

Black Country *LEP*



Repowering the Black Country

A prospectus to lead a clean growth revolution in the UK

June 2020

Innovate UK

Foreword

The Black Country was built on innovation and energy. In the 18th and 19th centuries it blazed a trail for the rest of the UK to create the world's first industrial economy.

Repowering the Black Country brings those traditions into the 21st century. It sets out a vision for clean economic growth drawing on the latest innovations in supply chain and manufacturing thinking and in clean energy technology. Once again it points to a path the rest of the country can follow.

Our vision is strongly supported by the Local Enterprise Partnership; by the four Black Country local authorities; by businesses of all sizes across the region; by the Mayor and West Midlands Combined Authority; and by our regional universities.

Our plans have been carefully-developed in the context of national decarbonisation strategies and to support and dovetail with the plans of the other strategic industrial clusters.

I look forward to continuing to work with local, regional and national partners to turn our vision into a reality.



A handwritten signature in blue ink, appearing to read 'Tom Westley', written over a white background.

Tom Westley DL

Chair, Black Country LEP

Acknowledgements

This project was part-funded by Innovate UK and delivered by a partnership led by the Black Country Consortium and Camirus. We are particularly grateful to the industrial and academic partners who provided match funding: CR Plus, Kew Technology Ltd, Pro Enviro, Skewb and Camirus. The University of Birmingham and WMG contributed their academic expertise and the project was delivered under very challenging circumstances with much goodwill from all parties.

Table of contents

Foreword.....	2
Executive Summary.....	4
1. Introduction	6
The Black Country Industrial Cluster.....	6
Rising to the challenge	7
2. A zero-carbon industrial vision for the Black Country	9
Circular economy	9
Zero carbon energy infrastructure	12
Process optimisation.....	13
Aligning with national decarbonisation and complementary industrial cluster plans	14
3. How we will get there (ten-year plan)	17
Deployment.....	17
Enabling activities.....	18
Governance and management	26
National replication	28
4. Immediate next steps	30

Appendices

Appendix I.	Carbon Capture Usage and Storage Opportunities in the Black Country
Appendix II.	Portfolio of Power Hub Designs
Appendix III.	Propositions to Cluster Members and Business Engagement
Appendix IV.	Data catalogue and long lists of potential locations
Appendix V.	National decarbonisation scenarios
Appendix VI.	Aluminium Case Study
Appendix VII.	Indicative project development process for the Phoenix 10 site

The appendices are provided as a separate document.

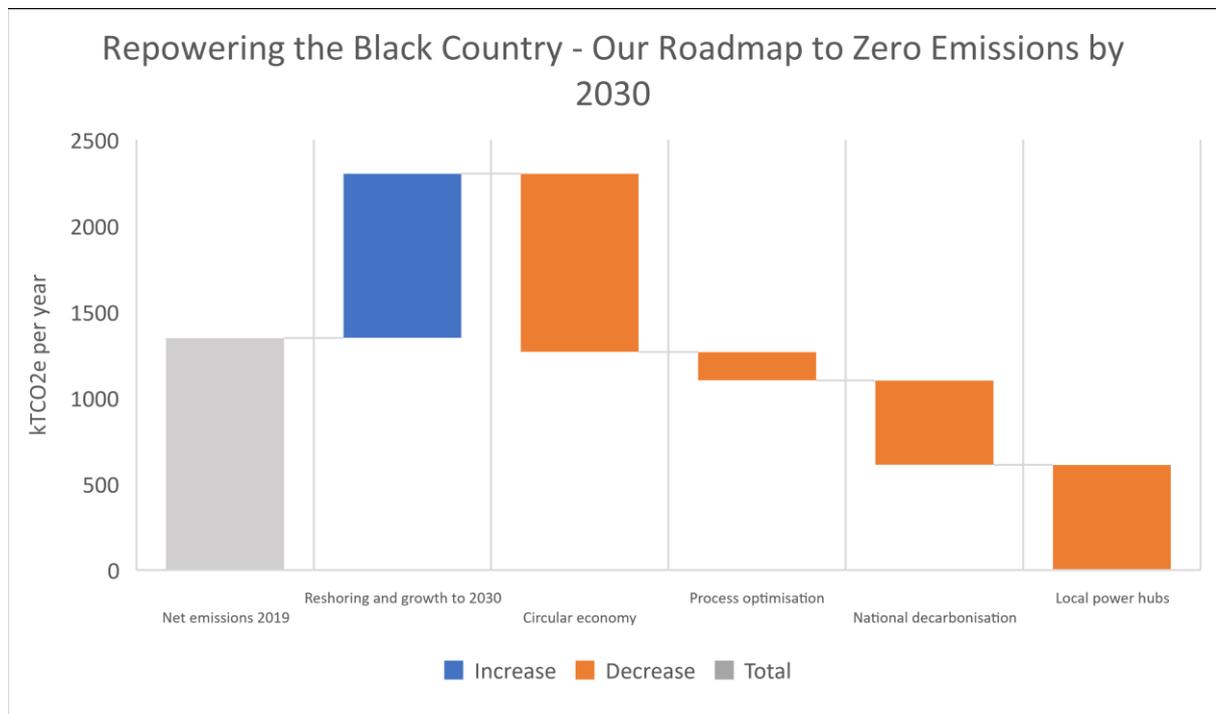
Executive Summary

This prospectus sets out an ambitious and bold plan to deliver the world’s first zero carbon industrial cluster in the Black Country. It will enable clean GVA growth of £16bn by 2030, creating or safeguarding at least 20,000 skilled jobs.

Repowering the Black Country builds on the Black Country’s strategic advantages of greater flexibility (stemming from large numbers of smaller businesses); connectivity; strong local partnerships; a regeneration imperative and strong local culture of enterprise and energy-intense manufacturing.

The portfolio approach we propose – a large number of fundable projects across diverse industrial supply chains - taken forward within a highly supportive enabling financial, technical and political context – will deliver faster and at lower overall risk than one or two large infrastructure investments. This offers a distinctive benefit to the UK and is complementary to the approach which will be necessary to decarbonise heavy industrial clusters elsewhere.

The project will create mini-clusters of zero carbon industry across the region in multiple industrial sectors by proactively using local authority planning powers and inward investment – reshoring activities which have drifted overseas over the past three decades - to create strategically-selected circular economy zero-carbon industrial hubs. A feasibility study for an initial hub based on aluminium re-processing (at Phoenix 10 in Walsall) has been completed and is included in this report.



This economic planning approach will be co-ordinated with spatial planning and energy network infrastructure planning (in partnership with WPD and Cadent Gas) using an energy innovation zone model. It will also be supported by targeted specialist energy efficiency and process optimisation support for local businesses and by tailored local investment funds.

These funds will include specially-designed mechanisms, for example, potentially to underwrite power and heat prices on the hub sites¹ and provide investors with long-term confidence in the costs of clean energy for industry in the Black Country.

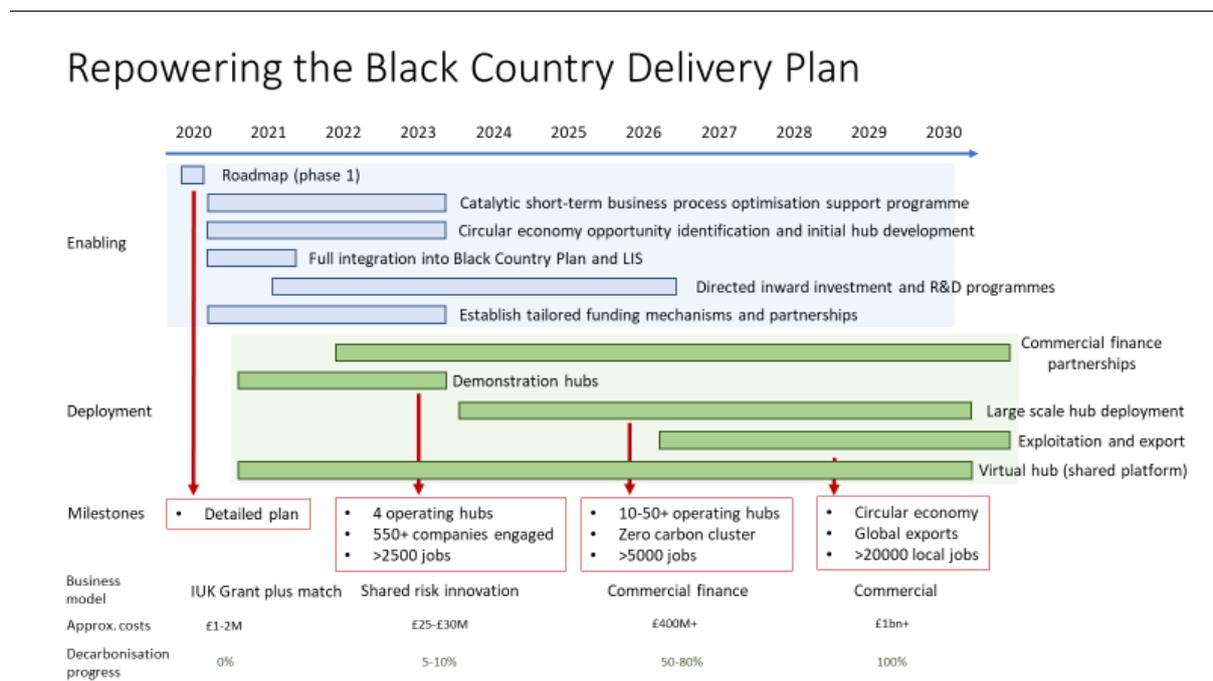
The flexible, localised approach is particularly suited to the Black Country and is well-aligned with a post-Covid world, creating local skilled jobs for local people within 20 minutes of home.

The whole project is grounded in national decarbonisation plans and the Black Country approach can be replicated nationally. In particular, we will work actively with the other strategic industrial clusters to optimise local use of hydrogen and carbon as the supplies of these increase.

There are also significant export opportunities. The modular energy generation and circular supply chain approaches developed and deployed through this project will have applications worldwide.

A pipeline of commercial funding is already being developed to support this plan and commercial finance is expected to fund the bulk of investment. In the short-term £30M of government enabling funding is being sought to augment and accelerate existing Innovate UK funds and enable the project to start delivering more quickly.

A delivery plan and team are in place and the project is ready to start now.



¹ This is about underwriting ongoing demand and circularity of supply chains (e.g., demand for low grade heat or aluminium alloys) and mitigating the risk of stranded assets. It's not an artificial subsidy.

1. Introduction

The purpose of this prospectus is to engage partners and funders in a compelling vision to make the Black Country the world's first zero carbon manufacturing cluster². In the nineteenth century the Black Country's unique infrastructure and geography made it the most attractive place to locate the small-scale energy-intensive manufacturing which still characterises the area today. By 2030 we intend to transform this infrastructure and build on our geographical advantages to make the Black Country the most attractive and competitive place to locate the equivalent 21st century manufacturing in an increasingly carbon-constrained world.

