Regional insights from the Future Energy Scenarios

2022

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Navigation

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Download the PDF in Acrobat Reader to view all interactivity.

Page navigation explained

Back a page

Forward a page

Return to contents

From here you can navigate to any part of the publication

Expand content

Rollover or click the plus symbol to expand or enlarge content

Call to action

Where you see this symbol in the document it is highlighting a call to action

Buttons

Button

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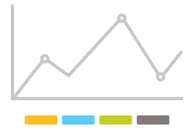


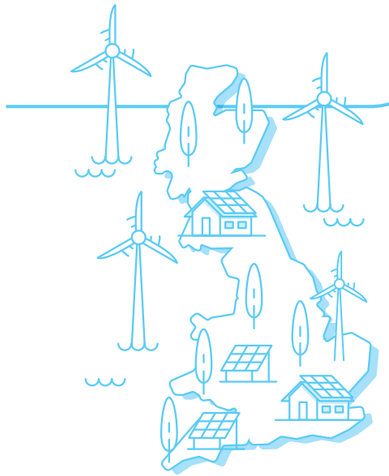
Text Pop-ups

Rollover highlighted orange text to view pop-ups

Text Links

Click highlighted grey text to navigate to an external link. Or to jump to another section of the document

Contents



Executive Summary

Enhancing Future Energy Scenarios through deeper regional insights

The 2022 edition of the Future Energy Scenarios was published in July 2022. It sets out the credible ways that the UK can achieve Net Zero by 2050, as well as the UK government's commitment to a decarbonised electricity system by 2035.

We have continually evolved how we develop our insights about the future energy system, nationally as well as regionally. As part of our analysis and engagement this year we have focussed more than ever before on understanding the regional insights for energy supply and demand out to 2050.

To develop and operate the whole energy system of the future and deliver value to consumers, three key areas must be fully considered: the energy consumer, the energy system and flexibility – all of which are explored in detail in our FES 2022 publication.

We continue to deepen our analysis to inform the potential credible pathways for the energy system into the future, including through 'regionalising' the Future Energy Scenarios. Regionalisation will enhance FES to accelerate Great Britain towards Net Zero, through greater granularity, broader engagement and more regional insights. This enhancement of our analysis, and therefore the insights we provide through the Future Energy Scenarios, is critical to ensure that the networks continue to deliver to meet customers' needs, and that decisions being made on the energy transition towards Net Zero are as informed as possible.

We recognise that a "one-size fits all" approach across the country will not be adequate if we are to meet the UK target for Net Zero by 2050 – it is vital to recognise the unique characteristics of different technologies, regions and communities. Key to this will be working closely with our stakeholders. By collaborating with industry and local decision makers, FES regionalisation will provide more robust analysis and consistent whole system scenarios. Ultimately, better information will be provided for policy and investment decisions which are a key enabler of Net Zero.

This document summarises the regional insights developed for FES 2022, which we will continue to build on for FES 2023 - such is the importance of understanding the whole system from a regional perspective. We want our stakeholders to be involved every step of the way as we evolve this thinking and invite your feedback and collaboration to continue to evolve our national and regional insights.

About the Future Energy Scenarios

What are the Future Energy Scenarios and why are they important?

Our Future Energy Scenarios (FES) outline four different, credible pathways for the future of energy between now and 2050. Each one considers how much energy we might need and where it could come from to try to a build a picture of the different solutions that may be required. FES is widely used by our stakeholders across the energy industry to:

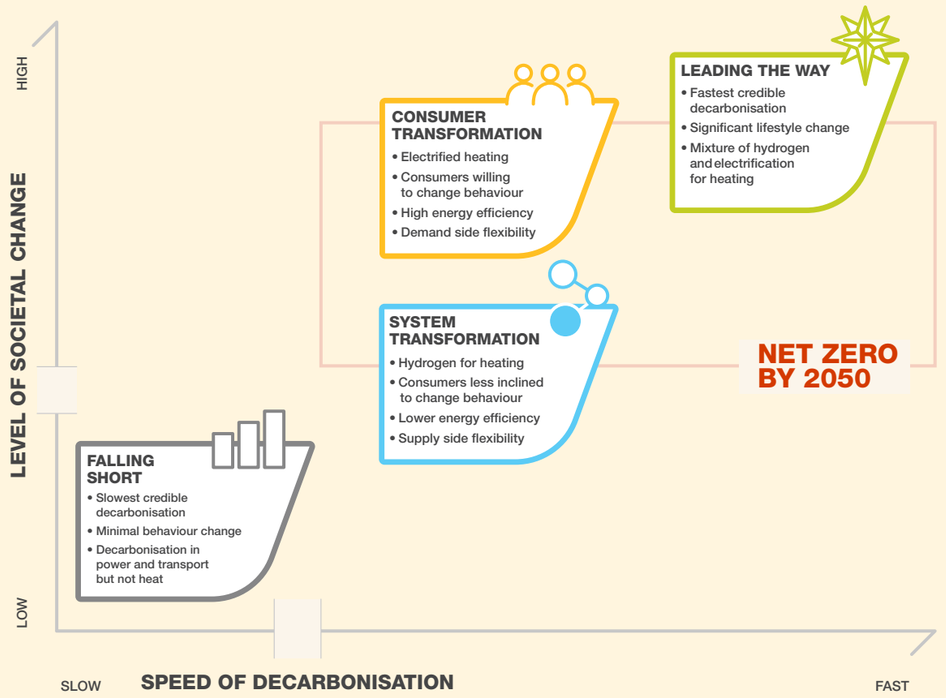
- underpin energy network development
- support investment decisions
- inform national and regional policy.

As well as producing FES for our stakeholders, feedback is collected as part of our comprehensive engagement work and incorporated alongside our own analysis and research to ensure that our data and insights remain robust and up to date. We also endeavour to make our data publicly available so that it can be used in academic work and innovation projects as well as to encourage challenge and collaboration.

The COP26 event in Glasgow in November 2021 showed how important it is for the world to reach Net Zero emissions by 2050 if global temperatures are to remain below 1.5 degrees. Reaching this target in the UK while also delivering an energy system for all that is secure, clean, affordable and fair is possible but will require a transition in how energy is both consumed and supplied.

The Scenario Framework

In line with stakeholder feedback, the top-level scenario framework remains broadly unchanged compared to recent years. However, the Steady Progression scenario has been renamed as Falling Short to reinforce how this scenario does not meet the UK Net Zero target by 2050. All the scenarios meet the relevant security of supply standards across the different fuels in every year.



Introduction

Regionalisation will enhance FES to accelerate GB towards Net Zero, through greater granularity, broader engagement and more regional insights

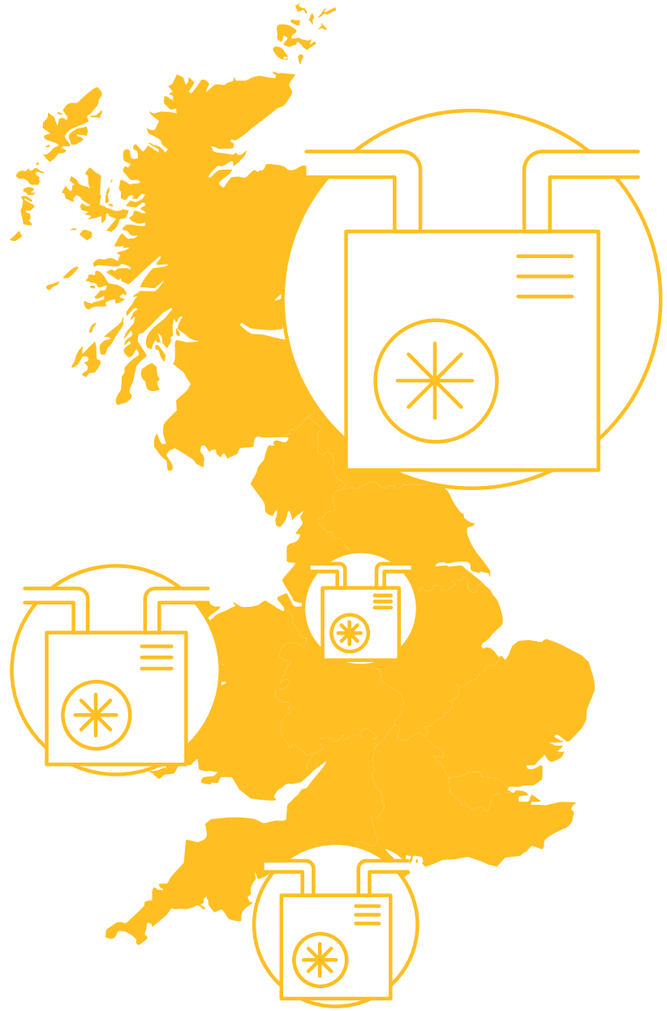
Through these activities we are enhancing our regional assumptions and modelling to allow us to more accurately represent aspects of the scenarios which vary due to local factors. We want to better reflect how different parts of GB will decarbonise at different rates and in different ways. Understanding this down to a local authority level will be an important step so we can reflect each local authority's unique journey towards Net Zero. This will be dependent on a number of factors such as local policy, availability of resources, local ambition, proximity to infrastructure, demographics and building stock attributes.

