

# Connected Clusters

## Landscaping Study

Clustering innovation to create  
thriving and prosperous  
low-carbon cities and regions



# Partners

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**Disclaimer:**

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**Prepared by the University of Birmingham for and on behalf of Climate-KIC**

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# Foreword

The ConnectedClusters project is at the start of an ambitious journey to discover how to unlock climate innovation whilst delivering renewal and clean growth in communities across Europe.

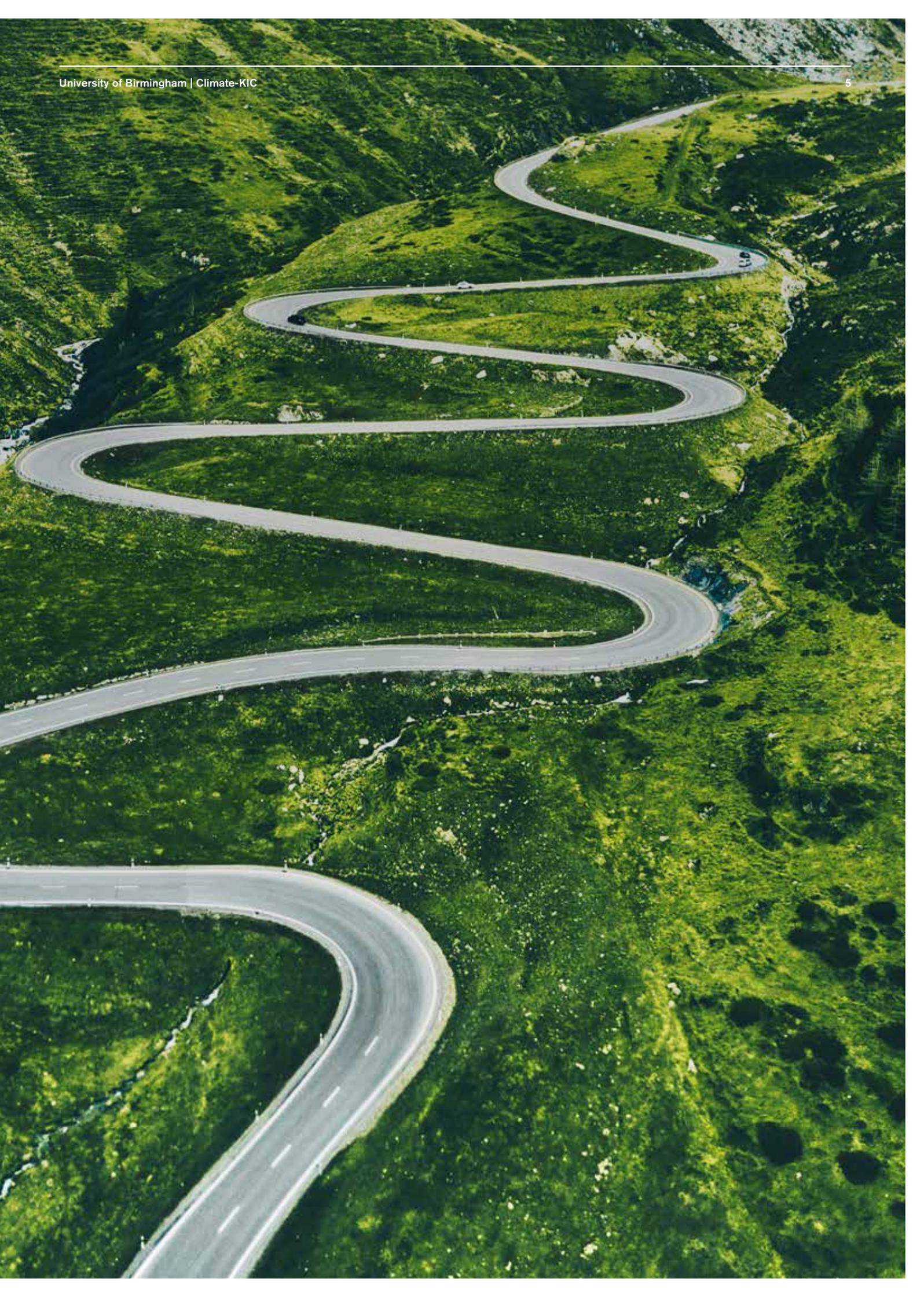
This study presents evidence from five dynamic, city region-based climate innovation clusters. Here businesses, academics, communities and government work together to deliver low-carbon innovation. We believe this concentration of resources, expertise and initiative is our best chance of meeting the Paris climate targets while also reaping social and economic benefits that come with the development and delivery of cleantech solutions.

Climate-KIC's ConnectedClusters project is an alliance of five city regions – Birmingham, Edinburgh, Frankfurt, London and Valencia – committed to sharing, replicating and scaling what works in developing innovation ecosystems for delivering effective climate action.

Between now and 2020, the project will work hard to accelerate and enable transformation of the places we live into clean, prosperous and thriving cities and regions by developing new collaborative approaches to technology, procurement, investment and training.

ConnectedClusters will help inform a transition away from product and technology innovation in isolation, towards a systemic, regionally-embedded approach to climate innovation. Paris shows that for our continued prosperity, transformation on a scale never witnessed before is imperative. Only by working together can we achieve that change.





# Introduction

Climate-KIC's ConnectedClusters project is an alliance of five cities – London, Edinburgh, Birmingham, Frankfurt and Valencia – committed to sharing, replicating and scaling what works in delivering effective climate action.

The paper 'Stimulating the Growth of Climate Innovation Clusters'<sup>1</sup> spearheaded Climate-KIC's Climate Innovation Insight programme, opening to the public the wealth of knowledge within and surrounding Climate-KIC regarding the development of innovation clusters and tackling climate change. The report's main conclusions were that:

- The current pace of climate innovation<sup>2</sup> is too slow to avoid dangerous climate change
- Climate innovation clusters have a vital role to play in increasing the rate of change to a low-carbon, resilient society and bringing local economic benefits
- Successful climate innovation clusters are most likely to grow where certain 'ingredients' are present – and the 'recipe' involves investment in research and development (R&D), a 'whole society' approach and strong national regulatory frameworks
- Some cities with these ingredients offer particularly good opportunities for climate innovation clusters to evolve, but even here, success is not guaranteed
- Stimulating climate innovation clusters should be the foundation of the economic development and sustainability plans of governments at all levels

In many ways, the present report is a sequel to that piece, as whilst it identified the factors which help *initiate* cluster growth, we seek to examine which factors *maintain* and *accelerate* clusters' growth. This proceeds through a deep dive into the five innovation clusters, each with a very different context and history, taking part in this project. It seeks to extract the lessons learned in each case to provide case studies which other evolving and established clusters can draw upon.

This mirrors the journey that Climate-KIC has been undertaking, as it begins to move from a focus on individual product innovation to a recognition that systemic change is required, particularly when seeking to tackle major societal challenges such as climate change.

The concept of business clusters, originates in the work of Porter (1990)<sup>3</sup>, however, the concept of the 'economics of agglomeration' dates back much further. Core ideas in economic geography postulate that firms in a similar sector benefit from co-location in a region, due to a variety of factors such as economies of scale and network effects.

Porter suggested three mechanisms through which clusters affected competition – by increasing productivity within clusters, by stimulating innovation and by acting as a catalyst for the creation of new firms.

Clustering is well established in economic literature, though relating mostly to industrial rather than innovation clusters. It has become even more prevalent in recent years as industrial strategies attempt to engage more dynamically with pre-existing endogenous assets, especially with the concept of 'smart specialisation' – building on a region's existing competences and infrastructure, and translating these into effective innovation strategies.

Subsequently, this landscaping report undertakes mixed-method analysis of five innovation clusters: the Edinburgh Centre for Carbon Innovation (ECCI)<sup>4</sup>, Energy Capital (EC)<sup>5</sup> in Birmingham, Cleantech London<sup>6</sup>, Provaldis School in Frankfurt<sup>7</sup> and the Asociación Valenciana Empresas Sector Energía (AVAESSEN)<sup>8</sup> in Valencia. We aim to gain a top-level insight into the dynamics of cluster growth, exploring the narratives of each cluster and analysing their key developmental factors. This is followed by the identification of areas of commonality whilst differentiating areas specific to certain cluster types. We hope that this report will act as a springboard for introspective analysis from the clusters involved, as well as acting as a toolkit for those seeking to develop and maintain innovation clusters of their own.

**Climate-KIC, in its work to accelerate place-based innovation, has supported the initiation and growth of climate innovation clusters.**

### The Climate-KIC definition of a climate innovation cluster<sup>9</sup>:

A dynamic mix of start-ups, SMEs, larger businesses, research organisations, investors, business angels, community actors and public bodies which are:

- Physically located close together (eg, in a city)
- Committed to co-learning and co-creating innovation on a specific climate-related challenge (eg, of a city)
- Focused on turning ideas into solutions that are positive for the climate and the economy

### This place-based, demand-led approach to innovation offers many layers of benefits for cities and regions.

Clusters bring local economic growth and jobs, the ability to respond quickly to demand for low-carbon and adaptation goods and services at home and abroad, and a framework for achieving national and international climate targets.

Climate innovation clusters provide the framework we need for a joined-up approach to tackling climate change and regional economic development, and for unlocking the momentum inherent in that combined challenge. Collaboration between these clusters will also facilitate the sharing of expertise and knowledge based on the relative strengths emerging in each cluster location.

They also provide bridges by which skills development and new and emerging businesses may move rapidly between innovation ecosystems allowing the fast and efficient transfer of successful ideas and solutions. Evidence shows that radical and fast-paced innovation is most likely achieved through dense, geographically-concentrated clusters of companies, start-ups, researchers and community groups, backed by supportive public bodies and policies. Such innovation clusters can become engines of local economic growth and create profound impact nationally, regionally and globally.

There is now a clear understanding of what makes a successful cluster, including leadership, critical mass and local and national government support and investment. However, turning this reality into practice, across the spectrum of stakeholders required to leverage benefit from a local cluster, is less well understood. The OECD<sup>10</sup> has identified several 'critical success factors' for clusters: building on pre-existing assets; leadership in the public and private sectors; leveraging of investment; cluster initiatives to facilitate networking; and 'externalities' such as human capital, skills and quality of life.

At the same time, they also note a number of risk factors: 'wishful thinking' (where there is significant investment, but no market); 'lock-in' of particular clusters/technologies, preventing diversification; excessive specialisation; insufficient differentiation to other locations working on the same issues; administrative boundaries creating a 'closed approach'; the lack of a skilled workforce; low access to innovation finance; and poor policy coordination. This is echoed by the Climate-KIC Insight Series<sup>11</sup> on climate innovation clusters, which identifies some additional ingredients that are critical for success.

# Report Aims

We know the ingredients required for cluster formation, but not what type of **relationships** are required in order to form an effective cluster. These also vary in line with the innovation capacity and political framework specific to each region. Examining a diverse portfolio of clusters allows us to identify common factors in accelerating cluster development in order to promote rapid innovation.

This report aims to review some of the aims of the ConnectedClusters project:

- Understand the challenges and opportunities involved in creating a climate innovation cluster and why they are created in the first place
- Test out ways in which these challenges can be overcome, and opportunities taken advantage of, by clusters
- Create and share guidance and insights on how to make the conditions for a successful climate innovation cluster a reality, including successes and failures
- Boost the capacity and effectiveness of the project partner clusters in their context
- Generate an education programme that trains people based in EU city-regions to build and lead successful climate innovation clusters
- Build a network of European climate innovation clusters and help them to collaborate and share insights and resources
- Explore the co-development and sharing of a new concept of clusters/clustering innovation
- Export the knowledge of climate innovation clusters across Europe so that others can make the shift and contribute to the Paris Agreement goals and subsequent UN climate meetings



# Report Methodology

The research was conducted using a qualitative mixed methods approach. A desk review was first undertaken to examine all of the five clusters. A questionnaire was constructed, which was piloted with one cluster and then completed by the others. This aimed to capture the key ingredients of the cluster, its main stakeholders and its evolution over time.

The questionnaire further probed vision, aims, services and structure with some scope for narrative. The narrative section breaks down into three phases: *creation* – the phase during which the cluster and its original vision and purpose is proposed and subsequently adopted by an initial group of actors; *growth* – the phase during which the cluster gains critical mass and begins to work towards its goals; and *maturity* – the phase during which the cluster has successfully completed projects and evolves its ideas and processes in order to keep pace with opportunities and challenges.

This was then followed up with semi-structured interviews were conducted with key stakeholders in the clusters both at the cluster locations and by telephone and Skype. The research also looked to uncover what role institutions (local government, universities etc.), businesses, funding frameworks, community institutions (traditions, local practices etc.) and regional demand played in the cluster's establishment and growth.

The initial findings were assembled into a draft report, which was then circulated internally for discussion at a ConnectedClusters workshop, held in Frankfurt in October 2018. This shaped the final Landscaping Study, which was completed in January 2019.



# Connected Clusters

## Location of the ConnectedClusters

- 1 AVAESEN**  
Valencia, Spain
- 2 Cleantech: London**  
London, England, United Kingdom
- 3 Edinburgh Centre for Carbon Innovation (ECCI)**  
Edinburgh, Scotland, United Kingdom
- 4 Energy Capital**  
West Midlands, England, United Kingdom
- 5 Provadis School**  
Frankfurt, Germany





# AVAENSEN – The Valencian Region Cleantech Cluster

## Introduction

The cluster established in Valencia has been held up as an exemplar of an innovation cluster, which has been through several cycles of development before establishing a collaboration and operational model which has secured its sustainability. AVAENSEN was founded in 2006 with the aim of representing, promoting and supporting the energy sector of the Valencian community.

Its creation was intimately linked to the regional establishment of sustainable energy as a powerful industry. The prime focus was on solar energy but also with wind energy as a fundamental source of energy in the Spanish energy mix. Though typical of Spain in general, this energy mix was a particular industrial focus of the Valencia region.

From a modest beginning, there was a strong conviction by the founders of AVAENSEN that they should do everything possible to bring together a whole sector with one voice. This has led them to become a group of more than a hundred associates that represent the entire value chain of the complex world of energy. This coherence and scale has become their strength.



## Development of the cluster

### Creation

In 2006 the AVAENSEN cluster was established out of the willingness of companies in the energy sector to collaborate by creating a physical location in order to attract new members. The initial aims were to act as a spokes-body for businesses within the sector, an idea which was also strongly supported by regional government, creating an effective lobby. It faced challenges in how to brand itself, how to navigate the composition of the sector and how to position the sector into the future. It overcame this initial set of challenges through communication, conferencing, publicity, involvement in regional government and creating and sharing business opportunities.

### Growth

The cluster continued to grow for twelve months. At its peak, the cluster had 235 companies. However, in 2007 Spain entered a recession associated with the 2007–2008 financial crisis. This set the tone for the cluster's subsequent development. The financial crisis meant that government at all levels had to undergo budget cuts. Regional government in Spain is responsible for running and financing most of the local services, and subsequently they accrued a large amount of debt, which meant that significant budget cuts were instigated. This was mirrored at the national level.