The Black Country Industrial Cluster

The Black Country Industrial Cluster consists of over 3000 energy-intensive manufacturing businesses spread across the four metropolitan areas of Wolverhampton, Walsall, Sandwell and Dudley. These are embedded in a wider community of over 30,000 businesses spread across approximately 138 sqm (see Figure 1). The Black Country was the world's first modern industrial cluster and metal processing is still the biggest sector of the local economy in terms of employment, sustaining more than 24,000 jobs. Carbon emissions from industry in the cluster exceed 1.35M tCO₂e a year.

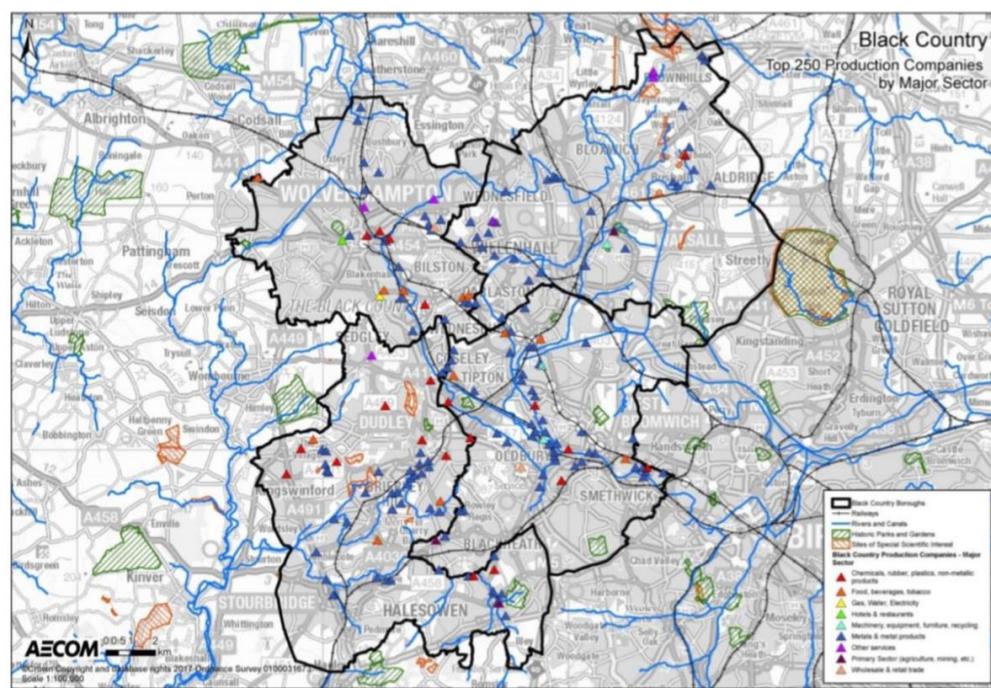


Figure 1 The Black Country Industrial Cluster

The Black Country Cluster is distinctive amongst UK clusters in its geographical extent (it is the largest) its location (it is the only non-coastal cluster) and in the variety and average size of industrial operations (unlike the other clusters there is no major steel or chemicals plant dominating the economic geography). Industry across the Black Country is often also co-located or integrated into residential areas, making it challenging to manage industrial and domestic energy demand separately (although creating significant opportunities for the right kind of manufacturing to take

² The scope of the vision is non-transport emissions from industry in the Black Country, defined by the boundaries of the four Black Country Local Authorities and the Black Country Local Enterprise Partnership.

place in a localised (post-Covid), low carbon context). A breakdown of emissions is shown in Figure 2 below.

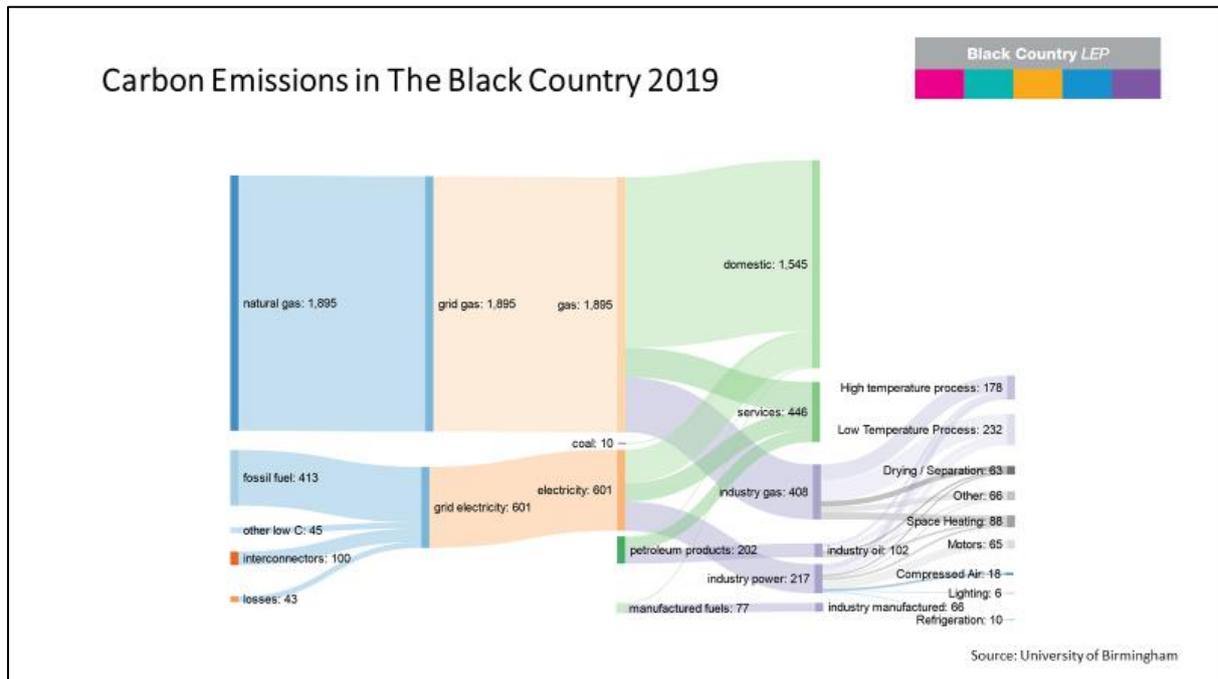


Figure 2 Breakdown of Black Country Carbon Emissions (based on BEIS data, 2017) ktCO₂

These characteristics create significant opportunities as well as challenges. In particular, decarbonising Black Country industry will create a model for wider decarbonisation of the UK manufacturing sector outside the core clusters and for effective industrial use of some of the by-products of cluster decarbonisation, such as hydrogen and carbon.

The Black Country Cluster has a historical integrity, identity and culture of industrial partnership which makes it particularly well-suited to developing and delivering a pioneering vision. The four local authorities have a long-track record of working together on economic development, most recently through the Black Country Local Enterprise Partnership (LEP) and there is a well-established Black Country energy steering group which is industry-led and actively supported by all four councils. The identity of the area is based on its industrial activities, and those industrial activities are based on the energy infrastructure. Reshaping this infrastructure and those industrial activities around a zero-carbon imperative thus has the full focus and support of the local business community.

Rising to the challenge

This prospectus, which has been funded by Innovate UK as part of the Industrial Clusters Mission³, sets out a vision and plan to reduce carbon emissions from the industry in the Black Country to zero, while at the same time delivering the long-term growth plans set out in the Black Country Local Industrial Strategy and Strategic Economic Plans⁴: these envisage adding more than £36bn to

3

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803086/industrial-clusters-mission-infographic-2019.pdf

⁴ <https://www.blackcountrylep.co.uk/upload/files/BC%20SEP/BCSEP%20Annex%205%20-%20Black%20Country%20Storyboards.pdf>

regional and national GVA by 2030 through reshoring manufacturing supply chains, increased productivity and inward investment.

Without radical action to restructure the region’s industrial and energy infrastructure, such growth would virtually double regional carbon emissions. Rather than see this as a problem, however, this prospectus views the challenge of delivering net zero carbon emissions at the same time as significant industrial growth as a major opportunity. It sets out a ten-year plan to align infrastructure investment with supply chain reconfiguration and inward investment, making the Black Country the most attractive place in the UK and world to locate clean manufacturing businesses.

Our roadmap has four distinctive elements (Figure 3): reconfiguring supply chains to create circular economies; process optimisation within individual firms; aligning with national decarbonisation scenarios; and the creation of local zero carbon power hubs (typically with a particular emphasis on heat). These four elements will be pursued in parallel focusing on a single shared vision.

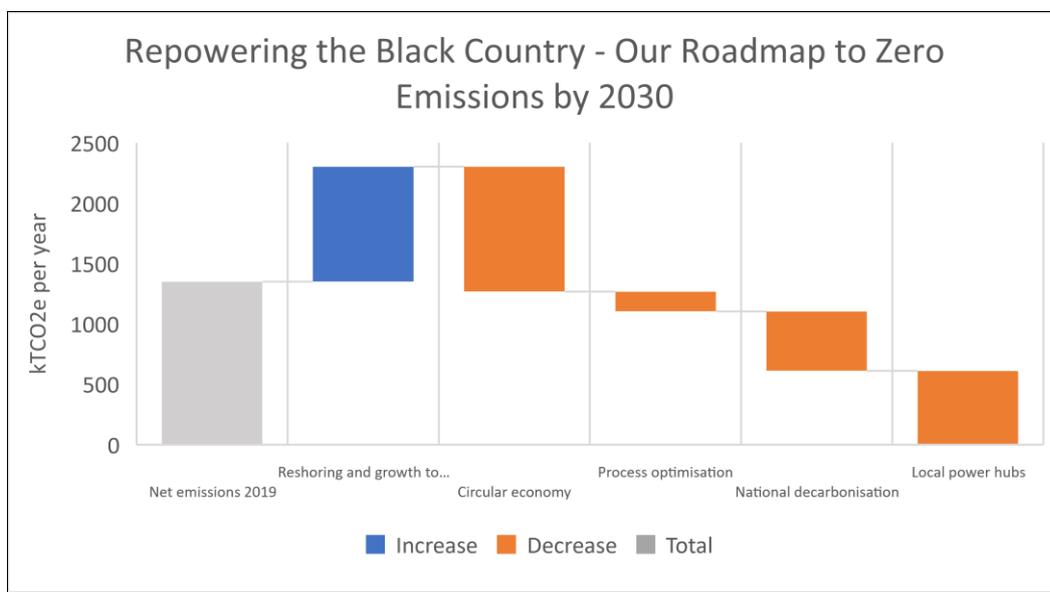


Figure 3 Black Country Cluster Decarbonisation Plan

The remainder of this document provides an overview of that vision and then sets out how we will take forward each of these elements in turn.

