy itself, which is summarised in Section 5. Section 6 puts this in the context of global best practice, and Section 7 summarises the planned next steps.

2. The West Midlands

History, geography and political context

The population of the three LEPs which make up the West Midlands Combined Authority is just over 4 million people[ii], and its central location means 90% of country's population is within 4 hours' drive.[iii] There are 1.7 million homes in the area, and over 2 million jobs across 145,000 businesses, with a business 'birth' rate of over 20,000 new businesses a year (around twice the UK average)[iv].

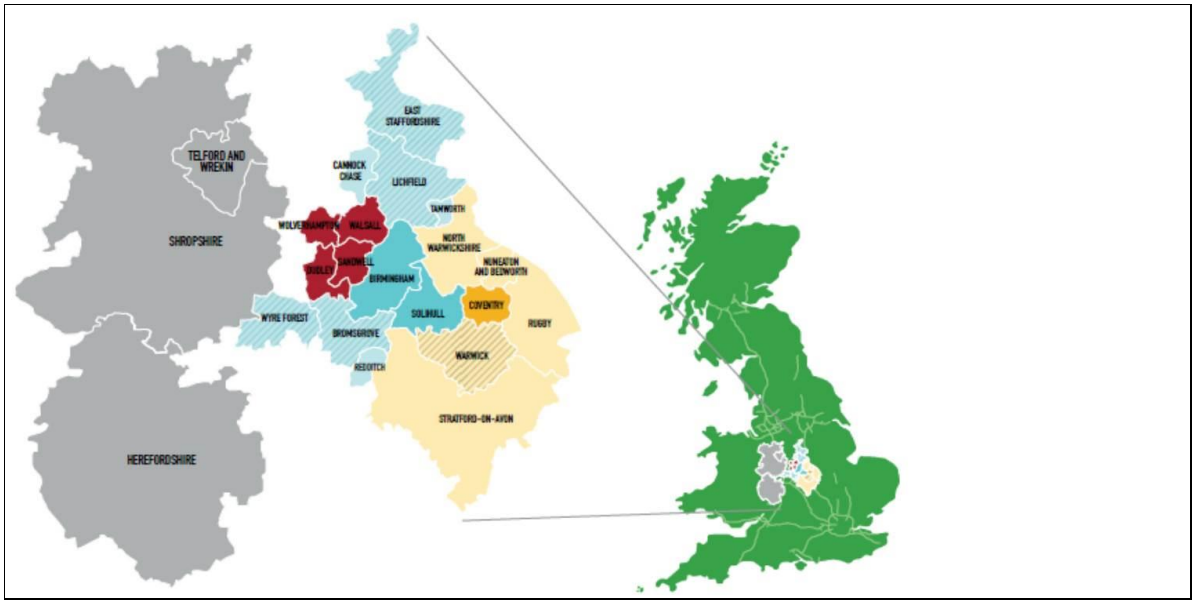


Figure 3 The West Midlands Combined Authority geography

The West Midlands is the largest regional economy outside London. The areas covered by the Black Country, Coventry and Warwickshire, and Greater Birmingham and Solihull LEPs have a combined GVA of around £90 billion per year. This is larger than those of Greater Manchester, the Leeds City Region and the South East. The West Midlands LEPs have grown their GVA faster than those regions from 2010 to 2015 (see Figure 4 below).

This density of population and industry reflects the region's history and identity, which were largely forged in the eighteenth and nineteenth centuries on the back of abundant local energy resources (particularly in the Black Country) and innovation, driven by the then prohibitive cost of skilled labour[v]. Strong sub-regional identities and economies persist to this day, with an emphasis on transport and mobility in the East (where Coventry's heritage in transport and automotive grew out of over 250 companies manufacturing bicycles from 1870 onwards[vi]) and metal processing in the West, where there are still over 240 medium-sized businesses within the LEP area focused on traditional metal forming and component production, largely for the high-technology and demanding aerospace and automotive supply chains.

The region has the highest concentration of manufacturers of any region[vii], and accounts for 9% of all manufacturing employment in Britain.[viii] It is home to world-class companies including Jaguar Land Rover (JLR) Aston Martin, UTC Aerospace, and Mondelez as well as much of their supply chains.

The West Midlands is Britain's largest exporter after the South East and London.[ix] In 2016, the West Midlands exported goods worth £3.3 billion to China, more than three quarters of which were road vehicles. This represented 26% of all UK exports to that country, twice that of the next largest region. With imports from China of £3.5 billion, the West Midlands is the only region to achieve anything close to trade balance with what is predicted to become the world's largest economy by 2030.[x] The West Midlands has secured more inward investment from China than any other region bar London - 52 projects in the past 20 years, and 30 in the past six – creating 2,500 jobs and safeguarding a further 1,500.[xi]

Table 2-1: GVA in 2015 and growth 2010-15 for the area and comparators

Area	GVA in 2015 (£bn)	GVA growth 2010-15
London	378.4	27%
3-LEP WM SIA geography	87.5	20%
South East	85.8	18%
Leeds City Region	64.6	14%
Greater Manchester	59.6	16%

Source: ONS, Gross Value Added (GVA) for Local Enterprise Partnerships (LEPs)

Figure 4 GVA in 2015 and growth 2010-15 for West Midlands LEPs and those of other regions.[xii]

Birmingham is Britain's second city, and its population of just over 1 million makes up around a quarter of the total West Midlands population[xiii]. It is a dense and thriving modern city, with many of the challenges common to cities worldwide in energy poverty, legacy infrastructure, and a need for new housing which puts pressure on the surrounding rural hinterland.

There are two further cities within the region which share similar challenges (Coventry (320,000 people) and Wolverhampton (260,000 people)) and seven metropolitan local authorities, as well as districts of Warwickshire, Staffordshire and Worcestershire which fall within the three LEP geography and have more rural economies. However, the region has a natural economic geography and political coherence because its existing transport systems and employment patterns mean a large part of the population of the WMCA area commute to and from work in the city centres.

Key local stakeholders

The political geography of the West Midlands is evolving rapidly and is currently working reasonably well (evidenced for example by the GVA growth illustrated in Figure 4). The three LEPs and WMCA focus largely on specific agendas where working together at regional scale makes sense, for example around economic development, including transport, inward investment and skills; while the local authorities run public services and maintain the integrity of their respective geographical places.

All these bodies are properly democratically accountable, and the LEP Boards (which are supervised by elected representatives) have effectively engaged committed local business interests and academic institutions, including all the region's eight universities.

Major energy-related corporates located in or close to the region include E.ON, National Grid, Calor, Cadent, JLR, Severn Trent, and UTC Aerospace. These represent a significant part of the GVA attributable to energy across the region (see Section 3) but a tiny fraction of the 10,000 businesses active in the energy sector across the region[xiv]. Smaller businesses are represented on LEP Boards

and sub-boards through organisations such as the EEF (formerly the Engineering Employers' Federation) and Chambers of Commerce.

The West Midlands hosts substantial national research and innovation assets in the Energy Systems Catapult and the universities of Aston, Birmingham and Warwick, which are part of the Energy Research Accelerator. These universities have highly complementary research expertise in energy and all have contributed to this strategy in distinctive ways[2]. Wolverhampton, Coventry and Birmingham City University further enhance regional energy capabilities, particularly around energy in buildings, smart systems, local skills development, and industry engagement.

[2] Aston's expertise is in bioenergy and infrastructure economics; Birmingham in thermal energy systems; Warwick in battery and storage technologies and automotive/transport/energy crossover.

3. Economic opportunity

Energy in the West Midlands Economy

Figure 5 shows the estimated split of annual energy spend in the West Midlands[xv].

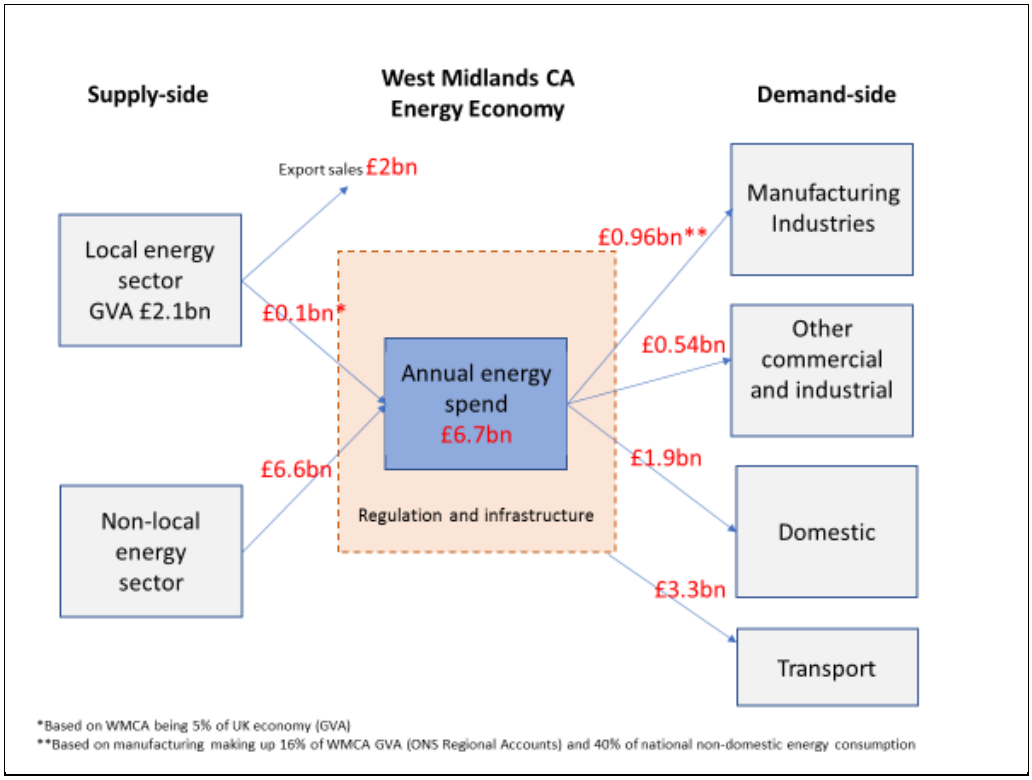


Figure 5 The West Midlands energy economy

Although the local energy sector contributes approximately £2.1bn of GVA to the regional economy, most of this is earned outside the region (it is dominated by companies like E.ON, who sell energy nationally). The more significant figure is the £6.7bn spent annually on energy by West Midlands businesses and households. Within this the largest segments are household (domestic) energy bills and transport costs. Over £960m is spent by the industrial and manufacturing sectors and £0.54bn by the remainder of the commercial and industrial sector.

The characteristics of each of these demand segments are very different. Much of the West Midlands' housing stock is of relatively poor quality and the economic opportunities therefore lie in large-scale refurbishment programmes and innovation in new build, delivering constant or better levels of comfort to citizens at lower cost. In transport there are substantial opportunities driven by global shifts to new fuels such as electricity and hydrogen, while in the industrial and commercial sectors the economic opportunity is around productivity. Each of these is considered in turn.

Industrial and commercial energy costs

The combined manufacturing and commercial annual spend figure of £1.5bn has a direct impact on industrial profits and productivity. If the figure were £500m lower, regional productivity and GVA

would be up to £500m higher (for the same output)[3]. It is thus very relevant that UK energy costs in many sectors are up to 41% higher than those of competitor economies (see Figure 6).[xvi]

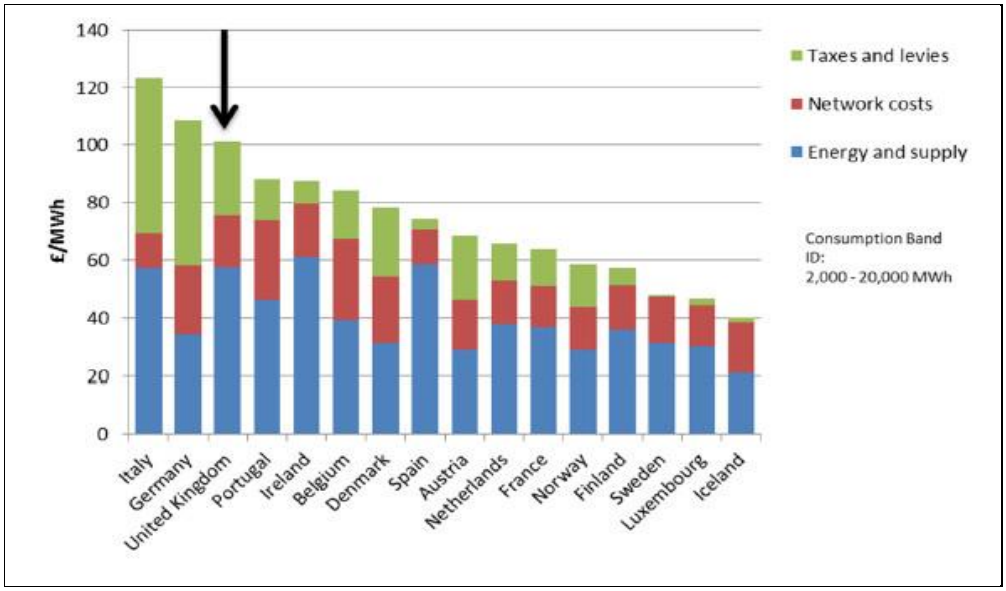


Figure 6 Commercial energy costs compared internationally[xvii]

It is relevant that around half of electricity costs for typical regional manufacturing companies are the apportioned costs of regional and national infrastructure investments (Figure 7). This is why Figure 5 has a shaded box labelled market regulation and infrastructure: there are considerable and increasing opportunities to influence energy costs, and hence sectoral productivity, simply through regulation and strategic choices.

Because of their magnitude and impact, the way energy infrastructure costs are apportioned between sectors is treated as an industrial strategy decision in many economies, although this has largely been resisted in the UK[xviii]. For example, in Germany there is a complex 'privilege' system which allocates network and renewables costs variably between industrial sectors, favouring some sectors (metal processing) and penalising others (paper mills). Thus, although average industrial energy costs in Germany appear on face value higher than the UK (Figure 8) in practice they are significantly lower in many manufacturing sectors (even after UK exemptions for energy intense industries have been applied) and higher in other sectors (including the domestic sector[4]) to ensure that the overall numbers balance (see Figure 8)[5].

[3] This is true in the short-term and for mature industries with sticky customers competing primarily internationally, like most West Midlands manufacturers. It is not true if GVA measures are based on value-added production function approaches which assume any saving in energy costs will be common to competing firms and hence not impact GVA. Reality is almost certainly somewhere between these two extremes.
[4] Headline energy prices in the domestic sector do not necessarily mean higher bills for households provided housing is well-built to high energy efficiency standards. Hence the German public is, up to a point, more tolerant of higher energy tariffs than the UK public, who live in lower quality housing (on average).
[5] Note that the UK also applies some (complex) exemptions to energy intense industry, which is why the figures in Figure 8 and Figure 6 don't align. Figure 6 shows standard UK commercial rates, Figure 8 shows rates specifically for energy intense businesses.

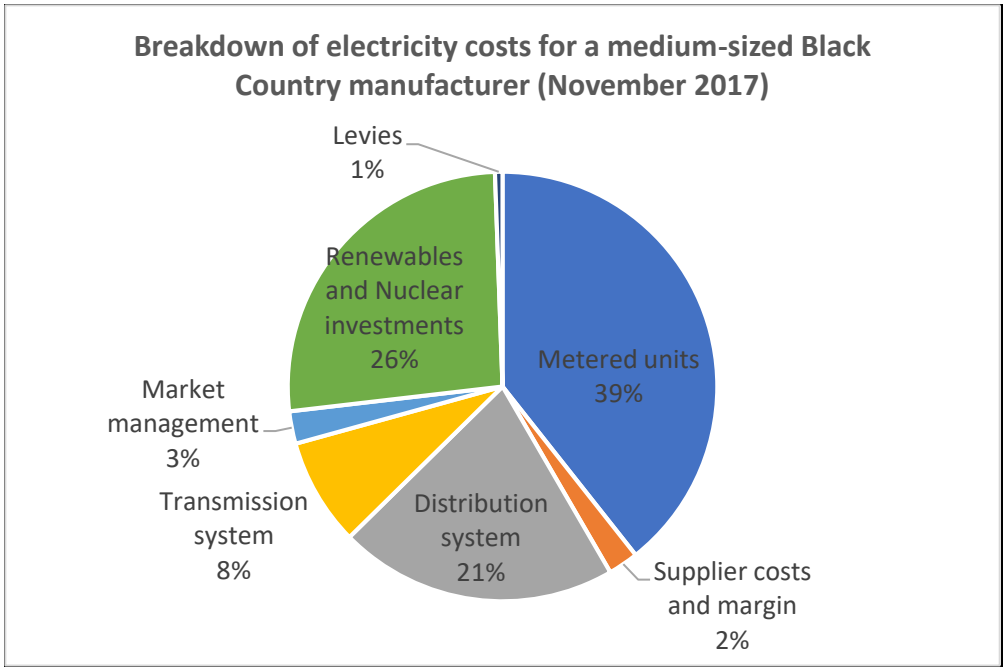


Figure 7 Split of electricity costs for a medium-sized West Midlands manufacturer[xix]

In the UK, however, we currently operate a regulated national market system which resists differentiation between industrial sectors, other than on size (larger businesses pay a lower share of infrastructure costs per unit of energy). This will tend to differentially handicap our more energy intense sectors (in comparison to competitor economies with industrial strategies) although several ad hoc dispensations have been secured over the years to compensate to a degree for this.[xx]

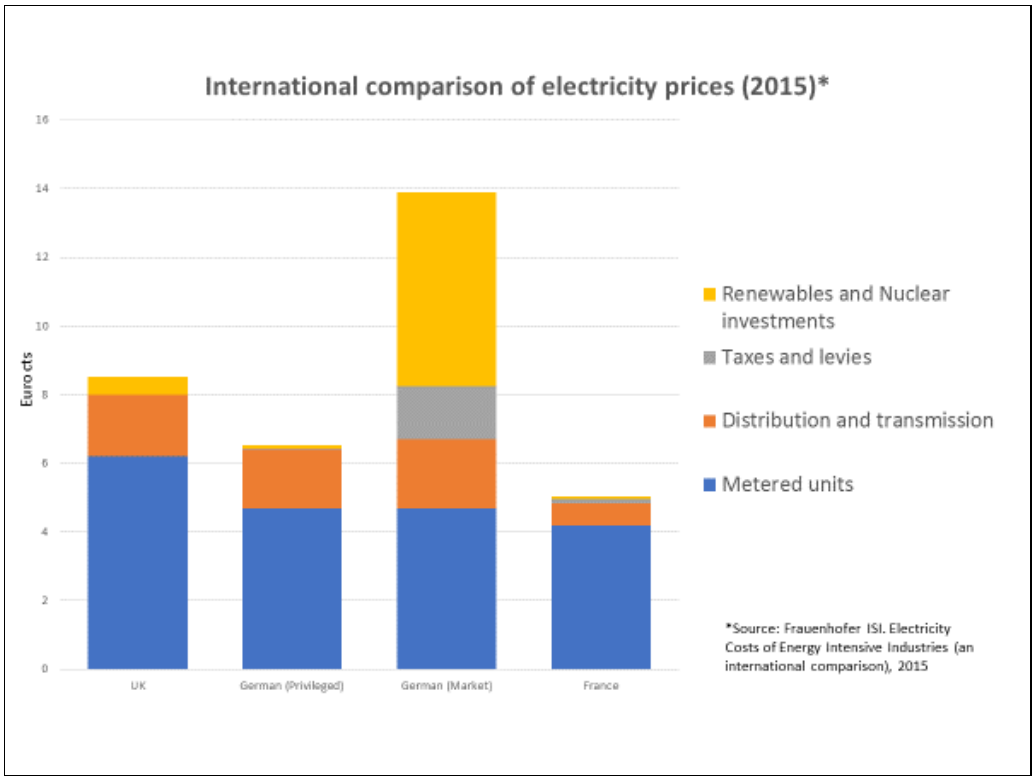


Figure 8 International comparison of electricity prices

The UK approach to energy market regulation has been extensively criticised in a high-profile report commissioned by the Secretary of State for Business, Energy and Industrial Strategy (BEIS) and written by Professor Dieter Helm[xxi]. In it, Helm makes several relevant observations about the direction of travel of global energy systems, including the powerful point that within a relatively few years almost all energy costs will be fixed and apportioned infrastructure costs, with virtually no variable costs as the cost of fuels essentially falls to zero[6].