This meant that the cluster, which up until this point had been reliant on funding from both national and regional government, faced a budget crisis of its own. In order to cut back on expenditure, government funding for clusters was stopped completely in 2012. Funding for the renewable energy sector was subjected to a series of cuts in 2008, 2011 and 2013, with 20 years' worth of forward funding being slashed from the pipeline. As a consequence of this evaporation of government support, international investment and pension funds lost confidence in the Spanish renewable energy sector and ceased to invest.

This complete change in confidence in the renewable energy sector led it towards severe decline. At AVAENSEN alone, the number of member SMEs fell from 235 to less than 100. In 2013, the new incoming manager, Bianca Dragomir, inherited a workforce of two employees, a bank account with €1,000, a total debt of €600,000 and a cluster funding model dependent on government funding that no longer existed. The solution to ensuring the cluster's survival was to simultaneously tackle the immediate issues of saving its members from collapse whilst saving the cluster organisation itself from collapse. The actions taken were twofold; first the funding model was changed, and secondly business creation activities were prioritised.

The funding model was converted from a public-private partnership reliant on subsidy to a self-sustaining service provider.

This was achieved by administering 'Tailored Action Plans' (TAPs). The TAP model was fee based; SMEs paid the cluster on a 'no cure, no fee' basis. The cluster assessed the SMEs' interests, needs and future plans and subsequently presented them with what the cluster could offer them: context, a personalised agenda, funding advice, innovation and internationalisation opportunities, all based on their specific profile. SMEs were also given the opportunity to attend meetings with ten different potential partners. To date, no SME has requested a refund, and the cluster has been able to finance itself in a self-sustaining manner.

Business creation had to be prioritised at AVAENSEN, as otherwise the base on which it was built would have ceased growing, leaving it with no-one to supply expertise and support services. In order to rebuild the regional, innovation-driven, cleantech sector, the cluster launched Spain's first cleantech accelerator. Through the Climate-KIC Accelerator Programme this has grown in number and scale year on year. Now in its fifth year, it operates on a national scale. AVAENSEN went on to become the leading partner of the world's largest green business idea competition, ClimateLaunchpad.



Having righted itself and successfully remained afloat, AVAENSEN pushed itself further to cement its future. This was achieved by diversifying the portfolio of businesses supported by the cluster, as well as aiming to ensure that policy was more supportive of clean energy and technology. These latter changes were mandated by the fact that the Spanish government had performed a complete U-turn on renewable energy policy, specifically surrounding solar panels. Solar feed-in tariffs, which were previously high, were completely slashed, meaning that households could only consume what they generated. The government then placed a 7% tax on the electricity generated by those panels – known as a ‘tax on the sun’ – that actively, and remarkably, penalised self-consumption, effectively undermining any shift towards renewable energy.

The closure of the domestic energy market drove the diversification of the cluster’s portfolio. As renewable energy was no longer accessible, green businesses became more cleantech-orientated. In order to attract enough funding from its fee-based model, the remit of the cluster was expanded to cleantech more generally.

Presently, AVAENSEN caters to over 160 energy-related SMEs, capturing over 80% of the Valencian energy sector. This covers 6,000 employees and an aggregated turnover of €3 billion. Additionally, as SMEs are effectively shut out of the domestic energy market, the cluster has focused on helping their members to internationalise. The progress is extraordinary with 80% of AVAENSEN’s member SMEs being active overseas.

The development of the Valencia cluster, built around the membership model coupled with the ability to shift focus and priorities, has been to its success. It has avoided lock-in and has created a business model which would appear to ensure sustainability – and exemplar status.

#### Maturity

Having secured and diversified the businesses it serves, the cluster has turned to new horizons to further drive the sector’s growth. It is currently engaged in policy shaping linked to renewable energy, and has set up new markets for its members through the creation of the SmartCities Think Tank.

The closure of the energy market in Spain has been due to a lack of support and protectionist policies instituted by the Spanish government endorsed by monopolistic major energy companies. The ‘tax on the sun’ has been the major lobbying focus for AVAENSEN, which has helped secure concessions through successful lobbying at the regional level. Given that Spain has the highest electricity prices in Europe, with 38.5% of Valencians suffering from fuel poverty in 2016 and with many hours of sunshine per year, the argument for the introduction of solar energy to the grid is exceptionally strong.

As a result of the political pressure, the Valencian regional government has agreed it will provide a partial compensation to the ‘tax on the sun’ – a major achievement as it is directly in opposition to national policy. Another major achievement in lobbying has been in the wind power sector. Valencia was to be home to just over €1 billion worth of investment from large multinationals in wind infrastructure, but the development collapsed during the financial crisis.

A large tract of land set aside specifically for the development has lain unused since. AVAENSEN gained agreement from the regional government to free up this land. This has opened the possibility for small communities and SMEs to use wind energy for their own self-consumption. Whilst the political will is present, the cluster will still need to manoeuvre through national government to ensure that the land is opened up for tender. Nevertheless, the political influence of the cluster has been crucial in driving local developments.

The final major success for AVAENSEN has come from its SmartCities Think Tank. Best described as a ‘cluster within a cluster’, the think tank brings together both pre-existing cluster members and external members from academia, regional government and business, with these external members paying an entry fee. The think tank is based very much on the TAPs model. The cities present the challenges they face, AVAENSEN then proceeds to understand which of the think tank’s members would be best suited to meet these needs, within the portfolio of SMEs, start-ups, corporates and research.

The selected think tank members then meet with the Mayor and Councillors of the city, and they run a co-creation meeting, helping to draw out an overall roadmap to achieve the city’s ambitions.

Subsequently the city might develop a tender for the plan formulated. This linkage between demand and supply, stakeholders and problem solvers has made the SmartCities Think Tank extremely successful already.



# Cleantech London

## Introduction

The Mayor of London set an ambitious target for London to be a zero-carbon city by 2050 and for it to be recognised as one of the global cities that has headed the transition to a low-carbon circular economy. The Mayor is leading a programme across London, Cleantech London, to help create a coherent and connected cleantech business community by bringing together leading academic, technical, financial and business expertise to help drive the development of the sector.

Cleantech London seeks to provide a centre of excellence for London's cleantech businesses. By harnessing London's powerful capacity for innovation, this provides a coherent voice for the sector which will help accelerate the growth of the cleantech community so that world-class and high-growth business can flourish.

London's low-carbon environmental goods and services sector currently generates around £30.4 billion annually in sales. Some 10,900 businesses employ 192,416 people. Although the capital has the UK's greatest concentration of green businesses and is growing at around 6% a year, that is still just over half of the global growth rate.

London is a city covering 1,572 km<sup>2</sup>, and is home to around 8.7 million inhabitants.

Combining the city's size with its status as both a capital city and a financial centre creates both opportunities and challenges. A GLA-commissioned report (Arup, 2016), looking at the smart city market opportunity in London<sup>12</sup> identified that by 2020 the market could be worth £10.7 billion a year and £4.5 billion of that could be in environmental services, with energy accounting for £1.7 billion, water £1.4 billion and waste £1.4 billion.

It also concluded that London has real strengths that can support the development of the new sector and create economic opportunities for the capital's businesses. These include local energy systems, smart energy solutions such as demand-side flexibility coming from London's tech sector, research and development activities and £50 million in finance to stimulate adoption of circular economy principles by the capital's businesses.

The circular economy opportunity for London is huge. A route map produced by the London Waste and Recycling Board estimates that transitioning to a circular economy could add £7 billion to London GDP annually by 2036 and generate 12,000 additional jobs. The route map contains, short- medium- and long-term actions that the public and private sector can take in the built environment, food, electrical products, textiles and plastics sectors that could contribute £2.6 billion of the £7 billion potential identified.



**London's strengths include:**

- Leadership in the UK's low-carbon and environmental good and services sector, representing about 20% of the overall UK's market with respect to sales.
- Its high concentration of inventive and entrepreneurial talent – London is home to the UK's largest concentration of cleantech businesses and London and the South East represent 42% of the UK's cleantech sales.
- As of 2017, London was home to 29 incubators and 81 accelerators, more than any other region, and 15% and 58% of the national totals, respectively. One third of the UK's green patents originate from London.
- Its world leading position in financing and business services – the UK, and especially London, is recognised internationally for its market-leading expertise in green finance. A UNEP study stated that the City of London helps to develop 'sustainable finance initiatives that are setting the agenda both domestically and internationally'.
- Its world-class knowledge and research institutions, with 40 universities and university colleges and 80 departments focusing on various elements of the low-carbon and circular economy.
- The scale of its own market with almost 9 million people, 3 million homes, and 300,000 businesses employing 5 million people.
- Its leadership in terms of its environmental policy and targets, for example its target to be zero-carbon by 2050, and its experience of delivering low-carbon, sustainable infrastructure projects such as the 2012 Olympics and Crossrail.



## Development of the cluster

### Creation

The London Sustainable Development Commission (LSDC) was set up in 2009 to support the Mayor’s commitment to sustainable development and help develop London’s low-carbon circular economy. The Commission is now advising the Mayor on ways to support the cleantech sector and make London a world-leading location for low-carbon circular businesses.

The report ‘Better Future: A Route Map to Creating a Cleantech Cluster in London’ was released by the LSDC in 2016<sup>13</sup> and provided the roadmap to creating the London cluster, now known as Cleantech London, creating the underlying principles enabling innovation to flourish.

### The LSDC’s current cleantech and innovation priorities are:

- Advising the Greater London Authority (GLA) on the cluster’s development
- Providing recommendations for actions that would speed up and strengthen the development of cleantech in London
- Providing recommendations for actions that would attract more women into the sector
- Acting as the Advisory Board to the Mayor’s Better Futures project
- Helping to raise the voice and profile of London’s cleantech community

Central to the report are three key locations: Imperial White City (IWC) campus, and Old Oak and Park Royal, which come under the Old Oak Park Royal Development Corporation (OPDC). The IWC campus seeks to become a multidisciplinary hub for innovation and entrepreneurship, home to both academic research and the translation of this research into viable businesses. As for its role in Cleantech London, IWC serves as the academic and incubatory heart of the project, and the seed from which businesses located in OPDC can grow, catalysing the growth of the cluster. Old Oak and Park Royal were selected as areas ripe for redevelopment, with good current and future transport links, as well as for their proximity to IWC, lower rents and capacity for small-scale manufacturing space.

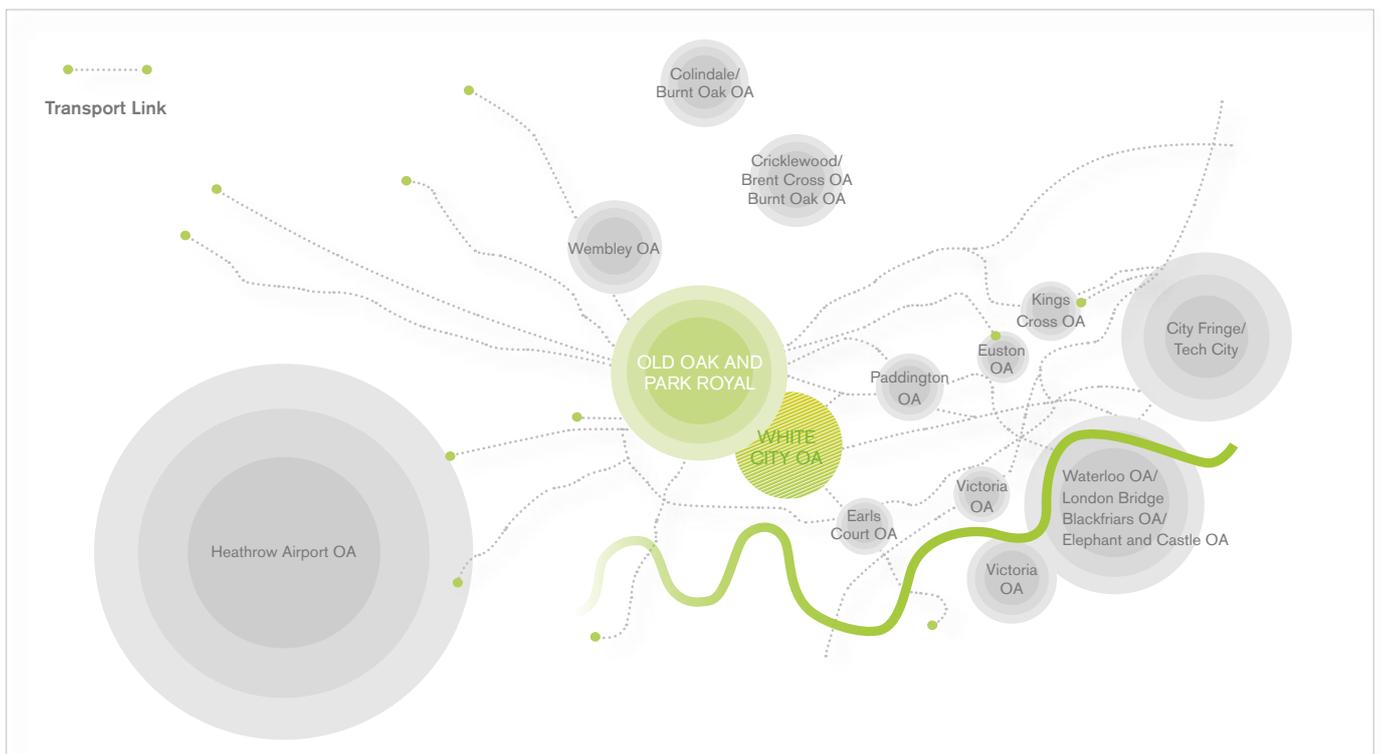


Figure 2 – Map showing Old Oak and Park Royal District and White City Opportunity Area with transport links

The report also identified potential key partners. The OPDC was included as it manages the development of the land in to which Cleantech London will grow. The GLA is a key political partner, with whom policy can be shaped to provide the impetus for cleantech business development and support as well as creating profile for the cluster. Imperial College London (ICL) boasts world-class academic reputation and expertise in innovation through its business innovation and incubation capacity. A number of other key stakeholders including Climate-KIC, the Carbon Trust and Sustainable Ventures also bring a range of expertise, experience and knowledge in cleantech. The OPDC, ICL and the GLA are currently involved in further developing the cluster.

The OPDC produced a feasibility report which is part of the GLA's ERDF-funded programme 'Better Futures' that aims at performing a preliminary mapping of the cleantech sector in London. As part of this, the GLA plans to explore the opportunity for developing festivals and exhibitions aimed at promoting cleantech development.

The growth of the cluster is separated into three steps focused on the three localities, and aims to integrate with the completion of development in those areas.

- The first step is to initiate accelerator programmes. This is based around the IWC development and seeks to build upon the ICL and Climate-KIC start-up and SME development programmes.
- The next stage seeks to develop incubator programmes in Old Oak in order to support the SMEs' development, and introduce new businesses into the innovation ecosystem. Sustainable Ventures and the Carbon Trust have been identified as potential partners.