2. A zero-carbon industrial vision for the Black Country

The industrial vision for the Black Country has four interlinked elements:

1. Identification and reconfiguration of strategically-significant supply chains within the region using circular economy principles
2. Provision of local zero carbon energy infrastructure designed specifically to support these new industrial eco-systems (zero carbon hubs)
3. Process optimisation within every individual element of the circular supply chains and hubs coupled with mass engagement of businesses across the Black Country in the vision
4. Effectively dovetailing Black Country industrial development into the context of national decarbonisation and the development of complementary clusters across the UK

This vision will play out in the context of ambitious growth plans for both the Black Country and the UK. The Black Country Strategic Economic Plan forecasts GVA growth of £16bn between 2019 and 2030⁵. This growth will be driven by reshoring of manufacturing from overseas and organic growth, particularly in high value manufacturing, building, transport and environmental technology sectors where the Black Country has long-standing strengths⁶.

However, if this growth simply follows the structural templates and energy practices of the past, annual CO₂ emissions from Black Country industry will almost double to 2.3M tCO₂⁷. To deliver green growth and meet UK industrial strategy objectives the Black Country needs to take the opportunities created by Brexit and Recovery from Covid-19 to reconfigure and repower its industrial base and create a fundamentally new economic model for the area.

Circular economy

Reconfiguring supply chains for foundation industries, particularly in the metals, plastics and food sectors, can reduce industrial carbon emissions by between 40% and 50%⁸. The keys are elimination of waste and pollution by design; keeping products and materials in use; and regeneration of natural systems.

Delivering green growth in the Black Country will mean adapting and applying these principles specifically to sectors where the region is already strong, and where it sees opportunities for competitive advantage and growth. The kinds of measures this will entail are illustrated in Figure 4.

⁵ <https://www.the-blackcountry.com/economic-intelligence-unit/black-country-intelligence-reports/black-country-annual-economic-review>

⁶ <https://www.blackcountrylep.co.uk/upload/files/BC%20SEP/BCSEP%20Annex%202%20-%20Sector%20Profiles%20Dashboards.pdf>

⁷ This figure excludes transport. It's calculated by extrapolating from 2019 industrial emissions of 1.35Mt CO₂ (BEIS).

⁸ <https://www.ellenmacarthurfoundation.org/publications/completing-the-picture-climate-change>

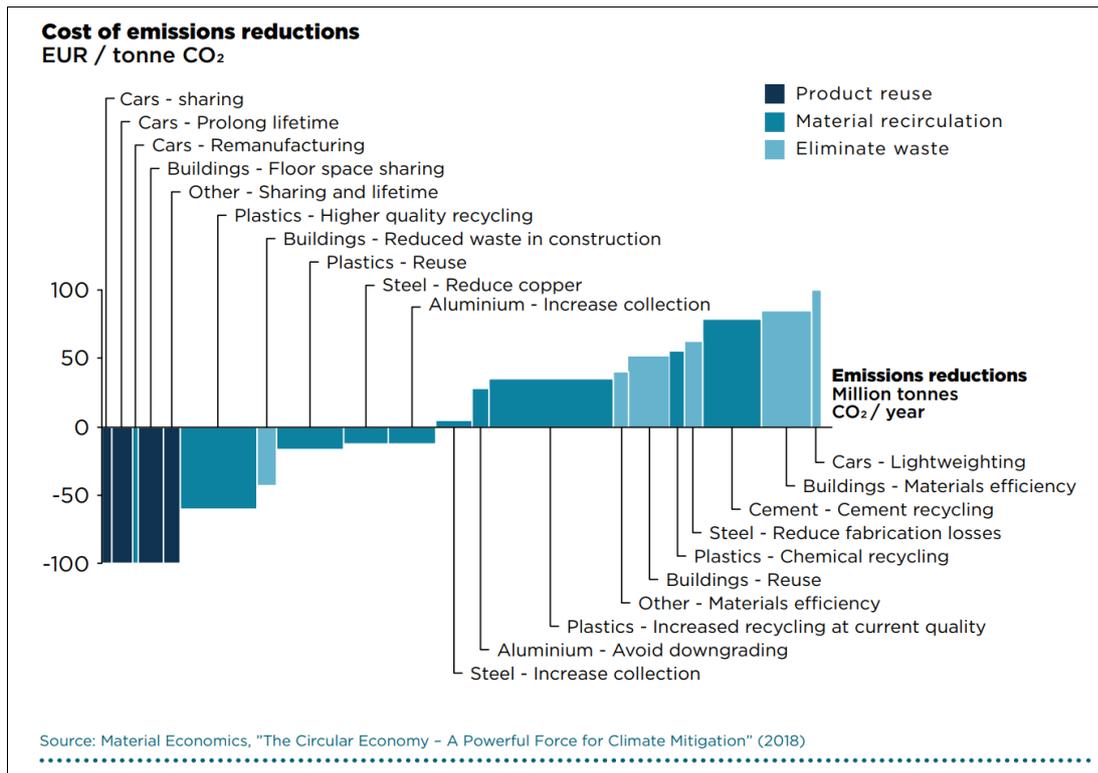


Figure 4 Emissions Reduction Potential from Circular Economy Business Models

The Black Country is already a centre both of materials reprocessing and brownfield land remediation for the UK. Metal manufacturing operations remain the biggest local industrial employment sector (see Table 1).

SIC Code	Key Sector Name	GVA In BC (£m)	Employees in Black Country	Businesses in Black Country
10-12	Manufacture of food, beverages and tobacco	£195	5,890	135
13-15	Manufacture of textiles, wearing apparel and leather	£112	2,820	185
16-18	Manufacture of wood and paper products and printing	£176	3,250	330
19-23	Manufacture of petroleum, chemicals and other minerals	£449	7,575	305
24-25	Manufacture of basic and fabricated metal products	£428	23,850	1,345
26-27	Manufacture of electronic, optical and electrical products	£114	2,155	115
28-30	Manufacture of machinery and transport equipment	£784	10,230	360
31-33	Other manufacturing, repair and installation	£241	7,775	560
35-39	Electricity, gas, water; sewerage and waste management	£1,027	6,110	235
41	Construction of buildings	£254	4,500	1,115
56	Food and beverage service activities	£368	19,000	2,060
87	Residential care activities	£405	12,500	230
	Total	£4,553	105,655	6,975

Table 1 Key Black Country Industrial Sectors

Source: Office for National Statistics, Regional Gross Value Added (2019), Business Register and Employment Survey (2020), UK Business Counts (2019)

Black Country industry is historically characterised by large numbers of smaller businesses. Even the larger employers, such as Liberty House, often have relatively independent operations distributed across multiple sites. This creates a degree of flexibility and resilience which are potential strategic

advantages in the increasingly dynamic and competitive business environment – in particular it is a structure well-aligned with the principles of industry 4.0⁹.

A circular economy vision is therefore achievable faster and more easily in the Black Country than many other clusters and regions in the UK.

An example of what this vision might look like is the potential redevelopment of the Phoenix 10 Enterprise Zone in Walsall to become an aluminium reprocessing and re-manufacturing hub, coupled with complementary industrial operations which will thrive on the low grade heat created by these activities. These might include, for example, urban farming or commercial bakeries (see appendices VI and VII (case study) and Figure 5)



Figure 5 A circular economy hub focused on aluminium at Phoenix 10

Aluminium reprocessing was specifically considered as a use case in this phase of the project to test the validity of the assumptions underpinning this vision (appendix VI). It is a particularly good example because of the historic strengths of Black Country industry in this sector and the significant local market for cast aluminium products: locally-manufactured Jaguar vehicles have more than twice the aluminium content by weight than the average car¹⁰.

We have consulted widely with relevant potential industry partners and the outcome of this initial feasibility study for the aluminium use case was positive (although subject to wider UK market conditions – principally investor confidence in the ongoing viability of car manufacturing in the UK and willingness of UK manufacturers to offer commercial volume contracts to competitive local suppliers). A more detailed overview of what a plant at Phoenix 10 might look like is illustrated in Figure 6 below.

It's important to note that the analysis in appendix VI applies to any sector, though, not just aluminium, and indeed diversity of industrial operations and economies of scope (i.e., ability to

⁹ https://en.wikipedia.org/wiki/Industry_4.0

¹⁰ See appendix VI.

serve multiple markets) will be key characteristics of industrial sectors examined for the other demonstration hubs in phase 2.

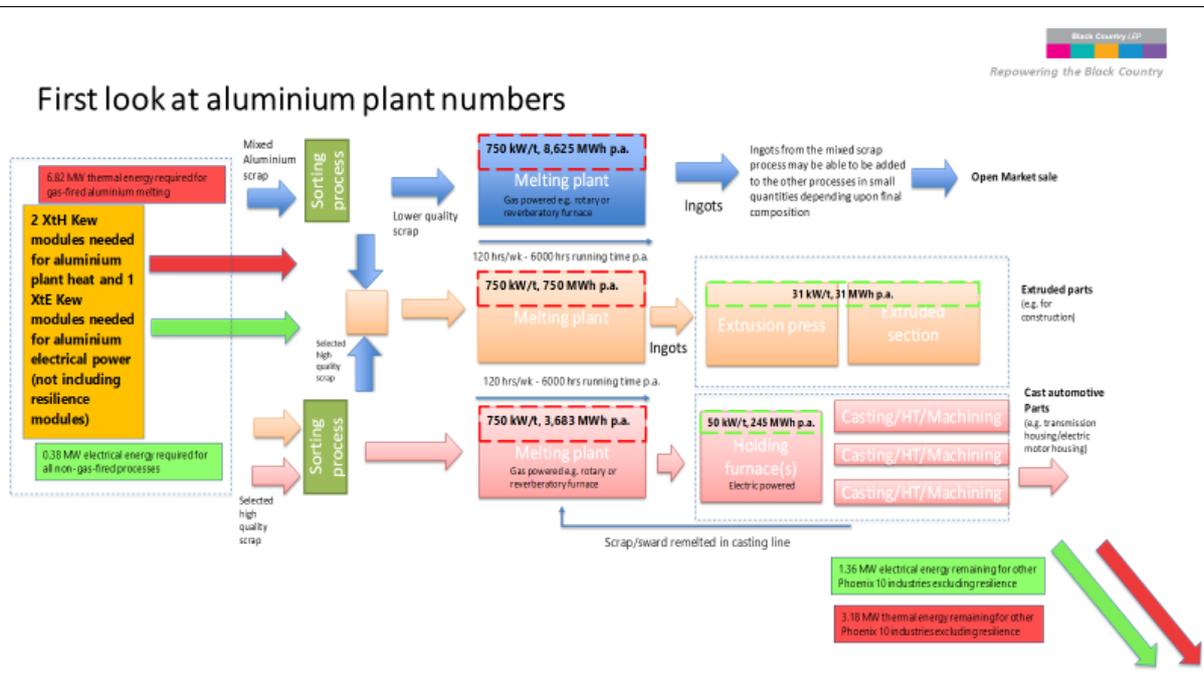


Figure 6 Schematic of potential circular economy aluminium processing facility at Phoenix 10 (see appendix VI)

Ultimately, there could be 10-50 such circular economy clusters focused on different industrial activities distributed across the Black Country, each supported by a zero-carbon power hub specifically-designed for the local energy requirement. Each hub is likely directly to support 500+ jobs and create 500 sqm of commercial floorspace.

