

# Low Carbon and Climate Change Research Strengths in the West Midlands

**Sustainability West Midlands**

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Climate-KIC



## **Report information**

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**Project Manager:** Simon Slater, SWM

**Project Contributors:** Anna Bright, SWM, Alan Carr, SWM and Science City Low Carbon Working Group, Climate-KIC Midlands Steering Group

**Proof read by:** Christina Marshall

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Our vision is that by 2020 businesses and communities are thriving in a West Midlands that is environmentally sustainable and socially just.

Our role is to act as a catalyst for change through our advice to leaders, to develop practical solutions with our members and share success through our communications.

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## Executive Summary

The purpose of this report and the supporting database is to highlight the low carbon and climate change research strengths within the West Midlands region.

This report is based on reviewing over 2,700 public funded research projects in the West Midlands involving local universities and business, local low carbon goods and services strengths, opportunities for wider application of research to other significant local business sectors, levels of local business engagement within research areas, and likely future demand for research.

The resulting research priorities for investment based on existing research strengths, links to local businesses, and future demand reflect the original three priorities set out in the West Midlands Low Carbon Investment Prospectus of transport, buildings and energy. In addition, there are new areas of industry, land use and governance.

### Transport

- **Vehicles:** highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.
- **Infrastructure:** recharging and fuel infrastructure, local shared office space for flexible working.

### Buildings

- **Materials and Technologies:** insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.
- **Services and users:** construction, electrical, heating, plumbing, energy management and behaviour change.

### Energy

- **Renewable energy generation,** such as wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.
- **Energy transmission and management networks,** such as efficient distribution networks, 'smart grid or metering' technologies to allow for local two-way flow of energy and generation.

### Industry

- **Low carbon and resource efficient manufacturing processes:** product design and use from 'cradle to grave', including environmental management systems.
- **Technologies and services to reduce, collect, process, reuse and recycle materials,** including chemicals, metals, cement, plastics, use of CO<sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.

### Land Use

- **Carbon efficient and resilient agriculture, forestry and land use,** e.g. crops, techniques, sequestration, supply chains.

### Governance

- **Risk management:** climate risk assessment and resilience plans, and decision-making tools.

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## 1 Introduction

The purpose of this report and the supporting database is to highlight the low carbon and climate change research strengths within the West Midlands region. It is designed to help the following audiences:

- ***Project developers seeking to build a business case and partners for new low carbon and climate change research bids.*** For example, applicants for the new rounds of European Regional Development or research programme funding.
- ***Policy makers seeking to develop strategies and investment programmes that will build on local low carbon and climate change strengths and opportunities.*** For example, Climate-KIC West Midlands as they develop future local work programmes connected to regional strengths, EU-wide research themes, and the West Midlands Combined Authority as they develop a future Single Economic Plan.
- ***Researchers requiring a methodology to update this evidence in the future or replicate in other regions.*** For example, as part of the future Science and Innovation Audit for the 'Midlands Engine' economic initiative or across the rest of the UK as part of the wider Climate-KIC UK programme.

The rest of this report sets out the approach used by the research and the summary results. There is also an accompanying database which contains the detailed information of the projects and organisations identified.

We are grateful for the support of Climate-KIC for the initial development of this research, and the subsequent support of the West Midlands Combined Authority and European Technical Assistance Programme.

## 2 Methodology

The methodology used was a desk-based exercise using a variety of sources of published and unpublished information to define the research criteria, and identify local strengths from December 2015 to March 2016. The draft findings were then tested with stakeholder groups such as the Climate-KIC WM Steering Group, SWM Board, and Birmingham Science City Low Carbon Working Group.

### 2.1 Defining the scope of the research

Our research was on public-funded supported research activity. The timescale we used was the period from 1995 to 2015. The geographical scope of the research was the West Midlands region as defined by the previous UK Government Office boundaries. This area is now covered by six Local Enterprise Partnerships and partly covered by the emerging West Midlands Combined Authority.

This was because, in practice and due to the various restructuring of public research funding over the years, the majority of the published research funding we were able to access only spanned the past 10 years, apart from Knowledge Transfer Partnerships (KTNs) which went back to 1995. We focused on public funding as this is in the public domain and it often

required some form of private match that helped to identify many private sector companies active in this space.

To identify the research criteria for the low carbon and climate change research strengths we reviewed a range of international, national, regional, and Climate-KIC documents. This produced a working definition that could be used by a range of organisations. Appendix 1 provides the summary of this analysis and an example of how the developed definition links to one of the local partner's, Climate-KIC, themes.

The definition we used is set out in Table 2.1 below and comprises 18 key criteria grouped under six headings of:

- *Energy*
- *Land use*
- *Industry*
- *Transport*
- *Buildings*
- *Governance*

**Table 2.1: Definition of Low Carbon and Climate Change Research**

Ref	Heading and criteria
<b>A.</b>	<b>Energy – renewable, low carbon, transmission</b>
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, 'smart grid or metering' technologies to allow for local two-way flow of energy and generation.
<b>B</b>	<b>Land use – agriculture, forestry, and environmental infrastructure</b>
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.
<b>C</b>	<b>Industry – design, processes, materials, specialist services</b>
C.1	<b>Low carbon and resource efficient manufacturing processes</b> : product design and use from 'cradle to grave', including environmental management systems.
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials</b> , including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.
C.3	<b>Environmental specialist services</b> : environmental consultancy, environmental monitoring, marine pollution control, air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>
D.1	<b>Vehicles</b> : highly fuel efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.
D.2	<b>Infrastructure</b> : recharging and fuel infrastructure, local shared office space for flexible working.
D.3	<b>Behaviour change</b> : sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>
E.1	<b>Planning and design</b> : standards for new and existing buildings, areas of land, and connections between them.
E.2	<b>Materials and Technologies</b> : insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.
E.3	<b>Services and users</b> : construction, electrical, heating, plumbing, energy management and behaviour change.
<b>F</b>	<b>Governance – leadership, finance, risk, reporting</b>
F.1	<b>Civic and Corporate Leadership</b> : strategic training and tools for leaders of cities, local councils, business and voluntary sector.
F.2	<b>Financial incentives &amp; instruments</b> : green bonds, carbon markets, city council fund.
F.3	<b>Risk management</b> : climate risk assessment and resilience plans, and decision-making tools.
F.4	<b>Monitoring and reporting</b> : monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.

## 2.2 Developing the database

We developed a database to capture the results from our review of different sources of public-funded research into low carbon and climate change in the West Midlands. This included the following criteria:

- **Location** - whether the organisation that had been involved or benefited from the research was based in the West Midlands.
- **Contribution** - how the research project contributed to one or more of the 18 key criteria related to the low carbon and climate change research definition.
- **Scale** - the status of the project and start and close dates, amount and source of research funding.
- **Contact** - detailed contact information, often down to the named lead researcher, the research project, programme and website link to more information, if available.

## 2.3 Populating the database – sources of evidence

We reviewed over 2,700 public-funded research projects in the West Midlands involving local universities and businesses from a range of information sources in the public domain. We used this to populate the database and then used follow up internet searches to address any gaps where possible, such as updated contact details. The main sources of evidence reviewed are described below.

### The Gateway to Research website

The Gateway to Research (GtR) website has been developed by the Research Councils UK (RCUK) to enable users to search and analyse information about public-funded research. The site can be found at: <http://gtr.rcuk.ac.uk/>

The website covers all public-funded research over the last 10 years and is supported by the following organisations and funding councils:

- Department for Business, Innovation and Skills (BIS)
- Arts and Humanities Research Council (AHRC)
- Biotechnology and Biological Sciences Research Council (BBSRC)
- Economic and Social Research Council (ESRC)
- Engineering and Physical Sciences Research (EPSRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Science and Technology Facilities Council (STFC)
- Innovate UK
- National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs)

Using key word searches based on our 18 criteria, we reviewed 2,267 closed and active public-funded research projects based in the West Midlands between 2006 and the end of 2015.



Within these research projects the small-scale research grant programmes such as innovation vouchers and Knowledge Transfer Partnerships that require a partnership between universities and businesses proved the best in identifying innovative local businesses.

### **Knowledge Transfer Partnerships (KTPs)**

Many of the KTPs were covered by the Gateway to Research website to 2006. However, as KTPs are a good indicator of engaged businesses and university departments in applied research and innovation, we used the original KTP website to conduct a review back to 1996 using key word searches from our 18 criteria. This site can be found here:

<http://ktp.innovateuk.org/search.aspx>

This identified several new relevant KTPs but also provided valuable additional information for the existing KTPs identified.

### **Research Assessment Exercise 2014 – Impact Case Studies**

The 2014 Research Excellence Framework (REF) is a peer assessment of the quality of UK universities' research in all disciplines. The REF was undertaken by the four UK higher education funding bodies, who use the REF results to distribute research funding to universities on the basis of quality, from 2015-16 onwards.

The impact of research beyond academia was a new feature in this round of assessment and counted for 20 per cent of the assessment. Part of this was to submit case studies to demonstrate how university research had affected business and others.

Like the KTPs these case studies provided valuable information on university and private sector links and often provide a narrative around particular low carbon research areas that involve a track record of a variety of funding sources over time. The website can be found here: <http://impact.ref.ac.uk/CaseStudies/search1.aspx>

There were 408 impact case studies from the 11 universities in the West Midlands and an additional 14 impact case studies involving universities outside the region, but involving West Midlands companies. Key word searches proved less effective with this data, so case studies were reviewed individually to identify relevant low carbon examples.

## **2.4 Other sources of evidence used for analysis**

### **Local university research strengths**

We also used the 2014 REF to identify the types of university departments that had the highest correlation with climate research and that was assessed as having made an external impact. Then we used the 2014 REF assessment to identify the quality rating in terms of international and national excellence. The results are in Appendix 2.



We used this evidence to assess the quality of local research strength. For example, if there was a cluster of more than half of the local universities with high-quality research departments involved in public-funded research around a particular low carbon criterion, we would score this a local high-quality research strength.

### **Other local research centre strengths**

There are a number of significant local research centre strengths that operated outside single local universities but are aligned with West Midlands low carbon research strengths. The results are in Appendix 3.

We used this evidence to add to the depth of activity when we were analysing the local research strengths in the region.

### **Local business demand for low carbon research**

The type and number of public research projects that involved some form of business engagement, investment or evidence of external impact were useful as an indicator for the level of local business demand for the type of research. The results are in Appendix 4.

We used this evidence to add to the depth of activity when we were analysing the local business demand in the region.

### **Local low carbon goods and services businesses alignment with local research strengths**

There is an ongoing national debate on what counts as a low carbon and environmental goods and services business within the overall economy. The two most recent research reports, published by BIS in 2013 and 2015, firstly use a broader and then later narrower definition. Despite this, there is useful information to apply to the West Midlands. The results are in Appendix 5.