- The final stage of the current plan is to develop affordable and flexible manufacturing space at Park Royal.

There is recognition that whilst physical development is ongoing, work should be done in the interim to draw key stakeholders together to capitalise on the current cleantech ecosystem that exists across London.

There is also significant activity underway in East London. Formed in April 2012, the purpose of the London Legacy Development Corporation (LLDC) is to use the once-in-a-lifetime opportunity of the London 2012 Olympic Games and the creation of Queen Elizabeth Olympic Park (QEOP) to develop a dynamic new heart for East London, creating opportunities for local people and driving innovation and growth in the capital and across the UK.

LLDC is a Mayoral Development Corporation and therefore directly accountable to Londoners through the Mayor of London. LLDC is undertaking a number of sustainability initiatives demonstrating innovation in the sustainability sector, in line with Mayoral priorities. These form a key part of the development of QEOP as a cluster for technological, social and economic innovation.

LLDC has a well-established reputation for trialling and deploying cleantech, with a specific focus on advanced mobility. This includes the Innovate UK-funded project for QEOP and Greenwich to host Smart Mobility Living Lab: London (SMLL:L), a test bed for connected and autonomous vehicles and associated technology and services. The initiative's founder members include Honda R&D UK, BP, Aviva and Hastings Direct. QEOP is also host to the Innovate UK-funded Capri project, trialling connected and autonomous pods on the Park in 2019 and 2020.

QEOP is the home of Here East<sup>14</sup>. With 1.2 million ft<sup>2</sup> of space, Here East brings together business, tech, media, education and data in pursuit of innovation. It is home to both established names and nimble start-ups. Radicals, reformers, visionaries, industry heroes and like-minded locals – they're all part of East London's heritage and its geography of innovation. This includes Ford's Smart Mobility Innovation Office, the High Speed Sustainable Manufacturing Institute (HSSMI), Loughborough University's Advanced Propulsion Centre (APC) and UCL Robotics. Here East's resident innovation centre, Plexal, is dedicated to pioneering new technology with accelerator programmes and an initial focus in the fields of sport, health, fashion, Smart Cities and the Internet of Things (IoT). Within 68,000 ft<sup>2</sup>, over 800 members converge at Plexal to imagine, design and create connected products that improve people's lives.

### Growth and Maturity

This cluster is in its early stages and much of the growth phase is yet to happen. However, there are significant opportunities for development, as identified above. There are also challenges. These fall into a broad set of categories: how to support, engage and connect businesses; how to create connections across 32 London Boroughs and the City of London; and how to engage with the city's universities. As the cluster is forming, these challenges are being addressed with stakeholders and partners.

The challenge of how to support and engage businesses and then help them to grow goes to the heart of the cluster’s purpose and its work to date. The challenge can be broken down into several areas:

- i) How to co-ordinate, coalesce and build on existing business accelerators and incubators
- ii) How to support emerging business when working space is at a premium
- iii) How to identify potential partners in a business community as large as London’s and
- iv) How to effectively communicate the idea of cleantech to businesses

The cluster is seeking to bring the existing and dispersed community and its support networks together to help meet the demands of a sector. The cluster will only be able to remain competitive by being able to build upon the pre-existing business support expertise within its partner institutions – IWC is home to incubators run both by ICL and private companies. ICL has ten years’ experience of running Climate-KIC accelerator programmes. The physical spaces in the cluster are being built with cleantech specifically in mind; providing flexible R&D, incubator and accelerator space, as well as being at the heart of ongoing national infrastructure investment (HS2, Crossrail and Heathrow Airport expansion).

It also aims to support businesses from set-up to manufacturing, by having the three sites cater to the three key stages of business development. Additionally, the cluster has access to financial resources. It has received ERDF funding for two projects: Better Futures, which aims to support the growth of 100

businesses to market stage, and Advance London, which has a focus on the circular economy. The support from the GLA will also increase its publicity capabilities allowing for Cleantech London to provide an important focus for the wider community.

This successful positioning of the cluster does not mean it is problem-free. Firstly, it will need to engage with businesses and create a network whilst the development of its physical infrastructure is ongoing. Secondly, it will need to communicate its vision and services clearly in the competitive acceleration and incubation market.

Whilst the cluster has a sectoral focus, there is a danger that businesses may not be able to engage with the term ‘cleantech’, which is cross-sectoral. Whilst businesses aim to meet demand with supply, in this case mitigating the environmental impacts of economic activity, they are less concerned with the idiosyncrasies of policy definitions. This means they may not self-identify as cleantech businesses even if they fall within this category.

The cluster currently aims to engage the business community and highlight the nature of cleantech by running a set of ‘mini challenges’. These seek to encourage entrepreneurs and businesses to highlight how their products or services can mitigate the environmental impact of economic activity.

The emerging cluster will also need to use the publicity resources of London government to effectively communicate the concept and potential of cleantech to the public. It will also need to be effective in engaging with London Boroughs, especially with their Economic Development Officers (EDOs), to help businesses self-identify as cleantech.

Engaging with businesses at all levels poses a challenge due to the size of London’s business community. London Boroughs and the EDOs can be used to help businesses recognise the benefits they provide to the environment. However, local authority resources have been stretched by nearly a decade of austerity measures, leaving many Economic Development Teams under-resourced and understaffed. A proposed model to support EDOs is to provide an ‘off the shelf’ pre-prepared set of resources explaining what cleantech is, the benefits it delivers and what the cluster can offer.

At a more holistic level, a data-driven approach towards business engagement has been identified. A new report on the low-carbon and environmental goods and services (LCEGS) sector in London is about to be published. This report aims to provide insight and analysis on the size and nature of LCEGS and seeks to identify supply chains and path dependencies at all scales. The report will also highlight how the activities of the sector align with Mayoral manifesto commitments and address London’s environmental challenges.

Additionally, the cluster’s access to the Mayor’s convening powers allows for high-level business engagement. The Mayor can play an important role in drawing in powerful big businesses to engage with, and even become members of, the cluster.

The limited amount of space, in particular for manufacturing and prototyping facilities, is a significant issue. However, local authorities are focused on young businesses and start-ups, especially how to meet their business space needs, as planning is within their power. The focus is currently on co-working space,

though whether this is the most effective type of space for businesses is not yet fully understood. The questions surrounding availability of manufacturing space is being partly addressed by the OPDC. Whilst this will allow the formation of small-scale high-value manufacturing businesses, there are currently not a lot of cleantech manufacturing businesses in London.

The city's political structure also makes engagement with businesses from across the city challenging. The political structure in London involves the Mayor's Office and the GLA as the regional body and then 32 London Boroughs and the Corporation of London. Each of which have their own role to play in London's economic development and growth.

The change of Mayor in 2016 was the first potential threat to the cluster's development. However, the change in administration actually resulted in greater policy support for the cluster as it has been fully embedded into the Mayor's London Environment Strategy and his draft Economic Development Strategy and draft London Plan. Supporting the transition to a low-carbon circular economy is a core policy priority for the Mayor and supporting growth and innovation in cleantech businesses is essential to delivering that transition.

Supporting growth and innovation in cleantech businesses to help deliver that transition is essential.

The change also provided the opportunity to embed the concept of the cleantech cluster in London's planning policy. The OOPR area has subsequently been incorporated into the draft new London Plan, giving it formal status.

Additionally, the cluster's ambitions overlap with pre-existing goals, such as for 2020 targets for air quality. The cluster's ambitions around affordable workspace are shared by the Boroughs' commitments to affordable business space.

In addition to its geographic size and large public and business populations, London is home to over 40 universities and university colleges. Whilst this is a tremendous resource, the cluster must overcome the challenge of how to maximise the impact from London's knowledge-based institutions which have world-leading expertise in this field.

London is a global city, and this is reflected in the attitudes and membership of its businesses and universities. A number of London's universities are large, well-established and world renowned institutions, but their focus can be on large-scale funding opportunities rather than those at a regional or local level. Therefore, the cluster will need to address how it engages with universities to help tackle local environmental challenges. Furthermore, cleantech is a fundamentally broad church, drawing inspiration and knowledge from all branches of science and engineering, as well as business and the social sciences. Accordingly, the cluster will have to galvanise cross-disciplinary collaboration. Whilst the benefits of such collaboration will be profound, this task will be difficult to accomplish at the scale that universities exist in London.

Finally, the uncertainty surrounding Brexit is cause of concern for the cluster. The status of EU funding, EU citizen's rights, the movement of people, goods and services and the City's access to financial markets are some of the

issues. To date, the cluster has used ERDF funding to catalyse its development. Continued access to both ERDF and ESIF funds, as well as other EU funds such as Horizon 2020 would allow for further growth. The regulatory environment is also currently derived from EU law, including environmental protection law and IP regulation.

The Mayor published a London Brexit blueprint which outlined what is needed in relation to trade and movement of labour to protect jobs, growth, services, the environment and living standards across the UK. The government's Withdrawal Act enshrined environmental protection principles such as 'polluter pays'; 'environmental rights for citizens'; and 'the precautionary principle' into law last summer and also proposed the formation of an independent watchdog to enforce UK law.

It is important for citizens and businesses of the EU and UK to have certainty for both workers and businesses around movement of labour, access to talent and immigration policy.

Supporting the growth of the cleantech cluster will be a key priority as the Mayor develops his forthcoming London Industrial Strategy for publication in early 2020. This will set out more granular, spatial priorities for maximising productivity growth and enabling more inclusive and sustainable growth in London. The strategy will set the priorities that will be the focus for the forthcoming UK Shared Prosperity Fund<sup>15</sup> – which will replace the Local Growth Fund and European Structural Investment Fund.

# Energy Capital – The West Midlands Energy Cluster

## Introduction

The city of Birmingham is a traditional English city, built on the back of the industrial revolution. It has a long and strong tradition of industry and manufacturing which was then steadily eroded from the 1970s as manufacturing largely moved overseas following lower cost labour. In the wake of this change, the city and region has sought to redevelop itself and modernise its ageing infrastructure through redevelopment of the city's buildings and transportation and a redefining of the major employment sectors. This is set against a backdrop of major cuts to local government funding and a reduction in capacity to deliver new initiatives as the size of the city council has reduced by a factor of more than five.

The space this has created mandates a stakeholder rather than council- or local government-led approach to innovation.

The wider West Midlands conurbation has a rich history as one of Britain's industrial heartlands. Described variously as 'city of a thousand trades' and 'the workshop of the world', Birmingham is built

on manufacturing, innovation and resourcefully seizing economic opportunity. As Britain's second largest metropole, Birmingham is a diverse, global city (McEwan, Pollard, Henry, 2005)<sup>16</sup>.

Throughout the 20th century, Birmingham came to specialise in the automotive industry. Austin Rover, later British Leyland and Rover, was based at Longbridge. Jaguar was based in nearby Coventry and many other marques were synonymous with the area. Around these Original Equipment Manufacturers (OEMs) was a hinterland of tier 1 suppliers and complex supply chains which supported a thriving industrial base.

However, since the 1970s, the West Midlands has faced more challenging circumstances. The near-collapse of the British auto-industry in the latter decades of the 20th century marked a transition from high levels of employment and good wages to increasing unemployment (Centre for Cities, 2014)<sup>17</sup>. The travails of the car industry were mirrored in any number of manufacturing sectors, where strong competition from low-labour cost countries has led to a decline in mass-manufactured goods.

A case in point is the Tyseley site of the firm Webster & Horsfall, once home to a large cable manufacturing concern. Its work was displayed in the Great Exhibition of 1851 and the company made the first trans-Atlantic communication cable. It once manufactured all manner of cables, wires and ropes. However, with competition too fierce for 'low-value' cable products, the firm now focuses exclusively on very high end, specialised cable products with a large degree of value added. By way of example, take the cheap bulk wire used in the reinforcement of car tyres, as an example of an old and discontinued product. Contrast this with the high value niche of orthodontic wires used in dental implants. The latter have to be produced to exacting quality standards, in sanitary environment suitable for medical applications.

The region is in the process of undergoing a metamorphosis. The renaissance of the West Midlands is evident in any number of dimensions – from new city centre architecture and urban renewal to new transport links and firms restoring the production of manufactured goods to the area.



Coupled with new powers to the devolved West Midlands Combined Authority and a reinvigorated regional politics – re-engaging local people with the appointment of a regional Mayor – the conditions are fertile for the rebirth of the region.

One long-term goal which has the potential to serve as a catalyst for growth in the area, is the construction of the UK's second High Speed Rail line (HS2) from London to Birmingham and then on to the North. With this new, fast transport corridor, there are plans for redevelopment around the East side of the City of Birmingham and a giant hub, 'UK Central', at a key interchange point on the line.

From a low point which culminated in the closure of a significant number of Midlands vehicle manufacturers, with an attendant number of redundancies, the transformation of the remnants of the West Midlands' car industry has been a phoenix-like tale of industrial transformation. Jaguar Land Rover has been reinvented, whilst new investment has established the London Taxi Company, producing electric vehicles in Ansty Park.

Williams has now entered a joint venture with Unipart (the multinational logistics, supply chain, manufacturing and consultancy company that grew out of British Leyland) to become the UK's first independent producer of electric vehicle batteries. Similarly, Jaguar Land Rover has invested in R&D to develop the next generation of electric vehicle batteries in the area. Whilst the industry has been reborn, the status quo is fragile. The global auto industry is undergoing seismic changes due to the challenges of decarbonisation.

The people and companies of the West Midlands spend more than £10 billion every year on electricity, gas and fuel. West Midlands industry spends over £2 billion every year on energy. The citizens of the West Midlands pay more than £2.7 billion in home energy bills every year.

There are more than 10,000 companies working in the energy sector supply chain across the West Midlands. Over 56,000 people are employed in the energy sector across the Black Country, Birmingham, Solihull, Coventry and Warwickshire. Some of the largest and most important energy businesses in the UK are based in the region, including National Grid, E.ON UK, Worcester Bosch and nPower, as well as some of the newest and most innovative, such as First Utility and Co-operative Energy.



## Development of the cluster

### Creation

Set in this context, the West Midlands Energy Capital cluster brings together a comprehensive range of actors from industry, academia and the public sector. Together they have developed an environment for market-led energy innovation through triple-helix partnerships that culminate in the establishment of 'Energy Innovation Zones' (EIZs) for new technology demonstration and validation.

The West Midlands builds on a firm foundation of centuries-old industrial heritage; however the fast-changing nature of industry demands solutions to modern energy challenges. A constellation of recent key investments in the region has cemented its leadership in energy. These include significant funding of the Midlands' universities through the Energy Research Accelerator collaborative programme, locating the UK Government-funded Energy Systems Catapult in the City of Birmingham, and significant European Regional Development Fund projects. The cluster has been adept at bringing together diverse stakeholders to unite around a common mission of energy innovation. As part of this process, a key point of differentiation has been the cluster's unique approach to informing local and national policy; shaping the market and creating opportunities for climate innovations.