We are harnessing top-down and bottom-up scenarios

At the moment we create top down GB scenarios from the individual components of demand and supply. We then split this into regions for network development purposes - we currently model demand down to over 300 points across the country. Regional scenarios mean we will work with the network companies and other stakeholders to adopt a more "bottom-up" approach on a regional basis (where it is relevant and material to do so). This will improve our data and insights, allowing us to model spatial and temporal variations to a greater level of accuracy and comparability. This will build upon and enhance the regional information we currently produce, such as the regional datasets that are used in the Electricity Ten Year Statement process.

How we have already enhanced our regional modelling

Last year we introduced our new spatial heat model, which received good feedback, and we have been able to update our regional assumptions to further improve the outputs we produce. This year we also made improvements to our regional assumptions in our transport model, and we have made better use of the Distribution Network Operators' data to model embedded generation. We will continue to enhance our regional modelling and insights, more details on our plans can be found **here**.



FES Regional Insights / Introduction 06

Purpose of this document

By taking a regional approach in our modelling we will be able to identify how GB can best meet the Net Zero targets, considering regional variations in heat and transport, industrial decarbonisation, the importance of having flexible solutions in the right locations as well as how a strategic approach will be required to ensure different regions can adopt the low carbon solutions most suited to the needs of their consumers. Ultimately, better information will be provided for policy and network investment decisions, which are a key enabler of Net Zero.

In this document we summarise what the key insights were from a regional perspective from this year's **FES publication** as well as provide further information about where you can find more detailed regional data and our next steps in regionalising our scenarios further.[1]

We want to give you an opportunity to help shape how we further regionalise our Future Energy Scenarios and we are interested in your views on the following topics:

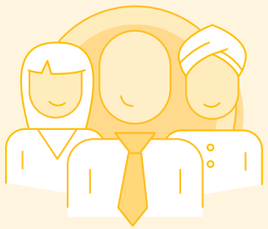
- What would you like to see us change, focus on, or prioritise as we develop regional whole energy system scenarios?
- We have provided more regional data than ever before, is this data useful? What additional data would you like to see from a regional perspective?
- This year we have integrated our regional insights within the main FES publication – would you prefer these to be in a separate publication?
- Would content and data being provided throughout the year be more worthwhile than an annual publication?
- Is data or are insights more important for you?

Please let us know your thoughts at: fes@nationalgrideso.com

1 There will references and links throughout to the main **FES publication** where more detail can be found.

Purpose of this document

Below is a summary of the principles behind this report



Stakeholder engagement

- **Engagement with our regional partners.** This will play a key role in providing insights for the ongoing regionalisation of FES.
- **Continuing the debate.** We want to use this document to continue the debate on regional energy, ensuring that our stakeholders have the opportunity to input into our assumptions as we further develop our regional modelling capability.
- **Better information.** We intend our modelling and insights to provide better information for policy and whole system investment decisions as well as being able to anticipate regional operability issues on the networks with enhanced regional data providing greater support for conversations with industry stakeholders.

Modelling developments and data sharing

- **Model developments.** We also provide further detail on the model developments we are making to enhance our regional outputs to enhance understanding and enable cross-industry collaboration.
- **Data sharing.** We understand the importance of clearly signposting where our customers and stakeholders can find our data and its purpose. This will become increasingly important as we increase the granularity of our data. We describe the data we currently publish in this document as well as highlighting data that will be available soon.

Innovation

- **Understanding consumer behaviour.** Innovation will play an important role in enhancing our future energy scenarios. An upcoming area of focus will be enhancing our understanding of consumer behaviour and we are exploring developing a set of industry standard consumer archetypes. We provide more detail on this project in this document.

FES Regional Insights / Purpose of this document 08

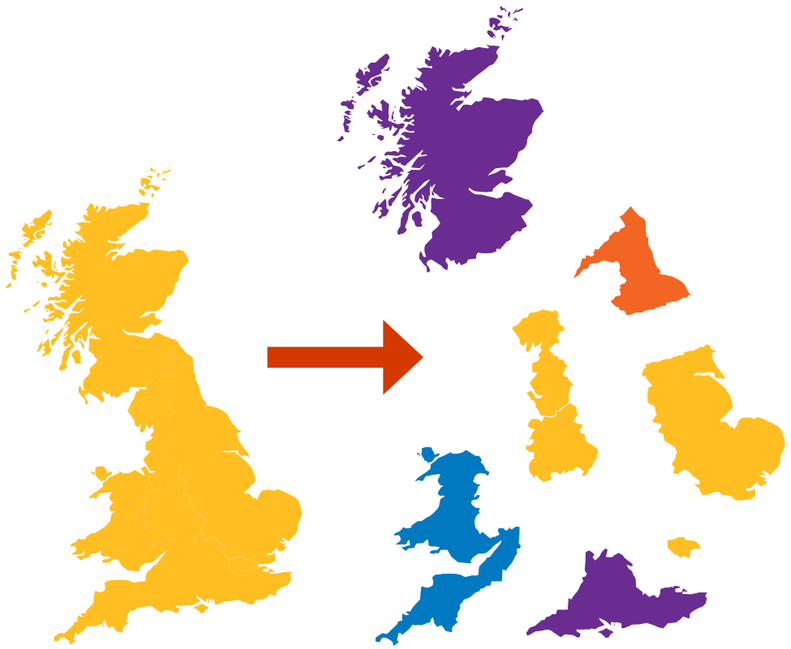
What do we mean by regionalisation?

Now

How we develop our regional modelling today

We analyse the demand and supply initially at a GB level.

The GB forecast is then broken down based on regional assumptions.

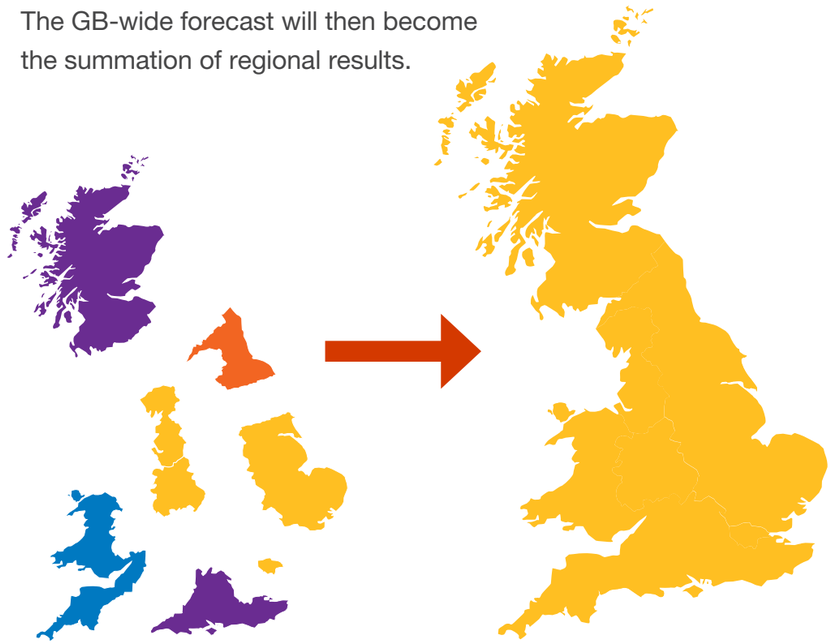


Future

How we will model regions in the future

Our ambition is for our modelling to start at regional level where it is relevant or material to do so (potentially down to GSP / Offtake level or individual supply point depending on the model).

The GB-wide forecast will then become the summation of regional results.



The map used here is for illustrative purposes only and doesn't show the full extent of the granularity some of our modelling may go down to.

FES Regional Insights / What do we mean by regionalisation? 09

What do we mean by regionalisation?

Current modelling ⊕ Future modelling ⊕

This diagram summarises how we currently develop our Future Energy Scenarios modelling

Demand Models

- Residential
- Industrial & Commercial
- Road Transport
- Heat
- Losses

Elec. Aggregation

Nat. Gas Aggregation

- Demand is currently an aggregated output of multiple independent sub-models.
- These are largely GB annual and peak demands.

Supply Models

- Electricity Generation and Storage
- Hydrogen supply
- Natural Gas supply

- With a view of demand, we match potential supply based on the FES framework assumptions.
- There are iterative stages between supply and demand modelling e.g. natural gas demand for electricity generation needs to be included in demand.

Outputs

- Documents, Data workbook
- Disaggregation to regional
- Building Blocks, ETYS, NOA, Demand Statements

- The results of the modelling are used in our FES publications and in various other obligations and downstream processes.
- Where regional results are required, these are normally created by disaggregating the GB level through separate processes.