A methodology for identifying the economic sectors most suitable for this approach in the Black Country is set out in section 3, and appendix VI includes a methodology (set of design principles) for supply chain reconfiguration.

Zero carbon energy infrastructure

Different industrial operations require different mixes of heat and power, which means optimal energy system solutions for each hub will potentially be very different. Figure 7 illustrates this.

Assuming grid electricity is decarbonised by national policy measures by 2040, which is a reasonable assumption (and virtually decarbonised by 2030, see Figure 8 below) the main challenge in delivering zero carbon energy to the circular economy hubs will be cost-effective delivery of zero carbon heat.

Zero carbon grid electricity can, of course, be used for industrial heat in many contexts and as an ultimate fall-back, but it can easily be 2-4 times as expensive as locally-supplied heat. This creates opportunities for bespoke heat-driven zero-carbon energy centres to be deployed at scale across the Black Country to support the new circular economy manufacturing hubs.

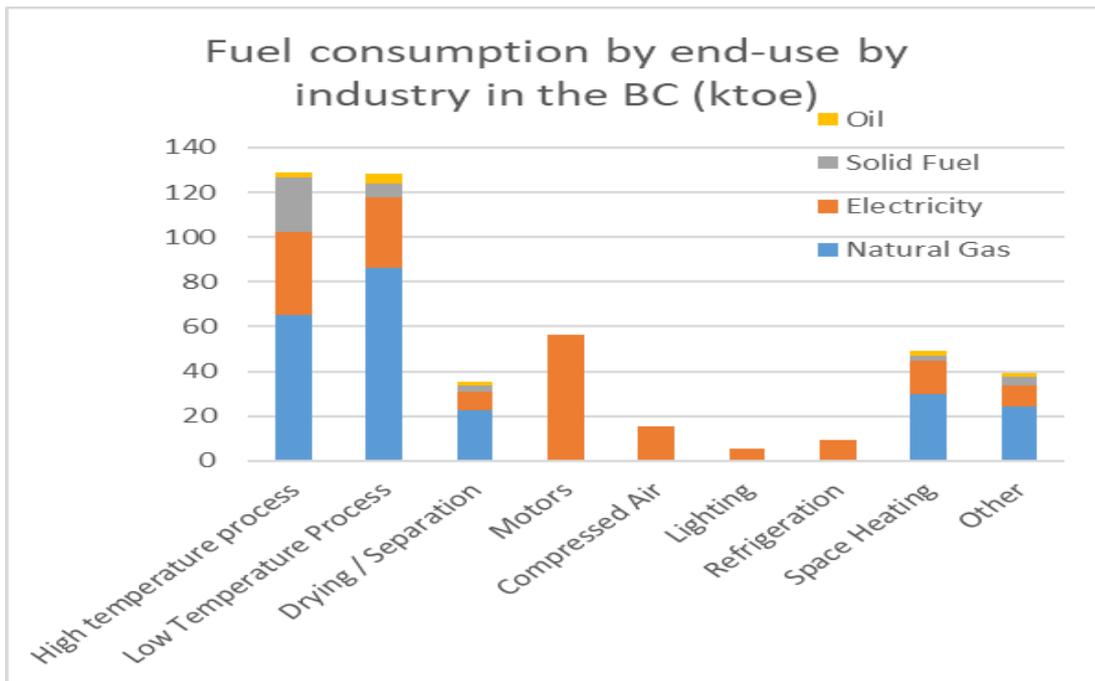


Figure 7 Variety in energy use for different Black Country Industrial Processes 2017 (Source: University of Birmingham, BEIS)

We have developed a 'pattern book' of five generic zero carbon hub designs which will provide the starting point for bespoke zero carbon energy centres located in each manufacturing hub. Section 3 describes how these will be developed and integrated into the existing local electricity and gas infrastructure.

Process optimisation

A fundamental principle both of good business and decarbonisation is to optimise the efficiency of every individual manufacturing process as well as sourcing the most cost-effective energy supplies (zero carbon energy infrastructure) and ensuring operations, business models and supply chains are configured in the most efficient way (circular economy).

Achieving this level of optimisation requires a culture of innovation and continuous improvement; a desire continuously to go beyond best practice and challenge global benchmarks, supported by financial mechanisms and academic institutions aligned to the competitive dynamics of global manufacturing and energy markets.

A zero carbon industrial cluster in the Black Country will therefore be characterised by thriving, active and engaged networks of complementary manufacturing businesses; local financial institutions embedded in these circular manufacturing 'ecosystems', able to supply patient capital and positioned to take well-informed risks, founded on sustained relationships and detailed knowledge both of the relevant global markets and local assets and constraints.

Regional universities will be proactively driven by Black Country business needs and problems as well as offering access to global technology opportunities and innovations.

Businesses will work together in areas where there are clearly common commercial interests and established trust, such as on energy costs and carbon reduction. In other areas they will actively compete, creating a constantly changing and creative local commercial environment, attractive both to start ups and inward investment.

Aligning with national decarbonisation and complementary industrial cluster plans

This transformation of the Black Country will be underpinned and supported by national and international developments, in particular the decarbonisation of the other industrial clusters around the UK and the transition to a net zero national electricity infrastructure (see Figure 8).

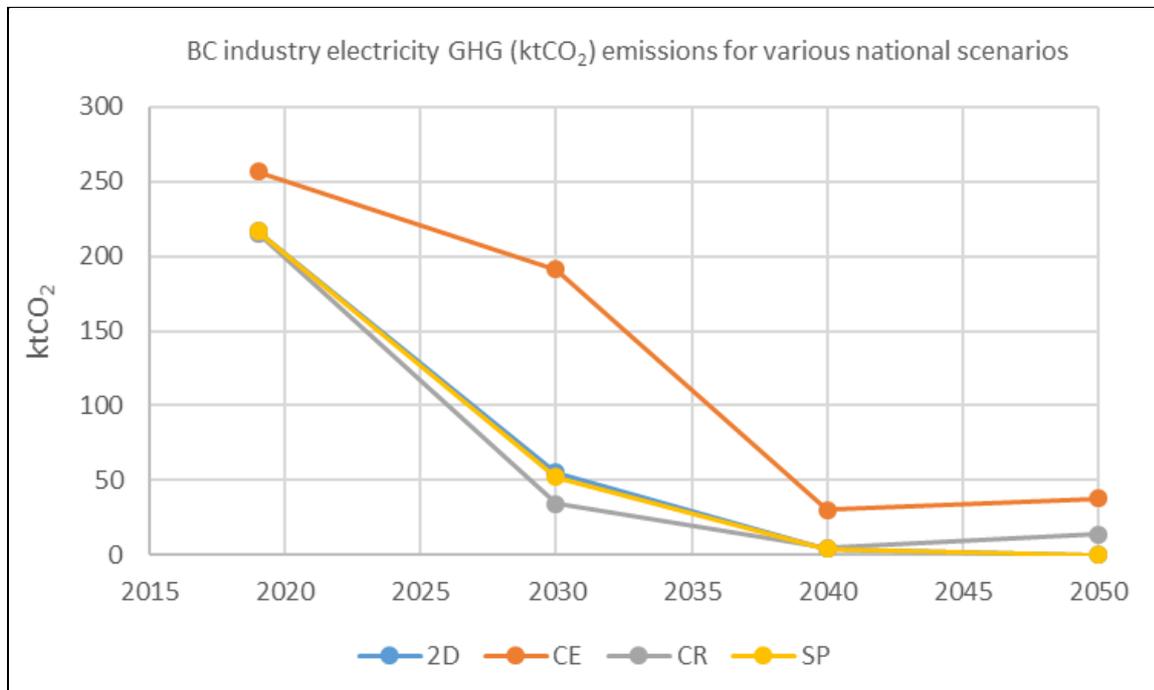


Figure 8 Decarbonisation of national electricity infrastructure in different scenarios (Source; University of Birmingham)

In almost all national energy scenarios¹¹ grid electricity is essentially zero carbon by 2040 and in most it is very close to carbon neutral by 2030. This will enable local energy supply activities to focus on generating zero carbon heat – specifically focusing on the activities currently powered by natural gas, solid fuel and oil (see Figure 7 and Figure 9).

The Black Country has a distinctive strategic advantage compared to many other industry clusters in that its industrial base is more flexible and re-configurable than clusters based around one or two single large operations. This means decarbonisation can be delivered via a series of smaller, more-easily fundable steps; offering a faster, lower risk approach.

¹¹ For this project, the University of Birmingham have reviewed the most recent future UK energy scenarios prepared by National Grid, the Energy Systems Catapult and the Climate Change Committee.

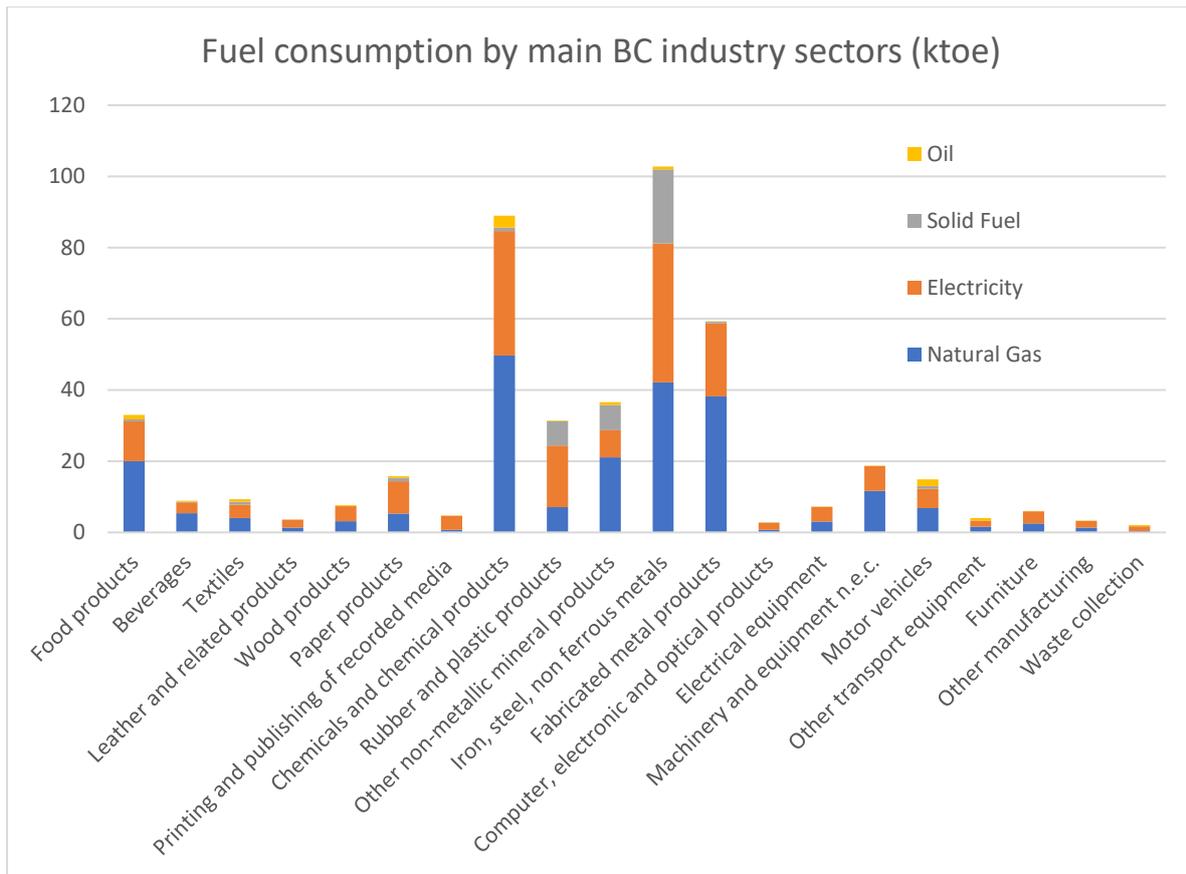


Figure 9 Black Country industrial fuel consumption by sector (2017 BEIS data, published 2019)