A number of universities in the Midlands (Nottingham, Birmingham and Loughborough) had previously collaborated under the auspices of the Midlands Energy Consortium on collaborative teaching programmes and combined research. That same partnership expanded with the addition of Aston and

Leicester University and jointly bid for and won an ambitious partnership, the Energy Research Accelerator (ERA). This project was funded by government to the tune of £60 million with match funding from industry of an additional £120 million. The ERA universities are spread across the entire Midlands geography, East and West, however, Aston University and the Universities of Birmingham and Warwick are in the West Midlands. More than 500 academics work in energy-related research in the region.

Additionally, Coventry, Birmingham City and Wolverhampton Universities have strong built environment research groups, focused on energy efficiency and low-carbon buildings.

Another significant foundation stone for the cluster, bringing critical mass and acting as a key anchor, was the location of the Energy Systems Catapult in the City of Birmingham. The catapult programme is an initiative funded by the UK government, designed to transform the UK's capacity for innovation in certain key sectors. The UK has a range of Catapult centres focusing on a range of different technology sectors. Whilst the Catapult has a national remit, it is undoubtedly a boost for the critical mass of energy activity in the West Midlands.

The Catapult has formed many new streams of activity. Nearby in the East Midlands, another organisation, the Energy Technologies Institute (ETI), a public-private partnership established in 2007, had reached the end of its lifecycle with its funding period drawing to a close. Some of the streams of activity from the ETI

were ongoing and still showed a great deal of potential. A deal was reached to transfer these streams of activity from the East to the West Midlands as part of the Catapult.

The sustainability team within Birmingham City Council, though limited in capacity, had developed ambitious plans for the redevelopment of the City of Birmingham. This was underlined by the formation of the Green Commission, a body that drew together stakeholders from across the city to shape the development of the City, covering a broad range of issues from everything from natural capital and fuel poverty through to major infrastructure investments. This period saw the City invest in a district heating, cooling and power scheme feeding the major local government buildings in the city centre, which was then linked to the refurbished New Street Station. This was powered by a centrally-located energy centre managed by the Birmingham District Energy Company. Most recently there has been a development of the concept of a low-carbon refuelling station, now being constructed at the Tyseley Energy Park, linked to the creation of a clean air zone within the city centre. The sustainability team and the Green Commission had a major influence on the ambitions of the City of Birmingham, which was eroded largely due to local government budget cuts which had a significant impact on Birmingham City Council. The Green Commission was then reshaped into Energy Capital, which first had a Greater Birmingham and Solihull Local Enterprise Partnership (GBSLEP) focus, but then expanded to cover the entire West Midlands Combined Authority.

The University of Birmingham is a large civic university with a significant footprint of activity in the energy arena. The decision was taken to create the Birmingham Energy Institute to bring together the energy community at the University. The significant scale of Birmingham's energy research has been a key anchor for the cluster's activity and the University has played a key role in furthering the Energy Capital agenda.

Another key partnership that may in time bear fruit for the cluster is the establishment of a Joint Research Platform between the German organisation Fraunhofer UMSICHT and the University of Birmingham. In Germany, Fraunhofer is the largest organisation focusing on applied research. The organisation is renowned as a motor for innovation. Whilst developments around the Joint Research Platform are in early stages, Fraunhofer already has an established portfolio of collaborative ventures operating outside of Germany. These potentially provide a template for a collaboration in the West Midlands.

Nearby, just outside Coventry, the University of Warwick, has partnered with Jaguar Land Rover through its Warwick Manufacturing Group to look at the development of the firm's next-generation electric vehicles. Together, they have worked closely together on electric drivetrain and battery innovation.

The Universities of Birmingham and Warwick have been successful in engaging with the UK Government's Faraday Battery Challenge.

The University of Warwick will be home to a new Battery Innovation Centre and has been successful at winning bids for higher TRL level research through Innovate UK on battery innovations that are close to market. The University of Birmingham has won one of the Faraday Institution's Fast Start projects and leads a consortium of researchers looking to recycle and reuse electric vehicle batteries.

#### Growth

The formation of the West Midlands organisation Energy Capital consolidated and secured the region's strengths and its potential for innovation. Energy Capital was initially a consortium of local government and associated organisations, regional universities, energy companies and other interested parties. It is now formally anchored within the organisational structure of the West Midlands Combined Authority under the leadership of the Mayor. It has responsibility for the development and implementation of the regional energy strategy.

#### Energy Capital has two complimentary objectives:

1. To ensure the vibrant and growing economy of the West Midlands is supported by a competitive, flexible and secure modern energy system providing low cost, clean and efficient power to its industries and people.
2. To make the West Midlands the most attractive location in the world to develop and build an innovative, smart energy technology company.

A significant moment in defining the Energy Capital cluster's mission came with the launch of a number of reports.

Energy Capital together with the University of Birmingham and the Energy Systems Catapult unveiled a policy commission<sup>18</sup> report making the case for the creation of EIZs in the West Midlands<sup>19</sup>. The commission, which was chaired by Sir David King, called for four pilot energy hubs to be located in Central Birmingham and Tyseley, UK Central in Solihull, the Black Country and Coventry and Warwickshire.

The main focus of the EIZs will be to integrate low-carbon technologies, to develop the business models and infrastructure needed to support new approaches to clean energy and to overcome the regulatory barriers necessary for them to flourish. They will be designed to stimulate local clean-energy innovation and drive productivity within the region, exports and growth. The EIZs aim to demonstrate new technologies and turn them into fully commercial propositions, breeding regional markets and supply chains that provide a platform for exports and growth. They will also offer a controlled environment in which innovators of all types can trial new services, technologies and business models.

Initially, four trial EIZs have been proposed.

## Black Country

As the seat of the industrial revolution in the late 18th century, the Black Country can claim to be the world's first EIZ, and this heritage perhaps explains the enthusiastic local support for the proposed zone. But of the four potential EIZs, the Black Country is the least developed, and so provides the greatest opportunity to demonstrate a complete model of how an EIZ can be defined, developed and implemented.

The Black Country Enterprise Zones comprise a portfolio of sites in Dudley, Wolverhampton,

Darlaston and i54 – Wolverhampton North, spread over 120 hectares. The focus of these zones is to promote and attract advanced manufacturing in the Black Country – by offering competitive advantage to manufacturers who locate there – especially targeting aerospace, automotive and high added value engineering.

There are already major manufacturing companies located on the i54 site, including JLR, Moog, Eurofins and ISP. This enterprise zone is known as one of the most successful

in the country, and total investment of more than £1.5 billion is expected across the Black Country over next 15 years.

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



Figure 3 – Illustration of the Black Country Energy Innovation Zone

## Coventry and Warwickshire

Coventry and Warwickshire is an example of a potential EIZ which could be used as an effective mechanism to ensure innovation and carbon reduction are effectively built into development plans, and that these are properly scrutinised and integrated into local infrastructure.

Coventry and Warwickshire covers Whitley, Baginton and the wider area around Coventry airport, incorporating land in both Coventry and Warwickshire. This area is well served by transport networks, and significant growth is planned through developments such the £250 million Coventry and Warwickshire

Gateway scheme and the £500 million development of Whitley South – a 60-acre engineering technology hub next to Jaguar Land Rover’s global headquarters.

There is little spare capacity in the local electricity network, yet demand is forecast to rise significantly over the next decade.

Coventry Central and Coventry South are reaching the limits their circuits can supply, requiring major reinforcement works to raise capacity.

Other areas of planned expansion in Coventry and Warwickshire are Gaydon and Ansty.

Jaguar Land Rover and Aston Martin have plants at Gaydon, which suffers grid constraints that would limit the growth plans of these and other companies. Ansty has shown considerable growth in recent years and has potential for large development in the future. Both sites need to ensure adequate power supply to enable future development.

Like UK Central Hub, these areas of economic growth and grid constraints need to develop timely and cost effective clean energy solutions, which an EIZ could facilitate.

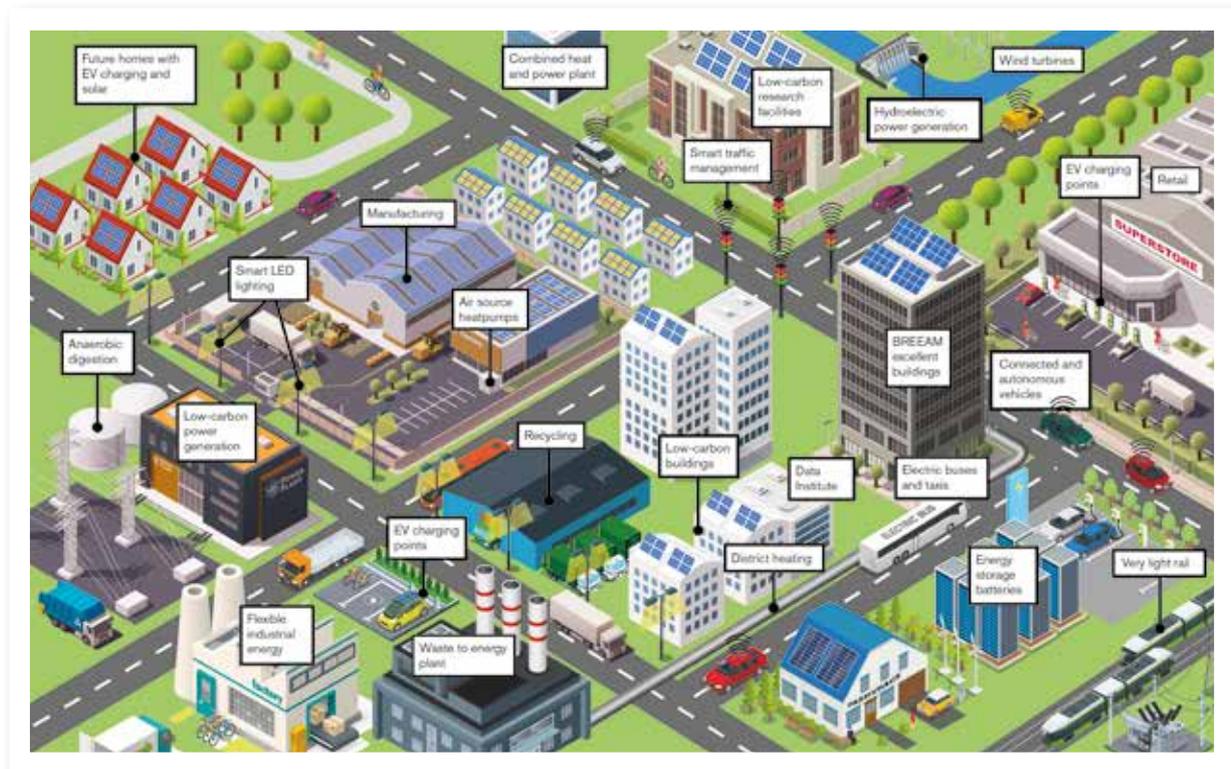


Figure 4 – Coventry Energy Innovation Zone

## Tyseley and Birmingham

Birmingham city centre will undergo massive redevelopment over the next 15 years, particularly around the High Speed 2 (HS2) Curzon Street station (£900 million), Smithfield (£600 million), Snow Hill, Typhoo Wharf and Arena Central. The area also suffers serious air pollution and the City Council is developing plans for a Clean Air Zone to start by 2020. This will require the construction of a substantial clean energy transport refuelling infrastructure including hydrogen and electric vehicle charging at scale.

There is little space available for vehicle recharging in the city centre. Part of the solution may be to use the industrial land available at Tyseley Energy Park, 5km east of the city centre, to produce clean energy for the city centre and local communities and power new clean transport refuelling infrastructure.

The Tyseley environmental enterprise district will be a clean technology hub for the city of Birmingham. With a long history of industry in this area, the remaining businesses seek new and innovative energy supplies in order to help the remaining firms stay competitive. It is against that backdrop of transforming industrial competitiveness that the vision has been conceived.

Tyseley is already the site of the city's energy-from-waste (EfW) plant, which burns 350,000 tonnes of waste per year to generate 25 MWe. The 16-acre industrial site next door is being developed as Tyseley Energy Park by its owners, Webster & Horsfall, and partners including the University of Birmingham, the City Council and the Local Enterprise Partnership.

Tyseley Energy Park already hosts a 10 MWe biomass generating plant and private wire electricity supply, and is also the depot for a growing fleet of rent-by-the-hour electric taxis – most of the city's taxi drivers live nearby. A clean energy refuelling station is being built to provide electric vehicle charging, hydrogen and CNG for the city's bus fleet, and for the refuse vehicles that supply the EfW plant.

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



Figure 5 – Tyseley Energy Innovation Zone

## UK Central Hub

The UK Central Hub is an economic area which includes the significant infrastructure of Birmingham Airport, the National Exhibition Centre, Jaguar Land Rover, Birmingham International Station and Birmingham Business Park. From 2026 it will also include the HS2 rail station and the enormous mixed use Arden Cross housing development. Each of the stakeholders has ambitious growth plans that will dramatically increase the level of employment and housing in the Hub area, and support the wider West Midlands economy. In order to support this opportunity, Solihull Council formed the Urban Growth Company (UGC) to concentrate public sector investment on removing infrastructure constraints. As an EIZ, the wider significance of UK Central Hub is that it epitomises the energy challenges of a modern multi-modal transport hub.

The Hub is only one of UK Central's four development zones. The others are North Solihull, Solihull Town Centre and Blythe Valley Park. Each has its own energy challenges and priorities. North Solihull, for example, must regenerate large amounts of 1950s–60s housing stock, where there are high levels of fuel poverty. Solihull Town Centre has recently completed a feasibility study that identified a low-carbon heat network opportunity that would be both technically and economically viable. Blythe Valley has the potential to develop a hydrogen hub. Each could therefore form its own EIZ, but there may also be a case for creating a single overarching EIZ to cover all four UK Central development zones.

### Maturity

The Energy Capital cluster has grown significantly in ambition to encompass significant parts of the West Midlands region. The maturation of this initiative will be interesting to monitor given the scale and complexity and the speed of growth. These provide challenges in terms of avoiding the development of stranded assets and distribution of limited resource.