FES Regional Insights / What do we mean by regionalisation? 10

What do we mean by regionalisation?

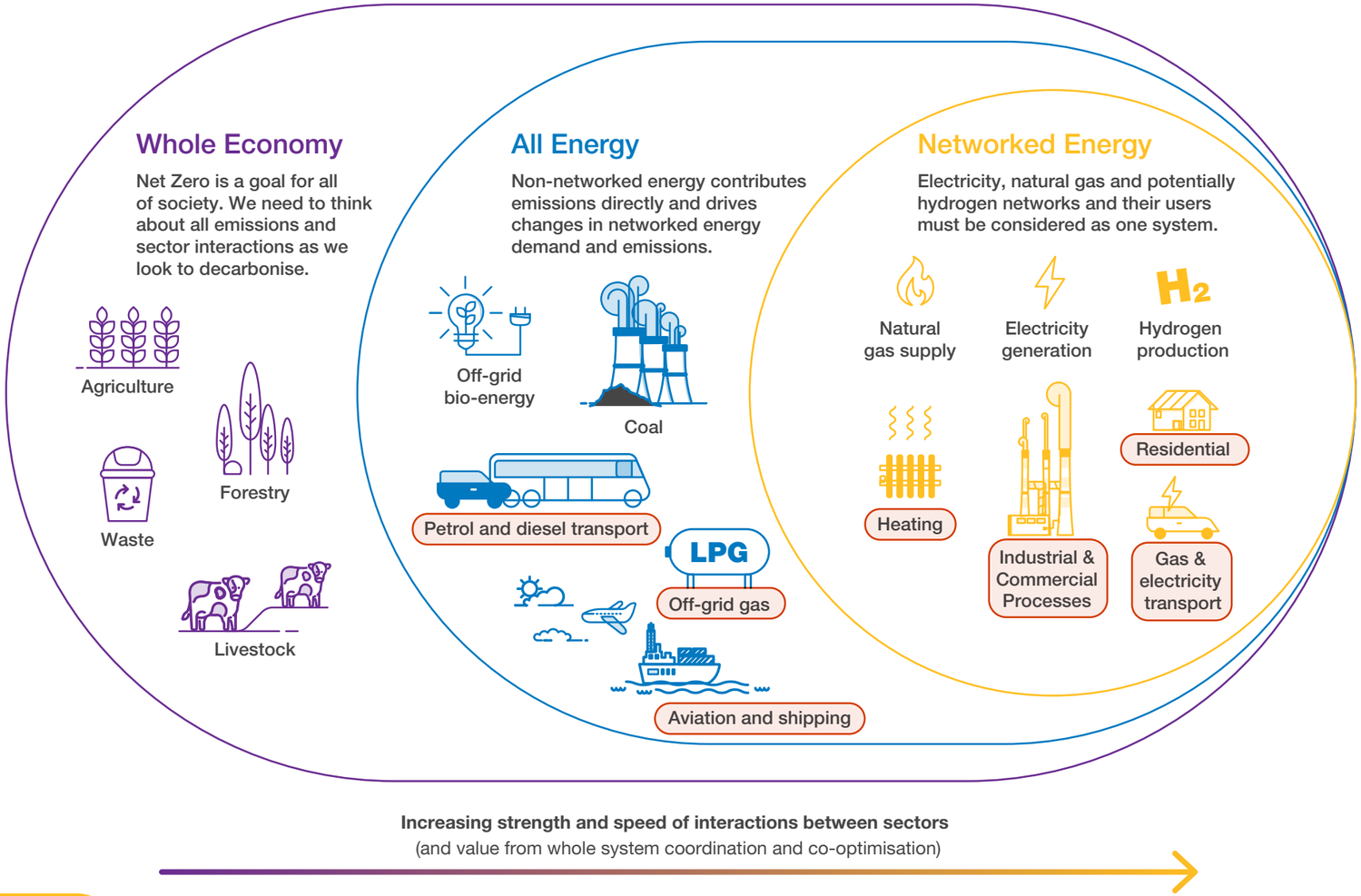
Developing Whole System Insights

A key aspect of regionalisation for use in our processes is that it is about the whole energy system[2], ensuring that cross-vector[3] interactions are fully considered as we transition to Net Zero. Taking this approach will ensure efficiency is maximised whilst driving consumer value. We currently share granular data with our network colleagues in gas and electricity.

This is now also expanding to include hydrogen, as the system becomes more dynamic with changes across energy vectors. Our regionalisation activities will build on this and ensure there is increased accessibility to the data and information, as well as enhancing the modelling from a whole energy system perspective.

Consumer

Consumers are at the heart of whole system thinking and coordination.



2 A collective term that is used to cover, but is not strictly limited to, transmission and distribution systems for both gas and electricity (potentially including hydrogen in the future).
3 A cross-vector approach considers the interaction of different energy carriers such as electricity, gas and hydrogen. Examples include where natural gas or hydrogen is used to generate electricity or the conversion of electricity into hydrogen via electrolysis.

FES Regional Insights / What do we mean by regionalisation? 11

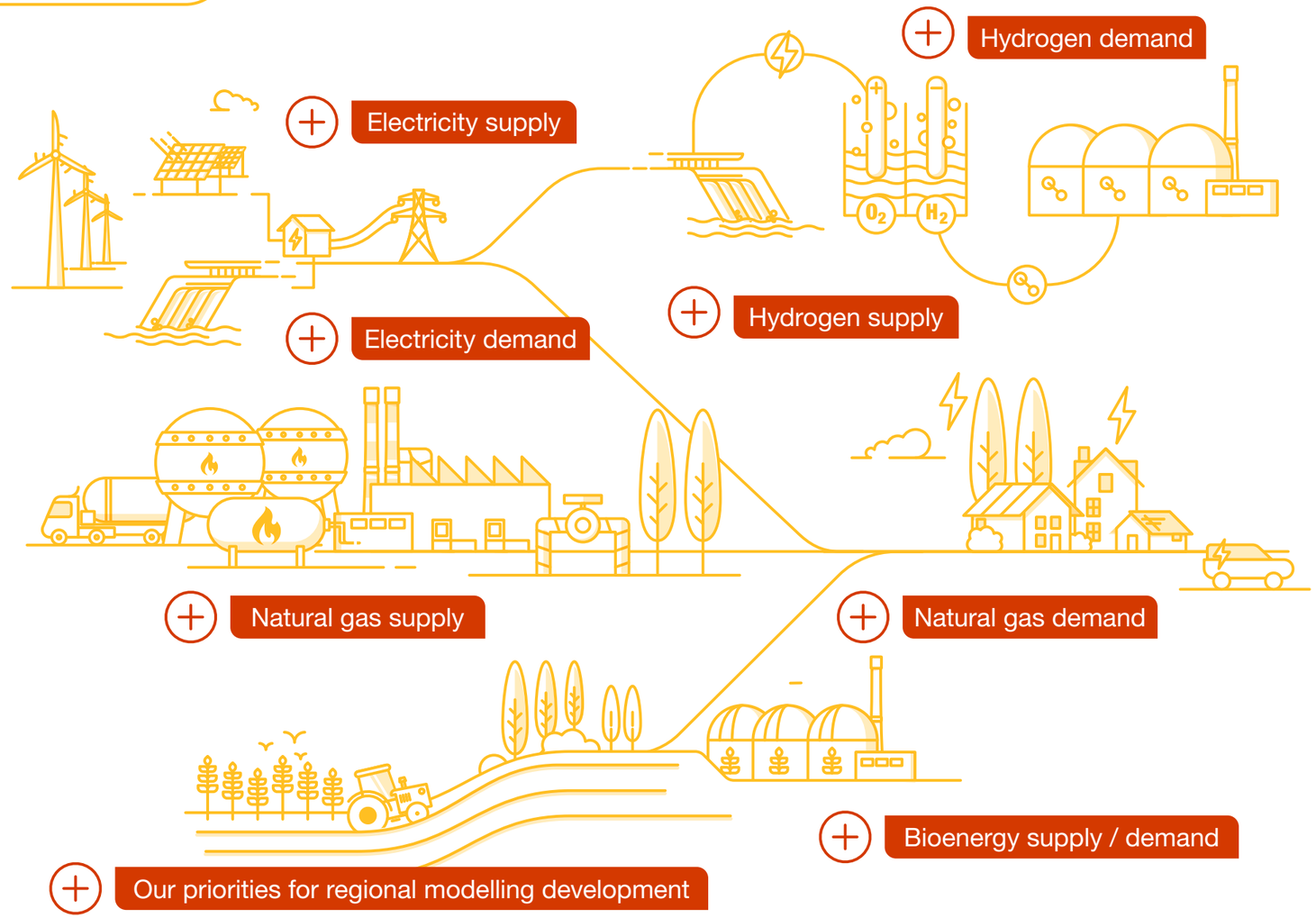
How we currently regionalise our scenarios

The FES already produces a regional view of supply and demand on the energy system

FES is used as a fundamental part of annual network planning and operability analysis for both electricity and gas. The data for these processes is needed geographically to identify points on the gas and electricity transmission networks where more transfer capacity is needed and where operability issues may emerge.