We use this evidence to make an assessment where possible on how the local low carbon research strengths align with local specialist business strengths.

### **Wider local business opportunities and alignment with local research strengths**

The local low carbon goods and services sector only form part of the wider local business opportunities. For example, the application of specialist low carbon services, such as energy management, to other businesses such as manufacturing often have a more significant impact in terms of productivity and carbon reduction than that of the growth of the energy management company.

The West Midlands was the first region in the UK to produce a low carbon regional economic strategy 'connecting to success' that had a clear evidence base underpinning sub-regional action to improve productivity and reduce carbon emissions. Subsequently, the region has a rich evidence base to inform low carbon policy. Appendix 6 provides a summary of this research.

We used this evidence to make an assessment where possible on how the wider local business opportunities around diversification and decarbonisation align with local low carbon research strengths.

### **Impact of future drivers on the demand for local low carbon research**

In 2015 SWM, working with the Government Office of Science and many other local partners, updated the previous future drivers of the West Midlands research. The result was 12 economic, environmental and social future drivers covering 2020-2060. These were used to assess whether the demand for the different areas of low carbon research were likely to increase in the future. The summary results are in Appendix 7.

We used this evidence to make an assessment where possible on the level of future demand for the local low carbon research strengths.

## **3 Results**

### **3.1 The database**

We produced a detailed searchable database from the review of over 2,700 public-funded research projects in the West Midlands between 1995-2015. The database includes:

- A total of 301 research projects that contribute to one or more of the 18 low carbon research criteria.
- The research projects funding range from £5,000 to £60m.
- These projects represent over £269m of public investment and probably overall £0.5bn when including the private sector funding associated with these projects, which is often not publicly reported.
- Over 159 local companies, five councils and nine universities were involved in the research projects.

### **3.2 The analysis of local research strengths**

We have produced a summary table based on the database and the additional quality and depth of research represented by local universities and research centres in low carbon research. This identifies that 12 out of the 18 research criteria are ranked very high or high.

Areas of very high research strengths are:

- Renewable energy generation
- Carbon efficient and resilient agriculture, forestry and land use
- Low carbon and resource efficient manufacturing processes
- Technologies and services to reduce, collect, process, reuse and recycle materials
- Lower carbon vehicles
- Building materials and technologies

### Areas of high research strengths

- Low carbon energy generation
- Energy transmission and management networks
- Environmental infrastructure of green and blue space
- Environmental specialist services
- Low carbon vehicle infrastructure
- Climate risk management

The full results are in table 3.1 below.

**Table 3.1: Summary of West Midlands Low Carbon and Climate Change Research Strengths**

Ref	Heading and criteria	Number of contributing public funded research projects 1995-2015	Indicative estimated public sector investment (a)	WM Universities involved with 2 or more projects.	International and national ranking of majority of Universities departments involved with research (b)	Other local research center expertise (c)	Summary of local research strength (d)
<b>A.</b>	<b>Energy – renewable, low carbon, transmission</b>						
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	66 projects	£103m	Warwick (23 projects) Aston (6 projects) Birmingham (5 projects) Keele (5 projects) Harper (4 projects) Birmingham City (2 projects)	HIGH	HIGH	<b>VERY HIGH</b>
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.	36	18.4m	Warwick (13) Keele (3) University Birmingham (2) Coventry University (2)	HIGH	HIGH	<b>HIGH</b>
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.	38	9.8m	Warwick (5) Aston (4) University Birmingham (3) Keele (3)	HIGH / MEDIUM	HIGH	<b>HIGH</b>
<b>B</b>	<b>Land use – agriculture, forestry, and environmental infrastructure</b>						
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.	58	78.3m	Warwick (11) Harper (7) University of Birmingham (6) Keele (2)	HIGH	MEDIUM	<b>VERY HIGH</b>
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.	35	9.3m	Warwick (22) Keele (2) University of Birmingham (1)	HIGH	MEDIUM	<b>HIGH</b>
<b>C</b>	<b>Industry – design, processes, materials, specialist services</b>						

Ref	Heading and criteria	Number of contributing public funded research projects 1995-2015	Indicative estimated public sector investment (a)	WM Universities involved with 2 or more projects.	International and national ranking of majority of Universities departments involved with research (b)	Other local research center expertise (c)	Summary of local research strength (d)
C.1	<b>Low carbon and resource efficient manufacturing processes:</b> product design and use from 'cradle to grave'. Including environmental management systems.	80	126.6m	Warwick (30) University of Birmingham (8) Aston (4) Coventry (2) Birmingham City (2)	HIGH	MEDIUM	<b>VERY HIGH</b>
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials,</b> including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.	51	99.5m	Warwick (7) Aston (5) University Birmingham (5) Harper (4) Keele (2)	HIGH / MEDIUM	MEDIUM	<b>VERY HIGH</b>
C.3	<b>Environmental specialist services:</b> environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.	51	31.8m	Warwick (14) Aston (5) Harper (4) Coventry (3) Keele (3) University Birmingham (3)	HIGH	MEDIUM	<b>HIGH</b>
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>						
D.1	<b>Vehicles:</b> highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.	67	157.5m	Warwick (17) Coventry (5) University Birmingham (5) Aston (2)	HIGH	HIGH	<b>VERY HIGH</b>
D.2	<b>Infrastructure:</b> recharging and fuel infrastructure, local shared office space for flexible working.	19	83.8m	Aston (6) University Birmingham (3) Warwick (2), Keele (2)	MEDIUM	HIGH	<b>HIGH</b>
D.3	<b>Behaviour change:</b> sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.	18	72.2m	Keele (3) Aston (2)	MEDIUM	MEDIUM	<b>MEDIUM</b>
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>						
E.1	<b>Planning and design:</b> standards for new and existing buildings, areas of land, and connections between them.	12	1.4m	Birmingham City University (2) Coventry University (2) Warwick (2)	MEDIUM/LOW	LOW	<b>LOW</b>
E.2	<b>Materials and Technologies:</b> insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering,	131	150m	Warwick (38) Aston (10) University Birmingham (7) Coventry (5) Keele (3) Wolverhampton (2)	HIGH	MEDIUM	<b>VERY HIGH</b>

Ref	Heading and criteria	Number of contributing public funded research projects 1995-2015	Indicative estimated public sector investment (a)	WM Universities involved with 2 or more projects.	International and national ranking of majority of Universities departments involved with research (b)	Other local research center expertise (c)	Summary of local research strength (d)
	efficient boilers, micro Combined Heat and Power (CHP) boilers.						
E.3	<b>Services and users:</b> construction, electrical, heating, plumbing, energy management and behaviour change.	27	10.8	Coventry University (4) Warwick (3) Birmingham City University (2) University of Birmingham (2)	MEDIUM	MEDIUM	<b>MEDIUM</b>
<b>F</b>	<b>Governance – leadership, finance, risk, reporting</b>						
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.	8	1.4	n/a	LOW	LOW	<b>LOW</b>
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.	8	1.4	n/a	LOW	MEDIUM	<b>LOW</b>
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.	25	10.4	University of Birmingham (5) Warwick (4)	HIGH	LOW	<b>HIGH</b>
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.	14	2m	Birmingham City (2) Coventry (2)	MEDIUM / LOW	MEDIUM	<b>LOW</b>

Notes

- Given that many projects contributed to more than one research criteria, the estimated investment is indicative of the scale of the research and not the overall total of investment, which is less.
- Taken from Appendix 2 research assessment of universities.
- Taken from Appendix 3 assessment of other local research centres.
- Overall summary is based initially on university ranking then, if investment is over £75m and additional high local research centre expertise, an upward movement in the ranking is made.

### 3.3 The analysis of current and future demand for low carbon research

We have produced a summary table based on the analysis we carried out on current and future demand for low carbon research in the West Midlands. This identifies that 10 out of the 18 research criteria are ranked high in terms of current and future demand.

Areas of high current and future demand research strengths are:

- Renewable energy generation
- Energy transmissions and management networks
- Technologies and services to reduce, collect, process, reuse and recycle materials
- Lower carbon vehicles
- Low carbon vehicle infrastructure
- Building planning and design
- Building materials and technologies
- Building services and users

- Financial incentives and instruments
- Climate risk management

The full results are in table 3.2 below.

**Table 3.2: Summary of West Midlands current and future demand for Low Carbon and Climate Change Research**

Ref	Heading and criteria	Significant local demand from business (a)	Strengths in local low carbon goods and services employment and growth (b)	Opportunities for local businesses to diversify and decarbonize by application of research (c)	Future demand for research 2020-2060 (d)	Summary of current and future demand for research (e)
<b>A.</b>	<b>Energy – renewable, low carbon, transmission</b>					
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	YES	HIGH – Wind, PV Solar, Biomass MEDIUM – Marine, Solar Thermal, Geothermal, Heat Pumps	Metals and metal products Non-metallic mineral goods Construction Environmental goods and services	HIGH	HIGH
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.		MEDIUM – Heat Networks LOW – Nuclear & Carbon Capture	Automotive and transport equipment Metals and metal products Non-metallic mineral goods Food and beverages Public Services Construction	MEDIUM	MEDIUM
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.		MEDIUM – Energy controls and systems	Transport, storage and communication. Public Services Environmental Goods and Services	VERY HIGH	HIGH
<b>B</b>	<b>Land use – agriculture, forestry, and environmental infrastructure</b>					
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.	YES	LOW/ Unknown	Food and beverage sectors	HIGH	MEDIUM
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.		LOW / Unknown	Food and beverage sectors Environmental Goods and Services Public Services	HIGH	MEDIUM
<b>C</b>	<b>Industry – design, processes, materials, specialist services</b>					
C.1	<b>Low carbon and resource efficient manufacturing processes</b> : product design and use from ‘cradle to grave’. Including environmental management systems.	YES	LOW	Automotive and transport equipment Metals and metal products Non-metallic mineral goods Food and beverages	VERY HIGH	MEDIUM
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials</b> ,	YES	MEDIUM	Automotive and transport equipment Metals and metal products	HIGH	HIGH