In addition to this, decarbonisation of the heavy industry clusters around the UK coastline will begin to generate significant quantities of carbon and hydrogen over the next 10-20 years. While some of this captured carbon will be put into long term geological storage and some of the hydrogen will be used within the coastal clusters, there is also likely to be an excess supply of both available for industrial use. The Black Country cluster will work with the other clusters as their plans develop to maximise the commercial potential for use of the available carbon in manufactured products and the hydrogen in energy generation and for zero carbon fuel.

An initial review of potential uses of carbon in manufactured products carried out by CR Plus for this project¹² (see appendix I) identified seven specific opportunities for using carbon in manufactured products:

- Carbonate mineralisation (carbonation)
- Concrete curing
- Novel cements
- Horticulture
- Polymer production
- Synthetic methane

¹² This work draws primarily on a report by Ecofys and Imperial College (2017)

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/799293/SISUK17099A_sensingCO2_utilisationUK_ReportFinal_260517v2_1.pdf

- Synthetic methanol
- Carbon nanotubes

These opportunities are at different technology readiness levels (TRLs) and this provides an immediate agenda for Black Country-sponsored academic R&D (Figure 10).

Table E.1. Summary of key information for the CCU technologies assessed.

Technology	TRL level	UK demand in 2030 (ktCO ₂ /yr)	Location factors and identified regions	Key barriers
Carbonation (via "Accelerated Carbonation Technology")	8	5-43 (excluding soil remediation projects)	<ul style="list-style-type: none"> o Key factors: availability of waste stream, CO₂ source, market access o Fly ash: co-location with concrete block manufacturers o Steel plants, cement plants, or other historical deposits plants: located at, or near to, the site 	<ul style="list-style-type: none"> o Availability of waste materials o Planning legislation o Long-term track record demanded by construction sector
Concrete curing	7-8	0-100	<ul style="list-style-type: none"> o Pre-cast concrete: installed at existing concrete plants o Ready-mix concrete: no specific location factors as building sites spread over the country 	<ul style="list-style-type: none"> o Long-term track record demanded by construction sector
Novel cements	3-6	0	<ul style="list-style-type: none"> o Located near to a port since we are unaware of any significant magnesite deposits in the UK 	<ul style="list-style-type: none"> o Long-term track record demanded by construction sector
Horticulture	9	108-218 (50 supplied via bulk market)	<ul style="list-style-type: none"> o Reliable source of all-year around CO₂ (and heat) o Possible co-location with waste-to-energy or biomethane plants o Identified suitable areas: East Yorkshire/Hull area, Lea Valley and Thanet 	<ul style="list-style-type: none"> o Limited types of industrial facilities that meet supply and quality requirements o Growers that have recently installed CHP systems are likely to have no (or limited) demand for industrial CO₂
Polymer processing	8	0-100	<ul style="list-style-type: none"> o Proximity to chemical industry clusters and downstream production processes using the CO₂-based polyols to provide opportunities for industrial symbiosis o Identified suitable areas: Teesside, Grangemouth, Fawley and Hythe 	<ul style="list-style-type: none"> o Lack of plants (even at large pilot scale) producing the polymers in the UK o Risk averseness around new products
Synthetic methane	7-8	0-18	<ul style="list-style-type: none"> o Access to low cost electricity (for H₂ production), potable water and gas connection that can accept the flow produced o Possible synergies with biomethane injection plants, bio-SNG plants, water treatment plants, fermentation processes 	<ul style="list-style-type: none"> o High costs associated with the synthetic methane process
Synthetic methanol	8	0-145	<ul style="list-style-type: none"> o Access to low cost electricity (for H₂ production), potable water o By-product H₂ from chlor-alkali production facilities (Runcorn) or coking gas from steel manufacturing (Port Talbot and Rotherham) 	<ul style="list-style-type: none"> o High costs associated with the synthetic methanol process o Restriction on blending levels o Lack of existing methanol fuelling infrastructure

Figure 10 Potential markets and technology readiness levels for novel carbon uses in manufacturing (Source: Imperial College and Ecofys9).

The Black Country project team has strong links to local academic institutions with strong track records and expertise and able to support this agenda. In particular:

- The European Bioenergy Research Institute at Aston University
- The Birmingham Energy Institute at the University of Birmingham
- WMG at the University of Warwick
- The University of Wolverhampton

3. How we will get there (ten-year plan)

Delivering this zero-carbon¹³ vision will require coherent and consistent enabling and facilitating actions over a sustained timescale.

The portfolio approach we propose – a large number of fundable projects taken forward within a supportive enabling financial and political context – will deliver faster and at lower overall risk than one or two large infrastructure investments. This is distinctive and highly complementary to the approach which will be necessary to decarbonise heavy industrial clusters elsewhere.

Our ten-year plan has two distinct elements: a public-sector-led enabling set of activities stimulating a private-sector-led large-scale deployment programme consisting largely of investment and industrial development by commercial partners (Figure 11).

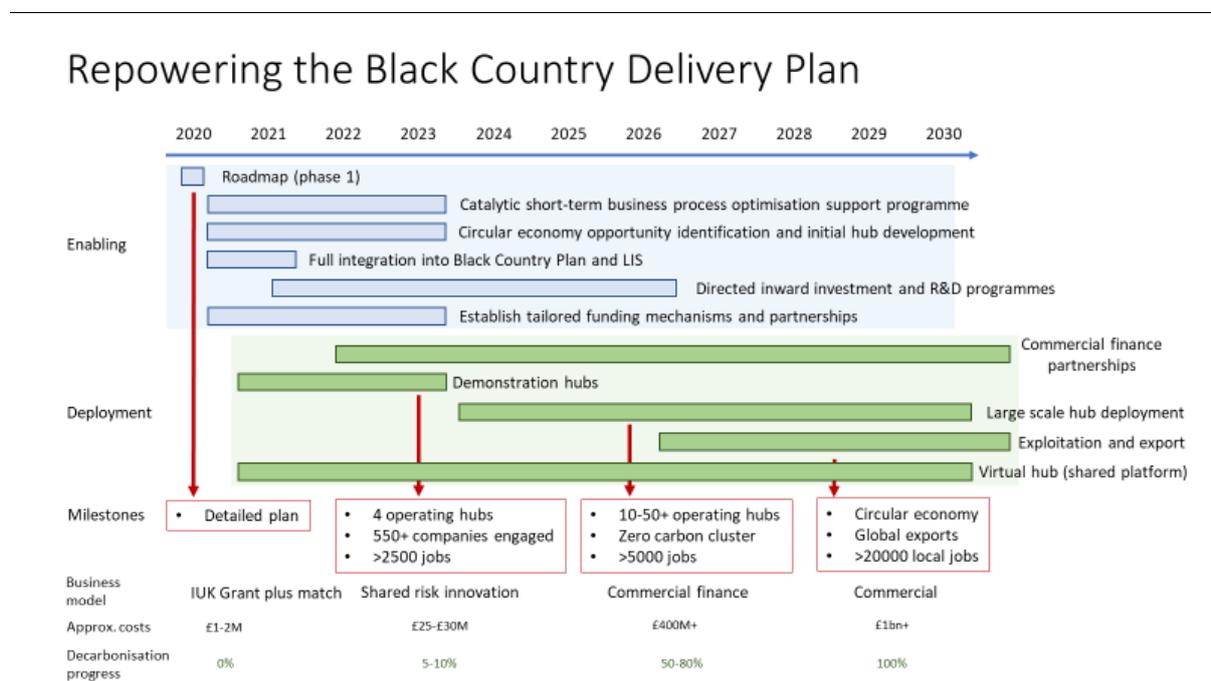


Figure 11 Black Country cluster 10 year delivery plan

Deployment

We anticipate requiring between 10 and 50 zero-carbon manufacturing/energy hubs across the Black Country (coupled with national electricity system decarbonisation) to deliver our target of becoming the world’s first zero carbon industrial cluster.

Each hub will typically be supported by an energy centre designed specifically to meet the collective manufacturing demand profile of the local circular economy and delivering between 15-30MW of clean heat and 4-8MW of clean electricity, with options on generating hydrogen fuel in addition (see appendix II).

These hubs will be deployed progressively on the most appropriate sites across the Black Country over a ten-year timescale. Each hub is likely to require in excess of £100M of investment by

¹³ The term ‘zero-carbon’ is used as shorthand for ‘net zero CO₂ emissions’ throughout this document. Re-use of carbon in manufacturing processes is an important part of the plans.

commercial partners and investors. Public finance will be used to catalyse investment on the first four hubs and facilitate engagement in the remainder. The first four hubs will be selected to act as demonstrators and to encourage large scale engagement in the vision.

These initial hubs will also act as 'shop windows' for the expertise and capabilities of the Black Country to the world. There are significant export opportunities for the low carbon energy generation technologies and circular economy approaches which will be deployed in the hubs, all of which will be easier to develop with strong local markets and demonstration sites in place.

A virtual hub will be used to capture interest and support decarbonisation of businesses outside the demonstration sites, particularly ahead of ubiquitous deployment of the hubs. This hub will enable manufacturing businesses to supply metered data and benefit from a range of cost- and carbon-saving measures tailored to their specific processes and sites, potentially ultimately including opportunities to trade capacity and carbon via an interactive platform. This hub will also act as a means to engage local businesses and potential inward investors in the project (see appendix III).