As most of our analysis is conducted at GB level, we need to make some assumptions to disaggregate the outputs across regions. Here we describe at a high level the assumptions we make across different fuels for supply and demand.

Our priorities for regional modelling development are also described to reflect how there are many emerging technologies and their adoption will vary by geographical location which means having a more in-depth regional understanding is needed especially considering changing peak demand requirements and flexibility needs.



Click ⊕ for information

FES 2022 regional whole system insights

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Overview of regional whole system insights for FES 2022

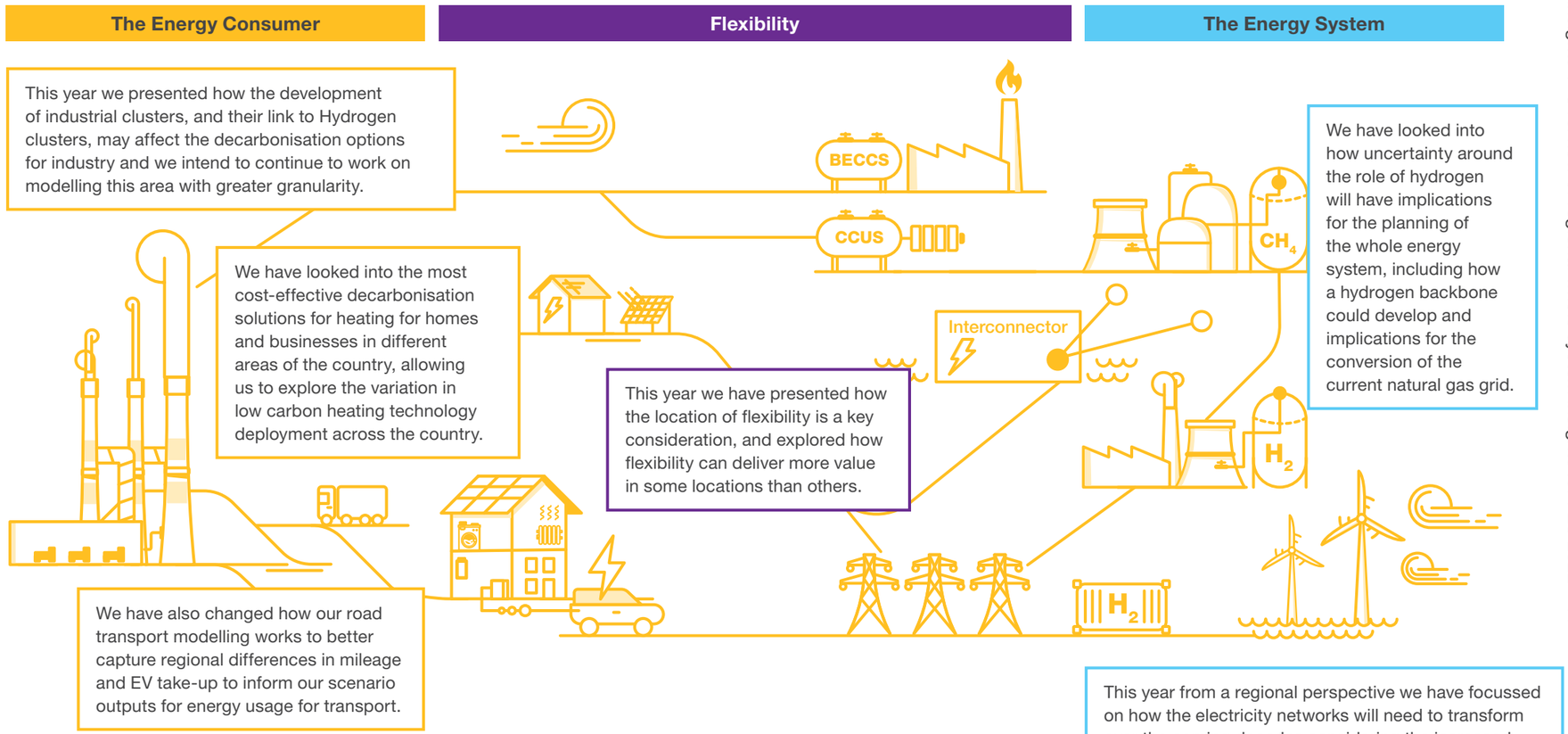
FES 2022 Key messages – a regional perspective

There were four key messages in FES 2022, the following section explain the role of regional insights for each of those key messages.

Summary of FES 2022 regional insights

In the Future Energy Scenarios, we consider the contribution of consumers to the Net Zero challenge (**the Energy Consumer**); the ways in which the whole energy system needs to adapt as it transitions to a low carbon future (**the Energy System**); and the importance of flexibility to the ongoing balancing of the system (**Flexibility**). Following the overview of the FES 2022 key messages we present a summary of the regional insights we presented in FES 2022.

We are improving our FES modelling year on year, with greater granularity and more detailed regional outputs, rather than just using a GB view. This year we are providing more clarity on possible pathways for whole system decarbonisation through regional insights which have been included within our main FES 2022 publication.



Summary of regional insights explored in this year's FES document

Key Message

Policy and delivery: a regional perspective

Significantly accelerating the transition to a decarbonised energy system can help to address security and affordability concerns at the same time as delivering Net Zero milestones.

Leading the Way reaches Net Zero in **2047**

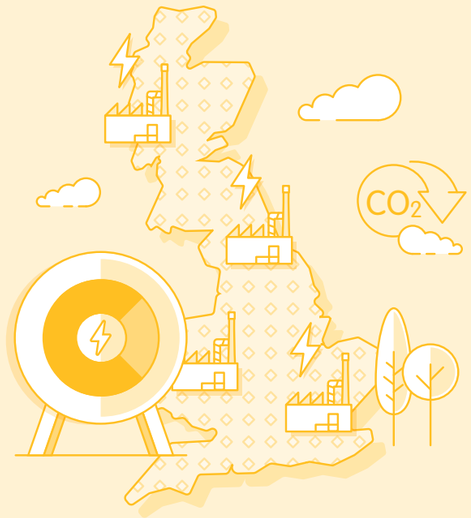
Overall end consumer demand reduces by over 40% by 2035 in Leading the Way

Leading the Way has no unabated natural gas generation capacity after **2035**

Levelised costs of wind and solar are much lower than unabated natural gas generation for projects commissioning in 2025

Regional diversity is increasing, our strategies and policies must reflect this for individuals and GB

- A “one size fits all” approach to decarbonisation of residential heat is not optimal due to; differences in consumer preferences, availability of resources, and proximity to energy infrastructure. Within a national strategy, delivery of the targeted solutions and investment required by consumers should take place at a more regional level to leverage local knowledge and improve affordability.
- Each region has different levels of renewable resources as well as different domestic, industrial and commercial demands. If we are to decarbonise the entire UK power sector and wider economy, understanding the cause and impact of these differences is critical. For example, these differences have already contributed to national policy differences with Scotland, which has high levels of wind capacity and relatively low demand, setting a target to reach Net Zero by 2045.



FES Regional Insights / FES 2022 Key messages - a regional perspective 15

Key Message

Consumer and digitalisation: a regional perspective

Consumer behaviour is pivotal to decarbonisation – how we all react to market and policy changes, and embrace smart technology, will be vital to meeting Net Zero.

BEIS Public Attitudes Tracker, Spring 2022, UK

84% of people said that they were concerned about climate change, with 41% saying they were “very concerned”

82% of people said they had given either a lot, or a fair amount, of thought to saving energy in the home

In our scenarios, consumer engagement in smart EV charging ranges from 43% (FS) to 92% (LW) in 2035

As at the end of March 2022, only 45% of installed energy meters were smart and operating in smart mode

There is a need to ensure that different regions can adopt the low carbon solutions that are most suited to the needs of their consumers and communities

- To facilitate developments in smart technology and better understanding of regional trends, data must be made available to innovators while ensuring that appropriate consumer protection is maintained.
- Sales of electric cars are accelerating, but further action is needed to meet the Government’s target for no new sales of petrol and diesel cars by 2030. Government and local leaders have announced measures to help increase uptake of lower emission vehicles, and further focus is needed on supporting consumer adoption, such as the upfront costs and the availability of charging infrastructure.

FES Regional Insights / FES 2022 Key messages - a regional perspective 16

Key Message

Markets and flexibility: a regional perspective

Reforming energy markets to improve price signals will help unlock the flexible solutions needed to integrate renewables efficiently.