This has profound implications for UK energy market regulation and how energy costs are managed, because it means that energy will become very like telecoms or road travel in that usage of the system once it's built will essentially be free for everyone up to local capacity limits. In this situation, pricing cannot meaningfully be based directly on usage: instead it will be entirely focused on ensuring infrastructure investment costs are recovered, and this may be done in a number of ways to meet industrial strategy or political objectives.

Transport energy costs

The £3.3bn spent on fuel for transport currently in the West Midlands is virtually all in the cost of petrol and oil for road vehicles[xxii]. However, by 2040, with the sale of new petrol and diesel vehicles being banned in the UK, the bulk of this demand will shift into electricity or hydrogen.

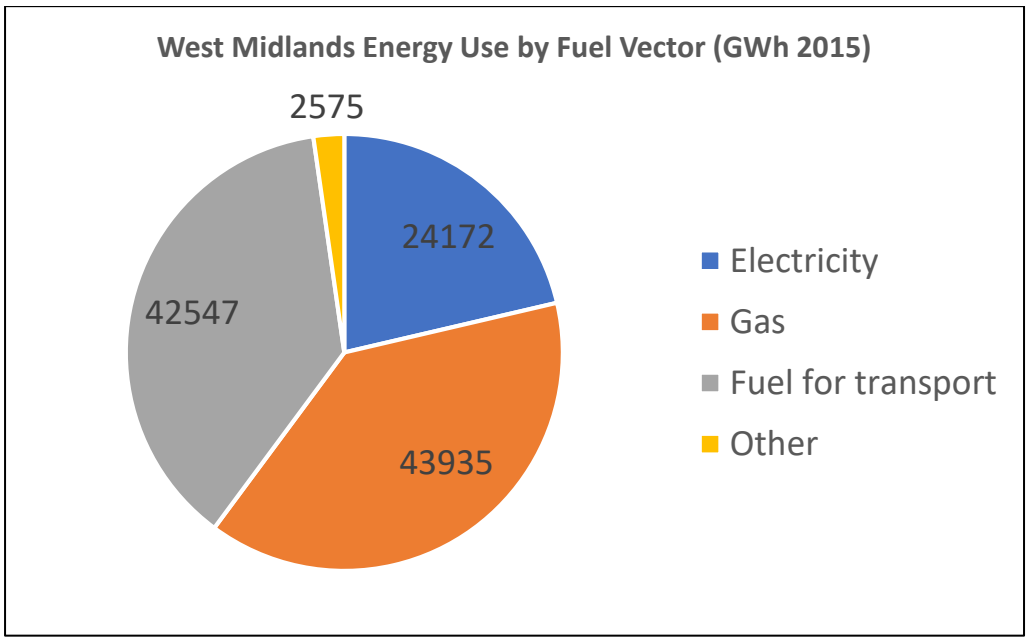


Figure 9 West Midlands energy use by fuel vector (2015)[xxiii]

This shift will have major implications for the regional energy system (see Figure 9 West Midlands energy use by fuel vector (2015)Figure 9). In energy terms, 42,547 GWh of energy currently delivered to vehicles in the region as petrol and diesel is nearly equal to the amount of energy delivered through the entire gas network in the region and almost twice that delivered by the

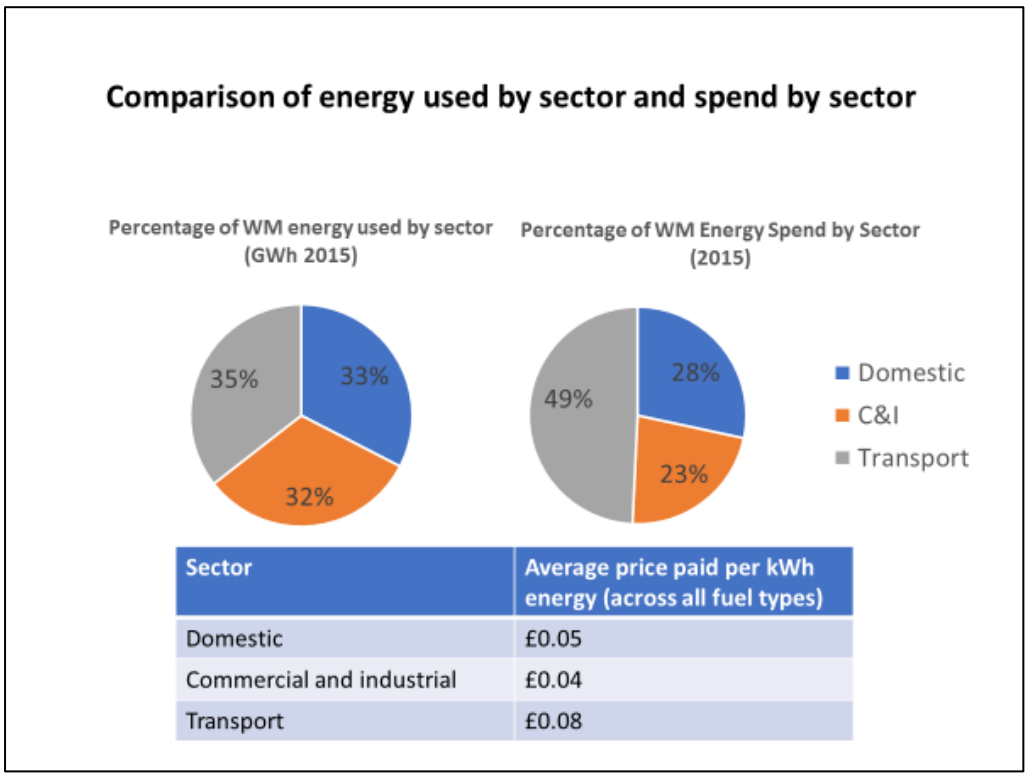
[6] This is obvious if you consider that nuclear and renewable energy systems are essentially all asset investments with free or essentially sunk fuel costs. Helm also (slightly more controversially) argues that fossil fuel prices will fall towards zero as it becomes impossible to sell them given increasing global penalties for pollution and carbon emissions.

electricity system. The implications for local energy infrastructure of shifting transport fuel use from petrol to electricity or gas are thus clearly significant.

This doesn't mean an immediate need for an electricity system that is three times bigger than the one today, or a gas system that is twice as big. There is a lot of devil in the detail of spatial and temporal usage patterns and existing spare capacities, and in uncertainties around the likely mix of electric and hydrogen vehicles. However, the direction of travel is very clear, and the need for detailed and closely integrated transport and energy planning at regional level is evident.

Domestic energy costs

Measured by kWh, household energy use overall is of a similar magnitude to commercial and industrial (C&I) and transport. The costs per unit of energy vary significantly because of infrastructure cost allocations and political judgements (tax allocations). It is more expensive to distribute gas and electricity to many small domestic users than to small numbers of concentrated industrial users (and to distribute transport fuels compared to electricity and gas).



Sector	Average price paid per kWh energy (across all fuel types)
Domestic	£0.05
Commercial and industrial	£0.04
Transport	£0.08

Figure 10 Comparison of West Midlands' energy use by sector and spend by sector

In the case of domestic energy costs, the annual spend on energy is significantly higher because of the poor overall quality of domestic building stock[xxiv]. This is a perennial challenge at national and local level[xxv] but one of increasing urgency as the search for cost-effective and socially acceptable responses to the challenge of climate change gathers pace. There are 1.7M existing houses in the West Midlands, with at least 200,000 of these falling within the official definition of homes in energy poverty[xxvi]. There are plans to build a further 215,000 homes by 2031[xxvii] which could easily add £100-300M to regional energy spending (at current prices).

In principle, domestic energy bills, usage and carbon emissions can be reduced cost-effectively and economically (using 'Green Book' analysis[xxv]) by between 10% and 30% i.e., £200-£600M p.a. for the

West Midlands. There are, however, significant challenges around financing, behaviours, transaction costs, cultural assumptions, customer priorities, regulations and political constraints which inhibit these benefits being realised. The corollary of this is that the challenges aren't primarily technical (i.e., economic technologies exist which could theoretically solve the problem) but more around innovation in business models, regulations and delivery and financing mechanisms.

The topic of housing energy performance is a major and complex area in its own right, and significant and detailed work has been done to analyse local housing stock performance by local authorities across the region. Most recently, the Sustainable Housing Action Partnership (SHAP) working with the West Midlands Housing Officers Group (WMHOG) has produced a series of reports on energy performance in both new build and existing housing (2017-18)[xxviii].

The key realities driving domestic energy performance from the perspective of a regional energy strategy are:

- The main determinants of domestic energy bills are the quality of the house and the behaviour of the occupants. Two houses which appear identical can have energy bills which differ by a factor of 5-10 because one is well-insulated and well-built (not draughty) while the other is poorly insulated, draughty because it was shoddily constructed, and occupied by a family comprising older people or small children.
- Houses and people are highly variable and diverse, and the 1.7M existing homes in the West Midlands are a particularly good and concentrated example of this diversity.
- In new homes there is a significant and negative gap between actual energy performance of homes 'as built' and the promised energy performance of houses as designed (and approved by building control). This arises because, in general, energy standards for new build housing are weak and poorly policed (with limited examples internationally of solutions to this problem[xxix]).

Established mechanisms to address energy poverty[7] and domestic energy efficiency in general include tightening energy performance standards for new build homes; schemes to provide subsidised energy efficiency measures for existing homes (the Energy Company Obligation (ECO) in the UK); local planning guidance requiring adherence to more stringent standards, sometimes even for renovations above a certain area threshold; local authority and nationally-funded energy efficiency advice services; and occasional attempts at financial incentives such as lower cost mortgages or rebates on rates.

Markets alone are ineffective at delivering optimal outcomes in this sector[xxx].

Investment flows

In the West Midlands, we invest around £1.25bn every year in our energy infrastructure: this is network investments including gas pipes, heat mains, wires and substations; key energy conversion technologies such as domestic boilers; and local energy generation assets such as solar farms, district heating and waste to energy plants.[xxxi]

[7] Energy or fuel poverty is defined by government as households who have theoretical fuel bills above average and were they to spend this amount it would leave them with residual income below the official poverty line.

Around £3.5bn is spent every year in the West Midlands on the built environment[xxxii], which has a significant impact on energy spend (e.g., see section on domestic energy use above) and on long-term productivity. This should also be considered as energy infrastructure.

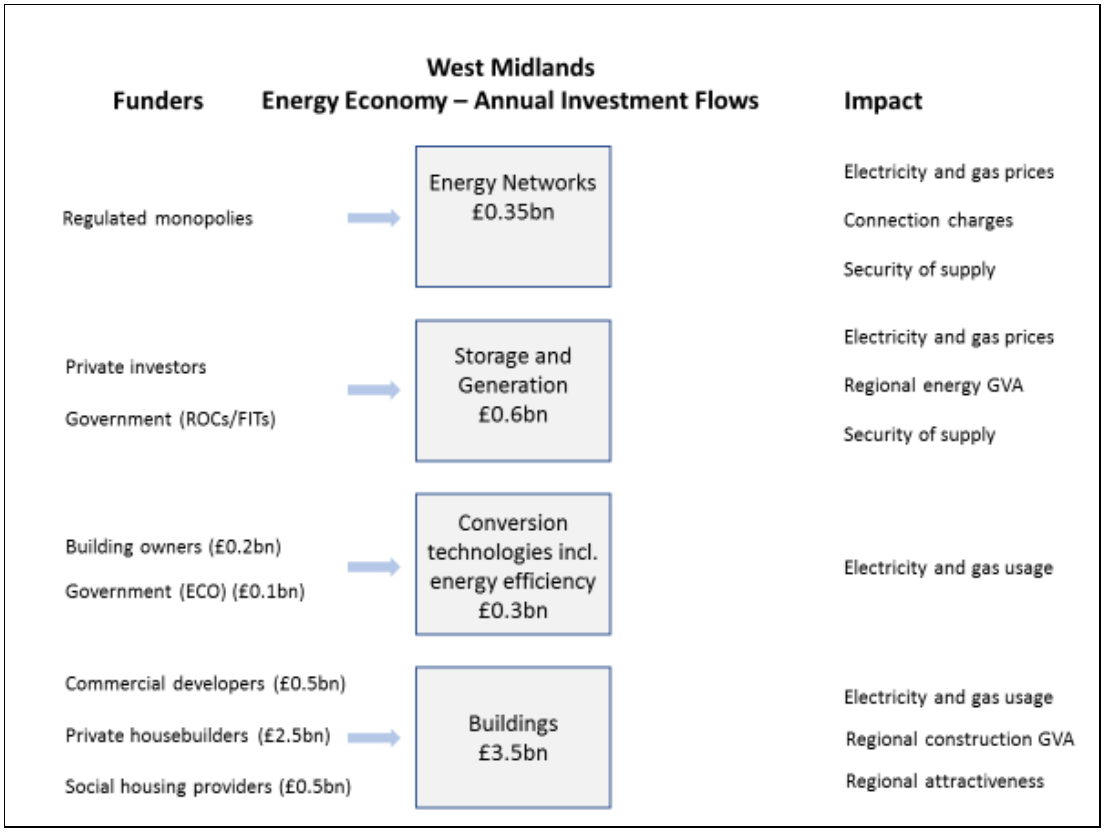


Figure 11 West Midlands annual investment flows - energy

Economic activity

Energy and environmental technologies currently account for £2.1bn of annual GVA in the WMCA area[xxxiii], and is the most productive of all sectors by value. It is the only sector in which regional productivity is higher than the UK average. Coventry and Warwickshire and the Black Country are both in the top five LEPs nationally in terms of % of GVA attributable to energy and environmental technologies.

Energy Storage and Systems has been identified as one of the four key market strengths in the recent regional Science and Innovation Audit[xxxiv]. This reflects the major academic assets in this sector across our regional universities (see Section 2).

Employment estimates vary between 24,500 jobs and 60,000 jobs[xxxv] depending on definitions of geography and sector boundaries. The GVA generated is concentrated in a small number of large firms (E.ON, National Grid, Cadent, Baxi, Calor) with a long tail of smaller firms. There are significant employers just outside WMCA regional boundaries (Worcester Bosch, nPower) and significant economic activity and employment within the region controlled by firms with headquarters elsewhere in the UK (Western Power Distribution, British Gas).

These statistics exclude closely-related jobs dependent on energy infrastructure, such as most manufacturing, transport and automotive jobs, and energy managers within larger organisations.

Engineering and infrastructure companies such as Balfour Beatty, Arup and Costain all have significant energy infrastructure divisions and presence in the region which may not appear in sectoral figures, as does Severn Trent which, as well as being primarily a water company, is one of the largest renewable energy generators in the UK.

Skills are an issue in energy as in many other sectors, with 36% of all vacancies across the energy and utilities sector nationally attributed to skills shortages.[xxxvi] The sector skills council for Energy and Utilities, Energy and Utility Skills, is based in the region (Solihull) as are other key sector interest groups and trade associations (e.g., Energy and Utilities Alliance, Sustainable Energy Association). There are several specialist training providers across the region (e.g., Energy Training Hub in Dudley) suggesting skilled energy sector people are as easy (or easier) to recruit in the West Midlands as anywhere in the UK.

Carbon emissions and environment

While the West Midlands faces similar challenges in carbon emissions and the environment to the rest of the country, the urban nature of its geography and position at the heart of the national motorway infrastructure makes these challenges particularly severe. A report[xxxvii] by Sustainability West Midlands (published in 2010) found the region suffers a carbon deficit compared to the rest of the UK of around 2MtCO_2e per year on top of national targets. This report is now eight years old, however, and it is likely the situation will have improved somewhat, as take up of renewables since 2010 has been substantial across the West Midlands and nationally, while manufacturing and transport activity has grown more slowly.

Carbon targets and plans vary significantly by local authority, and while the merits of seeking to set a regional carbon target were discussed, it was agreed this remains primarily the responsibility of local authorities. This strategy proposes to follow the national target at regional level and acknowledges in addition to this it is the region's responsibility to ensure the energy strategy is sufficiently flexible to support local authorities in delivering their local objectives.

Transport is a major element in the regional economy and recognised globally as one of the hardest sectors in which to reduce CO_2 emissions. However, vehicles are largely responsible for the toxic air pollution that afflicts cities worldwide. Nitrogen oxides and particulate matter emitted by diesel vehicles are key ingredients in outdoor air pollution that causes 3.7 million premature deaths each year[xxxviii]. In the UK, the government estimates that each year these emissions cause between 44,750 and 52,500 premature deaths and cost society between £25.3 billion and £29.7 billion.[xxxix] The West Midlands share of these figures will be between 5-10%, equivalent to 2,500 to 5,000 people dying prematurely in the Combined Authority area each year, at a cost to society of £1-£3billion.

The government has largely devolved the challenge to local authorities under the Localism Act 2011 and revisions to the Environment Act 2008. It has instructed five city authorities including Birmingham to implement Clean Air Zones by 2020. These will prevent the most polluting vehicles such as older diesel buses, coaches, taxis and lorries from entering the most polluted areas at times of day, or charge them for doing so. In Birmingham, the scheme will also cover vans.[xl]

Specific regional opportunities and needs

The West Midlands sees energy as core to the region's local industrial strategy (Figure 12). The scale of investment and potential benefit is substantial, so although this is a local strategy, it's important

to bear in mind that tackling the issues and opportunities will require a commensurately ambitious and innovative response.