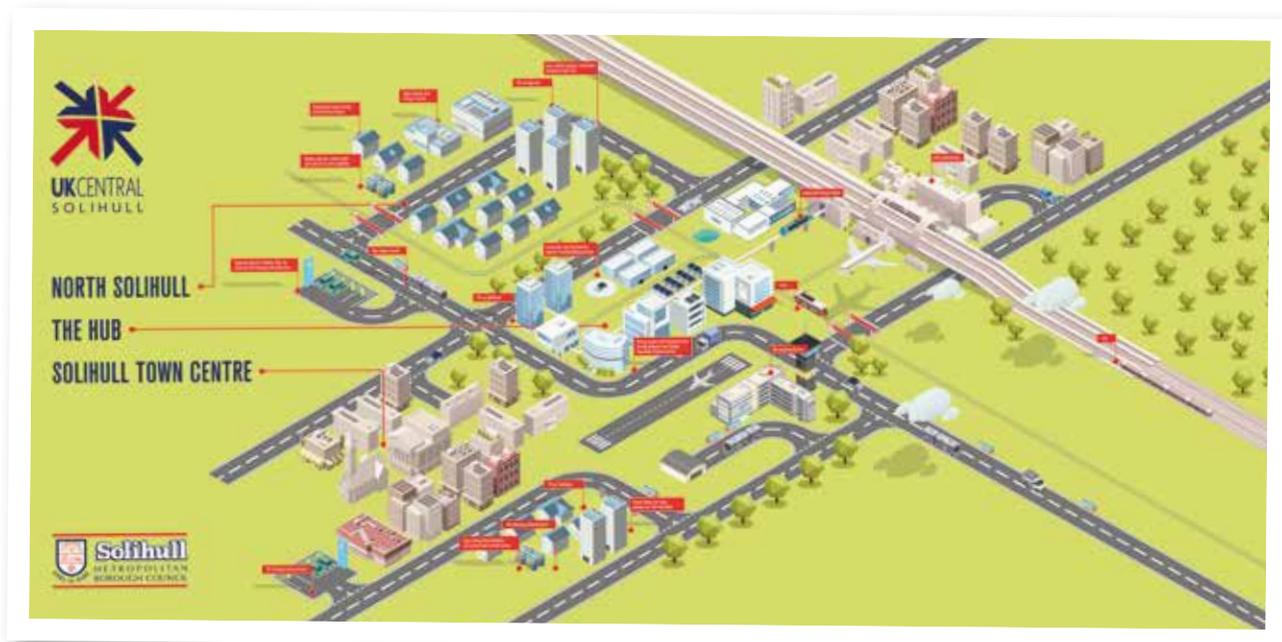


Figure 6 – Illustration of UK Central Solihull Energy Innovation Zone

# Edinburgh – The Edinburgh Centre for Carbon Innovation

## Introduction

The UK and Scottish Climate Change Acts of 2008 and 2009 respectively set world-leading legislation to mandate steep emissions reductions and develop effective risk management strategies for climate change. These were translated into legal frameworks requiring public and private sector organisations to manage their emissions, explore new sources of energy and manage climate risk. Meeting these legal targets required a step change in energy production and land use.

These developments also challenged the university sector to deliver issue-oriented rather than discipline-oriented research, to

ensure their research was relevant to and had impact in the real world, and to work in partnership with business and government to deliver solutions and develop the next generation of business and civic leaders.

This shift in focus presented major challenges for universities, who historically excel at discipline-orientated research/teaching and research collaboration but struggle to effectively engage external stakeholders on complex, interdisciplinary challenges. ECCI provided the opportunity for the University of Edinburgh, its host institution, to take the lead in this emerging space.

Located in Scotland's capital city and political centre, and building on the best ideas from around the world, the Edinburgh Centre for Carbon Innovation (ECCI) was established in 2010 to provide the place and space

for low-carbon leaders and networks from business, finance and the public sector to work together, drawing on a robust evidence base, to deliver a low-carbon future.

Today, ECCI is the leading low-carbon hub for Scotland and beyond, driving cross-sector collaboration and effective action for a zero-carbon world. It joins forces with leading national and international organisations to deliver ambitious projects and grow low-carbon businesses. It works at the cutting edge of policy, business and research to turn talk into action. And it inspires people and ideas through award-winning, low-carbon events and work space in its central Edinburgh base.



## Development of the Cluster

### Creation (2008–2010)

The idea for ECCI came from a collaboration between founding Director Andy Kerr and University of Edinburgh Professors Martin Siegert (then Head of GeoSciences) and Mark Rounsevell (Head of the Institute of Geography). From their backgrounds in the corporate renewable energy and academic sectors respectively, the trio were keen to find a way to overcome the lack of knowledge transfer and collaboration around low-carbon solutions between the academic, business and public sectors.

Professor Siegert and Professor Rounsevell led an extensive two-year process of consultation to develop the idea for the centre which lies at the heart of Edinburgh's cluster. The consultation covered stakeholders within the partner Universities of Edinburgh, Heriot-Watt and Edinburgh Napier, as well broader town meetings with external stakeholders.

This process saw initial ideas for an academic research centre develop into a broader vision for a centre which would be capable of bridging the gap between good research ideas and practical action to deliver low-carbon outcomes. This required the creation of an outward-facing centre which built relationships with policy-makers, business and civil society to support the practical implementation of research ideas and professional skills.

Andy Kerr was appointed as Executive Director in December 2010 and led the development of the centre from then on.

Concurrently, the University of Edinburgh's School of GeoSciences was undertaking a review of its building use. The High School Yards site in the city centre was identified as an ideal physical home for the cluster, close to Scotland's Government, Parliament and business community. With senior University approval, this option was taken forward and Malcolm Fraser Architects were appointed to design the hub.

The location of ECCI's High School Yards site, in central Edinburgh and close to Government, commercial activity and communications, was key to realising the cluster vision. The existence of a physical hub in a prime location facilitated and encouraged interaction between the disparate elements of the community that would drive forward the technical and social innovations required to deliver a low-carbon society.

The initial aim of ECCI was to be recognised in Scotland as a leading innovation and skills centre within one year of initiation, to be recognised within Europe as a leading centre within three years, and to have a global brand within five years.

ECCI aimed to enhance rates of business and social innovation – to *bridge the gap between good ideas and practical action* – by:

- Building vibrant communities of interest (policy-makers, businesses, civil society and leading researchers)
- Collating and packaging knowledge and information to support the practical application of innovative ideas
- Coordinating and sharing this knowledge across these communities to support the implementation of innovative solutions



Significant funding was required at the outset to core fund operations and develop the University of Edinburgh's High School Yards site into a low-carbon hub. Staff and operational budget was secured but the centre needed to develop partnerships to bring in funding for the activities and projects that would get the cluster off the ground.

Linking the centre's vision to the social and economic 'grand challenges' of the day helped secure operational and capital funding from the University of Edinburgh and private, European and Scottish Government funds.

**The main achievements over the initial phase of the centre's existence were:**

- Extensive consultation to refine and define the remit and vision of ECCI, the centre at the heart of Edinburgh's climate innovation cluster.
- Centre given go-ahead by the University of Edinburgh, with academic partners Heriot-Watt and Edinburgh Napier on board.
- Executive Director Andy Kerr recruited and given office space.

- Seed funding from the University and public, business and private sources was secured for both capital and operational activities. This included a substantial donation from the George and Kaity David foundation and funding from the Scottish Government and the European Regional Development Fund for the ECCI building. The University of Edinburgh agreed to underwrite the costs of the building project once enough funding had been secured from external sources.
- The High School Yards site was identified and the building project given the green light by the University of Edinburgh. Malcolm Fraser Architects were appointed to work up outline designs.
- Laying the groundwork for the initial operational projects which began shortly afterwards – the Low Carbon Innovation Project, supported through European funds to help Scottish SMEs to create low-carbon goods and services, and ClimateXChange, funded by the Scottish government to provide independent climate evidence and insight.

**Growth (2011–2015)**

ECCI's growth phase coincided with a dramatic increase in the breadth and scope of Scotland's low-carbon business ecosystem, worth almost £11 billion a year by 2014. This was accompanied by a rise in the emergence of new players in Edinburgh's business support ecosystem, from the Scottish Funding Council's innovation centre programme to new accelerators and incubators such as Napier University's Bright Red Triangle.

In the background, legislative changes in Scotland concurrently supported developments in the nascent cluster. The Climate Change (Duties of Public Bodies: Reporting Requirements) (Scotland) Order 2015 was passed, requiring public bodies to prepare reports on compliance with climate change duties. Progressively more ambitious renewable energy targets were set during this period, with renewable energy becoming core to Scotland's economic strategy rather than a 'nice to have'. This paved the way for the extensive development and uptake of renewable energy, and unlocked the potential for deeper ambition on climate targets due to actual and projected decarbonisation of the energy sector.

The cluster itself built a range of new projects and alliances during this time.

## Low Carbon Innovation Project

ECCL's Low Carbon Innovation (LCI) project supported Scottish SMEs to create low-carbon products and services. The project spanned four years, ending in 2015. A cornerstone of ECCL's evolution, LCI bridged the gap between university know-how and dynamic Scottish enterprises. It did this by matching expertise to new ideas, new people, new markets and new finance. It was commended by the Scottish Government as a key contributor to achieving the nation's 2020 climate change targets. And it gained ECCL a Guardian Sustainable Business Award in 2016 for its innovative and collaborative approach.

### In short, it:

- Actively engaged with more than 1,400 Scottish enterprises, providing intensive support to more than 200 enterprises with new products/services
- Met or exceeded all the targets set by the project funder ERDF
- Created net sales worth nearly £15 million and 68 new jobs by 2018

The positive impact of the LCI project continues today, through various ongoing activities and partnerships. It laid the foundation for ECCL's Innovation Suite, a shared working space for public, private and third sector organisations. And ECCL expanded abroad as a result of the success of the LCI programme, opening a Hong Kong base, HKCCI, in 2015.

The partnership with Edinburgh Napier and Heriot-Watt Universities ended in 2015 at the end of the LCI project, on which they had been steering group partners.



### ClimateXChange

ECCI collaborates with government, business and academics to help craft smart climate and energy policy. ECCI is the base for and jointly manages ClimateXChange, Scotland's centre of expertise on climate change which was established in 2011 as a research provider to the Scottish Government and its agencies. During this time, ClimateXChange has delivered hundreds of research projects which have underpinned major Scottish Government policy announcements. It has benefitted from regular annual funding of more than £20 million in total since it started, with access to around 50 staff around Scotland through its central team and partner institutions.



### Smart Accelerator

Between 2013 and 2015, ECCI's £1.2 million Smart Accelerator project offered intensive early support to 14 Scottish 'smart partnerships', helping them get investment-ready through advice, practical support and sharing international good practice.

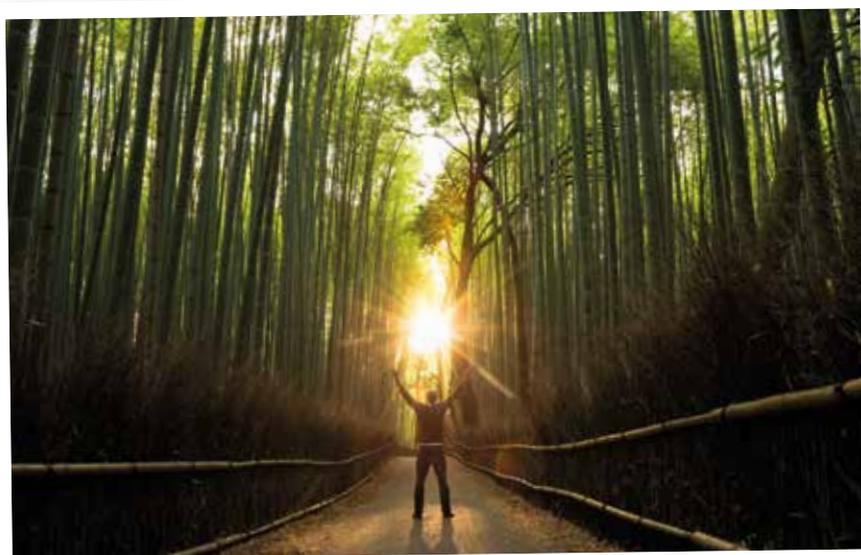
Supported by ERDF, Smart Accelerator identified and helped develop eight smart city, three sustainable island and three smart mobility projects. The aim was to create strong, effective partnerships and speed up Scotland's transition to a low carbon society. To deliver Smart Accelerator, ECCI created a framework for 'smart' city region and sustainable island projects in Scotland by:

- Combining resources across projects to create economies of scale

- Stimulating international knowledge exchange and competitiveness
- Engaging and partnering with innovative SMEs
- Using the Scottish research base to support competitive ideas
- Coordinating multiple public sector agency support

A key outcome of Smart Accelerator was to have good practice, pioneering projects, focused on collaborative business models, not technology. The project created a broad ecosystem of service providers and knowledge-sharing to reap benefits for the Edinburgh city region and others across Scotland.





### Ideas Lab

ECCI forged new ground by starting Scotland's first low-carbon business incubator, the Ideas Lab, in 2014. It ran until 2017 and supported more than 20 climate-positive entrepreneurs during that time. Each resident fought off stiff competition to secure a base at ECCI and get their business off the ground. Through the Ideas Lab, ECCI offered residents bespoke business support and mentoring, office space in our Edinburgh hub and access to its networks and events.

In the first two years of the programme alone, 60% of residents secured investment, 13 new products or services were created and seven new jobs were created.

### Scotland's 2020 Climate Group

Hosted at ECCI from 2013 and with the centre formally providing the secretariat from 2015, Scotland's 2020 Climate Group was an independent, business-led initiative. It was set up in 2009 in response to the passing of Scotland's ambitious Climate Change Act to drive collaboration between industry, government and society to help Scotland reduce carbon emissions while growing a sustainable economy.

Its influential network and events programme inspired commitment among Scottish businesses to prioritise reduced emissions. The group also helped launch and nurture other initiatives, including ECCI's Ideas Lab and the 2050 Climate Group, Scotland's leadership organisation for young professionals. Scotland's 2020 Climate Group was dissolved in the spring of 2018



### NERC

In 2015, ECCI was brought on board as part of the University of Edinburgh's NERC-funded Edinburgh Earth and Environment (E3) Doctoral Training Programme (DTP), with the aim of providing PhD researchers with meaningful policy and business work experience and training opportunities. This annual programme, which has run ever since at ECCI, strengthens our cluster by linking skilled researchers with early stage businesses on a fully-funded basis.



### SAGES

Supported by ECCI, SAGES is a network that gives organisations, businesses and policy-makers to access geosciences-related expertise from across Scotland. It acts as a knowledge broker between scientists and research users, including Government teams and small businesses. ECCI encourages collaboration by engaging end users in industry, policy and charities with research projects. ECCI also provides information about funding and networking opportunities, industry updates and communications support.

### Training

ECCI delivered executive education in low-carbon leadership for professionals within and outside of the UK and in 2015 worked with public body Skills Development Scotland to deliver a coordinated series of low-carbon skills and executive education events designed for middle and senior managers of high growth Scottish SMEs.



## Challenges

The cluster overcame many challenges during this stage of its evolution.

Three academic institutions of differing types and sizes working together – Edinburgh, Napier and Heriot-Watt – created challenges as well as opportunities. The new approach to collaboration for a low-carbon future embodied by ECCI and the Edinburgh cluster ensured that traditional institutional rivalries around research and funding were transcended. The way the three institutions worked together in a radically collaborative way was referenced in the 2016 Guardian Sustainable Business Award awarded to ECCI for its work on the LCI project.

The traditional university model of knowledge exchange as one-way broadcasting process – new research and technology broadcast to the outside world in academic terms – was different to ECCI's approach of stimulating demand and being market-led.



ECCI worked with businesses and public sector contacts across all of its areas of work to ensure that different sectors collaborated around challenges and opportunities and to link researchers and innovators with end users. A key example of this was the Smart Accelerator project, which worked across the public, private and academic sectors to convene project teams around themed challenges ranging from smart cities to sustainable islands. ClimateXChange also forged a radically collaborative approach to scoping projects and delivering the best ideas, knowledge and evidence – co-creating research priorities and programmes and involving communities and businesses in shaping and delivering academic evidence and analysis.