Wind and solar generation currently make up 43% of GB energy supply and this rises to at least 66% across the scenarios by 2030

Annual transmission constraint costs have increased from £170m in 2010 to £1.3bn in 2022 and are expected to continue rising

In Leading the Way, demand side flexibility reduces unmanaged peak demand by over 40% by 2035

Consumer Transformation and Leading the Way have more than 115 GWh of electricity storage in 2035 compared to less than 30 GWh today

The need for flexibility changes with time and region but markets don't currently reflect this

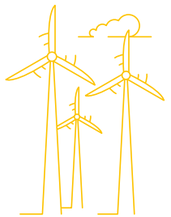
- ESO analysis shows that market reform is needed to provide the dynamic real-time locational signals required to optimise dispatch and siting decisions of flexible capacity on the whole energy system. Improving locational signals has the potential to deliver significant cost savings to consumers without any adverse impact on renewable targets.
- Flexibility can deliver more value in some locations than others. For example, electrolysers may be sited close to renewable generation and network constraints, or storage may be co-located with renewables. Appropriate and tailored price signals and incentives will be needed from policy and the energy market to encourage these new solutions, especially flexible demand-side response and inter-seasonal storage.

FES Regional Insights / FES 2022 Key messages - a regional perspective 17

Key Message

Infrastructure and whole energy system: a regional perspective

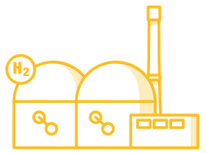
Strategic investment in the whole energy system is urgently required to keep pace with Net Zero ambitions and strengthen energy security.



Across the scenarios, at least 31 GW of offshore wind is connected in 2030 with 51 GW in Leading the Way

At least 15 TWh of electricity is curtailed in the Net Zero scenarios by 2030

There are over 40 GW of network-connected electrolysers in Leading the Way and System Transformation in 2050



56 TWh of Hydrogen storage is required in System Transformation by 2050

There is a need for targeted strategic solutions that specifically meet the unique range of challenges each area of the energy system will experience in the future.

- The GB electricity network will need to continue to rapidly transform over the coming decades, as the system changes from large, centralised generation in the past to more decentralised, low carbon sources in the future. Coordination is essential at all levels and across all technologies.
- Industrial cluster sites for Carbon Capture Usage and Storage (CCUS) and hydrogen could reduce whole system costs and the need for additional electricity and gas network investment. However, cluster locations must be carefully designed to maximise use of existing network infrastructure and avoid exacerbating system constraints. A shift towards locational marginal pricing, as explored in our Net Zero market reform work, could incentivise more efficient siting.
- Uncertainty around the role of hydrogen and where assets could be located in the future is one of the main obstacles to planning strategic investment across the whole energy system.

FES Regional Insights / FES 2022 Key messages - a regional perspective 18

A summary of the regional insights from “The Energy System” chapter of FES 2022

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Transforming GB electricity networks

Key insights

Today we already see high levels of power exported from Scotland into England at times of high wind generation. In the future, we expect;

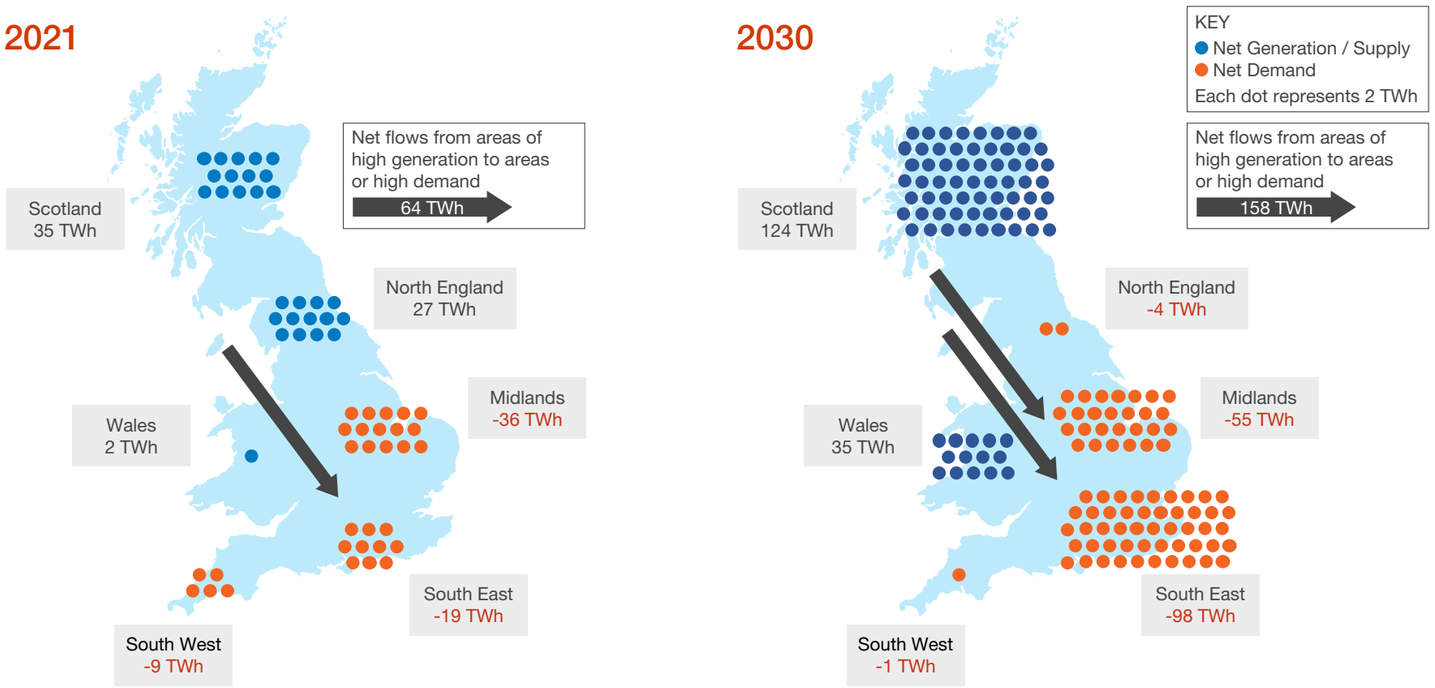
- Further significant power flows associated with the additional levels of new offshore wind that are expected to connect. This will mean power flows will become increasingly variable with higher peaks.
- Scotland, the north of England, East Anglia and the south coast regions expected to experience the highest amount of excess flow.
- Variations in year-round conditions, when designing the networks of the future. Focussing effort on a few key points in the year may no longer be suitable, as peak conditions are not the only time we see high flows in the network, especially when considered from a regional perspective.
- The continued rise in connection of renewables directly to the distribution network leading to variations in the geographic distribution of flows on the network, as well as presenting additional regional operability challenges on the network.

Our recently published **Holistic Network Design** is critical in enabling infrastructure to be delivered at the scale and pace necessary to achieve 50 GW of offshore wind by 2030. Importantly, it looks holistically across four areas including the cost to consumers, impact on local communities, environmental impact and deliverability and operability, making sure that this offshore wind infrastructure is delivered in the most efficient way with the lowest impact.

Urgent network reinforcement is required on an unprecedented scale

The GB electricity network will need to continue to rapidly transform over the coming decades, as the system changes from large, centralised generation in the past to more decentralised, low carbon sources in the future. Coordination is essential at all levels and across all technologies and there is a need for targeted strategic solutions that specifically meet the unique range of challenges each area of the energy system will experience in the future.