Ref	Heading and criteria	Significant local demand from business (a)	Strengths in local low carbon goods and services employment and growth (b)	Opportunities for local businesses to diversify and decarbonize by application of research (c)	Future demand for research 2020-2060 (d)	Summary of current and future demand for research (e)
	including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.			Non-metallic mineral goods Food and beverages		
C.3	<b>Environmental specialist services:</b> environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.	YES	LOW	Environmental Goods and Services Sector	VERY HIGH	MEDIUM
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>					
D.1	<b>Vehicles:</b> highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.		HIGH	Automotive and transport equipment Transport, storage and communications	HIGH	HIGH
D.2	<b>Infrastructure:</b> recharging and fuel infrastructure, local shared office space for flexible working.		HIGH	Automotive and transport equipment Transport, storage and communications	HIGH	HIGH
D.3	<b>Behaviour change:</b> sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.		LOW	Automotive and transport equipment Transport, storage and communications Public Services	HIGH	MEDIUM
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>					
E.1	<b>Planning and design:</b> standards for new and existing buildings, areas of land, and connections between them.		MEDIUM – sustainable architecture	Construction Public Services	VERY HIGH	HIGH
E.2	<b>Materials and Technologies:</b> insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.	YES	HIGH – energy efficient doors and windows  MEDIUM – Insulation, Heat recovery and ventilation	Construction Public Services	VERY HIGH	HIGH
E.3	<b>Services and users:</b> construction, electrical, heating, plumbing, energy management and behaviour change.	YES	MEDIUM	Construction Public Services	VERY HIGH	HIGH
<b>F</b>	<b>Governance – leadership, finance, risk, reporting</b>					
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.		LOW	Environmental Goods and Services Public Services	VERY HIGH	MEDIUM



Ref	Heading and criteria	Significant local demand from business (a)	Strengths in local low carbon goods and services employment and growth (b)	Opportunities for local businesses to diversify and decarbonize by application of research (c)	Future demand for research 2020-2060 (d)	Summary of current and future demand for research (e)
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.		MEDIUM	Public Services	VERY HIGH	HIGH
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.		LOW	Public Services Environmental Goods and Services	VERY HIGH	HIGH
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.		LOW	Public Services Environmental Goods and Services	MEDIUM	MEDIUM

Notes

- (a) Assessment of local business engagement with research projects in Appendix 4.
- (b) Assessment of significant low carbon goods and services businesses in Appendix 5.
- (c) Assessment of significant opportunities for application of low carbon research to wider local business base in Appendix 6.
- (d) Assessment of demand created by future drivers for the West Midlands in Appendix 7.
- (e) Overall summary is based on whether business is currently engaged in research and whether there are local business strengths and, if there is a strong future demand, an upward movement in the ranking is made.

### 3.4 Research priorities based on existing strengths and current and future demand

We have produced a summary table combining the overall results of the West Midlands research strengths and current and future demand. This identifies that 10 out of the 18 research criteria are ranked high enough to become a priority area for future investment. This is supported by existing local research strengths, local businesses and the sectors engaged who are well placed to benefit from the future demands for the research in the West Midlands and beyond.

These priority areas can be grouped by the three investment priorities set out in the West Midlands low carbon investment prospectus, with another additional three supporting priorities.

#### Transport

- Vehicles: highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.
- Infrastructure: recharging and fuel infrastructure, local shared office space for flexible working.

#### Buildings

- Materials and Technologies: insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.
- Services and users: construction, electrical, heating, plumbing, energy management and behaviour change.

#### Energy

- Renewable energy generation, such as wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.

- Energy transmission and management networks, such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.

#### Industry

- Low carbon and resource efficient manufacturing processes: product design and use from ‘cradle to grave’, including environmental management systems
- Technologies and services to reduce, collect, process, reuse and recycle materials –including chemicals, metals, cement, plastics, use of CO<sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.

#### Land Use

- Carbon efficient and resilient agriculture, forestry and land use, e.g. crops, techniques, sequestration, supply chains.

#### Governance

- Risk management: climate risk assessment and resilience plans, and decision-making tools.

The full results are in table 3.3 below.

**Table 3.3: Summary of West Midlands priority areas for research investment**

Ref	Heading and criteria	Summary of local research strength	Summary of current and future demand for research	Summary of priority areas (a)
<b>A. Energy – renewable, low carbon, transmission</b>				
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	VERY HIGH	HIGH	PRIORITY AREA
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.	HIGH	MEDIUM	
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.	HIGH	HIGH	PRIORITY AREA
<b>B Land use – agriculture, forestry, and environmental infrastructure</b>				
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.	VERY HIGH	MEDIUM	PRIORITY AREA
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.	HIGH	MEDIUM	
<b>C Industry – design, processes, materials, specialist services</b>				
C.1	<b>Low carbon and resource efficient manufacturing processes</b> : product design and use from ‘cradle to grave’. Including environmental management systems.	VERY HIGH	MEDIUM	PRIORITY AREA
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials</b> , including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.	VERY HIGH	HIGH	PRIORITY AREA
C.3	<b>Environmental specialist services</b> : environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.	HIGH	MEDIUM	
<b>D Transport – vehicles, infrastructure, behaviour change</b>				
D.1	<b>Vehicles</b> : highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of	VERY HIGH	HIGH	PRIORITY AREA

Ref	Heading and criteria	Summary of local research strength	Summary of current and future demand for research	Summary of priority areas (a)
	alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.			
D.2	<b>Infrastructure:</b> recharging and fuel infrastructure, local shared office space for flexible working.	HIGH	HIGH	PRIORITY AREA
D.3	<b>Behaviour change:</b> sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.	MEDIUM	MEDIUM	
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>			
E.1	<b>Planning and design:</b> standards for new and existing buildings, areas of land, and connections between them.	LOW	HIGH	
E.2	<b>Materials and Technologies:</b> insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.	VERY HIGH	HIGH	PRIORITY AREA
E.3	<b>Services and users:</b> construction, electrical, heating, plumbing, energy management and behaviour change.	MEDIUM	HIGH	PRIORITY AREA
<b>F</b>	<b>Governance – leadership, finance, risk, reporting</b>			
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.	LOW	MEDIUM	
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.	LOW	HIGH	
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.	HIGH	HIGH	PRIORITY AREA
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.	LOW	MEDIUM	

Notes

- (a) Overall summary is based on strength of local research base and if there is a strong future demand, an upward movement in the ranking is made.

### 3.5 Sub-regional implications for the West Midlands research priorities

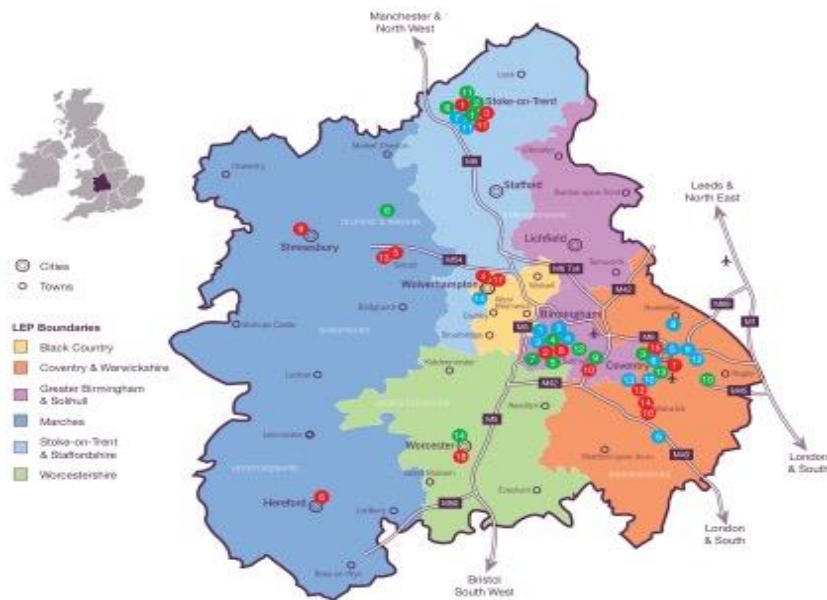
Previous work for the low carbon investment prospectus has illustrated that the main research centres follow the local economic geography of being part of major cities and towns in the region. Table 3.5 shows the distribution for the research priorities for transport, energy and buildings. The other research priorities of land use, industry and governance would follow a similar pattern with centres of excellence in Birmingham, Warwick and Harper Adams.

All six low carbon research priorities would have the majority of the local research centres and expertise within the emerging West Midlands Combined Authority area and that of the wider ‘Super Single Economic Plan’ covering the Greater Birmingham, Black Country, and Coventry and Warwickshire LEPs.

However, this will not be enough. In the same way the West Midlands six LEPs needed to market their collective network of research centres, skills, sites and local market opportunities to create a better offer in a globally competitive world, the WMCA needs to be able to market a wider, well-networked offer across the West and East Midlands. The Midlands Engine is one such initiative.

**Table 3.5: Map showing sub-regional distribution of low carbon research priorities of transport, buildings, and energy (extract from the West Midlands Low Carbon Investment Prospectus 2013)**

**Examples of low carbon research and training centres in the West Midlands**



**Low Carbon Vehicles:**

1. Aston University
2. Birmingham City University's Advanced Powertrain Group within the Centre for Low Carbon Research
3. Centre for Hydrogen and Fuel Cell Research at University of Birmingham
4. Centre for Low Carbon Research at Birmingham City University
5. Coventry University's Automotive Applied Engineering Research Group
6. Jaguar Land Rover's design, engineering and research centres in Whitley in Coventry and Gaydon in Warwickshire
7. Keele University
8. MIRA, near Nuneaton
9. Manufacturing Technology Centre at Ansty Technology Park
10. National Automotive Innovation Campus at the University of Warwick

11. Staffordshire University
12. TATA Motor's Technical Centre and research facilities in Ansty, Coventry
13. UK Energy Storage R&D Centre for the advancement of electric and hybrid vehicle batteries at Warwick University
14. Wolverhampton University

**Low Carbon Buildings:**

1. CoRE - Centre of Refurbishment Excellence, in Stoke-on-Trent
2. Centre for Low Carbon Research at Birmingham City University
3. CERAM Research in Stoke-on-Trent
4. City of Wolverhampton College
5. Constructing Excellence based in Telford
6. Herefordshire College of Technology
7. Low Impact Buildings Centre at Coventry University
8. South Birmingham College

9. Shrewsbury College
10. Solihull College
11. Stoke on Trent College
12. Sustainable Energy Engineering & Design at Warwick University
13. Telford College
14. Warwickshire College
15. West Midlands Centre for Construction Excellence based in Coventry
16. Walsley Sustainable Building Centre in Leamington Spa
17. Wolverhampton University
18. Worcester College of Technology

**Low Carbon Energy:**

1. Centre for Energy Efficient Systems at Staffordshire University
2. CERAM Research in Stoke-on-Trent
3. Energy & Environmental Technology Applied Research Group at Coventry University

4. European Bioenergy Research Institute at Aston University
5. Faculty of Technology, Engineering and the Environment at Birmingham City University
6. Harper Adams University
7. Institute for Energy Research & Policy at Birmingham University
8. Low Carbon Energy Group at the Keele University
9. The National Skills Academy for Power in Solihull
10. Power Academy at Warwickshire College in Rugby
11. Siemens wind energy research laboratory at Keele University
12. Solihull College
13. Warwick Institute for Sustainable Energy and Resources at Warwick University
14. Worcester Bosch training centre in Worcester
15. Wolverhampton University

## Appendices

### Appendix 1: Developing the low carbon and climate change research criteria

In order to produce research results that would benefit Climate-KIC WM and other local partners, we sought to develop a series of criteria that could be used and then combined in different ways in the future, depending on future priorities.