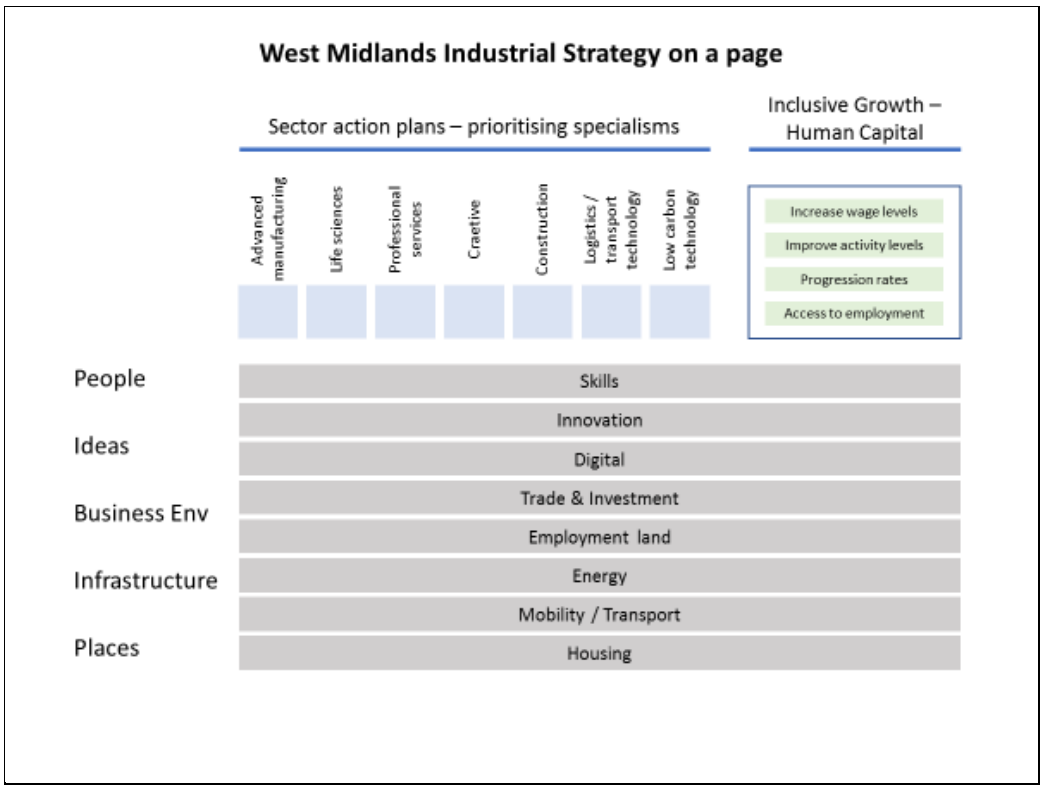


Figure 12 West Midlands Industrial Strategy Framework

A recent report produced for the WMCA by the Black Country LEP[xli] estimates that a focused regional energy strategy could deliver annual GVA improvements of between £400M and £820M. This is broken down as indicated in Table 1 below.

Note that in this table the benefits of enhanced building energy efficiency (including housing) are estimated (conservatively) within the 'attractiveness of the region to skilled people' line. The range of benefits shown is very large due to the challenging nature of this problem.

Accelerated roll out of new developments refers to the electricity and gas infrastructure required to support new investment in manufacturing and commercial developments across the region. This will amount to £3-4 billion over the next decade (see Investment Flows above): the figure of £100M is the estimated GVA benefit from accelerating the timing of this investment to align it more closely with local spatial and economic development plans.

Speed of new market development is about making West Midlands energy infrastructure fit for purpose to support mass roll out of low carbon transport systems, including EVs. Again, the scale of investment runs into billions (much of it around HS2 terminals) and the strategic need is to ensure this is timed to make West Midlands markets more attractive for inward investment and new technology deployment.

Potential Benefits of a Focused Regional Approach to Energy as an Enabler of Industrial Strategy	Provisional GVA impact estimate (p.a.)

Accelerated roll-out of commercial developments	£100M
Speed of new market development	£120M
Competitiveness of industry	£155M-£400M[8]
Attractiveness of the region to skilled people	£25M-200M
Total	**£400M - £820M**

Table 1 Summary of potential GVA benefits delivered by a West Midlands Regional Energy Strategy

Competitiveness of industry refers to the benefits of energy efficiency, smart energy systems, efficient procurement and strategic infrastructure cost allocation for energy intense manufacturing businesses, to ensure they compete on a level playing field against international competitors.

These figures exclude the benefits of clean air (estimated at between £1bn and £3 billion, see above) and are conservative on the potential benefits of clean energy innovation (the figure for the region offering opportunities for accelerated market development is based purely on additional local sales of low carbon vehicles by local companies).

In addition, the separate report by Arup[xlii] (see Appendix II – Pilot Energy Innovation Zones and Investment Cases) identifies up to £490M of economically viable energy infrastructure investment to optimise economic and environmental benefits in four pilot energy innovation zones.

Headline investment projects

The West Midlands is an ambitious region with major investment and regeneration projects underway across the geography: over £2 billion of investment is planned for UK Central and Solihull with the arrival of HS2; similar levels of investment are planned for Birmingham (again with HS2 and the redevelopment of Smithfield) and Coventry (housing and new manufacturing facilities for JLR) with £1.5 billion being invested in the Black Country's Enterprise Zones.

It will be critical to get the local energy infrastructure right for these projects, and that's challenging and risky at a time of major change in global energy systems. There is a danger that the tendency of commercial investors and developers to focus exclusively on short-term profit maximisation results in energy infrastructure investment which quickly turns into stranded assets and limits the long-term economic and environmental sustainability of the surrounding local community. There is a strong regional interest in getting investment in infrastructure right.

It's not just the headline schemes that need appropriate energy systems. As Appendix I summarises, there are clean energy opportunities across the region, including at least a dozen district energy schemes, four major waste-to-energy projects with contract renewals due in the next five years, and approaching £200M of solar PV investment opportunities in the Black Country alone.

Housing challenges

The West Midlands has significant housing issues and opportunities. The current expectation is that 215,000 new homes will be created in the region (net) over the next 12 years[xliii] . This represents

[8] The higher figure assumes Helm's national recommendation to establish a legacy bank for historic energy infrastructure investment costs is adopted in the West Midlands.

mixed public and private investment of around £20bn, and an additional electricity requirement which could vary from virtually zero to 8TWh per year[xliv, xlv]. In electrical capacity alone, these houses will need around 80MW of new base power generation and 200MW of available peak power generation (assuming no innovation in control technologies and load shifting)[xlvi]. This assumes heat continues to be provided by gas and allows for no electric vehicles.

Energy poverty is a significant issue for the region, with rates exceeding 13.5% in several areas of Birmingham, the Black Country and Coventry[xlvii]. This is a consequence of poor quality (often private) housing and domestic energy prices. A concerted strategy to address this needs to focus on the built environment and infrastructure as well as headline domestic energy costs.

The number of households in fuel poverty across the region is around 200,000[xlviii] which is potentially a substantive and targeted market for energy efficiency refurbishment (retrofit) using innovative models such as Energiesprong[9]. This is only likely to be appropriate to particular configurations and specifications of housing – particularly the large estates of the 1950s and 60s – and many other models are also being developed, for example by the Energy Systems Catapult in Birmingham. Energiesprong retrofits eliminate fuel poverty from households where they are applied and recover the costs over 30 years via (lower) energy bills. This scale of radical low carbon retrofit on 200,000 houses would require investment of around £4 billion, all with positive financial and social returns.

One of the main lessons from initiatives like Energiesprong and the Catapult's Smart Systems and Heat Programme have been that solving the housing energy efficiency problem will require a diversity of approaches, considerable attention to detail (which means new skills programmes, training, and cultural changes for construction workers and professionals) and new business models. For example, Energiesprong works well under Dutch regulations but requires significant modifications in business model to work in the UK, and even then models only exist so far for the social housing sector. Economies of scale will be important in keeping costs down, but reconciling the need for scale with delivering higher quality and more diverse and tailored outcomes is a challenge in any sector, let alone one as fragmented and traditional as housing and construction.

The major UK government scheme supporting energy efficiency in housing is the Energy Company Obligation (ECO). This has been in place for some time and is about to start a new four-year cycle, despite its many imperfections, which the government recognises[xlix]. The West Midlands' share of ECO is around £60M per year, and there is a strong alignment between government objectives and West Midlands' needs. Specifically, the scheme is now 100% focused on fuel poverty, recognises the need for greater local authority involvement to support efficient targeting, and seeks greater innovation.

Energy Capital therefore sees a significant opportunity in ECO for the West Midlands to work with government to develop a better model for fuel poverty elimination, and one that also supports the local industrial strategy. This will be a key element of this strategy.

Electric vehicles

Electric vehicles are a strategic and critical area of opportunity to this region because of the region's heritage and strategic strengths in advanced manufacturing, low carbon technologies, transport and logistics and construction. EVs represent a significant market opportunity for all these sectors. They

[9] Energiesprong is currently being piloted by a consortium in the UK including Accord Housing, who are based in the Black Country, and have a manufacturing facility (LoCal Homes) in Walsall.

are also a challenge we cannot ignore: the West Midlands must secure a leadership position in this area to retain a significant element of our economic strength.

The region's potential strength in this sector has already been recognised by the government in locating the £80M National Battery Manufacturing Development Centre in Coventry, and Jaguar Land Rover bringing its first electric vehicle to market in 2018. To maximise the economic and environmental benefits of this investment, the region – especially around Coventry and Solihull – plan to invest significantly in connected autonomous vehicle (CAV) development and infrastructure. Various stakeholders are already discussing the creation of EV charging hubs and infrastructure (including vehicle to grid) at commercial scale.

Electricity networks and distributed generation

Western Power Distribution commissioned Regen in 2017 to carry out a comprehensive review of renewables and distributed energy technology opportunities in the region. This provides further useful indications of the likely investment opportunities (and uncertainties) across the region up to 2030[I].

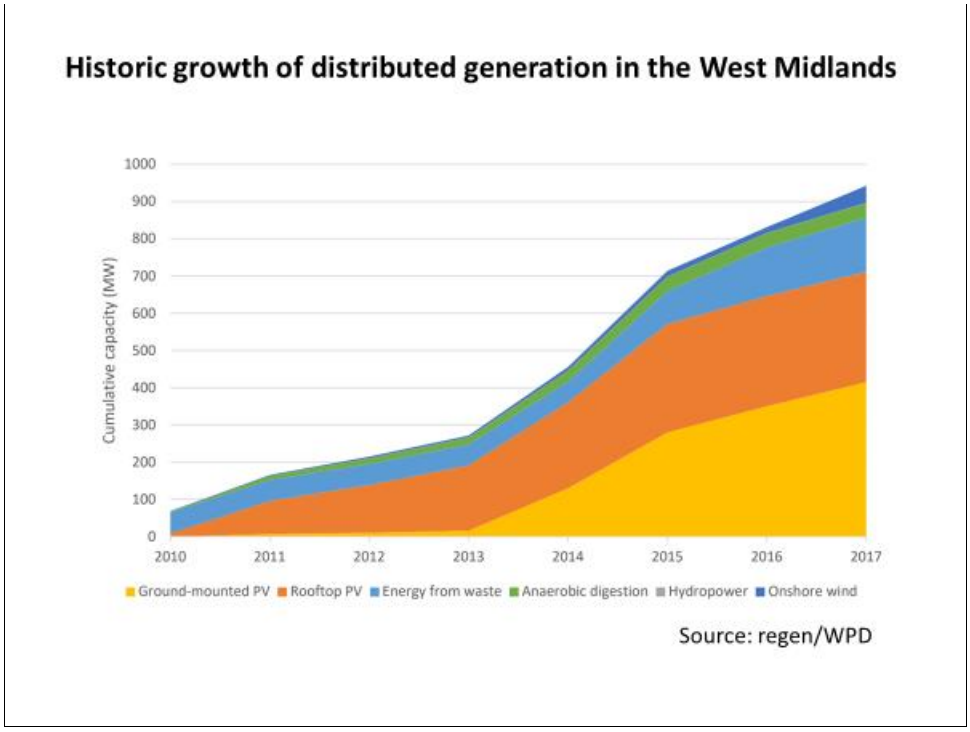


Figure 13 Historic growth of distributed generation in the West Midlands

Figure 13 shows cumulative investment of around £1 billion in regional distributed energy technologies over the past seven years, delivering more than sufficient power, for example, to support the housing growth planned for the next decade.

Figure 14 shows a range of projected futures for regional distributed generation investment modelled on National Grid's Future Energy Scenarios[Ii]. This includes varying assumptions for electric vehicle (EV) take-up, and broadly equates to between £400M and £2.5 billion of investment opportunities in local generation alone (before heat and network investments) up to 2030.

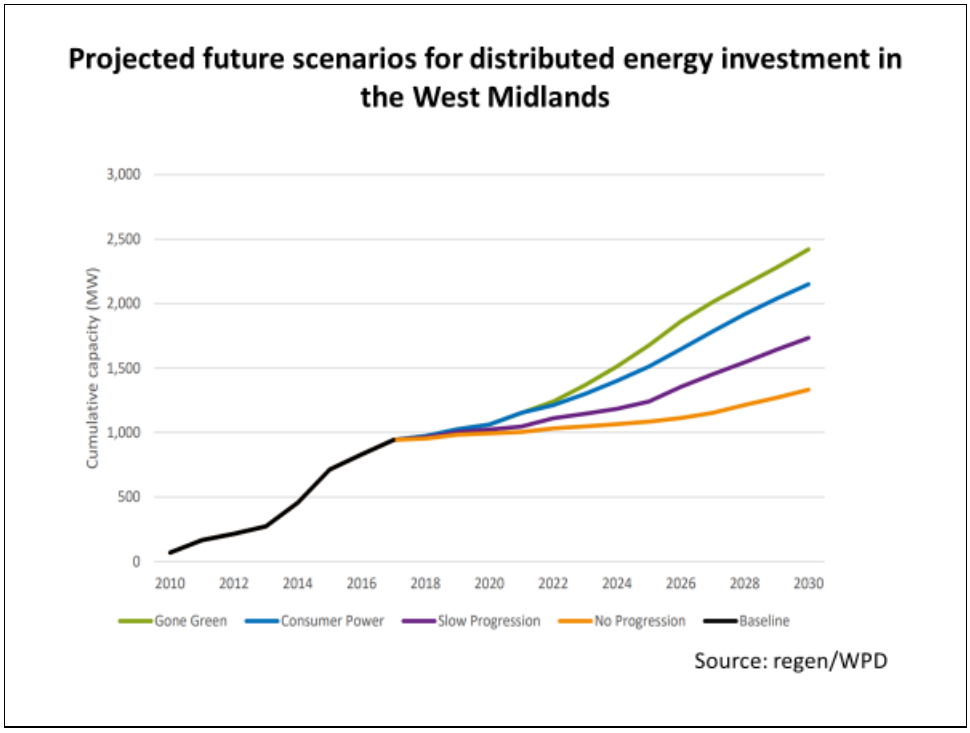


Figure 14 Projected future distributed generation investment in the West Midlands to 2030

Hydrogen

The West Midlands has longstanding interests in the developing hydrogen economy including companies such as Microcab that are developing fuel cell powered vehicles. There are plans for hydrogen refuelling facilities in Tyseley Energy Park alongside the existing 10MW biomass power station, and joint research and development facilities in emerging biomass and hydrogen technologies run by the University of Birmingham and Frauenhofer ISI.

The University of Birmingham has the UK's only integrated and internationally-recognised research programme across all aspects of fuel cells and their fuels[lii]. In 2017 a hydrogen-focused network was launched (the Midlands Hydrogen and Fuel Cell Network) specifically to support commercialisation activity around hydrogen in the region. Birmingham City Council is committed to trialling hydrogen powered buses[liii] and waste vehicles as part of their fleet.

Waste-to-energy and heat networks

There is a concentration of waste-to-energy facilities in the Black Country, as well as major plants in Coventry (44MWe) and Tyseley (25MWe). Currently, only the Coventry plant is committed to linking into a district heating scheme but plans and feasibility studies have been completed for the plants in Tyseley, Dudley, Wolverhampton and Sandwell. These create the opportunity to develop commercial integrated schemes (subject to negotiation and contracts) when waste contracts come up for renewal between 2019 and 2023.

There are several private waste-to-energy plants in the Black Country, and some are now exploring local private wire arrangements with nearby manufacturers. More detail on potential waste-to-energy and heat network schemes is provided in Appendix I.

Birmingham has an established district energy company, BDEC, serving much of the city centre including council buildings, the International Convention Centre, Children's Hospital and Aston

University. This is in partnership with ENGIE (as is the Coventry scheme). Both Warwick and Birmingham Universities have their own on-site gas-fired CHP[10] networks as the main source of heat and power for their campuses.

Global markets

The global energy system is on the cusp of a major transition. For most of the past century technology and economics have supported a largely one-size-fits all approach to energy infrastructure. Attempts to do anything more than superficially adapt energy systems infrastructure to local needs would either have imposed excessive costs or resulted in inequities in access.

However, rapid reductions in the costs of communications, ICT, and energy storage and generation technologies are changing this context fundamentally.[liv] Figure 15 illustrates one example: a projected 60% reduction in the installed cost of battery storage to 2030[lv,11].

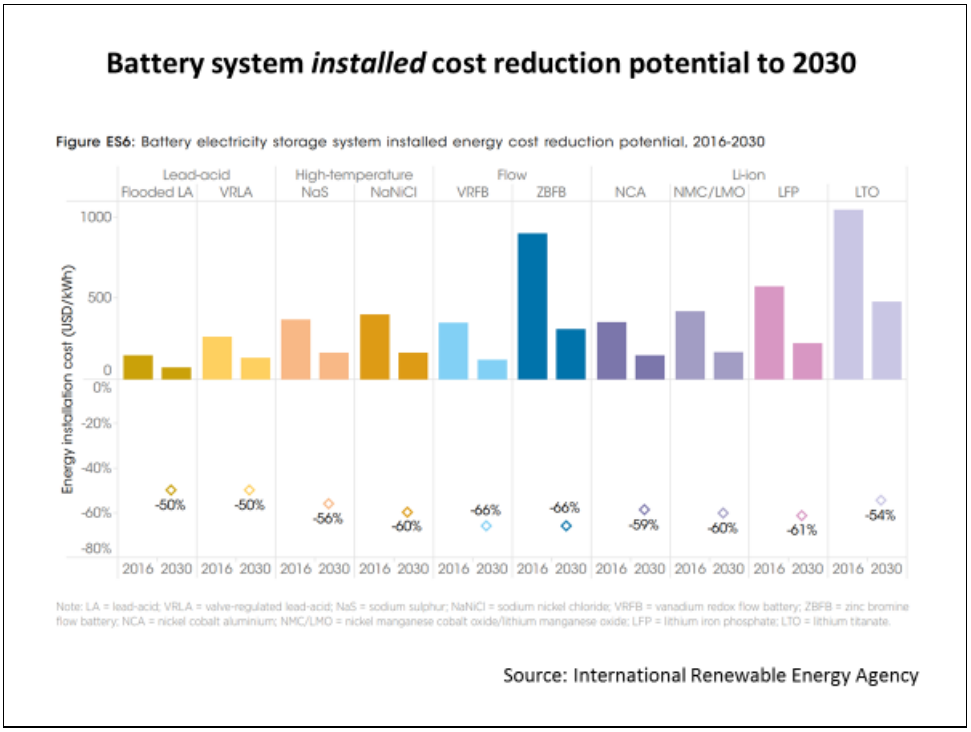


Figure 15 How costs of energy technologies can fall rapidly

Digitisation and energy storage technologies make it possible to optimise energy systems at much more local levels, and to manage them in a distributed way[lvi]. This in turn means national energy infrastructure, including energy market and regulatory structures, can accommodate more diversity and variety (at least in principle). The benefits of such local diversity in energy systems and responsiveness to local needs now outweigh the costs.

These fundamental technical changes have been accompanied by significant global political shifts, in particular, recognition of the need to address the challenges of climate change through reducing carbon emissions. The energy system is the largest emitter of carbon globally and thus at the forefront of these political changes.

[10] Combined Heat and Power

[11] Note this is installed cost; the actual technology costs are falling much faster (for example Lithium ion battery costs fell by 60% from 2014-17 (same source).

The economic opportunities associated with these shifts are potentially huge. The broad global political consensus around climate change is manifest in changing customer attitudes, varying national targets, regulatory nudges, and incentives across the world, all of which create significant markets for clean energy technologies and systems.