Regional Flows on the electricity transmission network in Leading the Way



Regional Carbon Intensity

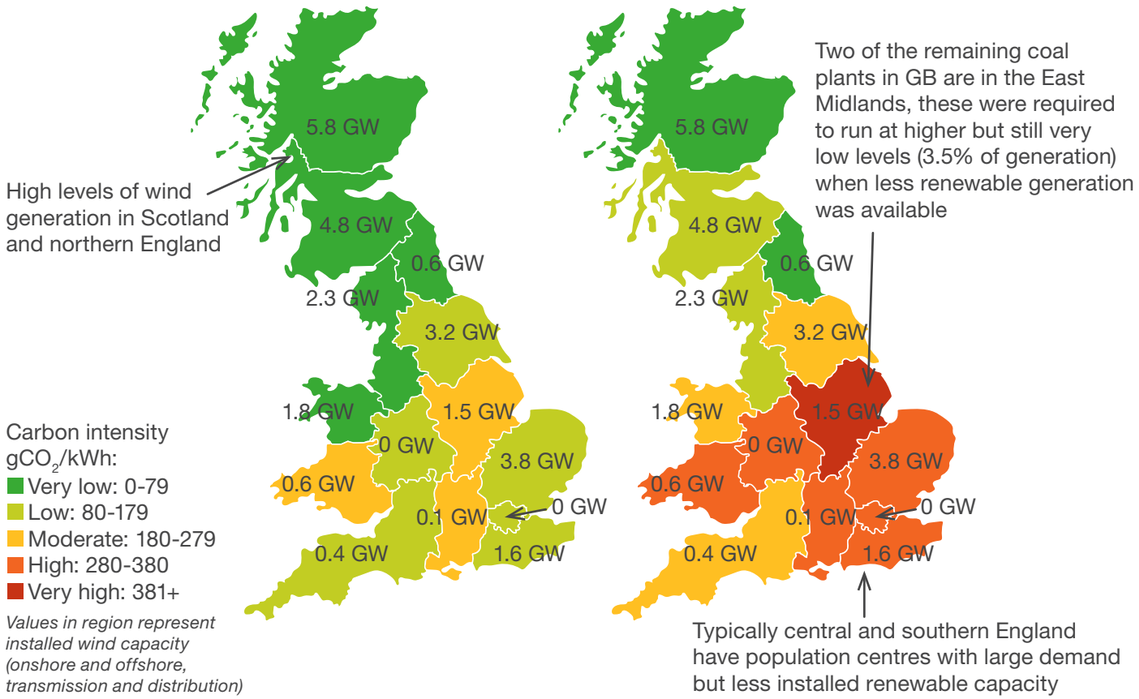
Key insights

- Regional differences need to be considered when identifying regional strategies. A region should not be measured by its carbon intensity as some are naturally demand or supply centres.
- There is clear regional variation, with Scotland generally having lower carbon intensity than English and Welsh regions, due to the high levels of renewable capacity (wind and hydro) in Scotland compared to its relatively small population density.
- Daily variation in renewable generation output could have significant impacts on the carbon intensity of individual regions.
- Future electricity supply assumptions in FES could impact emissions on a regional scale. For example, large single nuclear plants could have a significant impact on the carbon intensity of individual regions, while increased concentration of renewable generation in specific regions could also have an effect.

A region's unique aspects, from its geography to its people, should be considered with regards to its strategy, options and policies for decarbonising to meet GB's Net Zero target

Each region has different levels of renewable resources as well as different domestic, industrial and commercial demands. If we are to decarbonise the entire UK power sector and wider economy, understanding the impact of these differences is critical. For example, these differences have already contributed to national policy differences with Scotland, which has high levels of wind capacity and relatively low demand, setting a target to reach Net Zero by 2045.

Carbon intensity of UK electricity transmission system (gCO_2/kWh) and wind generation capacity (GW) per region: left; higher wind generation day, right; lower wind generation day



Hydrogen production locations

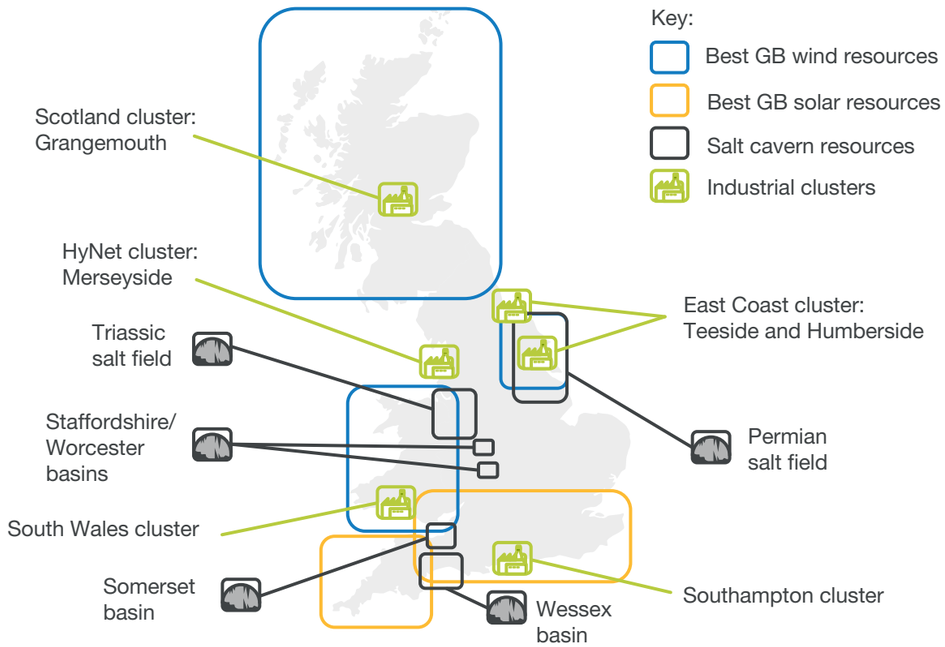
Key insights

- If hydrogen production is assumed to be developed within a small number of industrial clusters, then the uptake of hydrogen boilers would therefore also be focused in these areas.
- The conversion and repurposing of the current gas network will be a key requirement for increasing hydrogen boiler uptake and could therefore drive decisions in developing hydrogen production projects near current natural gas pipelines.
- We expect that as pilot projects are tested and proven, this will lead to a regional propagation of hydrogen as clusters are linked together and a potential hydrogen backbone is developed.
- Key decisions need to be made, such as the use of hydrogen for heating (expected in 2026) and the use of hydrogen in HGVs (mid-2020s), which until there is further clarity on will lead to uncertainty around the production of hydrogen at scale and where it will be geographically.
- If hydrogen does have a significant role to play in our future energy mix this will also have implications on current CCGTs and the interaction of when and where the network supplying these customers will convert from natural gas.
- Producers, suppliers and network operators also need to be ready and there needs to be sufficient demand, which will require decisions, coordination, incentives and investment from the government.
- Having adequate hydrogen storage is another important consideration, especially from the whole energy system perspective, as this allows additional energy to be provided at times of peak demand or low renewable output.

Uncertainty around the role of hydrogen and where assets could be located in the future is one of the main obstacles to planning strategic investment across the whole energy system

Identifying when and where hydrogen economy opportunities will develop will become increasingly important to help us understand how the whole energy system develops from a regional perspective.

GB Hydrogen co-location opportunities for production, storage and industrial clusters [source: DELTA-EE innovation project][4]



4 https://www.delta-ee.com/report/report-summary-hydrogen-as-an-electricity-system-asset/

FES Regional Insights / A summary of the regional insights from "The Energy System" chapter of FES 2022 22

A summary of the regional insights from the “Flexibility” chapter of FES 2022

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Location of Flexibility

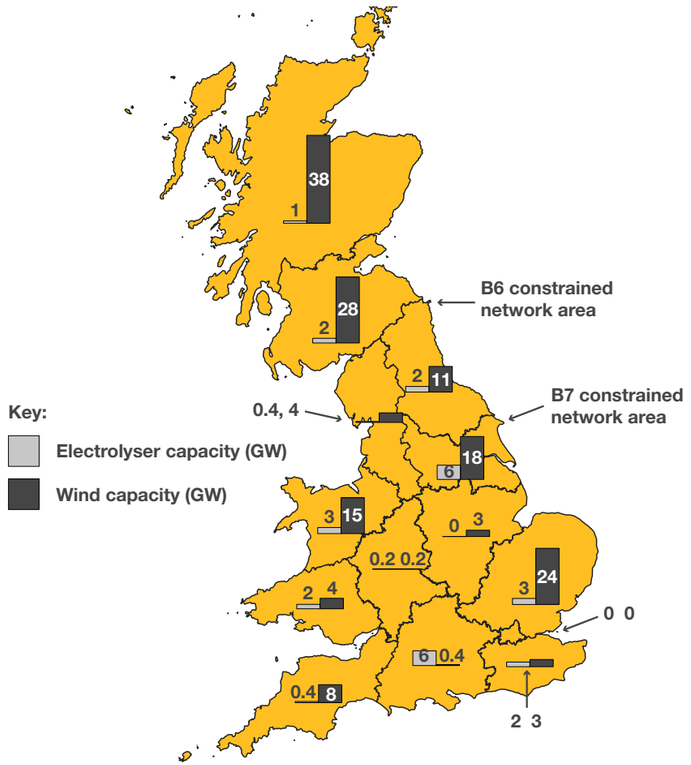
Key insights

- In general, all flexibility options connecting to the electricity network will have to ensure that they are; suitably placed on the network, that there is an adequate grid connection, and they are not limited by network constraints.
- ESO analysis shows that market reform is needed to provide the dynamic real-time locational signals required to optimise dispatch and siting decisions of flexible capacity on the whole energy system. More detail is provided here.
- Hydrogen production can be sited on areas of the network with potential constraints, through the installation of electrolysers. Electrolysers can convert electricity into hydrogen by diverting it from the electricity network therefore helping manage the constraint, reducing network reinforcement, integrating renewable generation into the network and reducing curtailment.
- Siting electrolysers in a way similar to that in Leading the Way and System Transformation will not only ensure they provide the maximum benefit in terms of flexibility, but may also boost the business case of electrolysers. This is because placing electrolysers next to constrained areas of the network may increase the demand to run them (i.e. increase their load factor).

The optimal placement of flexibility options could reduce the need for some network reinforcements

Flexibility options should be sited to maximise value whilst still considering other siting requirements. But the most suitable locations will vary by flexibility option.