A pipeline of businesses/projects had to be created for practical action, such as the LCI and Smart Accelerator projects, because it was a nascent sector and 'low-carbon' was a new idea to many entrepreneurs. ECCI effectively had to generate its own low-carbon ecosystem.

ECCI used its cross-sectoral networks – based around the professional contacts books of key staff, in-house business development professionals and formal project partners – and marketing of funding calls and opportunities to create a pipeline of SMEs and infrastructure projects for the LCI and Smart Accelerator initiatives.

ECCI had to make its cluster finances self-sustaining within three years of starting, ie, by the end of 2013. ECCI has been largely reliant on cyclical project funding to keep



its operations going. In 2015, the cluster's flagship LCI project came to an end and no other project funding was available immediately to enable those skilled staff to be retained within ECCI. A number of the project team therefore didn't have their contracts renewed. There was no solution at the time.

During the growth phase, however, ECCI developed new funding partnerships and won a series of contracts which supported subsequent and current staff teams, as outlined above. ECCI also focused on developing commercial streams of income from its Edinburgh hub by hiring space out for workspace, meetings and events.

**Maturity**

The continued development of ECCI is set in the context of a number of developments which demonstrate the need for clusters to be flexible and responsive:

- The 2016 Paris agreement united the world's nations in a commitment to tackling climate change for the first time in history, to keep global temperatures 'well below' 2°C above pre-industrial times and 'endeavour to limit' them to 1.5°C.
- Mainstream media coverage of heatwaves, droughts, wildfires and other extreme weather events in 2017–18 changed the narrative from whether climate change is happening to dramatic forecasts of the likely impacts.
- UK and Scottish Governments have committed to phasing out new petrol/diesel cars by 2040 and 2032 respectively.
- The Scottish Government's Climate Change Bill, published in May 2018, sets out increased ambition for emissions reductions, with a target of 90% cuts in greenhouse gas emissions by 2050 and powers for Scottish Ministers to set a year by which to achieve net-zero emissions.
- Scotland's world-leading record on climate action has so far been heavily reliant on easy wins such as increasing renewable energy and reducing waste – the challenge now is to deliver transformational change in areas such as heating and transport and implement solutions at scale.
- The UK voted to leave the European Union, with likely impacts at UK and Scottish levels – and on particular sectors such as universities – as yet unclear.
- The price of renewable energy continued to fall, with certain technologies becoming viable without subsidy when used 'behind the grid', ie, to power developments and buildings rather than being installed purely to produce power for the network.
- The Edinburgh and South East Scotland City Region Deal was announced, which will see £300 million of public funding invested in data-driven innovation in the next ten years, with Edinburgh City Council and the University of Edinburgh as key partners. ECCI is heavily involved in the implementation of the deal, focusing in particular on mobility and smart city innovation, with new developments on Edinburgh's waterfront providing an ideal test bed for radical new approaches.



ECCI's new strategy for 2017–2021 sets out its vision as 'A thriving zero-carbon world'.

ECCI has upped its ambition to creating a thriving zero-carbon – rather than low-carbon – future. Greater ambition is needed in response to the Paris agreement, national targets and latest science. We need to raise awareness of the co-benefits of climate action and its links to all areas of society. The vision is now more focused, with the wider strategic document setting out wider priorities and goals.

**Today, the ECCI model is to drive low-carbon innovation by:**

- Sparking connections between businesses, communities, academia and governments
- Sharing what works in practice
- Taking Scotland's successful low-carbon model global
- Providing and brokering expertise and leadership
- Using real life testing to accelerate existing ideas and develop new ones
- Leveraging and building on the resources and influence of the University of Edinburgh

**Critical to its success are ECCI's values:**

- *No one person or organisation has all the answers...* so ECCI works with and learns from a diverse range of people and organisations.
- *We need low-carbon leadership across society...* so ECCI equips emerging and established leaders with the knowledge and confidence to create transformational change.
- *Lots of organisations are involved in supporting the zero-carbon transition...* so ECCI makes sure ECCI always bring unique expertise, networks and impetus to projects.

- *Knowledge exchange depends on trust...* so ECCI empowers the low-carbon community to build effective relationships and provide a space where minds can meet.

In 2016, ECCI won a Horizon 2020 grant to deliver a pilot project for the Online S3 e-policy platform, aimed at helping regions use a smart approach to growing their economies. ECCI engaged thousands of people across the business, public sector, academic and civil society sectors networks in testing the platform and collated analysis of the results. In 2018, ECCI successfully bid for a Climate-KIC pathfinder project to apply the Online S3 tools to help re-industrialise carbon intensive European regions. The Communications and Project Manager recruited for the Online S3 project also coordinates and leads ECCI's communications function, delivering a new narrative and website for ECCI to engage the cluster in our vision and activities.

In 2017, ECCI became an associate partner of Climate-KIC, upgrading to full partner status in 2018. Climate-KIC funds the centre's business growth work and projects to stimulate large-scale transformation in city regions, including projects on using city-based clusters as engines of low-carbon transformation, smart procurement and unlocking finance for sustainable infrastructure.

ClimateXChange, which ECCI hosts and joint manages, delivered research comparing greenhouse gas accounting schemes and looking at the potential economic impact

of climate change as part of the evidence used in preparing the Climate Change Bill. ClimateXChange researchers also delivered evidence and analysis for government policy teams involved in drafting the Climate Change Plan which sets out how Scotland will deliver emissions reductions to 2032.

In June 2018, City of Edinburgh Councillors gave the go-ahead to the centre playing a key role in helping the council achieve its vision for Scotland's capital to become an 'inspired, connected, fair and thriving city' by 2050. ECCI provided an independent audit of the council's sustainability activity and delivered recommendations on how the authority can continue to improve its sustainability and climate change impact.

In early 2018 ECCI, together with resident charity Sniffer, won a Scottish Government contract to provide the secretariat service to the Sustainable Scotland Network (SSN) – Scotland's largest network of public sector sustainability professionals.

ECCI's building attracts more than 1,000 visitors through its doors each month, and has become Scotland's leading low-carbon hub and space for discussions and collaboration. A stakeholder survey in 2017 revealed that the award-winning low-carbon building, along with our access to low-carbon networks and the cross-sectoral approach, were some of the most consistently valued benefits ECCI offers.

# Sustainable Innovation Cluster FrankfurtRheinMain Provadis School – Frankfurt

## Introduction

The Sustainable Innovation Cluster FrankfurtRheinMain is physically located at the industrial park Frankfurt Höchst – one of the largest industrial parks in Europe with 150 years of history in the development and production of chemical products. The cluster combines the industrial network with municipal activities from the city of Frankfurt.

The city of Frankfurt is a frontrunner in terms of climate policy in Germany. Active since 1990, it was one of the first cities to take decisive action – and has been strongly supported in this by national government. This political support has manifested itself in funding for climate action master plans aiming for

100% energy supply from renewables by the year 2050. The city is one of 40 municipalities deemed 'excellent' in terms of climate governance by the national environmental ministry.

The cluster's vision is to support the transition of chemical and related industries into sustainable, low-carbon and climate-friendly businesses by informing, creating and implementing new processes, products, technologies and business models based on a fully circular economy. It aims to create synergies between circular economy actors through intensive networking within the sustainable innovation cluster.

Provadis School of International Management and Technology, a private university of applied sciences, is based at the industrial park and focuses its teaching and applied research activities on management challenges in the chemical industry. Provadis School offers a range of qualifications including a Bachelor's Degree in Business Administration; Business Informatics and Chemical Engineering; a Master's programme in Chemical Engineering; and a Master's programme in Technology and Management.



## Development of the Cluster

### Creation

The Frankfurt cluster builds on the long heritage of chemical innovation at the Höchst site. Founded in 1863, the site initially developed dyes from coal tar, and later – when it was discovered that many of the compounds used to create dyes were also effective in fighting diseases – pharmaceuticals.

Over time, the industrial site grew to encompass chemical manufacture for the production of not only dyes and pharmaceuticals, but also plastics and life sciences. The site now covers 460 hectares, with 22,000 people employed and over 90 companies based on the site.

The ownership and management of the park has an interesting history. The story is one of individual firms ultimately joining forces under the auspices of the leviathan German chemicals conglomerate IG Farben, before later being broken up again into smaller companies.

The interests of the different companies on site are managed by the industrial park operator Infraserv Höchst. As park manager, Infraserv produces the energy needed in the park. It is responsible for waste management, facility management, safety and security and also has a logistics company.

Provdavis School bundles its low-carbon innovation projects together at the Centre for Industry and Sustainability (ZIN). The ZIN is manager of the rhein-main-cluster chemie & pharma, a cluster organisation focusing on chemical and pharmaceutical companies in the region. It supports them to improve their operational excellence via knowledge exchange and to organise exchange opportunities between the industry and civil society.

This cluster was established 10 years ago, but does not explicitly focus on low-carbon innovation and transition topics. However, the low-carbon innovation element of the activities now form the basis of the Sustainable Innovation Cluster FrankfurtRheinMain.

The driver for the development of the cluster came from the Centre for Industry and Sustainability (ZIN). In parallel, the service provider of the industrial park, Infraserv, set up an Ideation Lab with agile collaboration methods and infrastructure. ZIN and Infraserv wanted to join forces due to their complementary approaches. This took place via the Ideation Lab, where its first campaign was 'Zero-Waste', which aligned with circular economy.

This grew to become a Sustainable Innovation Hub. Through the inclusion of other stakeholders the eventual target is the development of a regional sustainability cluster.

The ZIN has a large network and significant experience with the setting up of a cluster in the chemical area (rhein-main-cluster chemie & pharma). It was also planned that the Infraserv Ideation Lab would be further developed after a first testing phase by Infraserv. Through this agglomeration of resources and the development of the collaboration, the idea of a regional cluster was born. In many ways, the current incarnation of the cluster is a reactivation and reframing of the cluster that was founded ten years ago (rhein-main-cluster chemie & pharma). However, even though there is a long-established record of collaborative working, there remain many challenges common to all of the clusters, such as how to create a cluster that will have sound financing beyond public funding.



In time, it is hoped that the cluster will create impact by engaging the state and the city in how to develop the chemical industry of the future in order to create the necessary circular economy.

**The key aims of the Sustainable Innovation Cluster FrankfurtRheinMain are:**

- To set up a self-sustainable cluster with a registered legal form
- To create an umbrella organisation under which the already large-scale activities for the circular economy can be bundled in the region
- To create a 'real lab' providing a trustful, physical space for experimenting with new working techniques and business models
- To create synergies between the existing Circular Economy activities in the region and to come up with new (cross-sector) co-operation models and partnerships between the various stakeholders from industry, business, association, policy, civil society and academia

**Growth and Maturity**

From 2019 onwards, the Sustainable Innovation Cluster FrankfurtRheinMain aims to provide innovative work and co-creation methods ('agile work'), including a physical working space, and will deliver coaching and training as well as networking events and workshops on circular economy topics.

At present, the Sustainable Innovation Cluster is jointly run by the Centre for Industry and Sustainability (Provadis School for International Management and Technology) and Infracore Höchst.

In a first step to expand this, companies of the Industrial Park Höchst are to be invited to become a member of the cluster. It is intended in time, this will expand – at a later stage other stakeholders from the region, even beyond the industry sector – for example the Land Hesse, the City of Frankfurt including regional and economic development agencies and chambers of commerce, chemical associations, circular economy initiatives etc – will become part of the cluster.

The present arrangement is that Infracore Höchst provides the site, and underpinning infrastructure and services. Here, there is an opportunity for greening the cluster – with energy waste and water infrastructure for all of the cluster's participants being provided by a central provider, improvements to this central infrastructure have the potential to improve the sustainability outcomes of all on the Höchst site.

There is, however, a challenge. The infrastructure of the site is run by Infracore, a joint venture of the large anchor companies that own the site and are the successors of the break-up of IG Farben. They have significant interests in the site and are very important stakeholders, including being part of the governing board. However, by the nature of their size, they are also conservative in their plans. This is partly an understandable consequence of the large capital investments needed to develop new products in the chemical industry – with the consequent need to 'sweat assets' once built. However, in trying to develop circular economy ideas and practice, their conservatism is also a barrier to new innovation.

The anchor companies are keen not to be too provocative in terms of new ideas, and those developing the cluster desire more flexibility to develop SMEs. There is a tension here between the interests of large incumbents and the desire to stimulate new innovation. Provadis School feel that they can learn a lot from the development of the Valencia cluster. They desire the entrepreneurial independent entity that allows them not only to bring innovation into the park, but also to communicate expertise from the park to a broader organisation.

The idea is that there is a core team consisting of Infracore and Provadis School, who are responsible for managing the activities and bringing together a broader range of different anchor partners as part of the innovation hub. The chemical industry doesn't have a regional platform for their activities – and here, the cluster can fill a valuable gap.

For midsize companies, it is hard for them to translate the circular economy into their own experience. There is also a question around what future skills are needed. Key questions for the cluster then are:

- How can the cluster enhance interdisciplinary collaboration?
- How can the cluster link the technical expertise of the park to the wider world?

For the chemical industry, scale is important – which explains why the capital-intensive players follow a specific path.

However, there is a concept 'Chemical Industry 4.0' – core drivers are industry 4.0 and the circular economy. There is potential to decouple the production of goods and

the service they provide. Here, there is an opportunity for smaller firms and intermediaries. The logic is that the innovative firms sell solutions not chemicals.

Here, value is added by an in-depth understanding of customer requirements, and the applications for the products that are being produced by the industry. The logic here is simple. If you are selling the user a chemical, and have no understanding of the application they are using that chemical in, then it is a simple commodity that can easily be replaced by another supplier. However, in developing different relationships based on tacit knowledge of the customer's application, it may be possible to encourage more efficient use of chemicals and better customer solutions.