The most recent estimates (e.g., from the World Bank, Oxford Economics, McKinsey, and IEA) of the global market opportunity for clean tech products and services suggest a market of well over $3 trn a year, with energy infrastructure investment alone accounting for between $2.5trn and $3trn a year between now and 2040[lvii].

The challenge in taking advantage of this global market opportunity is that it will clearly require new cross-sectoral collaborations, for example between transport, energy, construction and digital sectors, and the transfer of know-how from sectors such as advanced manufacturing and logistics to construction and energy. Unlike the West Midlands, few regions have economies with strengths in all these areas, especially when coupled with a diversity of both research and practice-led universities to support effective cross-fertilisation and the emergence of new competencies.

Effective commercialisation of cross-sectoral innovations requires accessible markets of sufficient scale to support rapid scale-up (for example helping new businesses cross the 'valley of death')[lviii]. The West Midlands is big enough – comparable in population and economy to a small country such as Finland, Denmark or Norway – to offer such a market, particularly in the energy sector where public policy unavoidably plays a major role in determining outcomes (in any political system).

For these reasons, low carbon technologies and services are justifiably identified as a key strategic sector in the West Midlands' industrial strategy, and the region has a unique opportunity to benefit from the $3trn global market opportunity currently developing.

4. Challenges and constraints

There are, however, significant challenges in any attempt to address energy strategically at regional level in the UK, despite the clear potential economic and environmental benefits of doing so as summarised in Section 3. This section reviews these challenges under seven broad headings, setting the agenda for the focused strategy set out in Section 5.

The speed and nature of technological change and choice in energy systems

There are a wide variety of technical choices to make in any energy system, whether for an individual house, a region or a country. The economics of energy technologies in a given place are also not independent of each other[12]. For example, a district heat energy system may make economic sense if local housing is poorly insulated or no sense at all if the same housing is retrofitted with the latest insulation (an economic choice which makes complete sense for the householder but not for the district heat operator).

This context is further complicated when technological change and changes in the economics of individual technologies are occurring on the scale and at the rate illustrated in Figure 15. The current world is one in which proponents of hydrogen, electric vehicles, biomass, solar, nuclear, micro-CHP, district heating, smart controls, energy storage, building energy efficiency and heat pumps can all credibly claim to be offering game-changing rates of technical progress and cost reduction.

These two realities can create a significant risk of very poorly informed and meaningless public debate and policy-making. This is particularly true at national and international level, and in political systems where public servants are poorly equipped[lix] to resist specialist lobbying by corporates and academic proponents of specific technologies. The outcome is too often much time wasted debating questions which are meaningless and impossible to answer in the abstract: like 'are heat pumps better than gas? or wind better than nuclear?'. Such questions can only be answered in a defined context (i.e., for a specific geography and set of infrastructure and market regulations) and at a given moment in time.

Energy investment decisions will always entail significant uncertainty and risk, because a high rate of innovation means the only certainty is that tomorrow's economics will not be the same as today's. Some assets will thus be 'stranded' and looking back at decisions with the benefit of hindsight will find that if a different choice had been made a lower cost outcome would have resulted. The challenge then, is not to identify the best technologies to deploy in any kind of general sense, but to ensure that energy investment choices and decisions are made by those best placed to manage the unavoidable uncertainty and risks that all such decisions entail.

Two further points are increasingly relevant to many energy choices:

1. Energy infrastructure choices are becoming more granular and local. This point has already been made in Section 3 and is the outcome of the reducing costs of storage and digital

[12] This should probably be written more forcefully: the economics of energy technologies are typically highly dependent on other energy technologies already present and the infrastructure around them. To give a stark example, a gas boiler has no economic value at all to a property off the gas grid.

control technologies. Put another way, the proposition is that varying local energy infrastructure no longer necessarily means extra cost and risk to the national system.

The challenge this creates is that it's no longer economically optimal (or sensible) to think about a single national energy infrastructure. It's becoming in everyone's interest – especially the customers who pay for energy – to think about infrastructure choices more locally. This makes regional and local energy decision-making more challenging (because it's no longer simply about what investments should be made in generation and demand-side assets given a fixed infrastructure – the infrastructure itself is now fluid and part of the process) but is more likely to result in better outcomes and match risk to reward.

2. Energy investments (and their economics) are increasingly tied into wider (non-energy) infrastructure and policy decisions. Carbon pricing, carbon targets and environmental policy are the obvious examples of this at global, national and local level, but local waste, transport, and industrial strategies will also be critical factors determining the viability and attractiveness of energy projects, as will housing and spatial plans.

This means that to manage the risks and uncertainty of energy investments effectively, decision-makers need to be able to take a broad range of interests and issues into account. This becomes very difficult (and can easily lose touch with political realities and voters) where decisions are taken at regional or national level – and which is why much spatial, waste and transport planning is done at local authority level.

Customer engagement in energy markets

While customers can occasionally get very engaged by energy technologies and energy investment and infrastructure choices in particular (for example, wind turbines, waste-to-energy plants or nuclear power) they are largely apathetic and disengaged when it comes to the energy market. Around 95% of customers of the larger suppliers are paying more than necessary for electricity and gas, despite the best efforts of Ofgem and others to persuade customers actively to shop around and switch suppliers regularly[lx].

This is a significant problem for any effort to 'do energy differently', especially where such efforts assume benefits will be delivered by active competition. Markets simply don't work if people ignore them and refuse to visit.

So, it's essential that any strategy include some model for customer engagement and communication, particularly if benefits depend on customers making active and informed choices.

Narrow definitions of innovation

As discussed in Section 3, there are major opportunities for innovation and the emergence of new business models in energy (including potentially whole new industrial sectors, such as autonomous vehicles and connected homes). Facilitating the development of such models and such innovation is critical for the region to maximise both economic and environmental benefits. However, care needs to be taken not to constrain growth by taking too narrow an approach to innovation regionally.

A tendency to define innovation solely as commercialising new technologies emerging from university-led research, coupled with an innovation agenda largely set by existing (and typically larger) industrial interests, may result in too narrow an approach to innovation.

Both these aspects of innovation are, of course, fundamentally important and need to be supported. But in regional energy systems and to deliver the scale of ambition of the West Midlands, it's also critically important to recognise the value of investment which is innovative in the sense of, for example:

- new applications of existing technologies at a scale beyond anything previously attempted;
- new combinations of existing technologies in a systemic way, creating new business models and new customer outcomes;
- incremental development (including simple cost reductions) of existing technologies
- innovative market regulation and governance, creating incentives for investors and innovators to take significant commercial risks at scale;
- investment in energy infrastructure which may not be that innovative, but which unlocks whole new markets for low carbon energy technologies and systems and opportunities for economic development.

Innovations such as Tesla are (arguably[lxi]) far more likely to arise from this kind of innovation than innovation driven by leading edge research or existing automotive or energy interests.

Innovation focused entirely on business models and on facilitating activity is also critical, particularly in sectors such as domestic retrofit, for the reasons set out in Section 3. For example, installing insulation is not inherently innovative. However, guaranteeing the performance of this insulation is innovative, as is financing insulation through a new mechanism, whether this be local crowd funding of retrofit projects through bonds or debentures, or social impact bonds, equity release, or green mortgages. Building a library of common retrofit construction details and solutions to technical risks would also be innovative, as it would help upskill architects, and overcome some of the barriers to retrofit being rolled out to a high standard[13]. These types of innovation particularly need to be publicly driven and supported, because they are least likely to be driven by market forces and the private sector.

The innovation challenge in the energy sector (particularly energy infrastructure) is especially acute stemming from the combination of:

- the world currently emerging from a relatively long period (several working generations) when the whole energy sector has been relatively static and slow-moving, with very limited innovation;
- a one-size-fits-all approach to national energy infrastructure that was driven by the economics and technologies of the 20th century rather than the 21st;
- a long-standing cultural problem with UK innovation policy which places too much emphasis on the simplistic 'linear' model of innovation[lxii].

Some progress has been made in recent years with the creation of the Catapults nationally, and in particular the Energy Systems Catapult in Birmingham[lxiii], although there is still some way to go in recognising the need for (and value of) local variety and sensitivity in energy systems. The regional energy strategy is an opportunity to take a broader perspective on innovation.

[13] We are indebted to the consultation response of George Simms for this paragraph.

Diversity of local ambitions

The West Midlands' scale gives it economic weight and the ability to deliver substantial and ambitious schemes and policy objectives, to national as well as local benefit. It is, however, a diverse geography (see Section 2) and the workshop-style medium-size manufacturing of the Black Country has very different needs from, and offers different opportunities and challenges to, the concentration of automotive manufacturing in Coventry and Warwickshire (for example).

Similarly, the highly diverse and concentrated urban population and environment of Birmingham contrasts with the rural environment and town centres of Warwickshire, North Worcestershire and South Staffordshire. It isn't at all clear that the same energy system will benefit all areas equally.

The challenge is to see this diversity as a strength and a virtue, in common with the people who live in the region (who often commute from rural towns to Birmingham, or vice-versa for leisure and shopping) and not to develop an energy strategy which either ignores or undermines the diversity of ambitions and loyalties this variety creates.

Complexity of political institutions and public sector capacity

The diverse economic geography of the region is reflected in a complex layering of political institutions which can appear somewhat impenetrable to outsiders, although in practice it generally works very well and makes sense to those involved.

The table below summarises the political structure of the region.

Body	How many	Broad role(s)	Accountability
West Midlands Combined Authority	1	Transport; industrial strategy; housing and land; productivity and skills; strategic infrastructure	Democratic and to constituent members
Local Enterprise Partnerships	3	Economic development (Innovation; creativity; growth)	Local authorities via supervisory board
Constituent Local Authorities	7	Deliver public services – all metropolitan and unitary authorities	Democratic
Non-constituent Local Authorities	11	Deliver public services – fewer voting rights on WMCA; mix of unitary, shire and district councils	Democratic

Table 2 West Midlands' political structure[lxiv]

As at the end of 2017, only five of the seven constituent local authorities retained specialist energy or sustainability officers. The LEPs and Combined Authority had no dedicated energy officers at all, although the boards of all three LEPs include individuals with energy expertise (reflecting the strength of the sector across the region). Several local authorities retain energy project managers and specialists on a consultancy basis when required (e.g., Birmingham City Council has been working with a specialist team for over a year on the setting up a retail energy company).

This limited resource is potentially a significant challenge, particularly to efficient and informed ongoing discussion of local needs[14]. However, it has facilitated a recognition at all levels that energy investment is an area which may well best and most efficiently be supported from the Combined Authority and driven the formation of the Energy Capital partnership for the region. Energy Capital has been well supported by the public and private sector.

BEIS have recognised public sector capacity issues in energy nationally and are funding the equivalent of one specialist energy post per LEP area for the next two years. This funding will be very helpful in supporting better dialogue and knowledge transfer, but will fall some way short of the resource necessary to deliver any meaningful strategy for the region with the scale and impact justified by the opportunities outlined in Section 3. The lack of alignment between regional hubs and political boundaries (i.e., governance) is unhelpful and clearly inefficient.

Existing industrial strengths

The West Midlands has historic strengths in several sectors, especially automotive and manufacturing. This is a weakness and risk, of course, as well as a major virtue.

Given the global consensus that new cross-sectoral business models are likely to emerge as the energy transition unfolds (and companies like Tesla and Amazon already exemplify this), it will be very important to the long-term economic success of the region that not only existing industrial strengths are reinforced through our energy strategy.

The regional approach must support new firms and start-ups with potential to grow, and the 'silent majority' of mid-sized manufacturing firms[lxv] who could grow substantially by redirecting their existing skills and competencies to new markets and opportunities opening worldwide.

A mismatch between regulatory system design and market opportunities

There are two separate and equally fundamental issues with energy market regulation from the perspective of a region seeking to develop a coherent and meaningful energy strategy to deliver local economic, social and environmental objectives. One is the complexity of the system, the other is a structural mismatch between regulation and where technical and economic opportunities lie.

Historic complexity

Over the last 40 years the UK has led the world in developing a market-based regulatory model for energy. This model was initially successful, but the past 15 years have seen a progressive return to government control and increasing criticism of the complexity and outcomes delivered for customers, which generally result in higher prices[lxvi].

The desire of government to be involved in energy market regulation is understandable (and probably necessary) because energy has such a significant potential impact on economic and environmental outcomes at all levels – national, regional and individual. However, the consequence of recent UK history in this sector and the rather confused mix of 'independent' regulation of privatised companies and increasingly robust government intervention (e.g., the introduction of price caps[lxvii]) has created a complex and opaque energy sector. This slowly stirring soup of regulations is virtually impenetrable to many insiders[lxviii], let alone to local or regional authorities (or

[14] This did not prevent all seven constituent local authorities responding promptly and helpfully to this project.

small and medium-sized businesses) wishing to innovate or develop coherent and ambitious strategies in this sector.

Structural mismatches

The current structure of UK energy markets is summarised in Figure 16 below. Since 2010, criticism has come from all sides of academic and political debate (for comprehensive and largely opposing academic critiques see Helm[lxix], iGov (Mitchell)[lxx]).

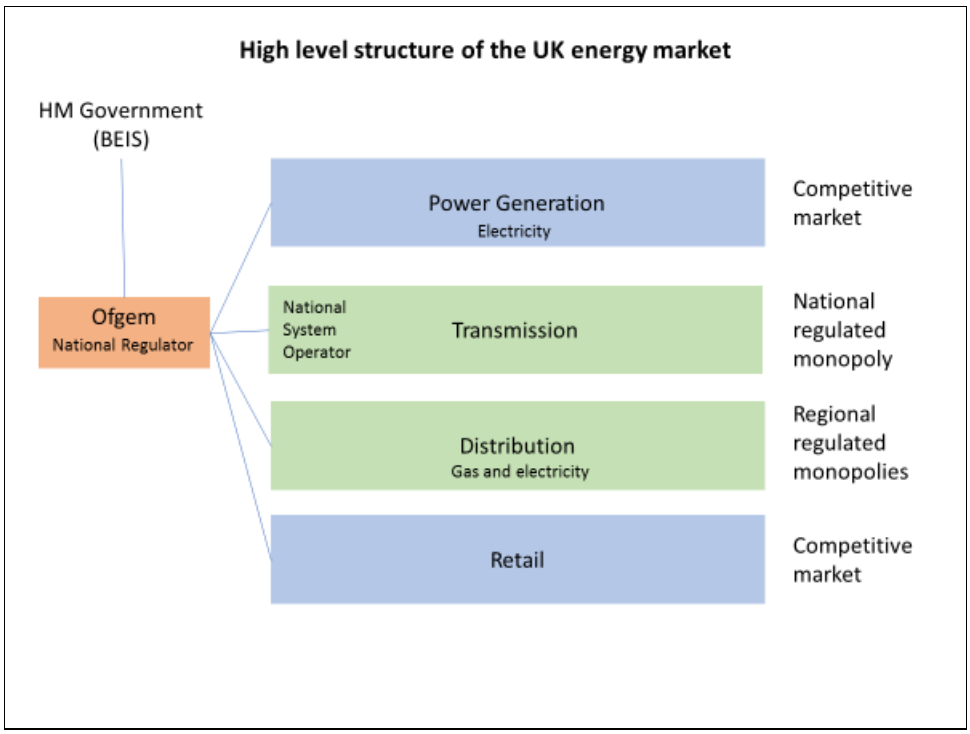


Figure 16 How the UK energy market is structured

The practical reality is that this makes it challenging to take an integrated, market-based approach to energy systems and energy infrastructure planning at regional level. This is because energy markets and energy infrastructure are primarily regulated, planned, and managed nationally, whereas transport, waste and spatial plans are primarily planned and regulated regionally and locally.

Successful modern distributed energy projects and economic opportunities associated with (for example) low carbon autonomous vehicles, smart connected homes, and optimised waste-to-energy systems, require integration of transport, waste, spatial, digital and energy strategies. They require local political and community consent and engagement. If energy systems investment is fundamentally regulated nationally while other key enablers of energy projects are controlled locally, progress will be limited.

This is not purely a regulatory and policy point. Regulation essentially specifies how returns on investment are allocated. If regions want or need to invest in substantial energy infrastructure to support their economic goals and local needs, they need to be able to offer investors returns on these investments. Constraining such returns within national regulatory frameworks inhibits and prevents this.

The essential argument in this strategy is that maximum economic, social and industrial benefit can be secured by optimising the energy system *starting from inherently diverse and place-based*

requirements and opportunities. Increasingly this means paying attention to distribution and generation infrastructure at a regional level (integrated with other regional infrastructure and industrial needs) in the context of an overarching national system which supports this.

The system is currently designed on the assumption that distribution and transmission infrastructure is essentially fixed, changes only slowly, and has little or no impact on competitiveness. It assumes that the only economically viable generation assets are national in scale. These assumptions were broadly true in 1970, 1980, and 1990 but from 2000 they became diminishingly true and no longer hold.

The present UK system therefore assumes that the only economic benefit and industrial advantage that the energy system can offer is through competition in retailing energy and in generating energy to supply a national system. In the 21st century, these assumptions are simply wrong[15].

[15] In saying this, this strategy agrees with Dieter Helm, who develops all these points at some length in his cost of energy review.

5. Our regional energy strategy

Overview and principles

The West Midlands Combined Authority is a new organisation with a new Mayor, working to an ambitious agenda with three highly effective Local Enterprise Partnerships and supportive constituent local authorities. This creates an opportunity to develop a distinctive and powerful regional energy strategy building on the region's unique history and meeting its unique regional needs (See section 3) while addressing the challenges set out in Section 4.

Reflecting this background and context, the strategy is built on five core principles:

1. **Respect for diversity** and existing strengths across the region.
2. **Leadership in the clean energy transition** nationally and internationally through innovation.
3. **Partnership** across sectors and between our universities, businesses and communities.
4. **Openness** to new thinking and transparency to support this.
5. **Focus** on areas where we can make the biggest difference by working together at regional level.

Local leadership of regional energy activity is seen as fundamental to success[16]. This means local authorities and the communities they represent. This strategy is thus a framework for local energy leadership at scale and creating impact across the West Midlands.

These core principles are translated into four specific initiatives:

1. Development and use of **Energy Innovation Zones (EIZs)** to provide a simple, flexible mechanism to support integrated local energy infrastructure transition, investment and accelerated deployment of innovation. The West Midlands has led on the development of the concept of EIZs nationally[lxxi].
2. Creation of an innovative and **democratically accountable regional energy governance structure**, **Energy Capital**, in partnership with national stakeholders and energy system operators. This will manage risks, help secure necessary funding and regulatory powers and provide assurance to national system operators and regulators that local activities remain within national market and regulatory frameworks.
3. Investing in **specialist resource to help secure long-term funding** at scale for targeted and appropriate local energy investments, innovation and development of an active innovative energy business cluster at scale. We propose to target raising £500M of investment funding to support commercially viable energy investment across the region[lxxii].
4. **Targeted support** for innovators, ambitious existing businesses and citizens in taking advantage of the economic opportunities created by the global energy transition. This will build on existing initiatives and institutions.

[16] This is a technical point as well as a political and logical one. The more localised an energy project, the more sensitive its economics tend to be to customer engagement: local people impact project development risk and costs significantly (for example for wind and waste-to-energy schemes) and customer behaviour is typically the key determinant of financial returns on demand side energy projects. For example, wayleaves for district energy pipework and other such details are all under local authority and community control and critical to efficient and profitable project delivery.