For example, our analysis of Climate-KIC themes showed that many of the identified priorities and activities did not always fit within one theme. Also local partners might want to combine activities within their own interpretation of a theme. For example, the West Midlands Combined Authority and Birmingham Science City are interested in building on this work to develop a future baseline of key research strengths.

Therefore, we conducted our analysis of a range of key published and unpublished materials identified by Climate-KIC WM and our research team to help identify the common climate change priorities and definitions that would contribute to a lower carbon and resilient economy. The results of this analysis are in Table A1.1. We then used these results to devise a summary set of search criteria for the research. These are set out in Table A1.2.

**Table A1.1: Summary of analysis of climate change themes and elements, priorities and definitions to inform the research criteria**

Climate Change themes and elements contributing to a lower carbon and resilient future.  Presented under key areas of global greenhouse gas emissions (GHG) and then Climate-KIC themes.	International and Climate-KIC Climate Change Priorities and Definitions					UK and West Midlands Climate Change Priorities and Definitions				
	5 <sup>th</sup> IPCC Report – thematic areas (2013)	WBCSD 2050 Climate Themes (2011)	UNEP thematic areas (2015)	Climate-KIC 12 potential thematic areas (May 2015)	Climate-KIC priority areas and supporting elements P.1-4 (Dec 2015)	UK Low Carbon Environmental Goods and Services, (2013)	England ERDF Programme I (2015)	WM Sustainability Roadmap 2020 Priorities (2010)	WM Components of Low carbon economy (2011)	WM low carbon investment prospectus local strengths (2012)
<b>A. Energy Production (35% Global GHG)</b>										
Renewable energy technologies (Climate-KIC theme)	X	X	X	X			X	X		X
Renewable energy generation, such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.					P1,P2	X	X		X	X
Renewable consulting.						X	X			X
Low carbon energy generation, such as: Combined Heat and Power, Carbon Capture and Storage, new nuclear.					P1	X	X			X
Smart, resilient energy infrastructure (Climate-KIC theme)	X	X		X			X	X		X
Efficient energy transmission, e.g. energy is transmitted via efficient distribution networks, with reduced transmission losses and incorporating 'smart grid' and metering technologies to allow for decentralised energy generation in homes and businesses, sometimes drawing from the energy grid and sometimes contributing to it.					P1		X		X	X
Energy management.					P1	X				X
<b>B. Agriculture, Forestry and other Land Use (24% Global GHG)</b>										
Climate smart agriculture production (Climate-KIC theme)	X	X		X						
Sustainable land use systems (Climate-KIC theme priority P2)	X	X	X	X	P2			X		
Carbon efficient and resilient agriculture, forestry and land use e.g. crops, techniques, sequestration, supply chains.					P2					
Environmental infrastructure of green and blue space, for recreation, food, health, and climate resilience.					P1, P2		X	x	x	X
<b>C. Industry (21% Global GHG)</b>										
Energy efficient production (Climate-KIC theme)	X	X		X						
Sustainable production systems (Climate-KIC theme priority P3)	X	X	X	X	P3			X		

Climate Change themes and elements contributing to a lower carbon and resilient future.  Presented under key areas of global greenhouse gas emissions (GHG) and then Climate-KIC themes.	International and Climate-KIC Climate Change Priorities and Definitions					UK and West Midlands Climate Change Priorities and Definitions				
	5 <sup>th</sup> IPCC Report – thematic areas (2013)	WBCSD 2050 Climate Themes (2011)	UNEP thematic areas (2015)	Climate-KIC 12 potential thematic areas (May 2015)	Climate-KIC priority areas and supporting elements P1-4 (Dec 2015)	UK Low Carbon Environmental Goods and Services, (2013)	England ERDF Programme I (2015)	WM Sustainability Roadmap 2020 Priorities (2010)	WM Components of Low carbon economy (2011)	WM low carbon investment prospectus local strengths (2012)
Low carbon and resource efficient manufacturing processes, product design and use from 'cradle to grave'.					P3				X	X
Resource efficient design of products and services, including industrial symbiosis.					P3					X
Waste management, water supply and wastewater treatment.					P1	X			x	X
Waste is minimised, in line with the waste hierarchy of reduction/reuse/recycling, products incorporate high levels of recycled materials and energy is generated from residual waste.					P3		X		x	
Technologies and services to reduce, collect, process, reuse and recycle materials.					P3	X			x	
New uses for disposal materials e.g. chemicals, metals, cement, plastic.					P3					
New uses of value of CO <sub>2</sub> for bio-based fuels, chemicals and products.					P3					
Environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration.						X	X		X	X
Contaminated land remediation.						X	X		X	X
Strategy advice on corporate social responsibility and environmental management system.							X			X
Low carbon workplaces - low carbon buildings, equipment, travel, use of resources and ICT.							X	X	X	
Low carbon goods and service applied to all sectors to minimise use of energy and resources, e.g. in automotives, construction, health services, retail and distribution.							X		X	
Support for low carbon jobs and skills.								X		X
<b>D. Transport and Infrastructure (14% Global GHG)</b>										
Low carbon mobility options (Climate-KIC theme)	X	X		X			X	X		X
Vehicles: highly fuel efficient vehicles, electric cars, use of alternative fuels vehicles, plug-in hybrids, rise in bikes and electric scooters.					P1	X	X		X	X
Smart transport and infrastructure systems (Climate-KIC theme)	X	X	X	X			X	X		X



Climate Change themes and elements contributing to a lower carbon and resilient future.  Presented under key areas of global greenhouse gas emissions (GHG) and then Climate-KIC themes.	International and Climate-KIC Climate Change Priorities and Definitions					UK and West Midlands Climate Change Priorities and Definitions				
	5 <sup>th</sup> IPCC Report – thematic areas (2013)	WBCSD 2050 Climate Themes (2011)	UNEP thematic areas (2015)	Climate-KIC 12 potential thematic areas (May 2015)	Climate-KIC priority areas and supporting elements P1-4 (Dec 2015)	UK Low Carbon Environmental Goods and Services, (2013)	England ERDF Programme I (2015)	WM Sustainability Roadmap 2020 Priorities (2010)	WM Components of Low carbon economy (2011)	WM low carbon investment prospectus local strengths (2012)
Infrastructure: recharging and fuel infrastructure, local shared office space for flexible working.					P1	X	X		X	X
Behaviour change: sustainable travel planning to increase use of public transport and smart use of other modes.					P1		X		X	X
Improved low carbon transport choices, flexible working, cycling, walking.					P1		X	X		
Car clubs.					P1					
<b>E. Buildings (6% Global GHG)</b>										
Energy efficient buildings (Climate-KIC theme)	X	X		X			X	X		X
Sustainable City Systems (Climate-KIC theme priority P1)	X	X	X	X	P1					
Low carbon building design.					P1		X		X	X
Urban Planning: standards for new and existing buildings, areas of land, and connections between them.					P1					
Energy efficiency in retrofit of existing homes and buildings.					P1		X		X	X
Materials: recycled content, insulation etc.					P1	X	X		X	
Technologies: micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.					P1	X	X		X	X
Services: construction, electrical, heating, plumbing, energy management and behaviour change.					P1	X	X		X	X
<b>F. Other</b>										
Measuring climate risk reduction (Climate-KIC theme)				X	X		X			X
Climate risk assessment and resilience plans.					P1					X
Climate adaptation measures – flood defences.							X			X
Tools to improve climate risk and mitigation in decision making.					P4					
Monitoring, reporting and verification of carbon emissions.					P4					
Climate finance and management (Climate-KIC theme priority P4)				X	P4	X				
Financial incentives & instruments: green bonds, carbon markets, city council fund.					P4					
Improved overall monitoring of impact of climate mitigation and adaption policies and technology.					P4					X

Climate Change themes and elements contributing to a lower carbon and resilient future.  Presented under key areas of global greenhouse gas emissions (GHG) and then Climate-KIC themes.	International and Climate-KIC Climate Change Priorities and Definitions					UK and West Midlands Climate Change Priorities and Definitions				
	5 <sup>th</sup> IPCC Report – thematic areas (2013)	WBCSD 2050 Climate Themes (2011)	UNEP thematic areas (2015)	Climate-KIC 12 potential thematic areas (May 2015)	Climate-KIC priority areas and supporting elements P1-4 (Dec 2015)	UK Low Carbon Environmental Goods and Services, (2013)	England ERDF Programme I (2015)	WM Sustainability Roadmap 2020 Priorities (2010)	WM Components of Low carbon economy (2011)	WM low carbon investment prospectus local strengths (2012)
Use of ICT for data and monitoring.					P1					
City governance, policy, decision-making, monitoring and reporting.					P1					X
Sustainable or green procurement.					P4			X		X
Corporate and Civic Leadership and perception and behaviour change.					P1			X		

**Table A1.2: Final research search criteria**

Ref	Heading and criteria	Example of how these relate to Climate-KIC theme priorities
<b>A.</b>	<b>Energy – renewable, low carbon, transmission</b>	
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	P1 Sustainable City Systems P2 Sustainable Land Use System
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.	P1 Sustainable City Systems
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.	P1 Sustainable City Systems
<b>B</b>	<b>Land use – agriculture, forestry, and environmental infrastructure</b>	
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.	P2 Sustainable Land Use System
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.	P1 Sustainable City Systems P2 Sustainable Land Use System
<b>C</b>	<b>Industry – design, processes, materials, specialist services</b>	
C.1	<b>Low carbon and resource efficient manufacturing processes</b> : product design and use from ‘cradle to grave’. Including environmental management systems.	P3 Sustainable Production System
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials</b> , including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.	P3 Sustainable Production System
C.3	<b>Environmental specialist services</b> : environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.	P1 Sustainable City Systems
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>	

Ref	Heading and criteria	Example of how these relate to Climate-KIC theme priorities
D.1	<b>Vehicles:</b> highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.	P1 Sustainable City Systems
D.2	<b>Infrastructure:</b> recharging and fuel infrastructure, local shared office space for flexible working.	P1 Sustainable City Systems
D.3	<b>Behaviour change:</b> sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.	P1 Sustainable City Systems
E	<b>Buildings – planning, materials, technologies, users</b>	
E.1	<b>Planning and design:</b> standards for new and existing buildings, areas of land, and connections between them.	P1 Sustainable City Systems
E.2	<b>Materials and Technologies:</b> insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.	P1 Sustainable City Systems
E.3	<b>Services and users:</b> construction, electrical, heating, plumbing, energy management and behaviour change.	P1 Sustainable City Systems
F	<b>Governance – leadership, finance, risk, reporting</b>	
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.	P1 Sustainable City Systems
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.	P4 Climate Finance and Management
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.	P1 Sustainable City Systems P4 Climate Finance and Management
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.	P4 Climate Finance and Management

## Appendix 2: University low carbon and climate change research strengths

There is a range of different research areas that contribute to our definition of low carbon and climate change research. We used the analysis of the recent Research Excellence Framework to identify relevant research strengths within local universities.