Electrolyser and wind capacity
by DNO region in 2050 - Consumer Transformation



Consumer Transformation | System Transformation | Leading the Way

A summary of the regional insights from “The Energy Consumer” chapter of FES 2022

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Industrial Clusters

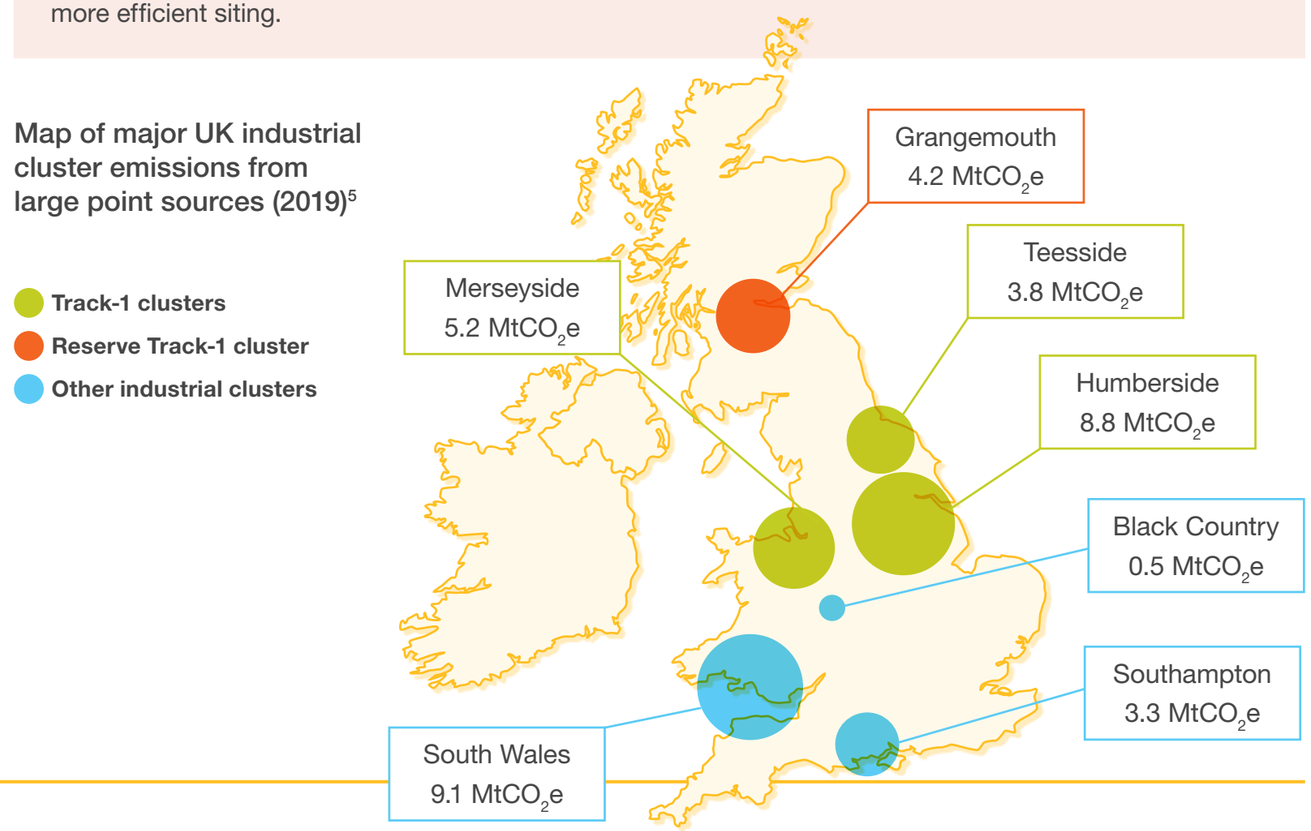
Key insights

- There are existing clusters of energy and emissions intensive industry across the country; finding decarbonisation solutions for these areas will be crucial to meeting Net Zero.
- We expect hydrogen supply to be developed in industrial clusters, and that industries located there, which can use hydrogen as a fuel, will adopt technologies to use this as a source of energy. Industries will be able to test and embed decarbonisation strategies, including manufacturing of chemicals, iron and steel. This will help build the market for hydrogen within industry between now and 2030 and help stimulate the transition to hydrogen industry-wide.
- CCUS infrastructure based in the industrial cluster sites will enable the decarbonisation of industrial processes that are unable to switch away from fossil fuels or that use fossil fuels as a feedstock. This will be particularly important for areas such as chemicals and cement production. It will also enable the production of blue hydrogen within industrial clusters to supply hydrogen to the clusters.
- Industrial sites located outside of clusters that are less energy-intensive such as the automotive or food production industries typically use natural gas for their industrial processes. If available, hydrogen is therefore a potential replacement to supply this industrial process heat, however in Consumer Transformation in particular these sites would need to electrify their heat requirements instead.

Cluster locations must be carefully designed to maximise use of existing network infrastructure and avoid exacerbating system constraints

Industrial sites clustered for Carbon Capture Usage and Storage (CCUS) or hydrogen production could reduce whole system costs and the need for additional electricity and gas network investment. A shift towards locational marginal pricing, as explored in our Net Zero market reform work, could incentivise more efficient siting.

Map of major UK industrial cluster emissions from large point sources (2019)[5]



5 Source: NAEI 2019 data, Government CCUS Investor Roadmap April 2022. Does not capture non-ETS (Emissions Trading Scheme) emissions in a cluster.

FES Regional Insights / A summary of the regional insights from "The Energy Consumer" chapter of FES 2022 26

Regional heat

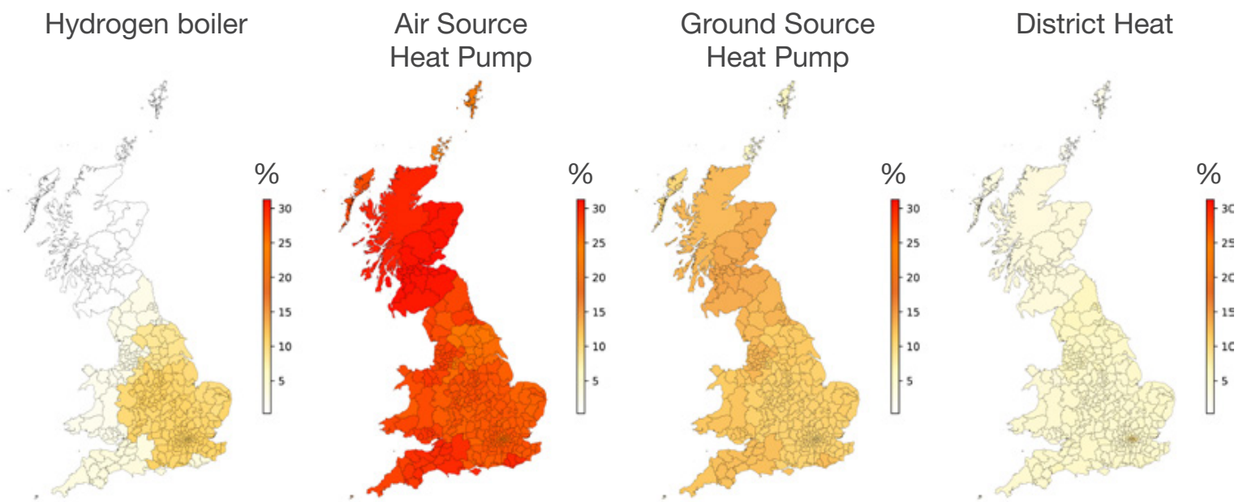
Key insights

- The take-up of different technology types varies by region and by scenario. Areas closer to the current natural gas grid are likely to have higher concentrations of hydrogen boilers in a hydrogen dominated scenario, such as System Transformation.
- In Leading the Way we assume that hydrogen production develops initially within clusters. The uptake of hydrogen boilers would therefore be focused in those areas where there is proximity to production as the associated costs of network upgrades to transport the hydrogen from further away become prohibitive.
- Consumer Transformation sees a more uniform deployment of most technology types, but greater take-up of district heating in more urban areas.
- Decisions on the roll out of low carbon heating, including the 2026 decision on role of hydrogen, must consider regional opportunities and complexities.
- There is a need to ensure the right powers and accountability are considered at national and regional / local levels.

A “one size fits all” approach to decarbonisation of residential heat is not optimal

This is due to differences in consumer preferences, availability of resources and proximity to energy infrastructure. With a national strategy delivery of the targeted solutions and investment required by consumers should take place at a more regional level to leverage local knowledge and improve affordability.