Objectives and vision

We aim to:

- reduce energy costs for our strategic industries to enhance their competitiveness and productivity;
- reduce the incidence of (and potential for) fuel poverty among households, particularly in Birmingham, Coventry and the Black Country;
- deliver the region's share of national and global carbon budgets;
- create a regional energy infrastructure which puts the West Midlands at the leading edge of the global energy and transport systems transition and make this region the most attractive market to commercialise new energy and transport system technologies in the UK.

For each of these objectives we will set ourselves measurable targets as set out in Table 3 below.

Objective	Proposed target
Energy costs for our strategic industries	Equivalent or better than costs paid by German competitors by 2023 This means delivering a typical 20-25% reduction, depending on sector
Reduced incidence of fuel poverty across our 1.7M households (currently approximately 200,000 homes are in fuel poverty across the region)	Beat national government targets[17,lxxiii] by at least 5 years As many fuel poor households as practical in Band C homes by 2025 As many fuel poor households as practical in Band D homes or better by 2020 Reduce the likelihood of households falling into fuel poverty by improving the average energy performance across all households and tenures in the region on an annual basis
Deliver our share of national and global carbon budgets	Reduce regional carbon emissions by 26% between 2016 and 2030[lxxiv]
Create a regional energy infrastructure putting the region at the leading edge of the global energy and transport systems transition	£1bn GVA improvement by 2025 through Energy Innovation Zones and associated cluster support and technology commercialisation[lxxv]

Table 3 Strategic objectives and targets

[17] In 2014, the Government put in place a new statutory fuel poverty target for England: to ensure that as many fuel poor households as reasonably practicable achieve a minimum Fuel Poverty Energy Efficiency Rating (FPEER) rating of Band C by 2030, with interim targets of Band E by 2020, and Band D by 2025. Bands are ways of measuring the energy efficiency of housing: A is good and E is poor.

Anticipated projects and pipeline - who picks the winners (and losers)?

There are over £490M of commercially sensible innovative energy infrastructure projects in the proposed pilot EIZs alone[lxxvi] and at least the same scale of opportunity again across the wider region (Appendix I – Sub-regional mapping reports). In total, the analysis in Section 3 indicates that more than £15 billion of investment will be needed *as a baseline scenario* in energy infrastructure across the three LEPs between now and 2030, plus a further £74bn in energy-dependent technologies such as cars (£32 billion[lxxvii]) and buildings (£42 billion) over the next 12 years.

The task of this strategy is clearly to influence these investment flows to ensure regional strategic targets are met, but given the challenges set out in Section 4, who is best placed to make the key investment choices is a moot point.

A fundamental challenge in the energy sector is that who picks the winning and losing technologies is not a simple question to answer. Individual customers select energy suppliers and choose between makes of car (creating what looks like competitive markets). However, the costs of delivering the energy to the customer's home or of driving the car are largely determined by local infrastructure, and the investment decisions which shaped this have been taken over decades by national and local stakeholders, including government and private companies[18].

Similarly, experts and innovators may be convinced a new energy technology, such as a type of fuel cell, is bound to succeed in the future. But if customers don't want it and the local infrastructure asset base doesn't support it economically, it probably isn't going to succeed.

So, the answer to 'who picks the winners' in energy is that it's not the market, nor the government, or experts or innovators, but a complex combination of all of these. An effective regional strategy (and indeed market design and national system) needs to recognise and work with this reality.

Currently, infrastructure technology winners and losers are chosen by network operators with regional monopolies regulated nationally, broadly on the assumption that not a lot is fundamentally going to change: a one-size fits all system is the only economic option. Thus, who picks winners and losers doesn't really matter. As previously discussed, almost everyone in the energy sector recognises these assumptions are now outdated, and the most economically competitive future systems will be more sensitive to local opportunities and needs (i.e., driven by local markets).

A more locally sensitive process for making energy infrastructure choices and investment decisions is therefore required.

This strategy responds to this challenge in three ways.

1. It creates a framework through Energy Innovation Zones for localities to act as intelligent and strategic customers (i.e., procurement and investment bodies) for future energy infrastructure and asset investments. EIZ Partnership Boards will comprise stakeholders relevant to the local area (often including academic experts and distribution network operators) and controlled by the local authority which represents the long-term democratically determined interests of the area.

[18] This is arguably one reason why customers fail to engage in retail energy markets: they know the real cost-determining decisions are not in their hands.

2. It provides support for the creation and operation of EIZs through Energy Capital, which itself provides a gateway to wider support (such as BEIS' Energy Hubs). Energy Capital will help fill gaps in expertise where necessary; it will develop large-scale investment funds; and provide access to regulatory and specialist legal advice and support where this is necessary and helpful (this will be provided to local authorities as well as EIZs where required). Energy Capital will ensure regional investment and activity in the energy sector continues to conform to national market regulations and policy.
3. It sets out measurable, focused, and ambitious targets to prioritise activity and ensure national and regional economic needs are reflected in EIZ and local authority objectives.

What the strategy does not do is tell localities which technologies or projects to invest in or which infrastructure choices will be best for them.

Energy Innovation Zones

Energy Innovation Zones (Figure 17) provide a flexible framework for focused energy infrastructure investment meeting local community needs. They are mechanisms for risk-managed transition to an appropriate energy infrastructure for the future. EIZs are defined areas operating with specified flexes in energy and planning regulations to encourage competitive innovation in energy infrastructure systems and meet local needs. The defined geography and local governance of an EIZ enables new energy infrastructure to be delivered integrated with transport, digital, and economic development plans and in innovative ways responsive to local needs that is simply not possible through existing national energy governance structures.

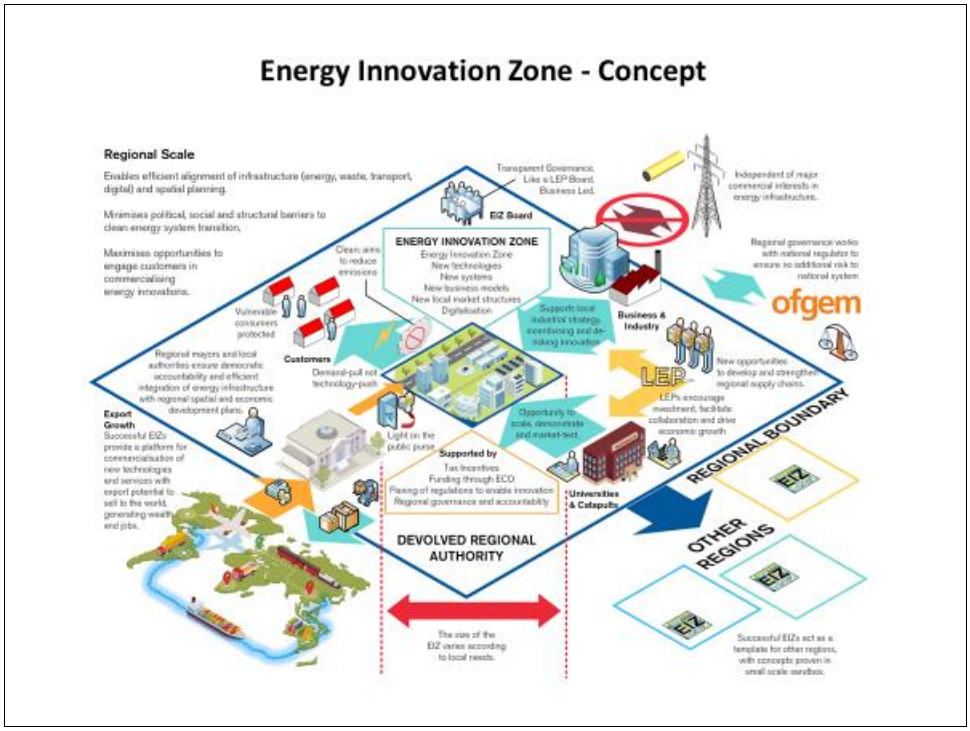


Figure 17 Energy Innovation Zones schematic (courtesy Dr Gavin DJ Harper)

Each EIZ is established and approved through the regional energy governance structure (see Figure 20) and has dedicated resourcing reporting to a local EIZ partnership board.

Discussions to develop an appropriate framework for EIZs have been taken forward through a Regional Energy Policy Commission[lxxviii], chaired by Sir David King and jointly funded by the Universities of Birmingham, Warwick and the Energy Systems Catapult. The Policy Commission is sponsored by the WMCA and Mayor and supported by BEIS, Ofgem, and national and local energy system stakeholders.

Appendix II – Pilot Energy Innovation Zones and Investment Cases provides overviews of each of the four pilot zones, while *Appendix I – Sub-regional mapping reports* summarises specific project opportunities (or references to existing sub-regional project pipelines) within these zones and beyond. The Arup report *Business Cases for Energy Innovation Zones in the West Midlands*[lxxix] sets out a range of infrastructure and project investment options for each EIZ from a baseline case (£270M investment across the four zones) to a more innovative case (£490M investment across the four zones). This investment will generate circa £200M GVA improvements by 2030 towards the overall £1 billion strategic target set out earlier in this strategy.

Wider initiatives, including cluster development and business support

The four pilot EIZs are only the start. The remaining £800M of targeted GVA benefit will be delivered through a range of locally led interventions, including identification and development of further EIZs and building on the framework set out in the *Energy as an Enabler* report recently published by the Black Country LEP[lxxx].

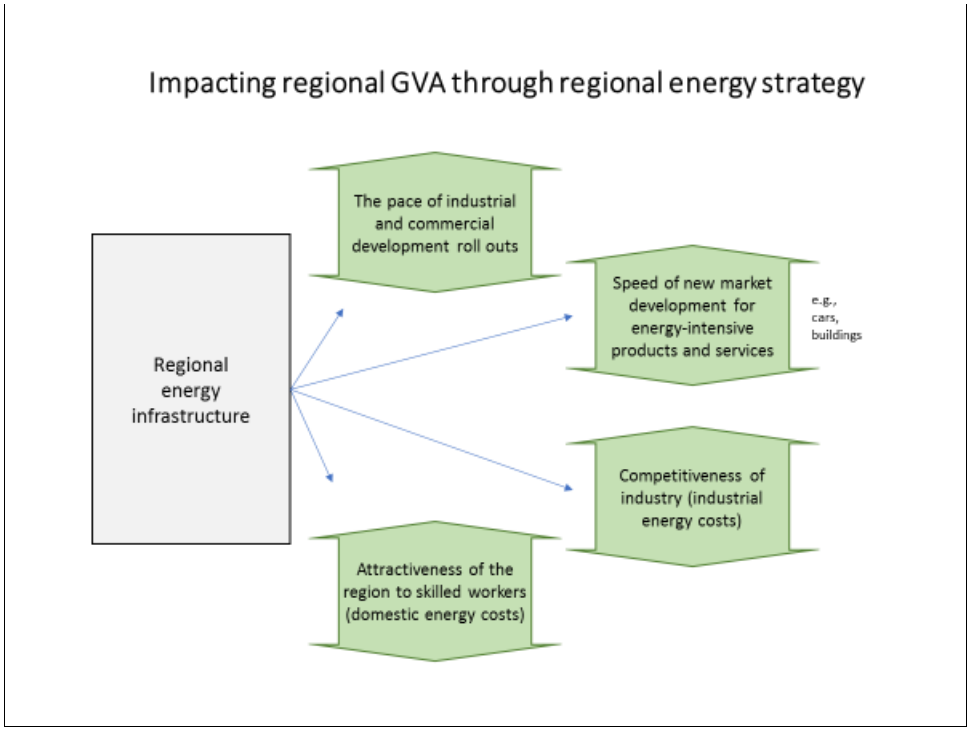


Figure 18 Impacting GVA through regional energy strategy

That report identifies four areas of opportunity (see Figure 18 and Table 1 (Section 2)) and indicative GVA benefits of £420-£800M through a variety of initiatives including:

1. Additional Energy Innovation Zones.
2. Strategic infrastructure support for accelerated new market development for locally sourced products such as electric vehicles and smart connected and low carbon housing.

3. Seeking to establish a legacy bank to cover sunk costs of stranded and legacy energy infrastructure assets and using this to reduce energy costs for innovative and competitive manufacturers.
4. Energy efficiency programmes for manufacturing and residential sectors.
5. Simplifying access and improving the transparency of energy markets for business customers.
6. More rigorous and targeted new build housing energy efficiency standards.
7. Large-scale retrofit programmes for fuel poor households and energy-inefficient housing.

These programmes will need to be developed through appropriate partnerships, for example with EEF (formerly Engineering Employers' Federation), West Midlands Housing Officers Group, the West Midlands Innovation Alliance (especially the Innovative Low Carbon Working Group) and the Sustainable Housing Action Partnership. The energy strategy will work with the Growth Hub and LEPs, and through existing working groups wherever possible.

Low carbon and energy technologies are identified as a strategic sector within the regional industrial strategy (Figure 12). There are a range of cluster support activities underway and about to be launched, for example supported by Aston University[lxxxi], Birmingham University[lxxxii] and Climate KIC[lxxxiii] (Figure 19). Energy Capital will support these initiatives through a dedicated working group, among which is Climate KIC that is about to start a three-year project to link the cluster development in Birmingham with best practice in London, Edinburgh, Valencia and Frankfurt.

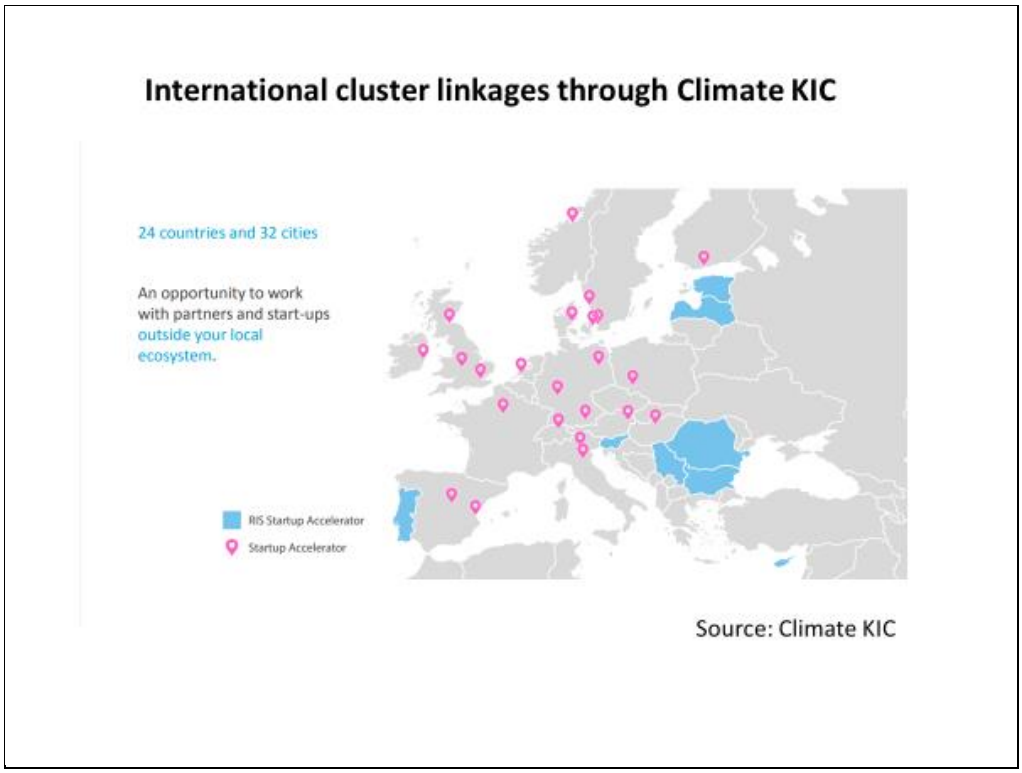


Figure 19 Access to international best practice networks via Climate KIC

Roles and responsibilities

EIZs provide a framework for local authorities to control and lead local energy investment activity within their areas, while establishing a mechanism which enables them to manage risks and to

support appropriate partnerships and expertise alongside and distinct from their existing organisations. The EIZ structure as set out in the Regional Energy Policy Commission report[lxxxiv] is entirely compatible with the existence of local retail energy companies where Councils are considering this (for example in Birmingham and Wolverhampton) as these will generally focus on trading within the current UK energy market structure, while EIZ partnership boards will be focused on infrastructure investment.

Formally the proposed division of responsibilities for energy is set out in Table 4.

Body	Responsibility	Accountable to
EIZ partnership board	• Energy infrastructure investment and strategic planning within its zone • Alignment with local plans	Relevant local authority(ies)
Energy Capital	• EIZ establishment and monitoring (where regulated powers devolved) • Funding • Delivery of regional energy strategy (i.e., specified targets) • Strategic regional energy planning, where appropriate (e.g., liaison with network operators and national regulator)	WMCA (SEP[lxxxv] Board)
Local Authorities	• Effective delivery of public services, including local energy infrastructure • Publicly-owned retail energy companies where applicable	Electorate
LEPs	• Economic development within strategic sectors, including energy	Members
WMCA	• Governance of Energy Capital • Devolved powers over energy as agreed with Whitehall	Mayor and constituent members

Table 4 Roles and responsibilities for energy in the West Midlands

These arrangements are shown schematically in the organisation chart below (Figure 20).

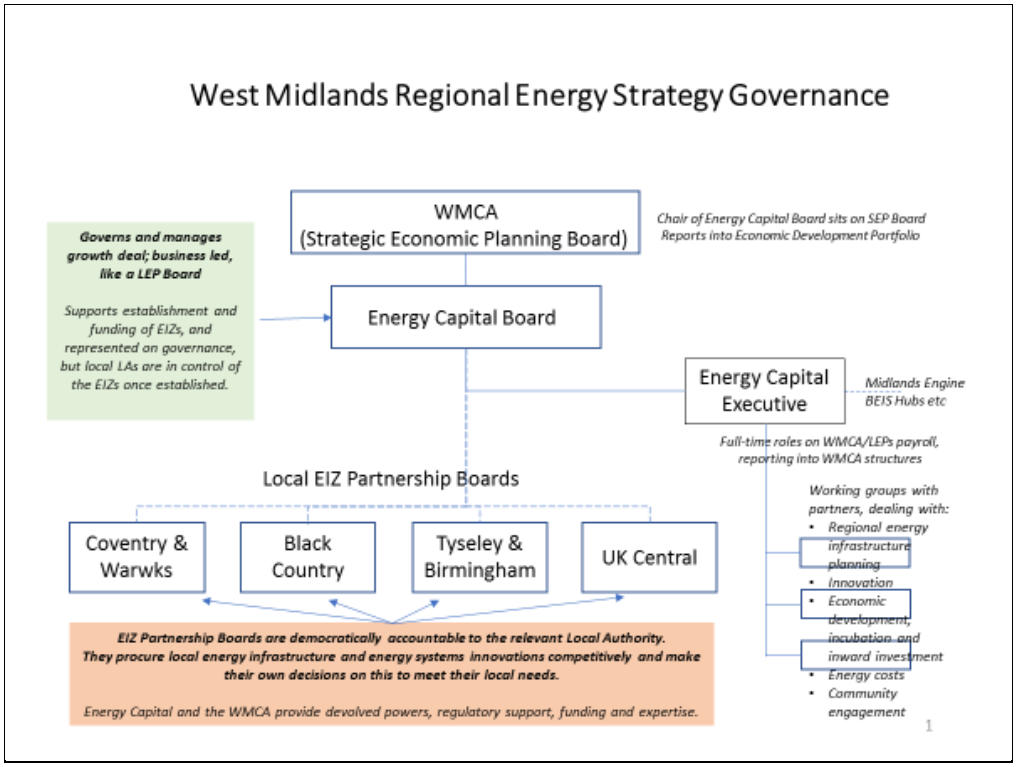


Figure 20 West Midlands Regional Energy Strategy governance

Funding, governance and resourcing

Energy Capital is accountable to the Mayor of the West Midlands through the WMCA and SEP Strategic Economic Plan) Board. It is a partnership board consisting of key stakeholders established to ensure effective delivery of the aims of this regional energy strategy in a way that creates an efficient model for future energy systems governance across the UK[19].