Enabling activities

The completed Roadmap Project (phase 1) has identified four key priorities to stimulate the large-scale private sector investment and commercial development required to deliver the vision (Figure 12). These are:

1. A structured approach to identifying circular economy opportunities appropriate to the Black Country's existing industrial base; and development and testing of a methodology for designing and facilitating the development of zero carbon circular manufacturing/energy hubs.
2. A catalytic and immediate programme of support to Black Country businesses, engaging them at scale in the vision and assisting them to optimise their processes to minimise carbon emissions and reduce energy costs.
3. Effective integration of the vision and hub development methodology into the spatial and economic plans of the Black Country, as well as wider existing economic, R&D and business support programmes and efforts to secure inward investment.
4. Establishing a portfolio of targeted financial mechanisms to support hub and cluster development.

The activities associated with each of these four priorities are described in more detail below.

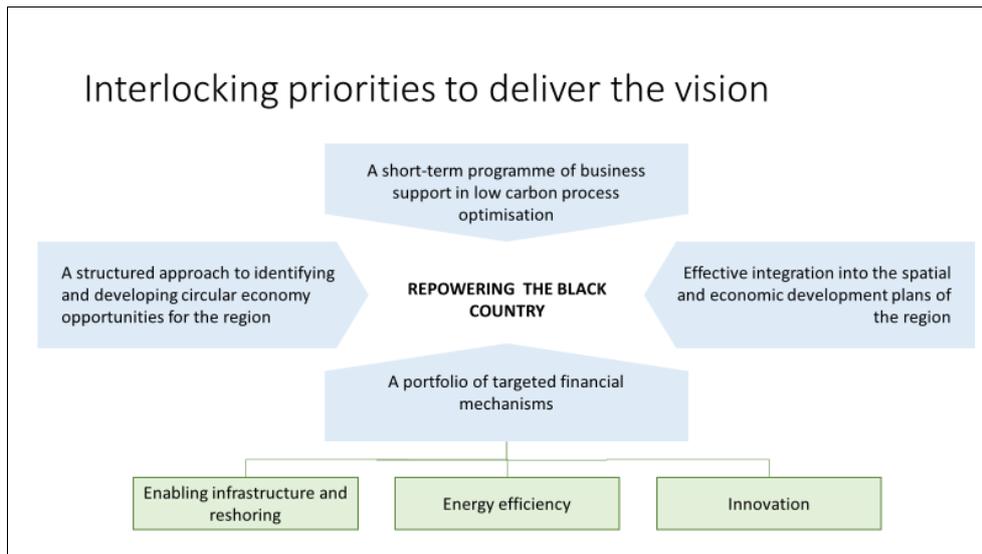


Figure 12 Enabling activities to deliver the vision

Development and testing of a methodology for zero carbon circular economy/energy hubs

Appendix VI includes an outline methodology for reconfiguring supply chains based on circular economy principles (Table 2).

Challenge	Approach	Investment Rationale
Local vs. Global sourcing	Investigate 'local-for-local' alternative to global sourcing and centralised manufacturing	From a global perspective, investing in smaller scale UK plants would create a 'distributed' approach, improving supply chain resilience and flexibility
Economies of Scope vs. Scale	Focus on the 'economies of scope' rather than the 'economies of scale'	A smaller scale plant but a great bandwidth of capabilities. This is inherent to the plant design through the integrated ability to recycle AND manufacture products.
Wide vs. Narrow bandwidth	Create 'bandwidth' through asset sharing, e.g. capacity and inventory	Creating an eco-system with other energy users to create closed loop system would enhance efficiency savings Opportunities for network-based competition such as joint ownership models
Multiple vs. Single options	Adopt a 'real options' approach to supply chain decision making	Mitigate future risk of availability of processed products (due to foreign controls and demand increases) by investing in additional secondary processing

Challenge	Approach	Investment Rationale
Old vs new sustainable business models	Adopting circular economy principles and embracing new technology to create new market offerings	Exploring different service offerings (such as life cycle management for automotive OEMs) would also support profitability Green site offers opportunities to exploit new technology (for effective plant running).

Table 2 New supply chain thinking and impact on investment decisions (Source WMG, see Appendix VI)

During the initial Roadmap development an aluminium reprocessing use case was developed (see appendix VI) and similar principles will be applied to develop further use cases which will act as the focus for additional hubs. These principles include:

1. Identification of an anchor industrial process ideally characterised by:
 - a. High embodied energy (or carbon) products and/or waste streams
 - b. Unnecessarily long or distributed supply chains
 - c. Existing or historical Black Country expertise and/or capacity
 - d. Clear opportunities for re-shoring (e.g., currently exporting raw materials and importing finished products)
 - e. Identified UK or UK-accessible markets
2. Iterative development of use case scenarios, working both with potential industrial partners and the energy hub design team (see Figure 13).

Outline approach

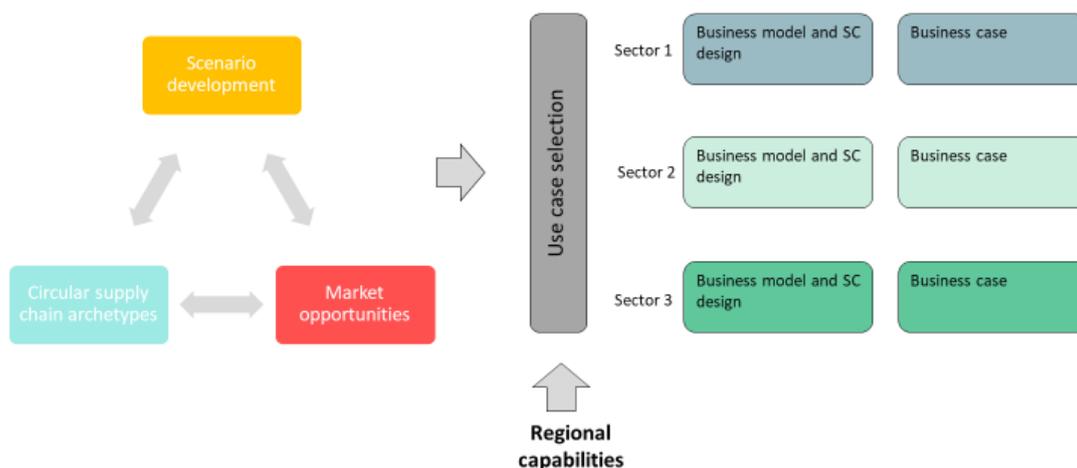


Figure 13 Outline iterative approach to developing circular economy opportunities

3. Systematic review of energy flows to identify complementary industrial activities and inform the circular use case development.
4. Matching the use case to the most appropriate and available shortlisted hub location (see appendix IV)

5. Drawing up an indicative development plan for the chosen location, working with local planners from both the local authority and transport and energy infrastructure companies.
6. Pro-actively seeking inward investment against this masterplan, working hand-in-hand with the tailored financial mechanisms and support funds designed for this purpose.

This process will be supported with a ‘pattern book’ of standard high-level energy hub designs (appendix II, Figure 14) and industrial operations which are generically-suitable for circular economy applications because they:

- require large volumes of relatively low-grade heat
- produce products which can be sold locally in urban markets
- are accessible and attractive to skilled Black Country workers

Good examples of such activities include:

- Urban horticulture (either industrial or community scale)
- District energy schemes
- Construction, chemicals and food processing activities involving drying or curing

Hub Parameter Matrix (indicative for Phase 1)

HUB	ACT / solid feedstock	Hydrogen electrolysis	CHP	Energy Storage	Power Gen	Heat Gen	Alt Fuels Gen e.g. H ₂	EV Charging	District Heat (+ export CO ₂ opp)	PV/ Wind/ GSHP	Heavy Industry Bias rating	Land Req
#1 – Kew Advanced Thermal Conversion	1		2	3	1	1	1	3	2		2	Variable as units modular. More space req for densification centre.
#2 – Conventional CHP + DHN			1		1	1		3	1		2	Variable as units modular.
#3 – Mixed Renewable (incl. Green H ₂)		1		2	1	3	2	3		1	3	Lower value (ex-land fill, rural)
#4 – High grade heat industry demand, export low grade residual heat	2			2		1			2		1	Smaller. Dependent on scale of heat
#5 – Energy Storage Focus with generation	2	2		1	3	3	3	3			2	Smaller if specific to EH

1 = Main aspect
 2 = Inclusion
 3 = some linkage

Figure 14 Standard hub designs (phase 1 indicative, see appendix II)

Urban horticulture is a particularly attractive opportunity and is likely to apply to many or all of the hub sites at different scales, so a scoping study for this activity specifically is included as an early deliverable within phase 2 of the project. An example of how a hub might include horticulture is shown in Figure 15.

engineering skills which are not available from traditional energy efficiency consultancies or business support programmes.

Moreover, the average Black Country business employs between 10 and 20 people (Table 1) which means that while it may have the manufacturing expertise to survive in its chosen market, it is highly unlikely to have expertise in manufacturing energy efficiency.

A high-intensity and highly targeted business support programme offering specialist energy efficiency and process optimisation support to Black Country businesses is therefore a fundamental element of the plan. Appendix III sets out the key components of this programme. They include:

- Free Energy Efficiency and Low Carbon Process Optimisation Strategic Review
- Technical and Management Support to help reduce energy consumption and establish plan to achieve net zero carbon status
- Access to Repowering the Black County's Virtual Zero Carbon Hub
- Access to targeted financing support
- Links to pilot Zero Carbon Hubs

The Virtual Zero Carbon Hub (VZCH) is an online system to accelerate uptake of zero carbon technologies amongst participating companies. It will include the following functionalities:

- Provision of a private, secure and easily accessible web-based space for each of the participating companies in the private dashboard area
- The collection and collation of data from intelligent meters and accurately calculating the level of CO₂ emission baseline and the reduction in CO₂ emission at each participant site, in the private dashboard area
- Sharing of regional and district energy maps, MSOAs and heat maps created by the Black Country Consortium with the stake holders for further development of Repowering the Black Country Project, in the public area
- Provision of network management; knowledge sharing amongst the participant companies and how to access and benefit from one of the regional Zero Carbon Hubs, in the public area
- Information collection and dissemination; provision of relevant information and data on zero carbon technologies and markets and repository of regional Energy Strategy and shared MSORA energy consumption and heat maps, in the public area
- The sharing of the development of the zero carbon technologies and systems as they develop from the Innovate UK's Decarbonisation of the Industrial Cluster programme at both Cluster Plan and the Deployment phases in the public area

The VZCH will support an ongoing engagement programme with local trade bodies, the Chamber, Make UK via events, conferences and direct marketing (see appendix III) and provide a mechanism for both capturing interest – particularly of companies outside the immediate circular economy opportunities and demonstration hub locations – and for inviting interest from potential external investors.

Effective integration into local strategic planning processes and programmes

The Black Country is planning to grow its economy from contributing £21.7bn (GVA, 2019) to the UK economy to contributing £37.7bn by 2030, an increase of £16bn¹⁴. The plans to reduce industrial carbon emissions to zero need to be effectively integrated into these existing plans, particularly the Strategic Economic Plan (SEP) and the Black Country Plan (which covers all four local authorities).