The 2014 **Research Excellence Framework (REF)** is a peer assessment of the quality of UK universities' research in all disciplines. The REF was undertaken by the four UK higher education funding bodies, who use the REF results to distribute research funding to universities on the basis of quality, from 2015-16 onwards.

The **impact** of research beyond academia was a new feature in this round of assessment and counted for 20 per cent of the assessment. Part of this was to submit case studies to demonstrate how university research had affected business and others.

There are 36 units of assessment used within the overall assessment e.g. Law. [The overall analysis report](#) demonstrated that some units of assessment had more of an impact on topic areas such as climate change, and environment than others (see Figure 8 in [the report on page 33](#)).

The topic areas that closely related to our research criteria were identified. These were climate change, food and nutrition, nuclear, oil and gas, water and flood management, nature conservation, transport, architecture and buildings, engineering and design and manufacturing, modelling and forecasting, community and local government, and banking and finance. We then identified the units of assessment that had scored 30 per cent or more in terms of a correlation with the produced impact case studies and where this had occurred twice or more.

This helped identify the units of assessment that had the highest correlation with having an external impact on climate change. These were:

- UOA 5 - Biological sciences
- UOA 6 - Agriculture, veterinary and food science
- UOA 7 - Earth systems and environmental sciences
- UOA 8 - Chemistry
- UOA 10 - Mathematical science
- UOA 12 - Aeronautical, mechanical, chemical and manufacturing engineering
- UOA 13 - Electrical and electronic engineering, metallurgy and materials
- UOA 14 - Civil and construction engineering

- UOA 15 - General engineering
- UOA 16 - Architecture, built environment and planning
- UOA 17 - Geography, environmental studies, archaeology

Therefore, if a university in the West Midlands has one of these type of activities this is more likely to support a range of climate change related research and impact.

The 2014 REF exercise also rated these units of assessment by quality.

<b>4*</b>	Quality that is world-leading in terms of originality, significance and rigour.
<b>3*</b>	Quality that is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standards of excellence.
<b>2*</b>	Quality that is recognised internationally in terms of originality, significance and rigour.
<b>1*</b>	Quality that is recognised nationally in terms of originality, significance and rigour.
<b>Unclassified</b>	Quality that falls below the standard of nationally recognised work. Or work which does not meet the published definition of research for the purposes of this assessment.

We used the assessment to identify the international and national quality of the research within the relevant units of assessment within local universities. The website can be found here: <http://results.ref.ac.uk/Results/SelectHei>

The results are in the table below.

**Table A2.1: International and national low carbon and climate change research strengths within local universities**

West Midlands University	Research Excellence Framework (2004) Units of Assessment (UOA) that have a high correlation to impact on low carbon and climate change research and external impact.										
	UOA -5 – Biological Sciences	UOA 6 –Agriculture, veterinary and food science	UOA 7 –Earth systems and environmental sciences	UOA 8 - Chemistry	UOA 10 - Mathematical Science	UOA 12 - Aeronautical, mechanical, chemical and manufacturing engineering	UOA 13 - Electrical and electronic engineering, metallurgy and materials	UOA -14 Civil and construction engineering	UOA – 15 General engineering	UOA 16 - Architecture, built environment, and planning	UOA 17 – Geography, environmental studies, archaeology
Aston University							16/55		15/57		
University of Birmingham	32/59		13/80	11/79	15/65	14/71 = Mechanical 27/60 = Chemical	14/72 = Electrical 31/55 = Material	7/59			30/46
Birmingham City University									14/42		
Coventry University			8/44		7/74				4/56		
Harper Adams University		10/46									
Keele University			2/55		12/59				20/69		
Newman University											
Staffordshire University									2/39		

West Midlands University	Research Excellence Framework (2004) Units of Assessment (UOA) that have a high correlation to impact on low carbon and climate change research and external impact.										
	Key e.g. 32/59 = In 2004 32% of research rated 4* in terms of quality that is world-leading in terms of originality, significance and rigour. 59% of research rated 3* in terms of quality that is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standards of excellence. Colour = Combined 4*&3* score. If over 75% then GREEN, if 50-74% then ORANGE, if 1-49% then YELLOW										
	UOA -5 – Biological Sciences	UOA 6 –Agriculture, veterinary and food science	UOA 7 –Earth systems and environmental sciences	UOA 8 - Chemistry	UOA 10 - Mathematical Science	UOA 12 - Aeronautical, mechanical, chemical and manufacturing engineering	UOA 13 - Electrical and electronic engineering, metallurgy and materials	UOA -14 Civil and construction engineering	UOA – 15 General engineering	UOA 16 - Architecture, built environment, and planning	UOA 17 – Geography, environmental studies, archaeology
University of Warwick	22/61	46/46		32/66	44/48				32/58		
University of Wolverhampton						1/21				5/21	
University of Worcester	6/33										2/25



### Appendix 3: Other local research centre strengths

In addition to the public funding of local universities research there is research funded by the private sector, charitable organisations and other sources such as the EU. This often follows the pattern of the public research funding. For example, our review of public funding research often revealed other private partners and funders which were captured in our analysis. However there are also a number of significant local research centre strengths that operated outside single local universities but align with local university strengths. Table A3.1 maps these against the 18 low carbon research criteria.

**Table A3.1 Other local research centre low carbon research strengths**

Ref	Heading and criteria	Energy Systems Catapult (Birmingham)	High Value Manufacturing Catapult (Warwick Manufacturing Group & Manufacturing Technology Centre)	WM Consortium for Demonstration for Intelligent Systems (Energy, Mobility, Health)	Energy Research Accelerator (Network of 6 Universities Led by Birmingham)	Motor Industry Research Association (Nuneaton)	Agriculture and Horticulture Development Board (Stoneleigh)	Additional local research strengths assessment. (Combined x = low, xx-xxxx = medium, xxxxx or higher = high)
<b>A.</b>	<b>Energy – renewable, low carbon, transmission</b>							
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	X	X	X	X		X	HIGH
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.	X	X	X	XXX			HIGH
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.	XXX	X	XXX	XXX			HIGH
<b>B</b>	<b>Land use – agriculture, forestry, and environmental infrastructure</b>							
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.						XXX	MEDIUM
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.						XXX	MEDIUM
<b>C</b>	<b>Industry – design, processes, materials, specialist services</b>							

Ref	Heading and criteria	Energy Systems Catapult (Birmingham)	High Value Manufacturing Catapult (Warwick Manufacturing Group & Manufacturing Technology Centre)	WM Consortium for Demonstration for Intelligent Systems (Energy, Mobility, Health)	Energy Research Accelerator (Network of 6 Universities Led by Birmingham)	Motor Industry Research Association (Nuneaton)	Agriculture and Horticulture Development Board (Stoneleigh)	Additional local research strengths assessment. (Combined x = low, xx-xxxx = medium, xxxxx or higher = high)
C.1	<b>Low carbon and resource efficient manufacturing processes:</b> product design and use from 'cradle to grave'. Including environmental management systems.		XXX	X				MEDIUM
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials,</b> including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.		X				X	MEDIUM
C.3	<b>Environmental specialist services:</b> environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.	X	X	X			X	MEDIUM
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>							
D.1	<b>Vehicles:</b> highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.		XXX	XXX		XXX		HIGH
D.2	<b>Infrastructure:</b> recharging and fuel infrastructure, local shared office space for flexible working.	XXX		XXX	XX	X		HIGH
D.3	<b>Behaviour change:</b> sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.			XXX		X		MEDIUM
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>							
E.1	<b>Planning and design:</b> standards for new and existing buildings, areas of land, and connections between them.							
E.2	<b>Materials and Technologies:</b> insulation, recycled content, resilient to heat and flooding, micro-generation renewables,		X	X	X			MEDIUM

Ref	Heading and criteria	Energy Systems Catapult (Birmingham)	High Value Manufacturing Catapult (Warwick Manufacturing Group & Manufacturing Technology Centre)	WM Consortium for Demonstration for Intelligent Systems (Energy, Mobility, Health)	Energy Research Accelerator (Network of 6 Universities Led by Birmingham)	Motor Industry Research Association (Nuneaton)	Agriculture and Horticulture Development Board (Stoneleigh)	Additional local research strengths assessment. (Combined x = low, xx-xxxx = medium, xxxxx or higher = high)
	energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.							
E.3	<b>Services and users:</b> construction, electrical, heating, plumbing, energy management and behaviour change.	X		X	X			MEDIUM
F	<b>Governance – leadership, finance, risk, reporting</b>							
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.	X						LOW
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.	XX			XX			MEDIUM
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.						X	LOW
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.	X		X	X	X		MEDIUM

#### Appendix 4: Local business demand for low carbon research

We used the type and number of public research projects that involved some form of business engagement, investment or evidence of external impact as an indicator for the level of local business demand for the type of research. Although useful, the type of business sector also appeared to have an impact. For example, there are a larger number of small environmental technology and construction firms eligible for business support compared to some other sectors.