Energy Capital will be supported by a small executive, initially funded by partners and located in the WMCA. Over 18 months we would expect this team to develop to encompass similar responsibilities and capacity to strategic energy teams in other combined authorities, such as the GLA (which has 25 FTE officers plus two contracted technical support teams and an annual commissioning budget of around £10M on top of this). A preliminary estimate of the capacity of such a team for the West Midlands would be around 10-15FTE with an annual operating and commissioning budget of around £3-£5M. This will need to be detailed and justified as part of the interim executive role.

The four areas of responsibility outlined in Table 4 reflect two fundamental roles:

1. To provide democratic governance and legitimacy to strategic regional energy infrastructure planning and major investment and cost allocation decisions. These decisions have a significant impact on the viability of the local industrial strategy, future economic prosperity of the region, and on domestic energy bills. They often require liaison with local authorities and national energy system stakeholders such as network operators, the regulator and major investors.

[19] Ensuring generation, distribution and supply of energy are managed together in an efficient way; and integrating infrastructure planning across housing, economic development, energy, transport, environmental and digital infrastructure.

2. To deliver the agreed regional energy strategy using the framework provided by the EIZs and working groups, facilitating investment and infrastructure development through identification, development, funding, support and supervision of designated EIZs.

The scope of the team is thus likely to cover as a minimum distributed energy infrastructure, energy efficiency including fuel poverty (housing and non-domestic buildings) strategic investment projects, regional energy data, energy policy and regional energy market regulation.

The Energy Capital Board will provisionally be constituted as follows:

- Chair (from membership)
- Infrastructure providers (4)
    - Cadent
    - Western Power Distribution
- Customers (6)
    - Black Country Housing Group (housing)
    - Climate KIC (environment) Engie
    - EEF (manufacturers)
    - JLR (manufacturer)
    - Severn Trent Water
- Local authorities and EIZs (7)
    - 1 representative nominated by each LEP
    - 1 representative nominated by local authorities per LEP area
    - 1 representative nominated by non-LEP WMCA local authorities
- Universities/Innovation (7)
    - 1 representative nominated by each contributing university
    - Energy Systems Catapult
- National government and stakeholders
    - BEIS
    - Ofgem
    - Sustainable Energy Association
    - National Grid

The model and approach is akin to a LEP board but specific to the energy sector.

Relationship to other regions

The West Midlands is already collaborating internationally in energy through Climate KIC – particularly with Edinburgh, London, Valencia and Frankfurt – and various university partnerships with overseas institutions. While developing this strategy Energy Capital has actively engaged and exchanged notes with Cornwall and West of England devolved authorities as well as the GLA (all of which have similar political structures and ambitions or experiences in local energy) and intends to maintain and expand this openness and willingness to share best practice and take it through into the strategy delivery phase.

Energy Capital welcomes the new regional energy hubs being established by BEIS and looks forward to supporting the staff allocated to the West Midlands. This region is part of the Midlands Engine and envisage this being helpful, for example in contexts like MIPIM[lxxxvi] (where external bodies – typically with little familiarity with UK regional geography – find it easier to relate to the various

economic regions within the Midlands collectively) provided it doesn't dilute the focus and efficiency with which we can deliver.

One of the recommendations of the Regional Energy Policy Commission is that the Energy Systems Catapult act as a conduit for transfer of best practices around innovation (which is not just what this strategy is about) so it's very helpful the Catapult is based in Birmingham. The strategy proposes the Catapult is invited to become a continuing partner in Energy Capital and represented on the Board on this basis.

6. Global best practice

This strategy has been developed over more than two years and informed by support from global consultancies[lxxxvii] and individuals from companies with global perspective and presence, as well as organisations like BEIS, which has a national view; Climate KIC, with a European view; and the universities across the region, with global views. Energy Capital commissioned a short piece of work by Sustainability West Midlands to understand what other LEPs nationally were doing on energy. This has enabled a good sense of best practice nationally and internationally to be compiled.

Much of this work has already been collated and written up for the region as part of the King Commission Report[lxxxviii] which provides an excellent overview and commentary. The following is a summary only. As mentioned in Section 5, the intention is to keep a strong sense of global perspective in everything we do in the region, and continuously to adapt and refine the strategy as we progress through delivery and take on board new ideas and experiences from elsewhere.

At the same time, we and constantly aspire to do better than our competitor economies worldwide and are comfortable providing leadership where we have distinctive contributions to make. So, we will seek to develop global best practice and positions of leadership ourselves.

UK examples

Cities which have made significant progress on energy include Bristol, Nottingham, Glasgow and London.

Bristol and Nottingham have set up retail energy companies. Bristol's now has over 100,000 customers and Nottingham's 50,000. Nottingham has recently expanded its offer to Leeds under a white label scheme[20]. Both have invested in energy project teams (numbering in 10s of staff) and have a reasonable pipeline of projects supported by funding from the EU and UK Research and Innovation (formerly Innovate UK).

Neither have yet managed to achieve the theoretical ideal of linking substantive funding streams from a successful retail energy company into local energy infrastructure investment. This has limited the scale of their achievements to modest savings on customer bills (of the order of 10%, or £130-£190 per household) and modest capital investment projects, of the order of £1-£10M[21].

Such achievements are substantial in the context of austerity and the wider challenges facing the public sector, but nevertheless fall significantly short both of what Bristol and Nottingham themselves set as targets (Bristol estimates £1 billion of investment is needed in its energy system to meet its 2050 targets) and what the West Midlands is seeking to achieve through its local industrial strategy.

Nottingham is hosting an early UK pilot of the Energiesprong[lxxxix] approach to large-scale housing retrofit, which is of interest to the West Midlands because of its significant fuel poverty challenges and interest in off-site manufacturing (modern methods of construction). Energiesprong was introduced to the UK through the West Midlands' Sustainable Housing Action Partnership and has

[20] Much of the evidence in this section is drawn from the work of David Strahan and the West Midlands Regional Energy Policy Commission, whose report was published in March 2018.
[21] Ibid.

been strongly supported from the West Midlands. The Energiesprong board is chaired by Accord Housing from West Bromwich and off-site manufacturing carried out in Walsall. This is already a good example of best practice travelling from the Netherlands to the UK via the West Midlands, as well as ongoing knowledge sharing.

Glasgow has made similar progress to Bristol and Nottingham with a retail energy company[xc], led by the social housing sector (which is helpful in providing access to a semi-captive customer base, thus reducing risk) while London has made useful progress in constructively challenging OFGEM around regulations which inhibit local authorities supporting infrastructure investment ahead of demand[xci].

International examples

International examples of progress and innovation in regional energy systems were recently comprehensively reviewed by the West Midlands Regional Energy Policy Commission[xcii]. Copenhagen, Munich, New York and South Australia are mentioned as regions which have benefitted substantially from locally-controlled energy investment, but the point is made that in all these cases the municipalities have far greater statutory powers and responsibilities than their UK counterparts.

Copenhagen has a history of local investment in integrated energy infrastructure suited to its needs going back for at least a century. A city region with a population of just under 2 million, its local authority recently issued a bond of EUR500M solely to finance regional energy projects.

Munich is comparable to the West Midlands in terms of population with an urban core home to 1.5 million people and a wider regional population of 2.65 million people. Interestingly, Munich operates its transport and energy systems through a single integrated municipal utility, Stadtwerke München, running a liberalised local energy (and transport) system and market on an entirely commercial basis and securing revenues of EUR6.5 billion in 2016[xciii]. Munich has already secured and invested over EUR3 billion on its local energy system and plans to raise a further EUR3-4 billion shortly.

As the Regional Energy Policy Commission report notes, what all these examples show is the power of local action to accelerate clean energy deployment and innovation, and to outstrip national targets. Munich is a good example (with its similar industrial heritage to the West Midlands) and is currently one of the fastest growing city regions in Germany.

7. Next steps

This strategy consolidates the findings and recommendations of several reports, including the *Regional Energy Policy Commission Report*[xciv], the Arup *EIZ Investment Case Report*[xcv] and the Black Country *Energy as an Enabler*[xcvi] and *Powering Growth*[xcvii] reports.

The key next step to take forward the recommendations in these reports is the establishment of a fully funded delivery body for the region, namely Energy Capital, building on the formal agreement secured in October 2017 to incorporate this within the WMCA structures.

Energy Capital will then take forward the work programmes agreed between the Mayor, the government and the LEPs to deliver the various recommendations, broadly following the timescale set out in Figure 21 below.

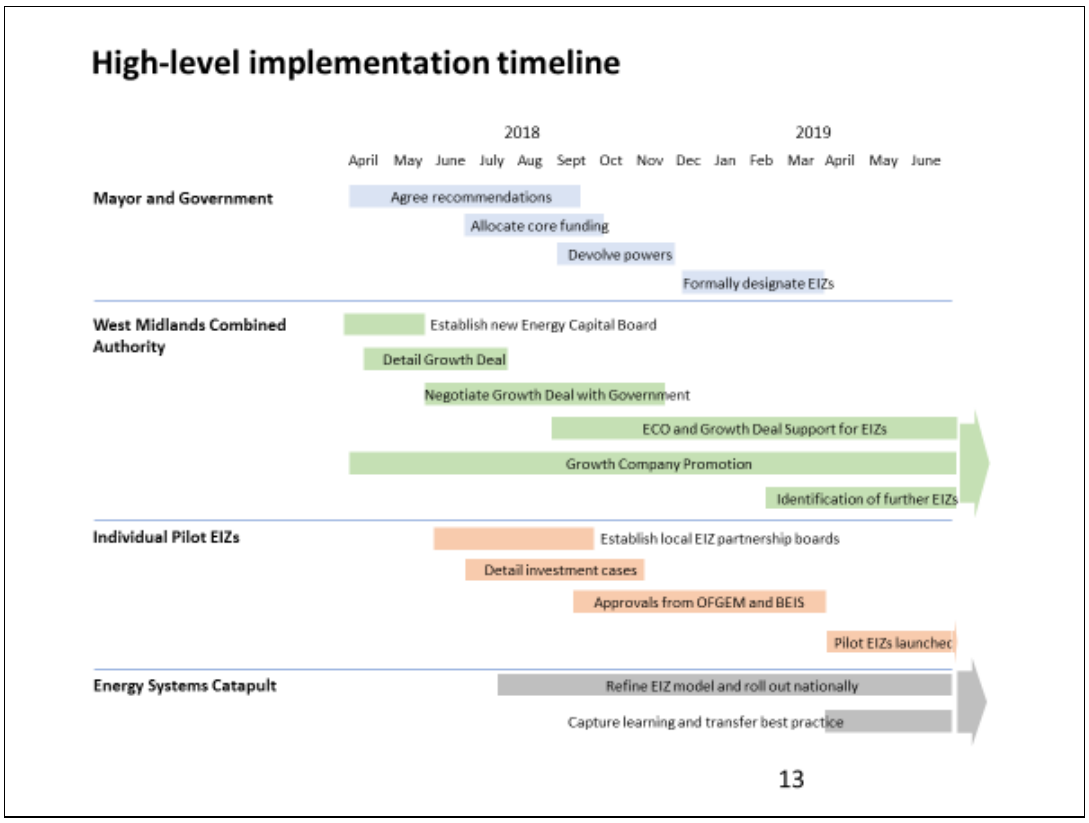


Figure 21 High level strategy implementation timeline

Within WMCA/Energy Capital responsibilities, securing substantial funding (of the order of £500M) to support investment in energy projects across the West Midlands should be a high priority. One way of doing this would be around a cross-sectoral 'Growth Deal' centred on the West Midlands emerging 'new energy economy'[22].

The second priority is to work with government and regulators to detail the EIZ model for the region, working with legal experts to ensure an operational level of detail. The Arup report suggests initially establishing EIZs as special purpose vehicles (SPVs) which might subsequently take on energy or

[22] The cross-sectoral aspect is the critical automotive, construction and digital elements constantly referenced throughout this strategy and associated reports.

other regulatory or financial powers, and which seems a sensible approach to avoid delaying immediate progress.

The context and framework created by this strategy is designed to facilitate raising a sensible mix of public and private finance: broadly public investment is appropriate where significant strategic innovation risk (and consequent social reward) is present[23] or there are significant social and health issues (such as fuel poverty) to be tackled; private finance should be appropriate where the risks are purely commercial.

A virtue of almost all regional energy projects is, however, that within appropriate regulatory frameworks – which EIZs should provide – most of this funding should be investable with acceptable rates of return to the right parties, albeit over relatively long timescales in some cases. This should limit the need for grant-type funding to targeted public investments designed to overcome market failures in innovation, early-stage project development and fuel poverty alleviation.

The role of the WMCA in delivering this strategy will therefore be one of facilitation focused on:

- ensuring regional energy infrastructure investment is aligned with strategic regional industrial, transport, spatial, and productivity and skills plans;
- facilitating regional energy markets which deliver clean, competitive power to businesses and homes;
- optimising investment in energy infrastructure (including housing energy efficiency) to reduce fuel poverty, increase industrial competitiveness and productivity, and maximise economic opportunities for the region;
- securing and managing dedicated investment funds, underpinned by public risk sharing and anchor funding where appropriate;
- supporting and encouraging innovation (broadly defined) in energy systems, business and financial models to support this.

In line with other combined authorities, a specialist team in the WMCA is likely to be required from 2019 onwards to deliver this. This is likely to employ around 10-15 people, based on models from the GLA and elsewhere.

[23] The Regional Energy Policy Commission report makes several suggestions on allocation of public funding to support EIZs.

Appendix I – Sub-regional mapping reports

Most of the local authorities in the West Midlands have renewables and local energy opportunity maps and studies produced over the past ten years and still hold these. In many cases they hold detailed housing stock data either because they own their own stock e.g., in Birmingham, Wolverhampton, Solihull, or because they have carried out HECA[xcviii] reporting for many years[24]. The South of the region including Solihull is particularly strong on supporting and targeting ECO, and has been a prime user of recent flexibilities introduced into the ECO scheme by government to allow local authorities to take greater control.

The main issue is not knowing what the project opportunities are, it is securing the local political consensus, stakeholder support and finance (within appropriate and predictable environments from the perspective of risk and returns) to make them happen.

This appendix summarises resources known to be available, including the additional Black Country Mapping report commissioned as part of this project to fill in the one major gap in the region.

Studies of relevance to this strategy are:

Heat network studies part financed by BEIS (HNDU) for:

- Canley
- Dudley
- Sandwell (in progress)
- Solihull
- South Staffordshire
- Warwick (in progress)
- Whitley (in progress)
- Several across Birmingham and Staffordshire (see Figure 22 below)

A comprehensive utilities study for UK Central by Peter Brett Associates (in progress)

A detailed study of Coventry's energy requirements by Rolton Group (subject to NDA)

GBSLEP Low Carbon Energy Plan 2016 (Gyron LLP) and associated Master planning study

Wolverhampton Renewable Energy and Carbon Reduction Study, Amec Group[xcix]

Detailed solar feasibility study for the city of Birmingham.

Various housing studies held by local authorities and the Sustainable Housing Action Partnership, which runs regional forums for the exchange of best practice in low carbon housing.

[24] Some consolidation and digitisation of this data would almost certainly be helpful.

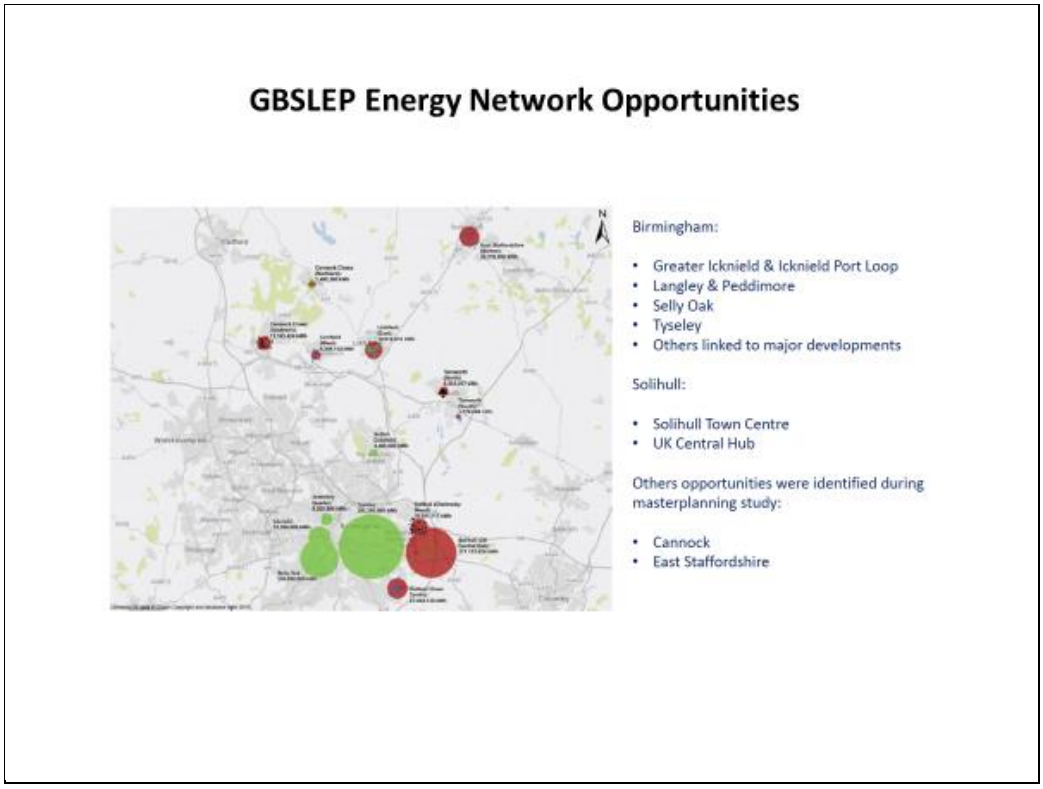


Figure 22 GBSLEP energy network opportunities

First principles renewables opportunity studies covering all technologies including wind, hydro, solar and biomass for Birmingham, Warwickshire and Coventry have also been completed in the past 10 years (by Encraft and EST respectively).

The Black Country as a LEP area lacked any overall 'masterplan'-level assessment of local energy opportunities and demand. Aecom was commissioned as part of this project to deliver this.[c] Selected excerpts from the report are provided to give an indication of the data now available.

The report looked at:

- energy demand patterns and magnitudes across the four metropolitan boroughs;
- energy costs for residential and commercial customers;
- technical and economic opportunities for meeting these needs using:
    - district energy schemes;
    - solar PV;
    - battery storage;
    - energy from waste;
    - other renewables/nuclear (although it concluded none of these were viable at any meaningful economic scale).

Detailed maps of demand were produced for each of the four boroughs in the LEP. These are held at the BCLEP in GIS form and available on request to project developers.