Technology deployment in Leading the Way in 2035



Technology deployment in Leading the Way in 2035 | Heat pump take-up in 2050

How and where zero carbon vehicles will be refuelled

Key insights

- Today's experience of refuelling at local petrol stations is likely to change in the future. This will vary according to the type of vehicle and the fuel: electricity, hydrogen or gas.
- We expect electric cars to dominate the passenger vehicle market, but there is some growth in hydrogen fuel cell vehicles, and hydrogen plays a role for some HGVs in all Net Zero scenarios. There is variation across the scenarios in how electric vehicles are charged, reflecting the differences in infrastructure development and consumer preferences in each scenario. In all scenarios the majority of those who can charge at home do so where possible, however a range of options is needed to ensure solutions for all consumers.
- Careful consideration is needed to ensure there is fair transition and affordable, equitable access to charging infrastructure in the shift to EVs. There is the potential for charging costs to be inequitable, should different consumer segments face different costs due to use of different types of chargers and their accessibility and location. Consumers who can afford their own solar panels, battery and off-street parking may be able to charge cheaply at home, while those without could face higher costs charging away from home. This highlights the potential role for policy and regulatory protection to support consumer fairness.

Wherever consumer change is needed, there must be a plan to deploy the infrastructure for that change

Sales of electric cars are accelerating, but further action is needed to meet the Government's target for no new sales of petrol and diesel cars by 2030. Government and local leaders have announced measures to help increase uptake of lower emission vehicles, and further focus is needed on supporting consumer adoption, such as the upfront costs and the availability of charging infrastructure.

Types of charging

Residential charging (3-7 kW)
Typically for those with off-street parking who can install their own home charger and charge from their domestic electricity supply. This could also be via communal chargers in private car parks for blocks of flats or on-street parking close to homes that have an overnight domestic charging pattern.

Workplace and destination charging (7-22 kW)
Using employer-provided EV chargers in workplace car parks, typically plugged in during the daytime, or charging in consumer locations such as retail parks, supermarkets and other commercial premises.

Rapid charging (50-150 kW)
High power chargers, typically 50 kW or greater, that can charge car batteries back to 80% or above in 20-40 minutes. Currently these are primarily found in motorway service stations, however there may be greater uptake of local rapid charging hubs.

FES Regional Insights / A summary of the regional insights from "The Energy Consumer" chapter of FES 2022 28

FES 2022 regional modelling enhancements

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Regional modelling enhancements

Heat

- We introduced the results from our new Regional Heat Model for the first time in FES 2021.
- Throughout the year we have been looking into the spatial heat model in more depth and we published **two thought pieces** building on our previous publications exploring our heat decarbonisation modelling. This work introduced our new regional heat model, as well as explaining in more depth the assumptions and results that were presented in our FES 2021 publication.
- We have updated our spatial heat model for FES 2022 with specific improvements made to the way that housing stock is processed regionally to enhance the quality of the outputs. We have also updated policies based on information from the Heat and Buildings strategy and other publications.
- We have published additional regional results alongside FES 2022 to increase the transparency of our outputs. This can be found on the ESO data portal **here**.

Transport

- We now incorporate mileage data from the Department for Transport when splitting GB level demands into regional components as well as the number of registered vehicles.
- This has enabled us to switch from just looking at numbers of EVs and where they are in the country, to looking at where the EVs are now being driven.
- In the future and for FES to deliver the insights required to plan an operable and cost effective net zero system, it is important we understand the extent to which EV demand profiles will vary by region as well as how flexibility might vary. This will require additional data regarding charging behaviour, location and consumer preferences based on access to infrastructure and willingness to engage in smart charging. We welcome feedback and input on the best sources of data as we continue to improve our transport modelling for upcoming FES publications.

Distributed generation

- We have used the Embedded Capacity Register (ECR) data published by Distribution Network Operators to inform our view of current and planned generation capacity connected to the network below transmission voltages.
- The use of the improved datasets in the forecasting process for FES has resulted in significant time saving and has reduced the time needed to process and check the data.
- We have worked closely with the DNOs to ensure that this transition is smooth not only for us but also for them. We will continue to work closely with the DNOs to further improve our distributed generation modelling as well as other areas in our process.

We have made a number of modelling enhancements aligned with our ambitions to introduce more granular regional modelling into the FES process.

Here we describe the key areas we have updated for FES 2022 from a regional perspective – distributed generation, road transport and heat.

FES Regional Insights / FES 2022 regional modelling enhancements 30

Summary of the regional data we publish

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Summary of the regional data we publish

This section summarises the regional data that we currently have available on our website and where to find it.

- **We publish the electricity spatial data to Grid Supply Point granularity that is used in the electricity ten year statement process.** This is provided in data workbook format here and is also available on our ESO data portal here.
- **We provide an overview the electricity spatial data set and modelling methods that are used to generate the outputs** in our main FES modelling methods document which you can find here.
- **We have agreed a set of common building blocks that ensure the results of the GB FES and Regional Distribution FES (DFES) are published to a consistent template making comparison easier.** These are published in our data workbook here and are also available on our ESO data portal here.
- **We publish the approximate GIS (Geographical Information System) geospatial boundaries associated with each of the GSPs on the GB transmission network.** These are available here on our data portal.
- **We have developed an online visualisation platform that allows stakeholders to explore the geographical differences in electricity demand within our Future Energy Scenarios.** This is a visualisation of the electricity spatial data that is used in the Electricity Ten Year Statement process, described above and is available here.
- **During the FES 2021 cycle we presented two additional thought pieces on the decarbonisation of heat, which took a closer look at the new modelling completed as well as providing additional spatial data**, which can be found here.
- **NEW for FES 2022: additional features to our visualisation platform in response to stakeholder feedback** – this includes the ability to download data directly from the visualisation and a new comparison tool which allows stakeholders to compare regions, scenarios and parameters.
- **NEW for FES 2022: Full spatial outputs from our heat model published.** The data includes the number of buildings per Local Authority on each heating technology, for each scenario between 2020 and 2050, in five year increments as well as the proportion of buildings in each Local Authority on each technology. This is available on our data portal here.
- **NEW for FES 2022:** We have added additional regional data to our data workbook, this year to go alongside the regional insights we have presented here and within the main FES document. This is available here and includes regional carbon intensity data, regional residential and commercial heat technology deployment in Leading the way in 2035, wind and solar generation capacity by region, locations of generation output and demand in Leading the Way and electrolyser locations.
- **COMING SOON:** We will be adding additional data to our visualisation platform, including visualisation of our spatial heat model outputs and the building blocks data we have described above.
- **COMING SOON:** We intend on publishing additional spatial data we generate as part of our natural gas modelling that is used in gas network development processes.

FES Regional Insights / Summary of the regional data we publish 32

Next steps

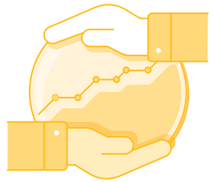
Our steps in developing the regionalisation of FES

Focus on developing regional whole system insights

- We intend on providing more clarity on possible pathways for whole system decarbonisation through additional regional insights throughout the year.
- We will also continue to broaden our engagement to bring in new voices and perspectives, enhancing our understanding of consumer behaviour and sense checking the FES outputs so we understand what they mean on a more local level.

Create a common language with the gas and electricity network companies

- One of our next steps is to create a common language and consumer segmentation with both gas and electricity network companies.
- We aim to understand how consumer behaviour will vary with time and across geographical locations to then apply to future scenario development for both distribution and transmission network planning.
- This project will be kicking off soon and will run in parallel to our FES 2023 cycle. As part of this we want to better understand how demographics will influence outcomes on the energy system, investigating what drives outputs at a regional level. We intend on publishing a thought piece on this topic and investigating this further as part of the Consumer Archetypes Project.



Increased alignment between FES and regional scenario projections

- We want to ensure there is increased alignment between FES and other regional scenario projections and we will be continuing to work with the network companies, ensuring further alignment of our assumptions and comparison of our data.
- We have been working with the DNOs to agree focus areas following comparison of our building block data and ahead of our next FES cycle we will be working to agree common definitions for GSPs as part of the ENA open networks project.
- We also intend to work with Gas Distribution Networks to explore a more granular view of gas scenario projections that can be shared with industry to help understand actions needed to decarbonise the gas network.

Strengthen regionalisations activities

- We are using FES 2022 to test some of our new regional outputs with stakeholders, which has included enhancing the visualisation of information and providing key regional insights.
- The feedback we receive from these activities will be used to strengthen our regionalisation activities in FES 2023 and as we continue to become more focussed on providing analysis and insight on a more granular regional basis.

FES Regional Insights / Next steps 34

Get in touch

Email us with your views on FES or any of our future of energy documents at: fes@nationalgrideso.com and one of our team members will get in touch.

Access our current and past FES documents, data and multimedia at: nationalgrideso.com/future-energy/futureenergy-Scenarios

Get involved in the debate on the future of energy and join our LinkedIn group: Future of Energy by National Grid ESO

To find out more on the Regionalisation of FES please visit: nationalgrideso.com/future-energy/future-energy-scenarios/regionalisation-fes

For further information on ESO publications please visit: nationalgrideso.com