**Table A4.1 Local business demand for low carbon research**

Ref	Heading and criteria	Number of public research projects contributing to criteria	Number of KTPs, Innovation Vouchers & Impact Case Studies and (as a % of projects in criteria)	Significant local demand and engagement from business (Average of 12 or above projects)	Local businesses involved with 2 or more projects
<b>A. Energy – renewable, low carbon, transmission</b>					
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	66	22 (33%)	X	Energy Transitions Ltd (3 projects) Tidal Stream Ltd (2 projects) Solar Box Ltd (2 projects)
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.	36	8 (22%)		Encraft Ltd (2) Alstom Power (2) Green engineering Ltd (2)
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, ‘smart grid or metering’ technologies to allow for local two-way flow of energy and generation.	38	8 (21%)		Encraft Ltd (3) Alstom Power (2) Anvil Semi Conductors Ltd (2) Future Energy Ltd (2) Oswald Consultancy (2)
<b>B Land use – agriculture, forestry, and environmental infrastructure</b>					
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.	58	15 (25%)	X	SERE-Tech Innovation Ltd (3) JLR (2) Saturn Bioponics Ltd (2) Tarmac Ltd (2)
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.	35	8 (23%)		JLR (2)
<b>C Industry – design, processes, materials, specialist services</b>					
C.1	<b>Low carbon and resource efficient manufacturing processes</b> : product design and use from ‘cradle to grave’. Including environmental management systems.	80	19 (24%)	X	JLR (9) Aeristone Tech Ltd (4) Alliance Software (2) SERE-tech innovation (2) Fusion Systems Ltd (2) Carllion Energy Systems (2) Lucideon (2)

Ref	Heading and criteria	Number of public research projects contributing to criteria	Number of KTPs, Innovation Vouchers & Impact Case Studies and (as a % of projects in criteria)	Significant local demand and engagement from business (Average of 12 or above projects)	Local businesses involved with 2 or more projects
					Lontra Ltd (2)
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials</b> , including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.	51	16 (31%)	X	Env-Aqua Solutions Ltd (2) JLR (2) SERE-tech innovation (2)
C.3	<b>Environmental specialist services</b> : environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.	51	23 (45%)	X	Middlemarch environmental (2)
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>				
D.1	<b>Vehicles</b> : highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.	67	10 (15%)		JLR (17) GKN Driveline (5) Aeristech (5) Fusion Innovation Ltd (4) Antonov Technologies (2) Anvil Semi Conductors (2) JCB Services (2)
D.2	<b>Infrastructure</b> : recharging and fuel infrastructure, local shared office space for flexible working.	19	5 (26%)		JLR (2) Anvil Semi Conductors (2)
D.3	<b>Behaviour change</b> : sustainable travel planning to increase use of public transport and smart use of other modes, such as walking, cycling, use of car clubs.	18	3 (17%)		None
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>				
E.1	<b>Planning and design</b> : standards for new and existing buildings, areas of land, and connections between them.	12	7 (58%)		N/A
E.2	<b>Materials and Technologies</b> : insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.	131	28 (21%)	X	JLR (13) Areistech Ltd (5) Anvil Semi conductors (4) GKN (3) Fusion innovation Ltd (2) Fusion systems Ltd (2) Integrated Systems Technologies (2) Lontra Ltd (2) Saturn Bioponics (2)
E.3	<b>Services and users</b> : construction, electrical, heating, plumbing, energy management and behaviour change.	27	13 (48%)	X	Encraft (2)

Ref	Heading and criteria	Number of public research projects contributing to criteria	Number of KTPs, Innovation Vouchers & Impact Case Studies and (as a % of projects in criteria)	Significant local demand and engagement from business (Average of 12 or above projects)	Local businesses involved with 2 or more projects
F	<b>Governance – leadership, finance, risk, reporting</b>				
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.	8	3 (38%)		n/a
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.	8	0 (0%)		Encraft (2)
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.	25	10 (40%)		Birmingham City Council (2) Hydro-Logic Ltd (3)
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.	14	10 (71%)		n/a

## **Appendix 5: Local low carbon goods and services businesses alignment with local research strengths**

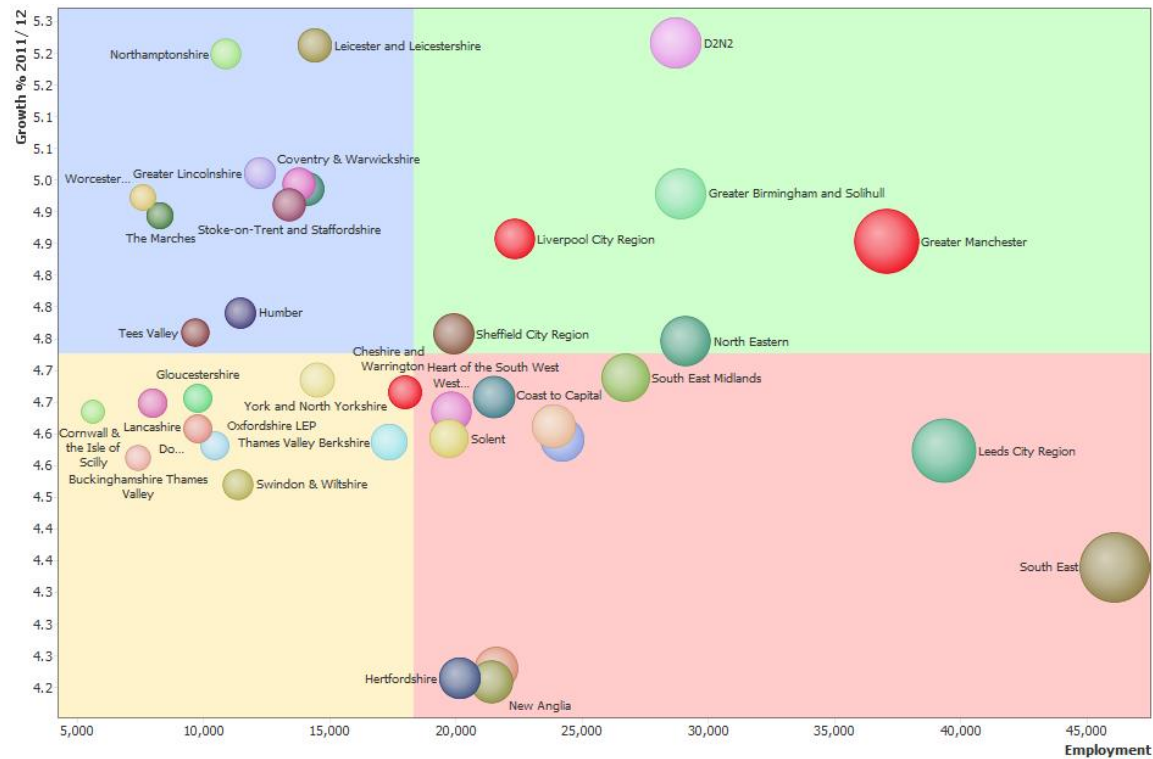
There is an ongoing national attempt to measure the size and performance of the UK low carbon economy and provide regional breakdowns. This is challenging as using a broader definition to find low carbon activity 'hidden' with traditional business classification is difficult. For example, how do you measure the proportion within a traditional automotive company that is focused on low carbon technology? Also the changing definitions in studies make trend comparison difficult. For example, the latest research published in 2015 only considered products and technologies delivering a "step change" in carbon performance rather than economic benefits. SWM is currently investigating the merits of expanding the recent low carbon good analysis for the Birmingham LEP energy study in early 2016 to the rest of the WMCA area.

Tables A5.1 and A5.2 illustrate the results of the BIS 2011/12 research published in July 2013 by BIS. The research indicated that of the six West Midlands LEAs, five were experiencing nationally significant high growth in sales (Worcester, The Marches, Black Country, Stoke and Staffordshire, Coventry and Warwickshire) and one (Birmingham and Solihull) was experiencing nationally significant growth in sales and employment.

Table A5.3 illustrates the results of the BIS 2012/13 research published in 2015 by BIS. As this used a narrower definition of the low carbon sector, the estimated employment covered is half of the previous research, although all the sectors monitored still show substantial growth.

Where possible we have used the two research reports to compile some indicator of growth and demand, and produced an assessment on how significant the sub-sectors are for the West Midlands based on rate of growth and employment share. Due to recent policy and legislation changes in 2015, some sectors, such as solar PV and construction, will no longer be so strong.

**Table A5.1 Weighting of LEPs (minus London) on low carbon sales growth and employment in 2011/12. (Extract from BIS 2013 research)**



**Table A5.2 LEP Low Carbon Sales and Employment employment in 2011/12. (Based on data from BIS 2013 research)**

LEP	Sales £m	Companies	Employment
Black Country	1,870.73	770	14,106
Coventry and Warwickshire	1,803.06	756	13,758
Greater Birmingham and Solihull	3,833.24	1580	28,899
Stoke on Trent and Staffordshire	1,777.65	730	13,387
The Marches	1,097.04	453	8,279
Worcestershire	1,004.94	411	7,569
<b>Total</b>	<b>14,055.51</b>	<b>4700</b>	<b>85,998</b>



**Table A5.3 Strength of West Midlands Low Carbon Goods and Services Sector (Based on data from BIS 2013 -2015 research)**

Low Carbon and Environmental Goods and Services Sector	Business investment by companies in UK £m (excluding supply chains) 2013	Jobs by sector in UK (including supply chains) 2013	Jobs growth by sector in UK (including supply chains) 2010-13	Turnover by sector in UK £m (including supply chains) 2013	Turnover change by sector in UK (including supply chains) 2010-13	GVA by sector in UK £m (including supply chains) 2013	GVA growth by sector in UK £m (including supply chains) 2010-13 (a)	UK demand not being met locally- value of imports 2012 £m. * = where same figure used across several sectors	Global demand – Value of UK exports 2012 £m * = where same figure used across several sectors	Employment in WM in companies and supply chain 2013	Ranking of WM out of 9 English regions including London (1 is highest) 2013	Share of WM employment within England including London 2013 (b)	Significance for WM  GVA growth (a) + WM employment share (b)  21%> = High, 11--20%=Medium 0-10% = Low
Onshore wind	240	19000	10%	6300	5.3%	1700	11.5%	736*	1718*	1,300	(4/9)	10%	HIGH
Offshore wind	170	13700	8%	3500	2.5%	1000	16.9%	736*	1718*	1,000	(5/9)	9%	HIGH
Nuclear Energy	830	59000	3%	12100	6%	3500	2.8%	81	194	400	(9/9)	1%	LOW
Hydroelectric energy	30	7400	2.9%	1900	4.5%	600	-2.1%	41	71	100	(6/9)	2%	LOW
Marine	30	3100	1.5%	400	5.5%	100	13.3%	5	9	100	(5/9)	5%	MEDIUM
Solar PV	150	34400	20.8%	8400	11.9%	3300	6.3%	689	1391	4,100	(2/9)	14%	HIGH
Energy generation from waste and biomass	420	21900	2.8%	4100	3.2%	1200	-1.2%	113	180	1,100	(8/9)	5%	LOW
Carbon capture and storage	20	4100	1.2%	600	-3.2%	200	-7.3%	63	71	300	(3/9)	6%	LOW
Biomass equipment	110	11700	2.2%	2500	6.5%	1000	8.1%	481	752	1,300	(3/9)	13%	HIGH
Geothermal	10	3500	8.5%	800	12%	300	11%	720	1043	200	(4/9)	7%	MEDIUM
Heat pumps	60	22700	2.9%	3100	4.5%	1000	1.5%	103*	1484*	2,200	(4/9)	12%	MEDIUM
Solar thermal	10	5200	4%	800	3.4%	300	3.6%	103*	1484*	500	(4/9)	13%	MEDIUM
Heat networks	10	1200	3.8%	200	6.4%	100	6.9%	103*	1484*	100	(3/9)	11%	MEDIUM