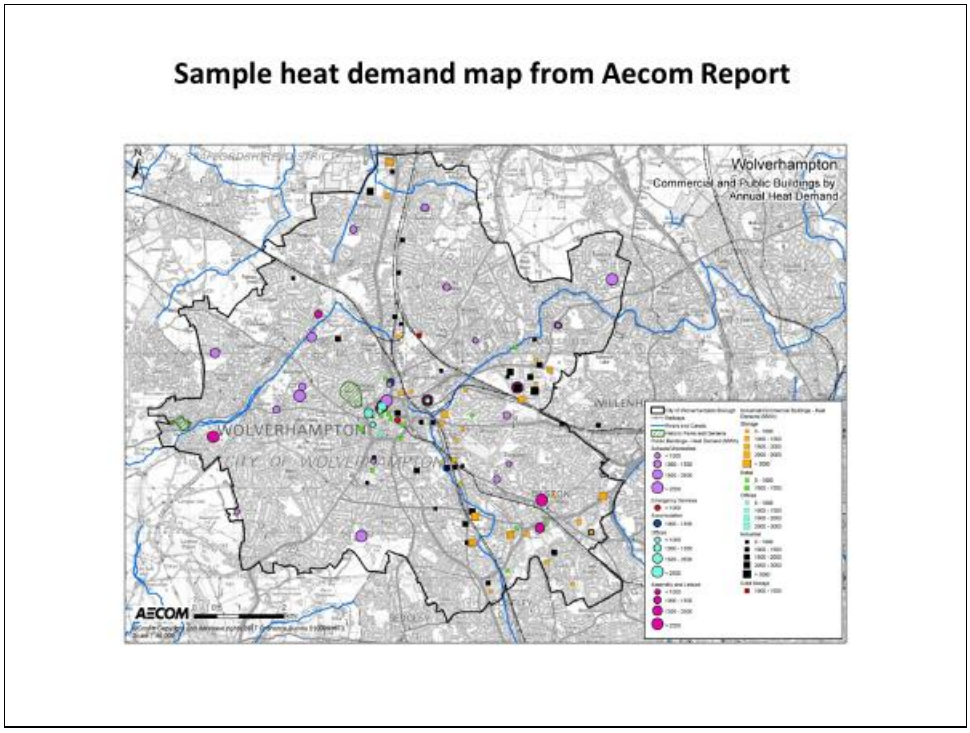


Figure 23 Sample heat and power demand map

Demand maps were used to develop high level business cases for energy from waste and district heating schemes.

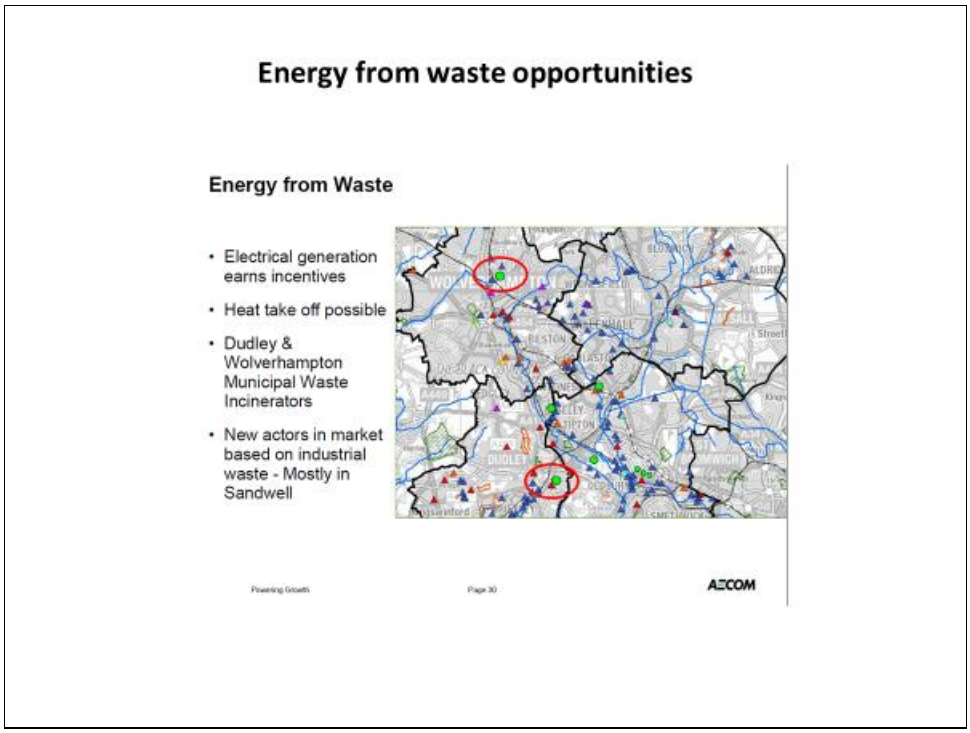


Figure 24 Energy from waste opportunities in the Black Country

Some specific private wire opportunities linked to existing energy from waste schemes were also identified as part of the project. This highlighted the scope for regulatory flexes to make this kind of efficiency easier to achieve.

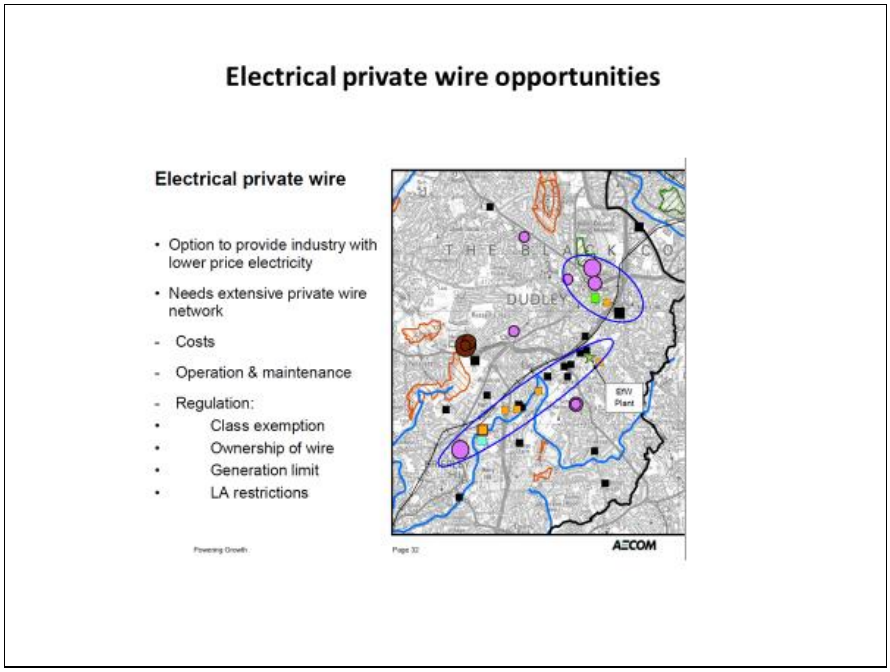


Figure 25 Private wire opportunities in the Black Country

At a high level, the report identified the large-scale solar potential of the region, which has large numbers of warehouses and factories with substantial unshaded roof space. It noted well over £100M of planning applications had been received for battery storage within the LEP area over the past two years, probably reflecting financial opportunities arising from national Capacity Markets.

Figure 26 Typical large-scale solar opportunity in the Black Country

Appendix II – Pilot Energy Innovation Zones and Investment Cases

For reference this appendix provides outline descriptions of the four EIZs (largely) extracted verbatim from the report of the Regional Energy Policy Commission, March 2018. Investment cases for the four proposed pilot energy innovation zones are set out in the separate Arup report for this project.[ci] ***Note that EIZ boundaries are subject to change as programmes of projects develop, up to the point at which any powers are devolved and funding allocated. The descriptions below are accurate as of March 2018***.

The report of the Regional Energy Policy Commission[cii] focuses on making the overall case for Energy Innovation Zones, while the Arup report provides an initial cost-benefit analysis of the specific zones.

It's important to note that the limitations of Arup's model prevented detailed or meaningful analysis of housing energy efficiency opportunities as part of this study. This does not mean housing is not seen as a critical opportunity in several of the EIZs and across the region more generally (see the main report) – it simply means that further local work will be required to detail the cost/benefit cases for housing energy investment. In practice, there are significant opportunities for commercially viable investment in housing refurbishment in Birmingham, the Black Country and North Solihull in particular. There are significant opportunities for innovative low carbon new housing in Coventry and Solihull and the Black Country (and indeed in the 215,000 new houses being built across the region in the next 15 years).

The four potential EIZs described have been proposed by local communities across the West Midlands and reflect local needs and perceptions of energy system opportunities and challenges. This is a critically important feature and point of departure for EIZs: that they are driven not only by climate imperatives and technical opportunities, but also by local market and customer needs. It immediately makes them distinct from many demonstration and innovation projects in the energy sector and aligned with the general shift towards more customer-centric approaches.

Each proposed EIZ presents distinctive opportunities for energy-system innovation, and each is at a different stage of development. This should help the process of generalising from the West Midlands' experience to develop a generic EIZ 'template' – meaning an institutional and process model – that could be rolled out nationally. The philosophy is to be inclusive and offer any community the opportunity to nominate an area as an EIZ, provided it meets defined criteria such as willingness to accept innovative low carbon solutions and special regulatory oversight. In this way EIZs should be seen and designed as a privilege for which areas compete, and a mechanism with potential significantly to accelerate energy systems transition nationally.

On the other side of the equation, innovators and government will in turn need to accept the validity, diversity, and importance of local needs in defining the goals of a given EIZ, even where these needs may not align exactly with national priorities. In some cases, it may be possible to meet these needs purely through integrating existing technologies in new ways and require no fundamental technical or product innovation. Such EIZs may still create new markets and industries simply by providing scale; in other cases, pure process or business model innovation may be sufficient. All EIZs will accelerate the transition to a low carbon, more competitive energy system in the UK.

Black Country

As the seat of the industrial revolution in the late 18th century, the Black Country can claim to be the world's first 'energy innovation zone', and this heritage perhaps explains the enthusiastic local support for the proposed EIZ. But of the four potential EIZs, the Black Country is the least developed, and so provides the greatest opportunity to demonstrate a complete model of how an EIZ can be defined, developed and implemented. There is a strong desire in the area to lead the energy transition by securing investment in modern, clean energy systems which deliver power at globally competitive costs and thus support delivery of the national, as well as local, industrial strategy. The EIZ is intended to provide a focus for this, specifically within the geography of the existing Enterprise Zones.

The Black Country Enterprise Zones comprise a portfolio of sites in Dudley, Wolverhampton, Darlaston and i54 – Wolverhampton North, spread over 120 hectares. [ciii] [civ] [cv] The focus of these zones is to promote and attract advanced manufacturing in the Black Country – by offering competitive advantage to manufacturers who locate there – e specially targeting aerospace, automotive and high added value engineering.

There are major manufacturing companies located on the i54 site, including JLR, Moog, Eurofins and ISP. This enterprise zone is known as one of the most successful in the UK, and total investment of more than £1.5 billion is expected across the Black Country over the next 15 years.

A key competitiveness issue for the Black Country is the cost of energy, and in particular the energy used in metal processing. Manufacturers using electricity to drive their processes are keen to secure reliable and high-quality energy supplies with predictable and highly competitive pricing.

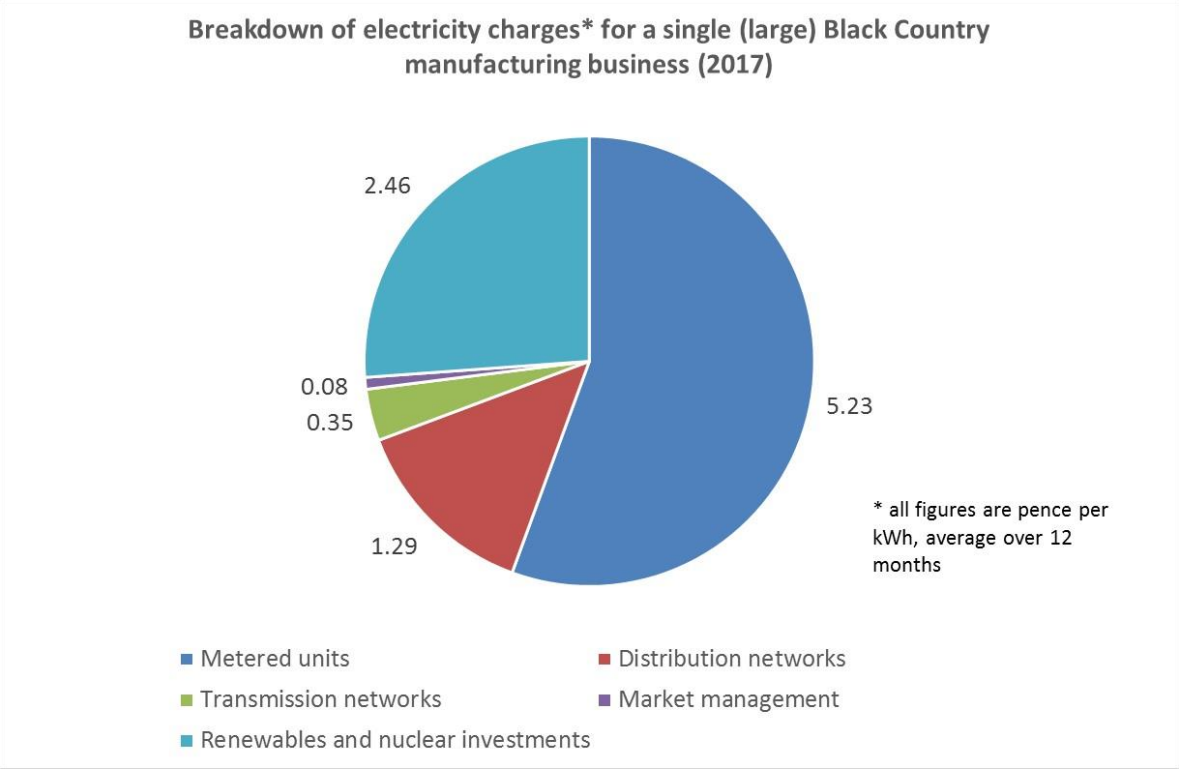


Figure 27 Breakdown of electricity charges for a large regional manufacturing business, 2017.

Figure 27 shows a breakdown of the electricity charges paid by one large Black Country manufacturer in 2017.[cvi] Only 56% of the cost of energy for this manufacturer is made up of the

payment to the energy supplier. The remaining 44% is the cost of infrastructure (distribution and transmission use of system and capacity charges) and a share of the costs of the clean energy transition in the form of renewables and nuclear investment levies (ROCs, FITs and Contracts for Difference).

This breakdown of charges compares unfavourably with the prices paid by similar industries in competitor economies, where differential energy pricing is an instrument of industrial strategy. In countries such as Germany, the Netherlands, France, Italy and Denmark[cvii], some industries pay less towards infrastructure and energy transitions and domestic consumers pay more. The resulting contrast in electricity costs for energy intensive industries in the UK, Germany and France is shown in Figure 28.

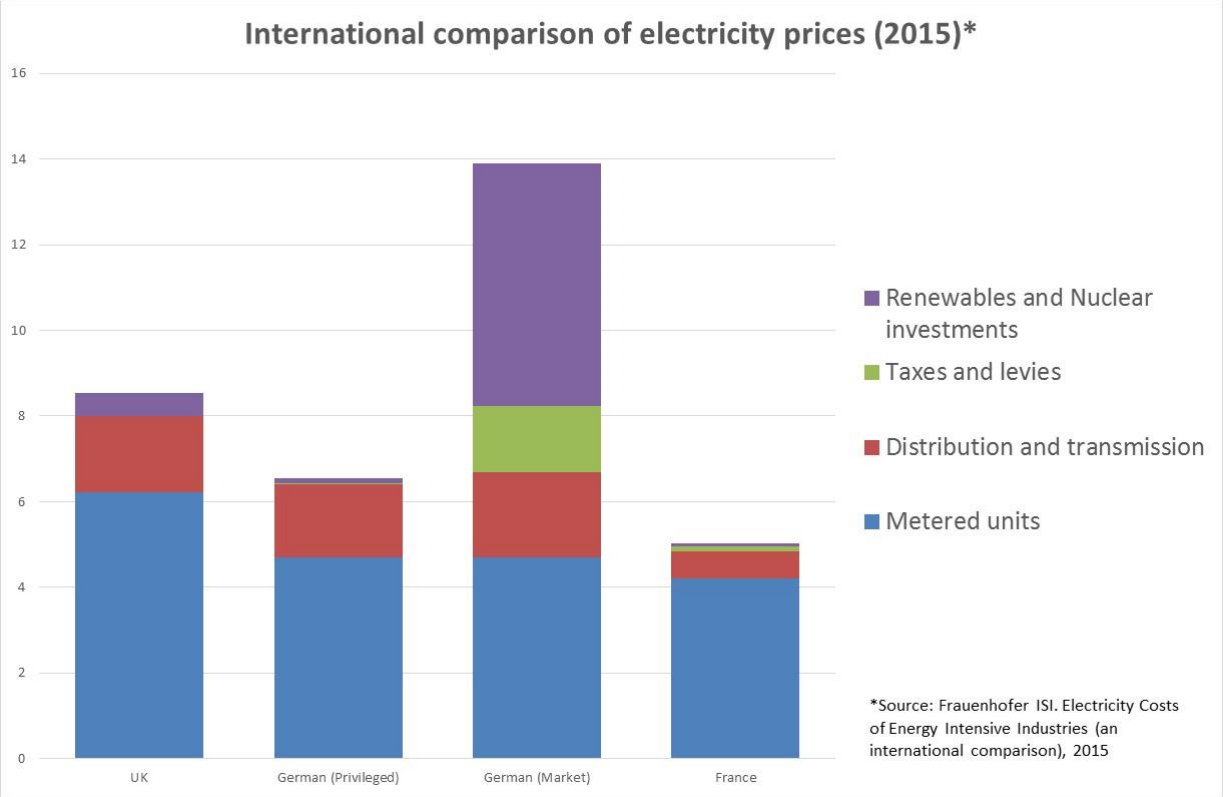


Figure 28 International comparison of electricity prices of energy intensive industries, 2015.

If a Black Country EIZ were to propose lowering industrial electricity costs through differential pricing as in Germany, it would in effect mean loading that cost onto domestic consumers, which would be politically unacceptable in a region with such high levels of fuel poverty. The prospective role of the Black Country EIZ would therefore be to reconcile these competing and legitimate concerns through clean energy innovation.

There are specific opportunities for local generation and supply in the Black Country, and a cluster of waste-to-energy firms is developing close to the Darlaston sites that need to be integrated with the LEP's plan for the region. Private sector investment in this type of activity could be encouraged through simplification of supply exemptions; support for manufacturers in managing relationships with the DNO; local incentives for energy-from-waste technologies; and the public sector taking an active role in matchmaking between potential generators and industrial energy users. Given the high density of similar small- and medium-sized metal processing businesses (more than 250 across the

region) there is scope for the Black Country to pioneer the collective use of smart energy data in optimising energy efficiency, for example by subsidising or mandating installation of smart sub-metering in industry.

Coventry and Warwickshire

Coventry and Warwickshire is an example of a potential EIZ driven by a relatively small number of key stakeholders with a tightly defined agenda: to satisfy strong electricity demand growth and develop infrastructure to support connected autonomous vehicles (CAVs) in particular. An EIZ could be used as an effective mechanism to ensure innovation and carbon reduction are effectively built into development plans, are properly scrutinised and integrated into local infrastructure.