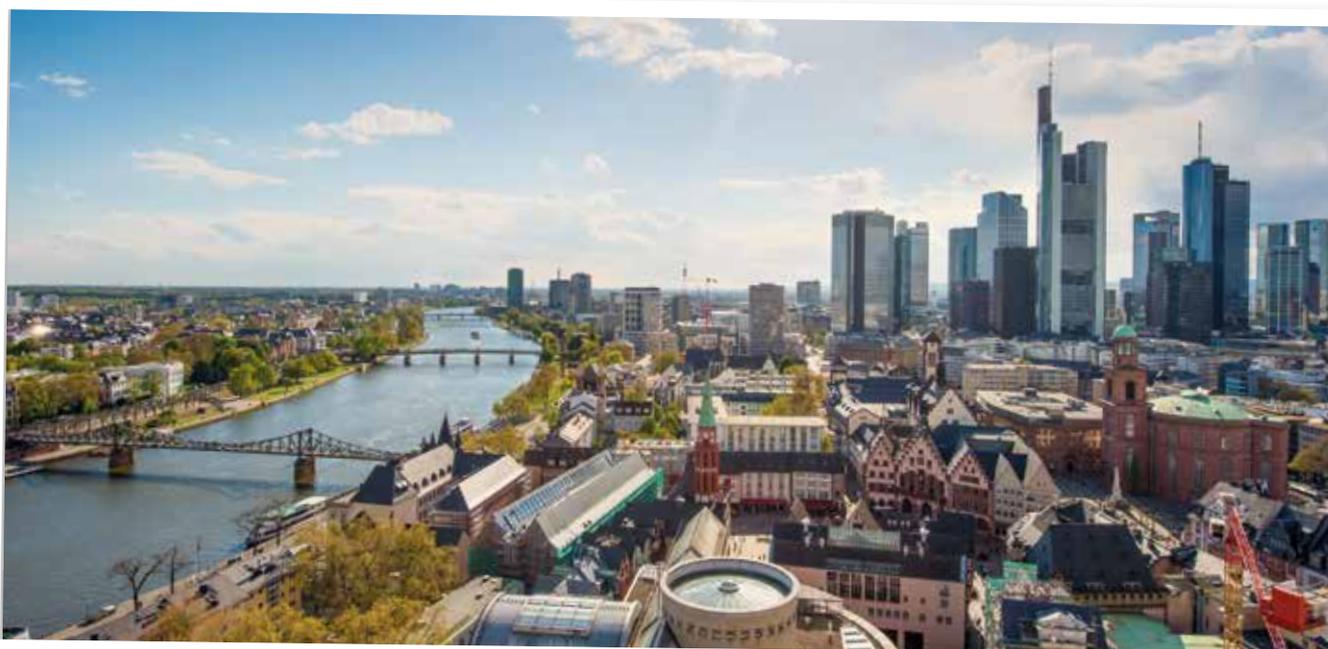
Here there is a role for new business models – this could be people that are not traditional chemical producers, but start-ups with a new role, eg, application expertise, or potentially being a solution provider, or a broker, etc.

It is hoped that by focusing on so-called 'application engineering', additional value can be created in a greener and in a more sustainable way.

With the new methods of working, enabled by new technologies, the cluster seeks to answer questions about how the chemical industry and their partners in a value creation network might evolve, by creating space for new ideas and creating value in new ways. Who will have the largest share with digitalisation and 3D printing? Is it the one who has the printer, the one who has the powder that is produced, or the one who has the software, who will be the ones to gain in the future?

Whilst there have been a number of environmental improvements to the way that services are provided on site, some still see these as incremental and not radical.

The park is already having to consider how to adapt to climate change. Over 32,000 containers a year pass through the park, many on the River Main which runs through the park and divides it in two. The park's strategic location on the water has been important to the movement of goods. However, changes to the climate have seen the water level in the Main fall. This in turn presents significant challenges for the shipping of goods into and out of the park, given that the Main is a significant transport corridor.



# What Makes Climate Innovation Clusters Successful?

In this section we aim to draw together the developmental elements common to all clusters, examining the factors that were important whether in the cluster's growth and trajectory or the interplay between actors in each cluster's context.

The five clusters described in this report have diverse origins. The Valencian model is one which grew from an industrial base and was associated with a transformation in regional energy generation. It has evolved through the development of membership and funding models into an organisation with a desire to influence regional policy. As such, it has created a template for a sustainable business model without a strong reliance on public funding.

Similarly, the Frankfurt cluster is born from an industrial, chemical industry base, albeit with the coordination being delivered by the academic institution Provanis School. This cluster is in its infancy, but is set in an established industrial context that has the potential to reach higher standards of sustainability in its operational and business models. The challenge for the Frankfurt cluster is to find a way to introduce into an established sector new practices associated with the circular economy which potentially

might undermine investments already made. Nevertheless, the industry stake in the cluster development could see it develop along the lines charted by Valencia.

The three UK-based clusters are rather different in nature. ECCI in Edinburgh is based at a university but looks beyond academia to cooperate across business, government and civil society. It has a physical hub at its heart although its networks and influence stretch far beyond this. And it has been through various cycles of development and redevelopment as it has matured and adapted to its changing context. It seeks to support smaller, developing companies, and also stimulate broader systemic transitions in energy, business and transport and so on. It is strongly reliant on public funding and grants, alongside being underwritten to some extent by the University. ECCI's adaptability and flexibility is a useful example for other clusters looking to thrive and adapt in a rapidly changing landscape.

In many respects the development of the cluster of activities in Birmingham and London are mirrors. They are both anchored in their local political structure. The West Midlands Combined Authority and the Greater London Authority, have a mix of stakeholders from politics, academia and industry. They have identified a number of development sites, eg, EIZs in the Midlands and the Olympic Park in London. They are highly complex from an organisational perspective and are high-risk, high-gain ventures. Both are in the throes of development and establishing an identity which provides confidence for national/regional investment together with the necessary stake from large energy companies. The timescale for the growth has been dramatic, which provides some lessons as to how effective political engagement can be in establishing an activity, as well as what the inherent risks may be.

## Creating Resilient Funding for Cluster Facilitation

Some clusters spontaneously arise out of the agglomeration economies that form when large numbers of similar industries gather in the same place. This may be because of certain local conditions, such as its skills base or natural resources. These provide the conditions to nurture similar minded-businesses which then coalesce within a certain geography.

In seeking to establish climate innovation clusters, there is an external desire to nurture businesses, innovations and developments that diverge from 'business as usual'. In the example of all of the climate innovation clusters, one common factor is the presence of a central driving force, steering organisation or coordinating body that champions and stimulates new innovation in an area.

Within all of the examples of ConnectedClusters, there is an overarching structure or management function that provides some centralisation, co-ordination or convening power to bring together the cluster members. In the case of Valencia, for example, it is AVAENSEN; in Frankfurt it is Provalid School and in Birmingham it is Energy Capital. While these central functions vary in the way they go about bringing together the constituent members of their clusters, a common challenge they all face is resourcing. If it is concluded that this central governance function delivers value to cluster members, then it must be resourced. In Valencia a sustainable model for resourcing has been found. In sectors where the stakeholders are closer to the SME end of the spectrum, it is arguable that funding through the public purse is a defensible

position given the regional, national and international importance of climate change and the need to accelerate innovation into market.

AVAENSEN had to radically overhaul its funding structure in order to survive. They employ a subscription-based model whereby their cluster and think tank members pay a fee for access to services. They started this model by using a 'no cure, no fee' approach to help their surviving members after the financial crisis. Whilst this is a seemingly simple and elegant solution to cluster funding, it is not risk-free.

A cluster needs to be established in its networks and service provision so that it can deliver on a model such as 'no cure, no fee' or even supplying cluster services. The consultancy-style fee that is employed for the Smart Cities Think Tank<sup>20</sup> is also a strong model to be learnt from. However, it too requires the establishment and consolidation of the cluster's reputation. Therefore, if clusters decide to emulate this particular model of cluster development, the challenge is reaching a stage where its service and network portfolio is strong enough to ask its members to pay a fee.

With regards to funding, Cleantech London has the potential to learn from its sister organisations within the ConnectedClusters project. It partly relies on EU funding to finance its development, and given the uncertainty surrounding continued UK access to such funds, it must seek a more reliable source of funding in order to survive in the future. Aspects of AVAENSEN's subscription and consultancy-based model and ECCI's rent and project-based funding could be adapted to suit Cleantech London's needs.

Within the West Midlands context, we see the development of Energy Capital, catalysed initially by the Universities and Local Enterprise Partnerships<sup>21</sup>. Eventually, the core grew, and the changing political context in the area, has meant that Energy Capital has become embedded within the West Midlands Combined Authority. However, this has only happened through careful, detailed organisation, the running of successful events and lobbying. This was orchestrated by those promoting the cluster – none of these developments would have arisen spontaneously.

The funding models for the core activity associated with these latter, geographically larger-scale activities are likely to be more closely aligned with streams from local government, perhaps tapping into national funding streams. The strong political anchorage necessitates that, at least initially, the path to sustainability be secured.

It is clear that cluster activity funding is precarious and can be undermined by changes in political priorities, eg, the solar energy incentive schemes in Spain, political transitions such as changes in regional Mayors or – on a much larger scale – Brexit. One key factor in establishing resilience is ensuring that the cluster is seen to be generating value to the major stakeholders – otherwise the reason for funding evaporates.

## Navigating Multi-Level Governance Structures

The governance of clusters is challenging, as they are subject to multiple layers of political influence from the different nested geographic units in which they belong. There is often a complex interplay in the relationship between national and regional units of governance.

A key skill of those responsible for cluster governance is navigating this relationship and changing political alignments.

The alignment, or not, of politicians at nation, region and city level provides a series of challenges and opportunities. It is important to find an agenda which commands broad political consensus and is thus resilient in the face of changing political alignments.

For business and the research agenda, the ideal scenario is positive continuity and clear support for climate-friendly technologies which provides momentum and impetus to complementary efforts in academia and industry.

However, the reality is often less than ideal. Political priorities are in many cases shaped by the electoral cycle, and not all political parties value climate innovation equally. Therefore a key skill of those responsible for steering clusters is couching their innovation priorities within the rhetoric that resonates with the politicians of their region and nation. There are, however, underlying themes which cut across the political divide. These include the development of new industrial opportunities, improvements in skills and productivity and enhancement in regional and national investment. Given that

the industrial opportunity associated with the global transition is upwards of \$3 trillion and that growth in the cleantech sector is demonstrably higher than in many other sectors, there remains a window in which these arguments will continue to resonate.

The work of London up until the time of writing provides a hopeful perspective on navigating such structures. The Greater London Authority<sup>22</sup> was formed in the year 2000, in the run up to the second cycle of elections for the London Mayor in 2004. The previous Mayor, Ken Livingstone, committed to the formation of a London Climate Change Agency, which was set up in 2005. A municipal company owned by the London Development Agency, its mission was to champion low-carbon projects. Shortly after the election of Boris Johnson this agency was scrapped. The Cleantech London initiative was subsequently formed under Johnson's Conservative administration. However, with the election of Sadiq Khan, London's mayoral administration changed to Labour. The transition to a low-carbon circular economy and supporting the growth and innovation of the city's cleantech cluster to meet this growing demand is central to the current Mayor's policies – as set out in his statutory strategies including the Economic Development Strategy, the London Environment Strategy and the draft London Plan.

Similarly, the formation of the Energy Capital group in the West Midlands in the UK has provided a forum in which there is significant buy-in from local regional governments

such that it has been possible to develop a regional energy strategy<sup>23</sup>. Such strategies are key building blocks to establishing a single coherent story, building confidence from industry and national government to co-invest in regional development.

In the case of AVAESSEN, the financial crisis and the subsequent crippling of both local and regional governments removed them as a major player from the cluster's development. However, despite this, the cluster re-engaged with municipal and regional government by aiming to meet their smart city agenda needs. The SmartCities Think Tank successfully navigates multi-level governance by circumventing the idea of engaging councillors on an individual basis.

Instead it addresses the entirety of top-level municipal governance at once, highlighting the overlap in responsibilities that aren't being addressed and seeking to energise these synergies, which has proven to be successful. Moreover, bringing in relevant SMEs, start-ups and researchers in to the room allows a more collaborative and direct method of problem solving that energises all parties to quickly institute changes.

The financial crisis in Spain and the austerity drive in the UK which saw significant downsizing of capacity in local government has provided opportunities for stakeholder groups such as AVAESSEN and Energy Capital to position themselves to work collaboratively with local and regional government to provide solutions.



This shift in the balance of capability from local government, which is limited by capacity to deliver, to organised multi-stakeholder groups may indeed provide an opportunity to accelerate low-carbon innovation. In Scotland, ECCL has worked with Edinburgh City Council, providing an independent audit of the council's sustainability activity and delivering recommendations on how the authority can continue to improve its sustainability and climate change impact.

Whilst some of the other clusters have been overtly political in seeking to win the engagement of the politicians of the day, Provaldis School's approach is distinctly different. The Höchst site is very clear to ensure that its engagement is seen as being apolitical. Given that the investments in the site and the capital assets are enduring, the Höchst cluster is very keen to ensure that it is not drawn into the political agendas

of the day, and to be seen as being 'above the fray'. For this reason, there are very clear guidelines on political engagement – eg, that the site will not be used as a venue for political photo-calls in the run up to elections – despite its attractiveness given its heritage of success.

## Influencing Policy: Shaping Decisions

Policy is not a given, and is open to being shaped, steered and influenced through public discourse and debate. Some exemplary clusters have taken an active role in shaping the policy discourse in their municipalities; contributing to shaping and fostering an environment in which climate innovation can thrive. Again, the involvement of ECCI in shaping Edinburgh City Council's sustainability activity provides an excellent opportunity to influence city-wide decision-making.

Another good example of this can be found in the West Midlands' Energy Capital, where a number of interventions have served to raise the profile of the cluster in the minds of local politicians. In the run-up to the election of the West Midlands Combined Authority Mayor, an 'energy hustings' was held as part of the Energy Capital launch. This brought together invited candidates from all of the participating political parties to discuss the region's energy innovation needs and establish the need for climate-friendly policies in front of an assembled audience of local business, industry, the public sector and academia.

Further ideas for good cluster practice can be found in the establishment of a 'Policy Commission'<sup>24</sup>, to shape regional West Midlands, policy by convening representatives from local industry, national regulators, the grid and distribution network operators – actors that are key gatekeepers for energy innovation. The process of drafting the commission itself acted as a focal point for bringing together a wide range of regional and national stakeholders with an interest in the cluster – and the high-profile Westminster launch of the cluster further heightened its profile.

AVASEN has influenced policy through lobbying and its work through the SmartCities Think Tank. Whilst lobbying is a traditional technique, it has been no less effective. This is evidenced by the success of the cluster in its collaborative lobbying of regional government, successfully securing a partial compensation of the 'tax on the sun'. The less traditional method employed by the SmartCities Think Tank – drawing entire municipal cabinets together with think tank members – has also proven effective, with numerous municipalities acting on the advice given through their interactions with the Think Tank. However, AVASEN still stands to gain from the other clusters, with a collaborative, bottom up approach to informing policy on a national scale through a 'Policy Commission' being a strong contender.

This could be developed by following the template set out in the West Midlands case study. Drawing together expertise from a broad range of stakeholders to inform a policy dialogue, followed by a high-profile launch and dissemination of the findings. In terms of developing the cluster, this serves several objectives. The most obvious of these is that it provides a coherent and reasoned argument to policy-makers, which may help to shape policy along more favourable trajectories that aid the introduction of systemic climate innovations. Secondly, it acts as a forum to bring together actors within the cluster at high level. Through encouraging this dialogue and providing a forum for discussion, cluster actors are drawn together to find common ground. Thirdly, it acts as a platform for elevating the status of the cluster nationally, and in some cases internationally.

However, for such an approach to be successful, the conclusions and recommendations of the study need to resonate with the prevailing local and national politics and not become mired in detail.