Low Carbon and Environmental Goods and Services Sector	Business Investment by companies in UK £m (excluding supply chains) 2013	Jobs by sector in UK (including supply chains) 2013	Jobs growth by sector in UK (including supply chains) 2010-13	Turnover by sector in UK £m (including supply chains) 2013	Turnover change by sector in UK (including supply chains) 2010-13	GVA by sector in UK £m (including supply chains) 2013	GVA growth by sector in UK £m (including supply chains) 2010-13 (a)	UK demand not being met locally- value of imports 2012 £m. *= where same figure used across several sectors	Global demand – Value of UK exports 2012 £m* = where same figure used across several sectors	Employment in WM in companies and supply chain 2013	Ranking of WM out of 9 English regions including London (1 is highest) 2013	Share of WM employment within England including London 2013 (b)	Significance for WM  GVA growth (a) + WM employment share (b)  21%> = High, 11--20%=Medium 0-10% = Low
Energy-efficient lighting	40	14600	0.6%	3500	-2.5%	1600	-0.9%	835*	1484*	1,000	(4/9)	8%	LOW
Insulation	50	36000	3.2%	5500	4.7%	2000	3.9%	835*	1484*	3,900	(3/9)	12%	MEDIUM
Energy-efficient windows and doors	20	17500	1.3%	2800	-3.5%	1,200	-5.5%	835*	1484*	5,200	(1/9)	35%	HIGH
Heat recovery and ventilation	20	9400	-0.4%	1500	-0.4%	700	2.1%	835*	1484*	1,000	(4/9)	13%	MEDIUM
Energy controls and control systems	100	12800	-4.9%	2200	5.1%	1,100	10.6%	205	356	700	(3/9)	6%	MEDIUM
Sustainable architecture and buildings	20	4000	0.8%	900	0.8%	700	2.7%	835*	1484*	500	(3/6)	14%	MEDIUM
Low carbon advisory services	230	22600	0.1%	2800	3.9%	1400	1.6%	121 Air pollution, 68 Renewable energy consultancy 59 Contaminated Land, 49 Environmental consultancy,	175 Air pollution, 68 Renewable energy consultancy 95 Contaminated Land, 102 Environmental consultancy,	1,100	(8/9)	6%	LOW

Low Carbon and Environmental Goods and Services Sector	Business Investment by companies in UK £m (excluding supply chains) 2013	Jobs by sector in UK (including supply chains) 2013	Jobs growth by sector in UK (including supply chains) 2010-13	Turnover by sector in UK £m(including supply chains) 2013	Turnover change by sector in UK (including supply chains) 2010-13	GVA by sector in UK £m (including supply chains) 2013	GVA growth by sector in UK £m (including supply chains) 2010-13 (a)	UK demand not being met locally- value of imports 2012 £m. *= where same figure used across several sectors	Global demand – Value of UK exports 2012 £m* = where same figure used across several sectors	Employment in WM in companies and supply chain 2013	Ranking of WM out of 9 English regions including London (1 is highest) 2013	Share of WM employment within England including London 2013 (b)	Significance for WM  GVA growth (a) + WM employment share (b)  21%> = High, 11--20%=Medium 0-10% = Low
								pollution controls	pollution controls				
Low carbon finance	10	5400	-0.8%	900	0.6%	400	-1.6%	101	169	700	(3/9)	14%	MEDIUM
Recycling - recovery and reprocessing of materials from waste	800	93500	3.2%	21800	5.3%	6200	4%	279 Recycling 926 Waste water treatment	605 Recycling 1263 Waste water treatment	9,900	(3/9)	12%	MEDIUM
Alternative fuels	120	19800	5%	26100	21.9%	13600	24.4%	740	1266	1,700	(3/9)	11%	HIGH
Low emission vehicles	80	18100	3.9%	8800	5.3%	1700	8.7%	387	662	2,700	(2/9)	17%	HIGH
Totals	3,580	460,600	3.8%	121,700	7.6%	44,900	8.7%	7035	12,211	Total WM employment 41,100	Average ranking = 4	Average WM share = 11%	N/A

## **Appendix 6: Wider local businesses opportunities and alignment with local research strengths**

The local low carbon goods and services sector only form part of the wider local business opportunities. For example, the application of specialist low carbon services, such as energy management, to other businesses such as manufacturing, often have a more significant impact in terms of productivity and carbon reduction than that of the growth of the energy management company.

The West Midlands was the first region in the UK to produce a low carbon regional economic strategy 'connecting to success' that had a clear evidence base underpinning sub-regional action to improve productivity and reduce carbon emissions. Subsequently, the region has a rich evidence base to inform low carbon policy.

### **The Low Carbon Economy in the West Midlands Research Programme (West Midlands Regional Observatory 2010)**

SWM chaired a research programme run by the WMRO for the region and the city region initiative to build on the 'connecting to success' evidence base. This included region-wide work, workshops, local authority profiles, and sub-regional analysis based on the city region initiative in 2010, similar to the WMCA in 2016.

This work was recognised as good practice by government and subsequently replicated in several other regions in the UK and Europe. Although the impact of the recession on the economy will have changed some of the figures, the overall analysis and recommendations for the local economic geography is still valid in 2016.

The research aimed to develop a better understanding of the risks and opportunities the low carbon economy can deliver for the West Midlands. A low carbon economy was defined as 'one where businesses deliver products and services of increasing value while reducing their overall level of carbon emissions'. Therefore, it took a holistic view of the whole economy rather than the narrow low carbon or environmental goods and services sector.

### ***Impact of Carbon Legislation and Energy prices in the West Midlands***

The research reviewed the potential impact that carbon legislation and energy prices would have on businesses and employment in the region. The findings included:

- Sectors that contribute a high proportion of the regional economic productivity, such as financial and professional services, have low exposure to carbon legislation and energy prices.
- The sectors more vulnerable to carbon legislation in the region are health and social work, transport and communications, education and construction. Mainly high energy-intensive industries.
- Businesses in these sectors are already responding to the low carbon agenda in their own efforts by improving their energy and resource efficiency.
- Support measures should also be implemented at regional and local level to help mitigation against potential risks of legislation, energy or changing markets.

The impact varies across local authority area – see the extract from main report below.

Table 4.2 - Proportion of employees & businesses in high risk sectors (according to operations and products/services)

LA	% of Employees at High Risk	LA	% of Businesses at High Risk
Stoke-on-Trent	46.0%	Staffordshire	27.4%
Wolverhampton	42.1%	Stoke-on-Trent	26.8%
Solihull	40.7%	Herefordshire	26.6%
Coventry	39.8%	Shropshire	26.3%
Shropshire	39.6%	Walsall	25.7%
Staffordshire	38.6%	Dudley	24.8%
Sandwell	38.1%	Sandwell	24.1%
West Midlands	37.1%	West Midlands	24.0%
Birmingham	36.3%	Telford and Wrekin	23.7%
Warwickshire	35.1%	Coventry	22.9%
Walsall	34.7%	Solihull	22.8%
Herefordshire	34.2%	Warwickshire	22.6%
Worcestershire	33.5%	Worcestershire	22.6%
Dudley	32.9%	Wolverhampton	22.3%
Telford and Wrekin	32.5%	Birmingham	21.1%

Source: Data provided by WMRO (ABI data), 2007

The West Midlands average is highlighted at the appropriate point in the table.

### ***Low Carbon Economic Opportunities for the West Midlands***

The research identified businesses can benefit from the low carbon economy in two ways:

- **Diversification** – developing new low carbon products
- **Decarbonising** – becoming more efficient in their current processes or delivering their current products more efficiently. For example, using fewer resources, producing less waste or using less energy.

The low carbon economy can deliver opportunities across a wide range of business sectors, not just to those seen as being in the 'traditionally' environmental technologies sector.

The sectors identified as providing the greatest low carbon opportunities in the region were:

- Non-metallic mineral goods
- Automotive and transport equipment
- Metals and metal products
- Construction
- Environmental goods and services
- Food and beverages
- Transport, storage and communications
- Public services

These sectors are present across all local authorities in the region, although concentrations vary - see extract from report below.

Table 4.6 - Summary of Opportunities within Sub-Regions within West Midlands economy

	Birmingham	Sandwell	Walsall	Dudley	Coventry	Solihull	Wolverhampton	Staffordshire	Worcestershire	Warwickshire	Herefordshire	Shropshire	Stoke on Trent	Telford & Wrekin
Manufacture of non-metallic mineral goods	L	L	L	L	L	L	L	H	L	L	L	L	L	L
Manufacture of automotive and transport equipment	H	L	L	L	H	L	L	H	L	L	L	H	M	H
Manufacture of metals, fabricated metal products and electrical equipment	H	H	H	L	L	L	L	H	H	L	L	L	L	L
Construction	H	L	L	L	L	L	H	H	H	H	M	H	H	H
Manufacture of food and beverages	L	M	L	L	L	L	L	M	L	L	M	M	L	L
Environmental goods and services <sup>5</sup>	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Transport, storage and communications	H	L	L	L	H	L	L	H	L	H	L	H	L	H
Public Services	H	H	H	H	H	H	H	H	L	L	L	H	L	H

**High (H)** – Industry has a *highly significant* presence in the sub-region (>2% employees)

**Medium (M)** – Industry has a *significant* presence in the sub-region (1 – 2% employees or local specialism (LQ analysis))

**Low (L)** – Industry has a *minor* presence in the sub-region (<1% employees)

Further analysis for the sub-regions of the Black Country, Birmingham, Solihull, Coventry, and Telford and Wrekin revealed a more detailed set of local business sectors where the low carbon economy could help grow or stabilise jobs in 2010. These were:

- Low carbon design for construction
- Low carbon renovation of Local Authority (LA) council stock and wider city housing
- Manufacturing of low carbon transport
- Low carbon vehicle design
- Development and use of alternative fuels
- Procurement of low carbon services / products for the public sector
- Low carbon education
- Use of planning to support development of the low carbon economy

The research identifies that the following sectors have the potential for increased employment:

- Environmental goods and services
- Manufacture of food and drink
- Manufacture of motor vehicles and transport
- Manufacture of non-metallic mineral goods
- Public services
- Transport, storage and communication

The following table summarise the opportunities and its impact on jobs across each of the Local Authorities included in the research.