The plans for zero carbon hubs will also need to be aligned into the infrastructure development plans of the utility providers, particularly Western Power Distribution and Cadent Gas, the electricity and gas distribution network operators; and the transport infrastructure planners at transport for the West Midlands and in the Black Country local authorities. This is to avoid unnecessary and costly infrastructure investment by these different parties when the proposed zero carbon hubs will potentially change energy and transport demand and supply patterns significantly locally within the immediate strategic planning horizons of the various bodies.

In addition, to make best use of the considerable regional academic expertise in energy systems innovation (particularly the emerging hydrogen economy, energy storage and bioenergy) mechanisms for aligning academic R&D to industrial problems and commercial opportunities will be required.

A proactive capability to identify and secure inward investment and encourage reshoring of manufacturing is also a key part of the plan.

The primary mechanisms envisaged to achieve these objectives are as follows (Figure 16):

1. Designating the Black Country as an Energy Innovation Zone (EIZ) and resourcing this with a qualified energy infrastructure specialist (on the local authority side of the table) so the four local authorities can work collectively and constructively on an on-going basis with the energy network providers to align and optimise strategic investment plans.
2. Effective linkage into the Black Country Plan and implementation of the Strategic Economic Plan through the LEP governance mechanisms, primarily the Place Board.
3. Identification and training of a specific resource within the existing inward investment and growth hub teams to promote inward investment opportunities arising from this plan.

¹⁴ <https://www.the-blackcountry.com/economic-intelligence-unit/black-country-intelligence-reports/black-country-annual-economic-review>

Ensuring integration into strategic local plans

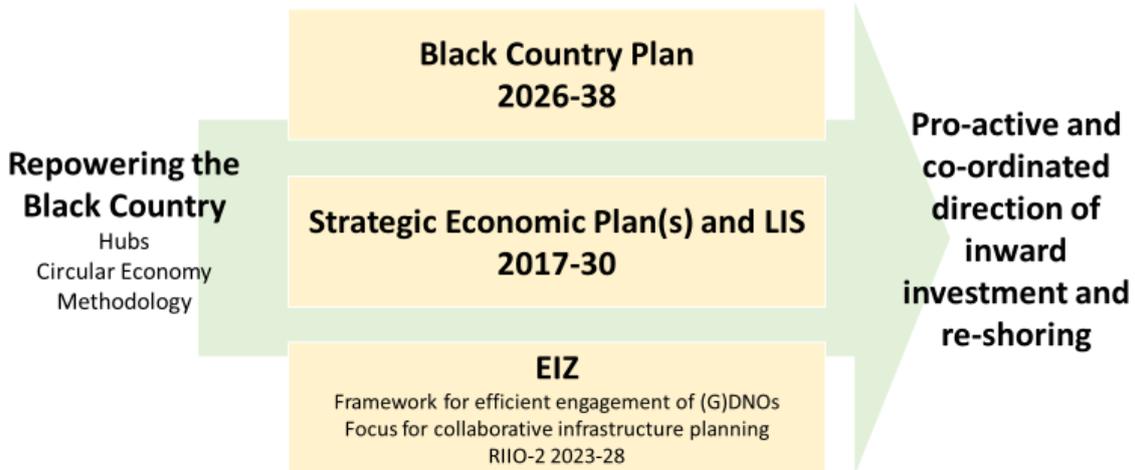


Figure 16 Integration into strategic local plans

Establishing a portfolio of targeted financial mechanisms

Accessible finance is fundamental to the success of this plan. Early indications from work in phase 1 are that the bulk of the plan should be fundable commercially, provided funds are available which match the risk profile and longevity of the investments required. In particular:

- the most important determinant of the attractiveness of local energy-related investments is the predictability and security of local demand – this is often largely under public sector control
- energy efficiency investments in any context tend to have long paybacks but are again relatively low risk
- a major risk for circular economy investments will be stranded assets (i.e., loss of a key participant in the value chain); to mitigate this some public underwriting or direct investment in enabling infrastructure is likely to be required
- there are significant opportunities for innovation (particularly commercialisation of innovations at scale) through this delivery plan. Investment in innovation is relatively high risk and high reward and typically provided by specialist funds
- reshoring and inward investment will be secured in competition with other ambitious regions globally. The ability to offer clean-growth-ready economic infrastructure is potentially a significant advantage but may require some strategic investment in enabling infrastructure at risk – the nature of this risk is primarily the timing of returns rather than their magnitude.

Given these characteristics, we propose to establish three distinct enabling funds with commercial partners to support this plan (Figure 17).

Proposed enabling funds

	Enabling infrastructure and reshoring	Energy efficiency	Innovation
<i>Nature</i>	Public funds to leverage private investment	Public grants and loans for equipment investments	Early stage venture capital
<i>Scale</i>	Initially £20M (£5M per hub)	£5M (Individual grants/loans up to £50k)	tba
<i>Risk characteristics</i>	Infrastructure risk (Low – but patience required)	Low risk, long returns	High risk, high return Risk reduced by RBC context
<i>Return potential</i>	Business rates Employment	Share of energy savings made	Equity
<i>Market failure addressed</i>	Unwillingness to invest in shared public infrastructure (public good)	Long paybacks inhibit commercial investments	High risk and novelty inhibits traditional capital

Figure 17 Proposed enabling funds

1. An enabling infrastructure fund. This will
 - a. Provide project development funds for early stage project development, specifically for hubs requiring investment by multiple private sector partners where the infrastructure will be shared
 - b. Invest strategically ‘ahead of demand’ in the zero-carbon circular manufacturing and energy hubs
 - c. Underwrite returns on circular economy and local energy infrastructure investments where there is a risk of stranded assets. This might include mechanisms for guaranteeing power and heat prices to companies locating on hub sites, for example.
 - d. Encourage reshoring and inward investment by providing flexible funds for land remediation and anticipatory (non-energy) infrastructure development where appropriate.
2. An energy efficiency fund. This will provide finance for businesses wishing to invest in low carbon process optimisation technologies, accepting longer-term returns than normal. The detailed structure of this fund will be developed as part of phase 2: there are a variety of established models available including energy performance contracts, lease finance, grants (typically matched by the company and up to around £50k) or loans accepting lower than market returns and/or longer payback times.
3. An innovation fund, specifically investing in companies seeking to commercialise innovations using the Black Country zero carbon hubs and energy innovation zone as their initial target market and platform for commercialisation. Because the fund will be specific to innovations deployed within the Black Country Energy Innovation Zone, the risk will be lower than normal for these kinds of funds given the guaranteed local market demand.

Governance and management

During the ten-year delivery of this plan, the objective is to move from a directed and highly-focused project management structure into a more diffuse governance structure where zero carbon clean

growth is effectively institutionalised in the governance structures across the Black Country and indistinguishable from everyday political and local government processes.

Three stages are envisaged.

1. Phase 2 Cluster Plan Delivery (2020-2023). A focused project governance structure.
2. Large scale deployment and replication (2024-30). Distinct organisational elements within existing local authority and LEP structures.
3. Institutionalised within on-going planning and governance mechanisms.

Initial (phase 2) project governance

The proposed initial project governance structure is illustrated in Figure 18 below.

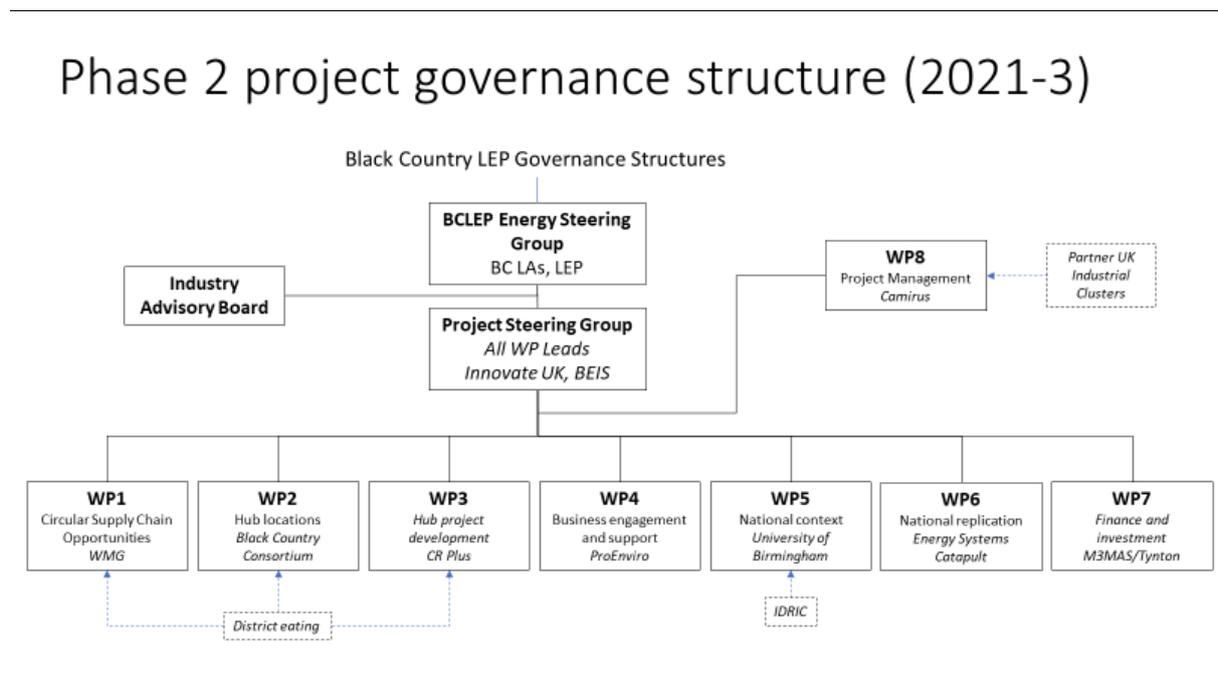


Figure 18 Phase 2 project structure

This is a continuation of the public-private partnership formed to deliver phase 1 of this project, with the addition of an Industry Advisory Board. Links to the other strategic clusters have also been formalised through membership of the Cluster Forum and a linkage to the Industrial Decarbonisation Research and Innovation Centre at Herriot Watt University is included.

The Industry Advisory Board will consist of a mix of established and strategic industry leaders in the Black Country (e.g., Liberty House, Thomas Dudley) and innovative businesses seeking to deploy new low and zero carbon technologies at scale (e.g., Adelan, Kew Technology).

Large scale deployment

An indicative structure to support large scale deployment and replication is shown in Figure 19. The intention is that by 2023 the project team will no longer be necessary and a more 'business-as-usual' structure will emerge. This will be a mix of industry networks and bodies; public sector teams facilitating and co-ordinating activity in areas where this would not otherwise occur; and commissioned programmes ranging from 100% publicly-funded or facilitated infrastructure projects (roads, shared heat networks etc) through to 100% private capital investment funds.