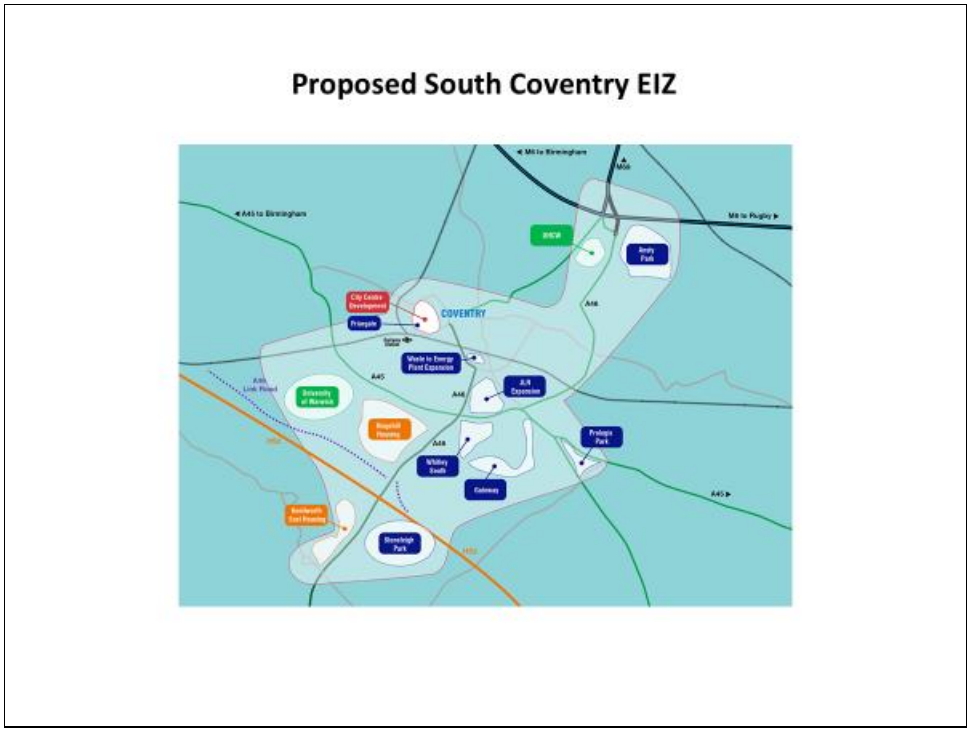


Figure 29 Proposed Coventry and Warwickshire EIZ

Coventry and Warwickshire EIZ covers Whitley, Baginton, and a wide area around Coventry airport, incorporating land in Coventry and Warwickshire. This area is well served by transport networks, and significant growth is planned through developments such the £250M Coventry and Warwickshire Gateway scheme, and the £500M development of Whitley South – a 60-acre engineering technology hub next to Jaguar Land Rover's global headquarters.

There is little spare capacity in the local electricity network, yet demand is forecast to rise significantly over the next decade. Coventry Central and Coventry and Warwickshire are reaching the limits their circuits can supply, requiring major reinforcement works to raise capacity. The city council has investigated options including a new 132 kV bulk supply point to the south of Coventry and a new super-grid transformer, which would involve significant capital expenditure. Current regulations do allow capacity to be built ahead of demand, but this requires someone to bear the risk, and if no entity is willing to, then it could hold up development.

Other areas of planned expansion in Coventry and Warwickshire are Gaydon and Ansty. Jaguar Land Rover and Aston Martin have plants at Gaydon, which suffers grid constraints that would limit the growth plans of these and other companies. Ansty has shown considerable growth in recent years and has potential for large development in the future. Both sites need to ensure adequate power supply to enable future development. Like UK Central Hub, these areas of economic growth and grid

constraints need to develop timely and cost-effective clean energy solutions, which an EIZ could facilitate.

Tyseley and Birmingham

Birmingham is a well-developed potential EIZ, and the context is a much more established and dense urban environment, so the needs and opportunities are clearly distinct from those at UKCentral Hub, which is essentially greenfield. There is not yet a dedicated institutional structure congruent with the potential zone. There is, however, strong stakeholder and community engagement; a well-defined and large local market; a portfolio of energy innovation and investment projects at the Tyseley Energy Park; and 35MW of existing waste-to-energy power plants.

Birmingham city centre will undergo massive redevelopment over the next 15 years[cviii], particularly around the HS2 Curzon Street station (£900M), Smithfield (£600M), Snow Hill, Typhoo Wharf and Arena Central.[cix] The area suffers serious air pollution and the City Council is developing plans for a Clean Air Zone to start by 2020. This will require the construction of a substantial clean energy transport refuelling infrastructure, including hydrogen and electric vehicle charging at scale.

There is little space available for vehicle recharging in the city centre. Part of the solution may be to use the industrial land available at Tyseley, 5km east of the city centre, to produce clean energy for local communities, and power a new clean transport refuelling infrastructure. Tyseley is already the site of the city's energy-from-waste (EfW) plant, which burns 350,000 tonnes of waste per year to generate 25MWe. The 16-acre industrial site next door is being developed as Tyseley Energy Park by its owners, Webster and Horsfall, and partners including the University of Birmingham, the City Council and the Greater Birmingham and Solihull Local Enterprise Partnership.

Key energy challenges and opportunities for an EIZ based around Tyseley and the City Centre include:

- integrating energy and transport infrastructure developments at a time of rapid change in both sectors;
- optimising use of the city's 350,000 tonnes of waste which currently pass through Tyseley annually, ensuring neither waste nor energy market regulation inhibits delivery of sensible outcomes;
- making use of the latest clean technologies being developed and deployed by the Universities of Birmingham and Aston at Tyseley and elsewhere;
- making best use of the city's planning powers to optimise the energy performance of new and existing buildings as more than £2 billion of construction investment flows into the city;
- ensuring the local community is fully engaged in the major changes proposed, and actively contribute to the success of the zone.

The stakeholder group for this EIZ includes the Birmingham City Council Planning and Regeneration Team, along with key city centre development stakeholders; ENGIE; the University of Birmingham; and Webster and Horsfall. The Tyseley Energy Park falls within the Tyseley Energy & Environmental Enterprise District, and the local authority has decided it will become Birmingham's Energy and Waste nexus.

Tyseley Energy Park hosts a 10MWe biomass generating plant and private wire electricity supply. It is the depot for a growing fleet of rent-by-the-hour electric taxis – most of the city's taxi drivers live

nearby. A clean energy refuelling station is being built to provide EV charging, hydrogen and CNG for the city's bus fleet, and for the refuse vehicles that supply the EfW plant.

Tyseley Energy Park has the potential to become an innovative demonstrator that integrates energy vectors including electricity, heat, liquid air, and hydrogen. The site will also be home to a University of Birmingham / Fraunhofer Institute shared research platform and Energy Skills Academy.

Work already completed or ongoing includes:

- Birmingham District Energy Scheme (owned by ENGIE);
- Clean Air Zone / vehicle refuelling recharging studies;
- masterplans for the Tyseley site by owners Webster and Horsfall/Energy Capital;
- heat network project at feasibility Part 1 stage;
- city solar feasibility study completed.

Future plans include recycling waste heat from the EfW plant through a heat pipe to the Birmingham District Energy Scheme in the city centre, owned and operated by ENGIE. This route would run through areas of dense housing including many energy-poor households. There may be synergies with new transport initiatives such as the proposed tram route to the airport, and refuelling and recharging infrastructure for the city.

UK Central

UK Central is a well-defined and developed potential EIZ. Local institutional structures to support major investment and regeneration projects already exist; the location is one of the best current opportunities in the world to set the benchmark for the type of mixed-use development that can be delivered around a multimodal transport interchange; and there is strong stakeholder support for innovation. Significant work has already been undertaken to define future energy and utility scenarios and potential local investment incentives and value capture mechanisms.

The UK Central Hub is an economic area which includes the significant infrastructure of Birmingham Airport, National Exhibition Centre, Jaguar Land Rover, Birmingham International Station and Birmingham Business Park. From 2026 it will include the High Speed 2 rail station and the mixed-use Arden Cross development. Each of the stakeholders has ambitious growth plans that will increase the level of employment and housing in the Hub area and support the wider West Midlands economy. In order to support this opportunity Solihull Council formed the Urban Growth Company (UGC) to concentrate public sector investment on removing infrastructure constraints.

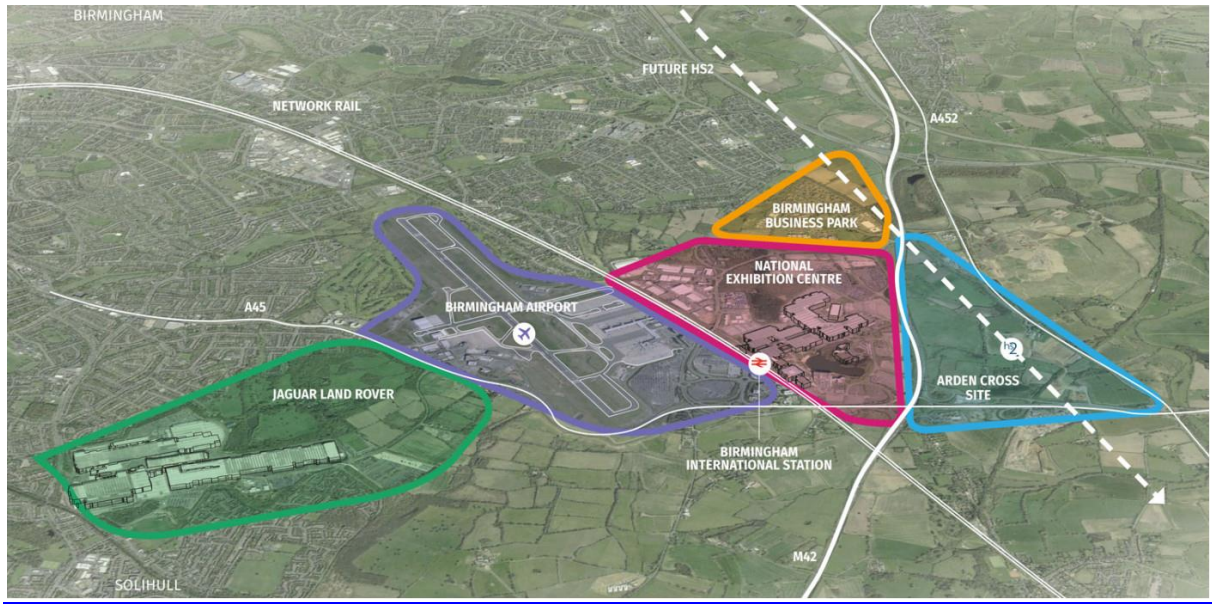


Figure 30 UK Central Hub

UGC has already done considerable work to develop infrastructure plans for the area[cx], and a 'value capture' framework of potential funding mechanisms.[cxi] It is now investigating potential constraints in the capacity of utilities to supply the planned developments and has commissioned Peter Brett Associates (PBA) to analyse current capacity and potential demand over the next 30 years. Initial discussions with Western Power Distribution and National Grid suggest current spare electricity grid capacity amounts to 20–25MW at the Elmdon Primary Substation, but that planned developments may need a further 80MW. This could require an additional primary substation and reinforcement of the local substations. Without this investment the growth will either stall due to power shortages, or be delivered at a much slower rate, as the developments need to bear the additional costs of upgrading the electricity network.

Electric vehicles could present an even greater challenge to grid capacity. The Hub currently has around 40,000 car parking spaces, which could rise to over 60,000 in the next 20 years. High level estimates procured by UGC suggest that if the Hub installs multiple EV charging points it could require significant additional grid capacity. This estimate is based on private cars only and does not include an allowance for future electric heavy goods vehicles or aircraft.

No-one yet knows exactly how much impact the planned development and electric vehicles will have on electricity demand at the Hub, but innovation in supply, control and use must be encouraged if a system is to be designed in the most economic way.

One potential solution might be to find alternative funding mechanisms to build additional substation capacity ahead of demand and reserve the capacity for Hub members – like the approach of the Ebbsfleet Development Corporation, which is investing £30M for new substations to supply the new garden city in Kent.[cxii] Another would be to create an Energy Innovation Zone to encourage lower cost and more innovative solutions. The Hub has many energy-intense users with large peaks and troughs in demand, and it may be possible to avoid or at least minimise capacity upgrades through innovative approaches.

The Hub has large heating and cooling loads that could be integrated with the electricity grid and wider systems such as waste. The scale and concentration of its electricity and thermal demand creates a huge opportunity for clean energy innovation and building efficiency that will probably be unmatched in the UK over the next two decades. The Hub has commissioned a Heat Network Techno-Economic Feasibility Study, due to report later in 2018.

The Hub is only one of UK Central's four development zones. The others are North Solihull (Zone 2, a £1.8 billion regeneration programme), Solihull Town Centre (Zone 3, a major retail, office and leisure destination), and Blythe Valley Park (Zone 4, a business park). Each has its own energy challenges and priorities. North Solihull, for example, must regenerate large numbers of 1950s/60s housing stock in Chelmsley Wood, where there are high levels of fuel poverty. Solihull Town Centre has recently completed a feasibility study that identified a low carbon heat network opportunity that would be technically and economically viable. Blythe Valley has the potential to develop a hydrogen hub. Each could therefore form its own EIZ, but there may also be a case for creating a single overarching EIZ to cover all four UK Central development zones.

Appendix III – Consultation responses and attendees at the stakeholder engagement event

A stakeholder engagement event was held on Tuesday 6 March 2018 at the Energy Systems Catapult in Birmingham. The event was open, widely publicised, and every local authority in the region was invited directly, along with neighbouring LEPs, all existing Energy Capital partners, regional universities and members of relevant regional networks.

In addition, the draft strategy was released for consultation from March to May 2018. Further responses were received from ten organisations and individuals included in the list below.

Act on Energy
AECOM
Aston University
BEIS
Birmingham City Council
Black Country Citizens
Cadent
City of Wolverhampton Council
Climate KIC
Coventry City Council
Daikin Air Conditioning UK Ltd
Dudley MBC
E.ON UK
Ecuity
EEF Ltd
Energy Systems Catapult
EnergyHarmonics Ltd
Engie UK
George Simms
Greater Birmingham and Solihull Local Enterprise Partnership
HS2 Ltd
International Synergies Ltd
Jaguar Land Rover
Lichfield District Council
Manufacturing Technology Centre
MEBC
The Metals Council
Midlands Engine
Oersted
Sandwell MBC
Severn Trent
The Sustainable Housing Action Partnership
Solihull Metropolitan Borough Council
Sustainability West Midlands
Tyseley Energy Park

University of Birmingham
Birmingham Energy Institute
University of Warwick
Western Power Distribution WPD

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[viii] *A Science & Innovation Audit for the West Midlands*, June 2017, WMCA, https://www.wmca.org.uk/media/1682/west-midlands-sia-final-for-publication-21617.pdf
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[xiii] https://www.birmingham.gov.uk/info/50065/population_and_census/1003/population_in_birmingham/1
[xiv] *A Science & Innovation Audit for the West Midlands*, June 2017, WMCA, https://www.wmca.org.uk/media/1682/west-midlands-sia-final-for-publication-21617.pdf
[xv] This data is sourced from BEIS, DECC, the Digest of UK Energy Statistics, The Office of National Statistics and OFGEM. GVA figures are from a SIC code analysis by Charlie Hopkirk for BCLEP.
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[xliii] https://www.wmca.org.uk/media/1713/wmca-economic-review.pdf

[xliv] Based on National Grid Future Energy Scenarios – low estimates are 'two degrees' and 'slow progression' scenarios; higher estimates are 'steady state' and 'consumer power' scenarios.

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[l] https://www.westernpower.co.uk/docs/About-us/Our-business/Our-network/Strategic-network-investment/West-Midlands/West-Midlands-scenarios-accompanying-report.aspx. Note that this report covers the West Midlands as defined by WPD, which excludes Coventry and includes large parts of the Marches and areas to the South West which have never been in any government definition of the West Midlands, such as Gloucestershire. However, having said this the net effect in terms of gross housing investment figures and associated demand (for example) is negligible, as the total planned new housing is around 200,000 homes for either geographical definition. In other words, the net economic activity covered by the report is very similar, and the major economic hubs of Birmingham, the Black Country and UK Central and Solihull are common to both regional definitions.

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[lxxvi] Business cases for Energy Innovation Zones in the West Midlands, Arup, March 2018

[lxxvii] UK automotive turnover (SMMT, 2015). The figure of £32bn is calculated from UK sales only (£37.3bn p.a multiplied by 7.3% as the WM share of the national economy, to give £2.72bn new car sales per year in the region.)

[lxxviii] Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation, An Energy Capital Policy Commission, Chaired by Prof. Sir David King, March 2018

[lxxix] Business cases for Energy Innovation Zones in the West Midlands, Arup, March 2018

[lxxx] https://www.blackcountrylep.co.uk/upload/files/NewFolder/Energy%20as%20an%20Enabler.pdf

[lxxxi] http://bioenergy-for-business.org/

[lxxxii] https://www.birmingham.ac.uk/Documents/partners/ERDF-marketing-FINAL-for-web.pdf

[lxxxiii] http://www.climate-kic.org/news/west-midlands-energy-climate-innovation-cluster/

[lxxxiv] Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation, An Energy Capital Policy Commission, Chaired by Prof. Sir David King, March 2018

[lxxxv] SEP stands for Strategic Economic Plan or Industrial Strategy Board

[lxxxvi] MIPIM is a major global property investment conference, where the East and West Midlands have successfully exhibited together for several years.

[lxxxvii] Arup, Aecom

[lxxxviii] Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation, An Energy Capital Policy Commission, Chaired by Prof. Sir David King, March 2018

[lxxxix] http://www.energiesprong.uk/

[xc] https://our-power.co.uk/

[xci] Energy as an Enabler, Linkages between Regional Energy Strategy, Productivity and Growth, March 2018.

[xcii] Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation, An Energy Capital Policy Commission, Chaired by Prof. Sir David King, March 2018

[xciii] https://www.swm.de/dam/swm/dokumente/english/swm-annual-report-2016.pdf
[xciv] Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation, An Energy Capital Policy Commission, Chaired by Prof. Sir David King, March 2018
[xcv] Business cases for Energy Innovation Zones in the West Midlands, Arup, March 2018
[xcvi] Energy as an Enabler, Linkages between Regional Energy Strategy, Productivity and Growth, March 2018
[xcvii] Powering Growth – A Black Country Energy Strategy, Aecom, February 2018
[xcviii] Home Energy Conservation Act: A requirement on local authorities to monitor the energy efficiency performance of all housing, including private housing, in their areas. Variably observed.
[xcix] http://www.wolverhampton.gov.uk/CHttpHandler.ashx?id=1567&p=0
[c] Powering Growth – A Black Country Energy Strategy, Aecom, February 2018
[ci] Business cases for Energy Innovation Zones in the West Midlands, Arup, March 2018
[cii] Powering West Midlands Growth: A Regional Approach to Clean Energy Innovation, An Energy Capital Policy Commission, Chaired by Prof. Sir David King, March 2018
[ciii] http://www.investblackcountry.com/investment-opportunities/industrial/gasholders/
[civ] http://www.investblackcountry.com/investment-opportunities/industrial/i54/
[cv] http://www.investblackcountry.com/investment-opportunities/industrial/phoenix-10/
[cvi] Actual figures, calendar year 2017, for a large metalworking business.
[cvii] Electricity Costs of Energy Intensive Industries, An international comparison, Ecofys and Frauenhofer ISI, 2015.
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