Sector	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; background-color: #92d050; display: flex; align-items: center; justify-content: center; margin-bottom: 5px;">+</div> <div style="border: 1px solid black; width: 20px; height: 20px; background-color: #add8e6; display: flex; align-items: center; justify-content: center;">=</div> </div>	Opportunity Increase in jobs	Stabilise jobs	Birmingham	Coventry	Dudley	Sandwell	Solihull	Telford & Wrekin	Walsall	Wolverhampton
Construction		Low carbon design and construction for buildings	+	+	=	=	+		=	+	
		Use of low carbon design for civil engineering	+	=	=	=	+		=	=	
		Reuse of materials and use of recycled materials	=		=	=	=		=	=	
		Low carbon renovation of LA council stock and wider city housing	+	+	+	+	+	+	+	+	
		Provision of low carbon services and trades	+	+	+		+	=	+		
		Provision of low carbon equipment		+				=			
		Off-site construction of buildings			+	+					
	Use of low carbon materials and equipment	=							=		
Manufacture automotive & transport equipment		Manufacturing of low carbon transport equipment	+	+	=	=	+	=	=		
		Low carbon vehicle design	+	+		=	+	=	=	=	
		Development of alternative fuels and associated infrastructure	+	+			+	=	=		
Manufacture non-metallic mineral goods		Low carbon design, construction methods and materials	=			=		=			
		Cost savings by use of more efficient vehicles and equipment	=		=	=	=	=	=	=	
		Use and development of low carbon products	+		=	=	=		+	=	
Public Services		Ability to procure low carbon services and products for the sector	+	+	+	+	+	+	+	+	
		'Low Carbon' Education	+	+	+	+	=	=	=	+	
		Use of planning to support development of LCE transport, energy, waste, etc.	+	+	+	+	+	+	+	+	
		Defence sector support and advice to reduce carbon emissions						+			



Sector	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="border: 1px solid black; width: 20px; height: 10px; background-color: #8ebf42; margin-bottom: 2px;">+</div> <div style="border: 1px solid black; width: 20px; height: 10px; background-color: #a6c9ec;">=</div> </div>	Opportunity Increase in jobs	Birmingham	Coventry	Dudley	Sandwell	Solihull	Telford & Wrekin	Walsall	Wolverhampton
		Stabilise jobs								
<b>Manufacture metals &amp; fabricated metal products and electrical equipment</b>		Low carbon processes	=	=	+	+	=	=	=	+
		Production of equipment for low carbon energy systems and vehicles	+		+	+			+	+
<b>Transport, storage and communications</b>		Sustainable logistics for inbound and outbound distribution transports and increasing the use of rail freight	+		=	+		+	+	+
		Shared loading for cargo					=			
		Development / use of alternative fuels and associated infrastructure	+		+	+	+	+	+	+
		Low carbon travel services					=			
		Use of low carbon vehicles and premises	=		=	=	=		=	=
<b>Environmental goods and services</b>		Increase of non-metals waste recycling						+		+
		Provision of specialist advice to all sectors on low carbon	+	+			+	+		=
		Continued establishment of metal waste and scrap sector			+	+			+	+
		Development of electric motor and generators							+	+
<b>Manufacture of food and beverages</b>		Development of low carbon community energy companies / schemes	+	+	+	+	+	+	+	+
		Commercial opportunity from use of food waste	+	+	+	+		+	+	+
		Increased recycling of packaging from food and drink products				=	=		+	
		Decarbonisation of processes to retain cost effectiveness			=	=	=	=	=	=
	Low carbon products				=		=		=	

## Appendix 7: Impact of future drivers on the demand for local low carbon research

In 2015 SWM, working with the Government Office of Science and many other local partners, updated the previous future drivers of the West Midlands research. The result was '[The Future we made: Birmingham and West Midlands Futures Toolkit 2020-2060](#)'. The 12 future drivers were used to assess whether the demand for the different areas of low carbon research were likely to increase in the future. The summary results are in the table below.

**Table A7.1 Impact of West Midlands future drivers on demand for local low carbon research**

Ref	Heading and criteria	Population Changes	Changing workforce, skills and working practices on business	Impact of lifestyles and environment on health	Increased demand for more regional or local powers and governance	Widening inequality and inclusion gap	Knowledge economy and networked world	Accelerated change from new technology opportunities for business	Globalisation of markets and competition on business	Increased stress on transport infrastructure for public services and business	Pressure for climate change adaptation	Pressure on natural resources	Emphasis on lower carbon energy supply, security and cost for public services, business, and communities Increased pressure on natural resources	Overall Future Demand for Research  Occurrence of HIGH 1-4=Med 5-8=High 9-12=Very High
<b>A.</b>	<b>Energy – renewable, low carbon, transmission</b>													
A.1	<b>Renewable energy generation</b> , such as hydro, wave, tidal, biomass, anaerobic digestion, wind, geothermal, solar thermal, solar photovoltaic.	MED		HIGH		MED	HIGH	HIGH	HIGH			HIGH	HIGH	6/12 HIGH
A.2	<b>Low carbon energy generation</b> , such as Combined Heat and Power, Carbon Capture and Storage, new nuclear.	MED		HIGH			MED	HIGH	HIGH			MED	MED	3/6 MEDIUM
A.3	<b>Energy transmission and management networks</b> , such as efficient distribution networks, 'smart grid or metering' technologies to allow for local two-way flow of energy and generation.	HIGH	HIGH	MED	HIGH	MED	HIGH	HIGH	HIGH	HIGH	HIGH		HIGH	9/12 VERY HIGH
<b>B</b>	<b>Land use – agriculture, forestry, and environmental infrastructure</b>													
B.1	<b>Carbon efficient and resilient agriculture, forestry and land use</b> , e.g. crops, techniques, sequestration, supply chains.	HIGH	HIGH	HIGH	MED	MED	MED	HIGH	HIGH	MED	HIGH	HIGH	MED	7/12 HIGH

Ref	Heading and criteria		Population Changes	Changing workforce, skills and working practices on business	Impact of lifestyles and environment on health	Increased demand for more regional or local powers and governance	Widening inequality and inclusion gap	Knowledge economy and networked world	Accelerated change from new technology opportunities for business	Globalisation of markets and competition on business	Increased stress on transport infrastructure for public services and business	Pressure for climate change adaptation	Pressure on natural resources	Emphasis on lower carbon energy supply, security and cost for public services, business, and communities	Increased pressure on natural resources	Overall Future Demand for Research  Occurrence of HIGH 1-4=Med 5-8=High 9-12=Very High
B.2	<b>Environmental infrastructure of green and blue space</b> for recreation, food, health, and climate resilience.	HIGH		HIGH		HIGH					MED	HIGH	HIGH			5/6 HIGH
<b>C</b>	<b>Industry – design, processes, materials, specialist services</b>															
C.1	<b>Low carbon and resource efficient manufacturing processes:</b> product design and use from ‘cradle to grave’. Including environmental management systems.		HIGH	HIGH	MED			HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH		9/12 VERY HIGH
C.2	<b>Technologies and services to reduce, collect, process, reuse and recycle materials,</b> including chemicals, metals, cement, plastics, use of CO <sub>2</sub> for bio-based fuels, chemicals and products, and industrial symbiosis.		HIGH		MED	MED		HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	MED		7/9 HIGH
C.3	<b>Environmental specialist services:</b> environmental consultancy, environmental monitoring; marine pollution control; air pollution control, noise and vibration, contaminated land, waste management, water supply and wastewater treatment.		HIGH	HIGH				HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH		9/12 VERY HIGH
<b>D</b>	<b>Transport – vehicles, infrastructure, behaviour change</b>															
D.1	<b>Vehicles:</b> highly fuel-efficient vehicles, use of lightweight materials, electric cars, use of alternative fuels vehicles, plug-in hybrids, bikes and electric scooters.		HIGH	HIGH				HIGH	HIGH	HIGH	HIGH			HIGH		7/9 HIGH
D.2	<b>Infrastructure:</b> recharging and fuel infrastructure, local shared office space for flexible working.		HIGH	HIGH	MED			HIGH	HIGH	HIGH	HIGH			HIGH		7/9 HIGH
D.3	<b>Behaviour change:</b> sustainable travel planning to increase use of public transport	HIGH	HIGH	HIGH	HIGH	MED		HIGH	HIGH		HIGH	HIGH				8/12 HIGH

Ref	Heading and criteria	Population Changes	Changing workforce, skills and working practices on business	Impact of lifestyles and environment on health	Increased demand for more regional or local powers and governance	Widening inequality and inclusion gap	Knowledge economy and networked world	Accelerated change from new technology opportunities for business	Globalisation of markets and competition on business	Increased stress on transport infrastructure for public services and business	Pressure for climate change adaptation	Pressure on natural resources	Emphasis on lower carbon energy supply, security and cost for public services, business, and communities	Increased pressure on natural resources	Overall Future Demand for Research	
	and smart use of other modes, such as walking, cycling, use of car clubs.															Occurrence of HIGH 1-4=Med 5-8=High 9-12=Very High
<b>E</b>	<b>Buildings – planning, materials, technologies, users</b>															
E.1	<b>Planning and design:</b> standards for new and existing buildings, areas of land, and connections between them.	HIGH	HIGH	HIGH	HIGH	HIGH	MED	HIGH	MED	HIGH	HIGH	HIGH	HIGH	HIGH		10/12 VERY HIGH
E.2	<b>Materials and Technologies:</b> insulation, recycled content, resilient to heat and flooding, micro-generation renewables, energy metering, efficient boilers, micro Combined Heat and Power (CHP) boilers.	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH		HIGH	HIGH	HIGH			11/12 VERY HIGH
E.3	<b>Services and users:</b> construction, electrical, heating, plumbing, energy management and behaviour change.	HIGH	HIGH	HIGH	MED	HIGH	HIGH	HIGH	HIGH		HIGH	MED	HIGH			9/12 VERY HIGH
<b>F</b>	<b>Governance – leadership, finance, risk, reporting</b>															
F.1	<b>Civic and Corporate Leadership:</b> strategic training and tools for leaders of cities, local councils, business, and voluntary sector.	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH		12/12 VERY HIGH
F.2	<b>Financial incentives &amp; instruments:</b> green bonds, carbon markets, city council fund.	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH			12/12 VERY HIGH
F.3	<b>Risk management:</b> climate risk assessment and resilience plans, and decision-making tools.	HIGH	HIGH	HIGH	HIGH	HIGH				HIGH	HIGH	HIGH	HIGH			9/12 VERY HIGH
F.4	<b>Monitoring and reporting:</b> monitoring, reporting and verification of carbon emissions, impact of climate change policies and technology.		MED	HIGH	MED	MED	HIGH		MED		HIGH	HIGH	MED			4/12 MEDIUM

END