Indicative structure to support deployment (2023-30)

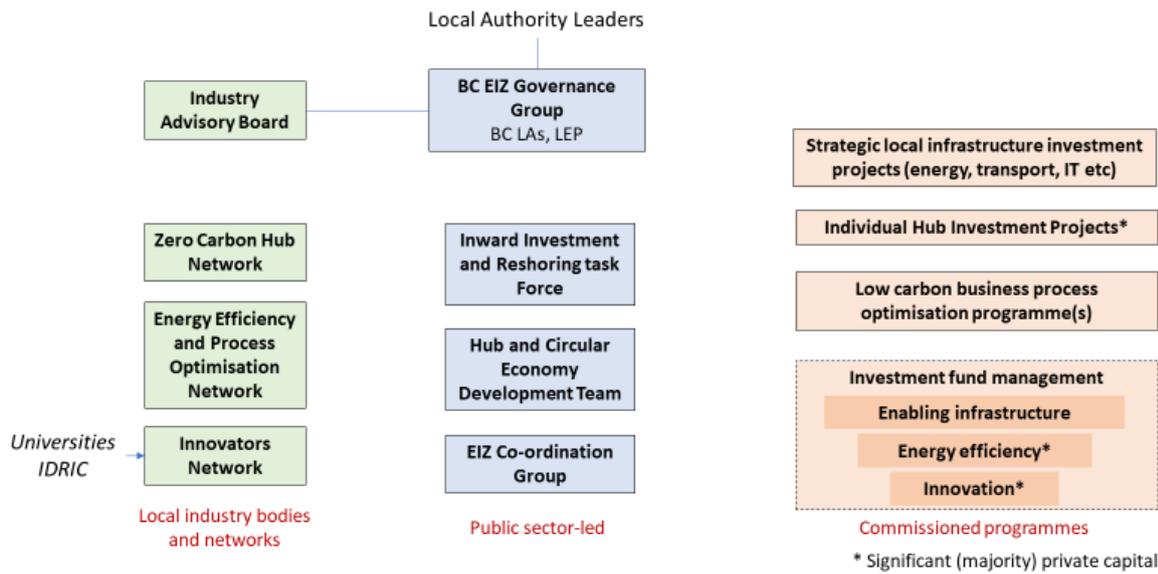


Figure 19 Indicative deployment structure 2023-30

After 2030 the expectation is that these activities will have merged completely into the wider investment, strategic planning and economic development activities of the Black Country, by when clean growth and circular economy approaches will have become an intrinsic part of both public and private sector cultures.

National replication

While the Black Country forms a distinctive and historic industrial cluster, with a clear identity, the 7000 energy-intensive businesses within the cluster are in many ways representative of the bulk of the UK economy (Figure 20). This means that circular economy and zero carbon energy approaches developed and applied across the Black Country through this plan potentially create a template for national replication and decarbonisation for industrial areas across the UK. The carbon reduction potential of such replication is of the order of 10-20M t CO₂e¹⁵.

Our intention is to work with national partners¹⁶ to ensure this replication occurs efficiently, in particular through the formalisation of methodologies, templates and toolkits, and through participating in knowledge sharing forums as appropriate.

¹⁵ This figure is estimated by extrapolating from the Black Country's 1.4 MtCO₂ to the ~20 LEPs with equivalent or greater numbers of manufacturing jobs (see Figure 20).

¹⁶ Principally BEIS, the University of Birmingham and the Energy Systems Catapult.

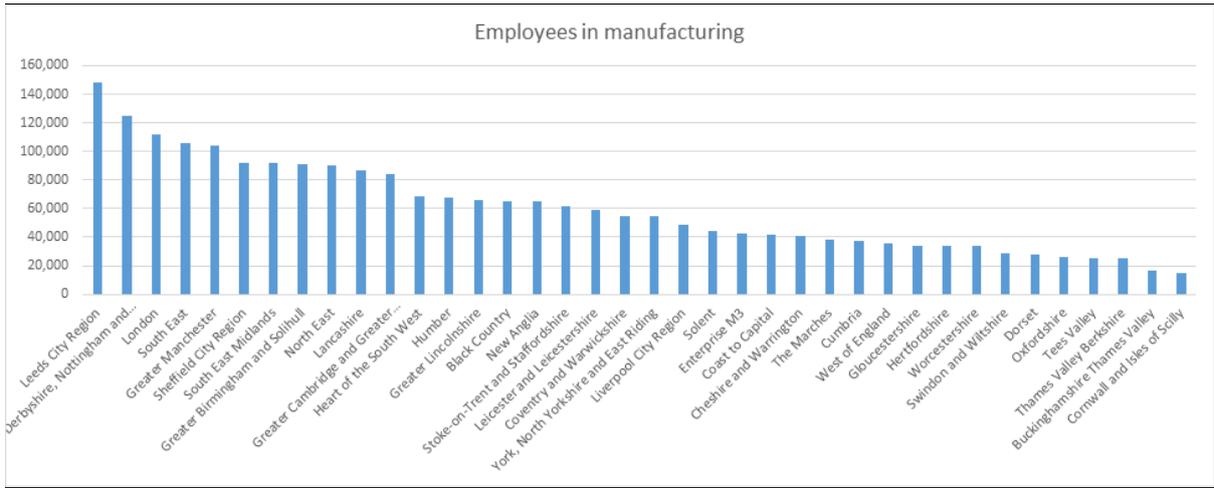


Figure 20 Manufacturing jobs by LEP

The Black Country Cluster will also work closely with the other strategic clusters around the coast, particularly those without easy access to carbon capture facilities (or suitable geologies) where there is potential for Black Country industry to use either excess carbon or hydrogen produced by those clusters (for example South Wales).

4. Immediate next steps

The project is seeking public funding for the enabling activities summarised above and in order to secure between £400M and £1bn commercial funding for the deployment activities.

We have been invited to bid for up to £1.5M via the Innovate UK competition for phase 2 cluster planning. This would fund the core project team from January 2021 to December 2023 to carry out the initial project development activities and secure seed funding for the three funds identified in section 3.

However, this approach leaves an unnecessary six-month gap and creates a delay in the programme, so we are also applying directly to government for £30M funding to eliminate this delay and enable us to progress the project faster. This funding is broken down as follows:

1. Acceleration and gap funding to keep the project team in place July-Dec 2020 (before phase 2 Innovate UK funds available). <i>This will enable the whole programme to deliver at least six months faster than otherwise.</i>	£0.5M
2. Business support programme to provide low carbon process optimisation to existing Black Country manufacturers over three years. <i>This will support more than 500 Black Country manufacturing businesses to reduce energy costs and carbon emissions.</i>	£2.8M
3. Enabling funding for four pathfinding zero carbon energy hubs, including aluminium reprocessing at Phoenix10 (4 * £5M). <i>This funding will support pre-investment project development; relocation and re-configuration of supply chains: in addition we would expect each hub to attract a minimum of £100M private investment.</i>	£20M
4. Section 31 award of phase 2 Cluster Plan funding for central team 2021-23. <i>This will enable the Black Country Consortium and LEP to manage the programme and ensure it is effectively integrated into local authority plans and replicated nationally.</i>	£1.7M
5. Grant and revolving loan fund for energy efficiency investments in manufacturing firms (low interest, long payback). <i>This will enable businesses to act on expert advice and invest in energy efficiency projects; it will offer capital grants and loans of up to £50k to eligible businesses and be used to incentivise engagement in the programme.</i>	£5M
Total	£30M

Table 3 Budget breakdown for immediate next steps

Detailed budget breakdowns for each of these elements are available separately.

An initial estimate has been made for project development costs at Phoenix 10 using a stage-gate-based Front-End Loading (FEL) methodology (see Appendix VII and Figure 21)¹⁷. This shows how the £20M enabling funding has been estimated based on each of four hubs requiring similar support to Phoenix 10.

¹⁷ This methodology is widely used on very large capital investment projects to minimise risks.

FEL stage	Budget cost estimate
Stage 1. Preliminary studies	£843,500
Stage 2. Business models and specifications	£1,638,875
Stage 3. Contracts and common infrastructure	£1,833,125
Contingency and shared infrastructure investment	£584,500
Total per hub	£5,000,000

Table 4 Hub Development and enabling costs

+ Front End Loading

Front End Loading: a methodology to assess projects, minimising expenditure stage by stage to determine Risks & Opportunities, ensuring maximum understanding....

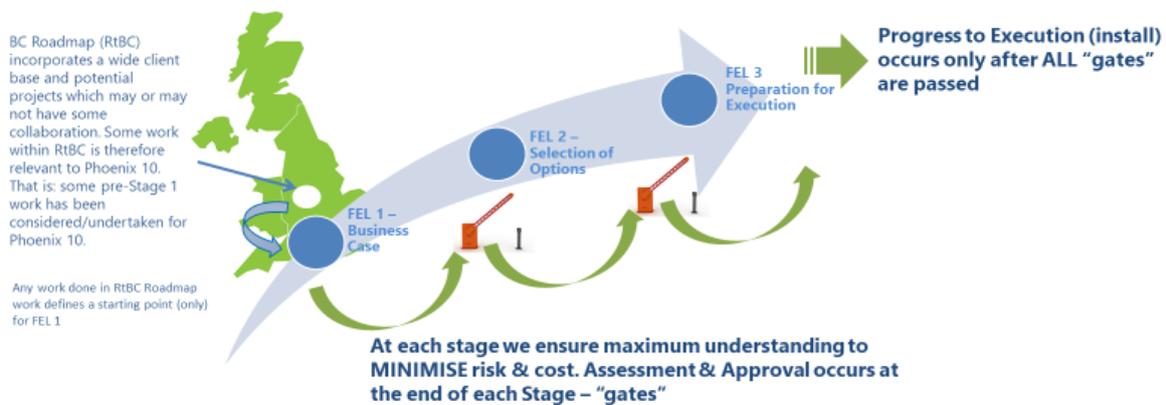


Figure 21 Front End Loading (FEL) formal project methodology

In practice, each hub will be different and these costs will vary. The proposal is that any savings in professional fees and development costs are made available for a shared infrastructure investment and enabling fund. This can be used to pay for capital enabling works on the hub site and underwrite investment ahead of demand in shared infrastructure - for example, electricity, gas or heat networks, or transport infrastructure. It can also be used to mitigate the risk arising from stranded assets if any elements of circular supply chain networks locally fail¹⁸

Particularly in the context of hub masterplans based around circular supply chains (i.e., with multiple investor partners and/or tenants) this enabling fund structure can be used to create incentives for collaborative behaviour. For example, by minimising professional project development fees and sharing data, more funds are made available for shared infrastructure investment and underwriting longer-term risks.

We anticipate this level of funding will leverage a minimum of £400M private capital and create 2,550 jobs (safeguarding a further 2,200). These figures relate to the first four demonstration hubs only (2021-23). A successful roll-out to at least 10 further hubs by 2030 will deliver or safeguard a further 10-15,000 jobs and leverage £1bn of private investment.

¹⁸ For example, if a significant customer for low grade heat leaves the hub the supplier of that heat will lose a revenue stream. A shared fund could potentially underwrite or insure against losses until a new customer is found.