Cleantech London's present form has its heart in the London Sustainable Development Commission within the GLA. It has been able to shape policy accordingly, allowing for greater business support as well as climate-friendly regulation and development – supporting the future growth of the cluster. This is an interesting contrast to Energy Capital and ECCI, who both influence policy through a demonstrative and advisory capacity in order to catalyse nationwide change. London's approach evidently stems from the GLA's deep involvement in the cluster, and as it is still in its birth phase there is potential for it to adopt models similar to Energy Capital and ECCI.

## Developing Markets for Climate Solutions

Developing innovation alone is not a fruitful strategy unless there are customers for the products, services and knowledge that clusters have generated. Often, in the case of climate innovation clusters, green products and services present an alternative from the status quo and natural markets do not always exist. Climate innovation clusters create value for their stakeholders by working together to create new markets for cleantech technologies.

Examples of this can be found in Valencia, where AVAESSEN convened meetings between city and regional governments aimed at showcasing the work of local innovators to those responsible for commissioning local works. By showcasing the potential advantage of new climate-friendly products and approaches and brokering relationships, a market for those products is created to supply the municipality.

Sometimes, there are infrastructures that will enable certain types of climate innovation. For example, hydrogen fuelling stations for fuel cell vehicles; EV charging points for electric vehicles. Sometimes to enable the adoption of climate innovations, successful clusters have focused on remedying the infrastructure barriers that prevent markets for new technologies from growing.

In the Frankfurt study, we see the creation of hydrogen refuelling infrastructure, enabling the industrial hydrogen generated on site for chemical processes to be used as on-site low-carbon transport fuel. Similarly, in Birmingham the development of fuel cell refuelling facilities enabled a market for hydrogen transport solutions as part of the Energy Capital EIZ at Tyseley.

Sometimes, it is about creating the foundations to enable infrastructure to work at scale. For example, the roadmap thinking going into the development of UK Central in the West Midlands will consider the effects on the local grid of a massive electro-mobility hub.

Out of all the clusters, AVAESSEN is currently placed in the most hostile regulatory environment. The fact that renewable energy not only doesn't receive government support, but is actively discouraged from being included in the grid, meant that it was forced to diverge and innovate in order to survive. The divergence came in the form of broadening from energy to cleantech as well as helping internationalise some of its members.

The innovation comes from its business support and think tank services. In terms of developing markets for climate solutions, the TAPs model has been effective in funding its efforts. One of the key services, aside from the 'business as usual' support, is access to networks which need climate solutions. The success of the TAPs model has led to the development of the SmartCities Think Tank, except this time the roles are reversed – rather than matching businesses to demand, demand (municipalities in this case) comes to the businesses.

It is acknowledged that without having gained the support of businesses through the TAPs system, the reputation and goodwill would not have been there to institute the Think Tank model. AVAESSEN is also an excellent example of how having in-house accelerator projects can help develop market solutions, as well as ensuring the cluster's stability.

The fact that businesses mature through the cluster means they are more likely to be happy to pay for the cluster's services. Strengthening the breadth of businesses within the cluster means it is a more diverse and attractive partner, meaning it draws in more business for its members. Growing the ecosystem grows the market for climate solutions.

The involvement of the GLA in Cleantech London means that policy has been very effectively used to develop markets for climate solutions. Both demand and supply are supported through regional policy in London. Demand is created by the need for London to meet its 2020 clean air targets, the stronger environmental regulations proposed in the Energy and Environment Strategy, and the desire for sustainable development in the 37 areas identified for redevelopment in the London Plan. Supply is supported by the Economic Development Strategy, which seeks to support cleantech businesses to reach market.

## Agglomeration and Identity

Agglomeration and identity are key issues that clusters must overcome in order to become stable and recognisable. These are the two sides to the coin that is cluster growth.

Through forging a strong regional identity for certain sectors – in the case of ConnectedClusters, cleantech and climate-friendly products – others of like mind may be attracted to develop their innovations in the region. Incumbent firms may also feel inspired to green their offering if a region establishes a clear cleantech trajectory.

Clusters generate greater returns for their members through agglomeration benefit. However the ways in which clusters generate such critical mass differ. Those identified within this project are creation, collection and transformation.

Creation refers to those clusters, such as AVAESSEN, which have had incubators at the heart of their models for a number of years. Such clusters tend to have a smaller number of actors at the top level, but through supporting SMEs and start-ups focused on climate innovation they build a cluster almost as a by-product of helping these nascent entities to grow. Through encouraging these small firms with fledgling innovations to reach the market, the cluster develops and grows as these companies scale. This ties in closely to the notion of a cluster developing markets for climate solutions. Whilst business creation is inherently based upon providing a demand with a supply, a cluster's ability to broker entry into previously untapped or inaccessible markets is an important emergent feature.

The notion of collection is primarily based on Energy Capital. The cluster has a broad top tier of actors covering academia, local government and industry. The cluster gathered critical mass by 'collecting' all the relevant actors and, through discussion and by convening meetings, aligning a pre-existing group of actors to focus on a common mission. This was achieved by the initial group seeking to draw in others with relevant interests and expertise in the energy sphere.

Here, some fresh developments helped to create the initial conditions for being able to construct a convincing narrative about the critical mass of energy activities in the West Midlands – the location of the Energy Systems Catapult in the City of Birmingham, the award of the Energy Research Accelerator programme to a group of Midlands universities and the formation of the Birmingham Energy Institute being key points.

The potential for transformation is seen in the nascent Frankfurt cluster. There already exists a huge footprint of interconnected industrial activity at the Höchst site. However, at present much of this work can be characterised as 'conventional' chemical engineering approaches. In seeking to transform this cluster into a 'climate innovation cluster', the challenge is manifold – encouraging the 'new shoots' of clean growth, by nurturing new ideas and developing new ventures that can be grown into SMEs, whilst simultaneously making an appeal to the existing incumbents to join the journey and transform their goods and services into cleantech alternatives.

AVAESSEN presents an interesting representation of agglomeration. Its original form was a 'collected' group of energy sector businesses in the region, however the decimation of its membership meant that it had to change how it grew from then onwards. Currently, AVAESSEN utilises both 'collection' and 'creation' simultaneously to grow and fund its cluster. The cluster 'collects' members by having external and previously established businesses pay a fee to become a cluster member, and it 'creates' members through its accelerator programmes, and by encouraging those who reach market to become cluster members. This synergistic approach could be an effective model for clusters at all stages of their development.

Cleantech London is still in its birth phase. At present, it appears to possess traits of both the above definitions – a smaller group of 'collected' actors, though it seeks to 'create' businesses and support them within the cluster too. Moreover, Cleantech London is reliant on physical development, with limited dedicated space at present. This is, however, changing in line with growing business demand.

The branded organisation at the heart of each cluster is not the entirety of the ecosystem – but a catalyst, hub or organiser. Around the world, there are many pockets of concentrated activity in a specific domain or sector that do not have an overarching brand or identity. However, the creation of brands and identities to describe agglomerations of activity is powerful – both to stakeholders inside and outside the cluster.

Identity plays a double role in cluster development. On the one hand, it can be used as a visioning tool to help galvanise those within the cluster towards a common mission. The creation of a brand under which regional activity can be united is a useful device to allow regions to construct their identities and stories of industrial transformation. These stories can be used to capture buy-in from actors inside the region and focus them on climate-friendly goals.

Identity is also key to the way that clusters present themselves to the outside world and to cluster growth. Once critical mass has been attained, cluster growth is sustained by its ability to draw in new members. The cluster's identity affects how it markets itself, either to potential start-ups and SMEs or to political actors and industry. This affects the quantity, calibre and scale of actors attracted.



## Managing Incumbents and Insurgents

Clusters face a significant challenge around managing co-existing firms on different scales. They will often be home to large anchor firms as well as smaller start-ups and new SMEs. There is a challenge in managing the sometimes-conflicting priorities of firms at different scales. For climate innovation clusters, successfully disrupting the status quo to encourage the transition to cleaner alternatives is also key.

There is an enduring tension in the innovation space between large firms and smaller newcomers. Whilst new firms may have new ideas and novel thinking, they may not have the resources to bring an idea to market. However, they are smaller, more agile and may

be able to develop solutions more quickly than established players. With fewer resources, smaller entrants must find innovative ways to develop 'lean' solutions that do not impose a high overhead on scarce resources. By contrast, larger firms may be more set in their ways. They have brands to defend, and large amounts of sunk assets invested in certain products, processes and services – so may be slower to change. That said, by virtue of their size and scale, they have the potential to have substantial impact if they change direction. Whilst they have the resource to develop solutions, their capacity to change is often limited by hierarchy, structure and organisational inertia.

The Frankfurt cluster is an interesting example of these tensions in the positioning of the cluster as an innovator in circular economy solutions, within a cluster of industrial partners with a long tradition of the production of chemicals whose processes might not be readily adapted.

Trends and technologies change quickly. Globally, there are clusters that are littered with the remains of firms that did not manage to innovate quickly enough. Kodak missed the digital camera revolution, and Nokia didn't manage to capture the smartphone market quickly enough. However, for every failed leviathan, there are thousands more small ventures that did not make it to market.

## Creating Templates for Co-opetition

Traditional competition can be combative and adversarial. In a world of finite resources, challenging circumstances can sometimes be viewed as a zero-sum game, where if one partner wins, another must lose.

A common lesson that has come from a number of successful clusters is how to unite previously competing partners, by focusing them in a spirit of competitive co-operation on energy and climate goals. The need for progression towards climate goals is a common target that binds humanity. That provides a compelling reason for rivals to pool expertise and share insight.

We have seen in the Energy Capital case study how the ERA partnership brought together universities that would traditionally be seen as regional rivals, pooling resources and expertise around a common mission to make a whole that is greater than the sum of the parts. Furthermore, the Energy Capital partnership brought together firms, some of whom were rivals and competitors, around a narrative of regional energy innovation.

Similarly, in Edinburgh's case study, ECCI brings together different sectors and organisations to work together in a spirit of common endeavour.

The economic changes which have taken place within many of the cities in which the clusters are embedded have seen local government being downsized to the point of being able to deliver only core services. The ability to be strategic and develop new infrastructure and new approaches has been significantly curtailed or even extinguished. In this environment, cooperation rather than competition is required to positively shape transition of cities and industry to meet climate change targets and clean air zone requirements and to seize the benefits of the global expansion of the cleantech sector.



## Developing Skills

Without doubt, skills development lies at the heart of any transition. Here academic institutions have a key role to play, but they need to be responsive in terms of the development of programmes to match the diverse set of skills and training needs and the rapidly-evolving agenda. What is clear is that relying on an existing menu of well-established programmes is a poor match for the sector and that there is a need to tailor provision and join up skills and training, from apprenticeship to higher education and continuing professional development. If a cluster is successful in developing new products and services, any scale-up requires a skills pipeline already in place to maintain momentum. This mandates that skills and training need to be developed in parallel with innovation.

This methodology is strongly embedded into the approach of Provdavis School and ECCI, but it is clear from the London case study that

there are challenges in getting universities with established reputations to flex.

The creation of a portfolio of higher education partners working collaboratively, as established earlier on in ECCI and within the Midlands and London, could in principle allow the development of a spectrum of integrated and progressive skills and training programmes. The ECCI model of co-locating businesses in a cross-sectoral hub so that SMEs can work closely with researchers, other businesses and public sector organisations provides a powerful opportunity for knowledge transfer and the acceleration of new developments and innovations to market.

Lack of expertise and resources is often one of the most significant barriers to systemic low-carbon transformation of our cities and regions. Within local government, there is often limited expertise and experience when it comes to making decisions relating to

the development of new infrastructure and procurement. This locks in a conservative mentality, whereby the safe, established way of doing things is often selected over a direction that might be more innovative. This impedes any transition towards low-carbon, low-pollution solutions. The work of the ConnectedClusters group has identified a key set of stakeholders as local government civil servants who are charged with developing policy. There appears to be a strong need for the development of specialist workshops to help upskill key decision makers and influencers in a range of areas, for example the circular economy, procurement, the hydrogen economy and electric vehicle infrastructure. Many of these areas face the twin challenges of resourcing for infrastructure development, combined with the need to improve public awareness and user acceptance of new, clean approaches to technology and infrastructure.



# Conclusions

Climate-KIC believes that the climate change challenge cannot be met in a ‘business as usual’ fashion. That is why the development of effective low-carbon clusters is so important. To date, some of the activity ascribed to clusters has been rather narrowly conceived and has had limited impact. There is a value in bringing together a number of companies in the same sector for a trade visit and maintaining e-mail contact with them afterwards. However, at best, this is cluster 1.0. We are exploring an approach that is much more ambitious and comprehensive.

From the activities outlined above, we are able to suggest the elements of a comprehensive climate innovation cluster scale which indicates a number of key features of thriving climate innovation clusters:

- Broad partnerships
- Aim to influence policy
- Stimulate new companies
- Diverse means of funding
- Promote collaboration alongside competition
- Foster skills development
- Have a public profile and identity

Clusters can assess their progress and impact against this scale. This vision would be the development of Cluster 4.0, where the learning from the cluster experience is shared and fed back to the ecosystem of low-carbon innovation clusters.

Climate innovation clusters differ from traditional clusters in that they are broader than support aimed at SMEs and entrepreneurs. They recognise the important role of public and private sector innovation and practice in cutting carbon and boosting climate resilience, rather than purely early stage business growth. They bring together businesses of all sizes, researchers, governments and communities across city regions to make rapid progress in systemically transforming the way we live for a thriving, zero-carbon future.

The creation of these city region ecosystems in a market sector that will grow exponentially in years to come is crucial to Europe’s aim to boost innovation and export solutions to the world. And they are key to delivering on national and city region aims – not just on sustainability and climate, but across a range of outcomes from reduced air pollution to better health and wellbeing, more employment and buzzing places. But to do this at the speed and scale required, clusters must link to and learn from each other. This is where the ConnectedClusters project comes in.

Evidence shows that the fastest innovation can be achieved in clusters – Silicon Valley being the most celebrated example – but broader, city region-wide climate innovation clusters have received relatively little attention until now. This clustering of climate innovation gives city regions huge potential to drive systemic shifts in how we live – this is what ConnectedClusters will explore and accelerate. Climate-KIC believes this could be the answer to delivering climate action rapidly and hand-in-hand with strong economic and social progress.

Creating thriving low-carbon city regions is our best chance of creating impact on the scale required to achieve the Paris targets while also supporting local economic growth and creating vibrant, healthy places.

This report showcases five concrete examples in which climate innovation is clustered around cities (bringing quadruple helix stakeholders) and the impact of these climate innovation clusters on growth of the regions and cities in which these clusters are embedded. This manifests itself in many forms – from new innovations being brought to market to the creation of skilled, clean jobs and the greening of industry. The success of these clusters provides a template for scaling the climate innovation clusters up across the entire European continent with the aim of multiplying climate impact.

Creating thriving low-carbon city regions is the most efficient and effective way to generate innovation and economic growth at scale at the same time as co-benefits, from reduced air pollution and fuel poverty to improved health and sustainable skills and employment for local people.

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