WPD Distribution Future Energy Scenarios 2021

Methodology

November 2021

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Distribution Future Energy Scenarios

Methodology

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Distribution Future Energy Scenarios

Introduction to DFES

The **Distribution Future Energy Scenarios** outline a range of credible futures for connections to the distribution network.

Using a scenario framework consistent with other distribution network operators and National Grid ESO – known as the Future Energy Scenarios or FES – these local stakeholder-informed projections are developed annually and encompass potential changes in distributed generation, electricity storage and demand, including electrified heat and transport.

Western Power Distribution (WPD) works with Regen to create the **Distribution Future Energy Scenarios** out to 2050 for all four of their licence areas, on an annual cycle.

Why Future Energy Scenarios?

The need for scenario based planning

Our energy system is changing. Climate emergency declarations and the recent commitment to a net zero electricity system by 2035 demonstrates the need for energy networks to evolve and adapt to changing customer requirements.

The DFES builds on historic trends, as well as analysis of the pipeline of near-term projects, local resource factors and stakeholder input to create a range of credible scenarios.

The DFES also assesses the potential uptake of emerging low carbon technologies, such as electric vehicles and chargers, heat pumps, battery storage and hydrogen electrolysis.

The DFES is used by WPD to conduct a detailed review of its network licence areas and how they will be impacted by each scenario. This helps WPD to develop strategic reinforcement solutions to solve the network constraints that could potentially occur under each scenario.

The DFES has also been used to inform WPD's RIIO-ED2 business plan, and to publicly signpost potential system flexibility needs.

The four WPD DFES scenarios

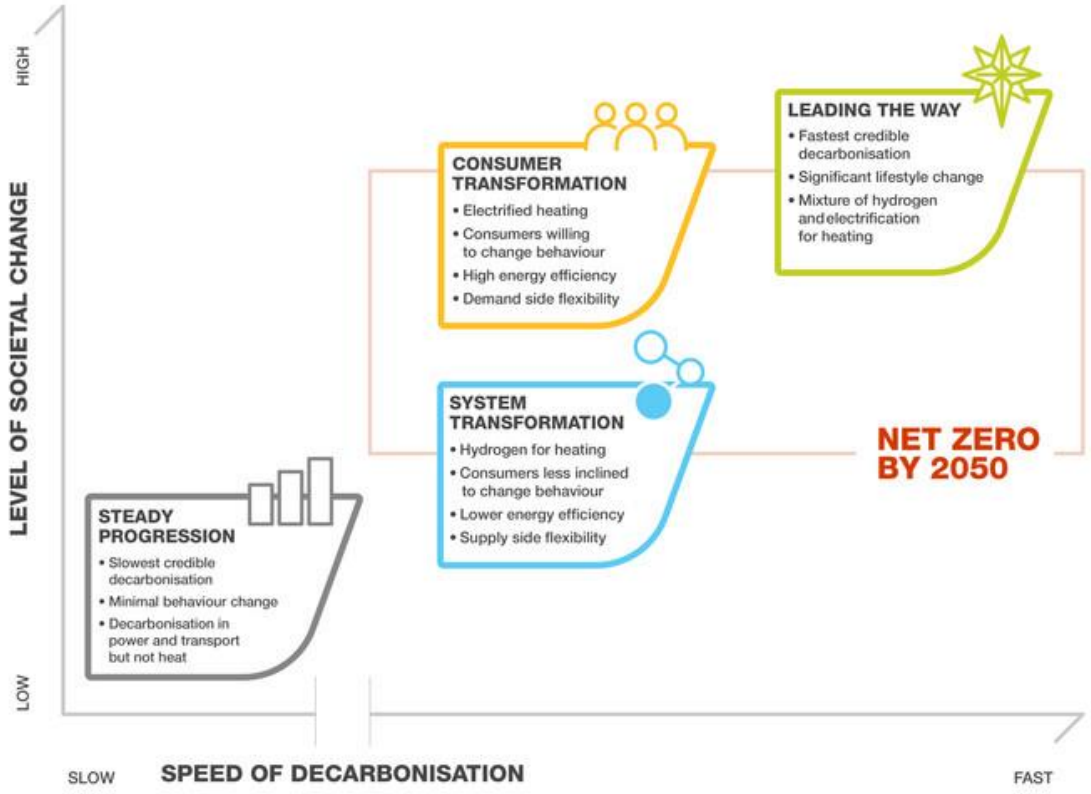
Incorporating the FES 2021 scenarios

The National Grid ESO FES 2021 scenarios are used in the WPD DFES 2021. The 2021 scenarios follow the same framework as the previous 2020 scenarios, with three scenarios achieving net zero by 2050, and one non-compliant scenario, **Steady Progression**.

Key overarching assumptions are published by National Grid ESO for each of the four scenarios, which are applied in the WPD DFES 2021. The four scenarios are defined by different "speeds of decarbonisation" and "levels of societal change".

Additional local and regional assumptions are made by Regen and the WPD DFES team. This includes the identification of pipeline projects in the area and the lifetime of existing operational projects. Spatial factors, such as renewable energy resources, building stock and socio-demographics of each local area are also key to the analysis.

Three of the scenarios are compliant with the UK government's net zero emissions target for 2050. Each of these scenarios meet this target in a different way.



WPD DFES Methodology

Methodology in brief

Overview

Local factors are combined with assumptions from the National Grid FES to project the deployment of each technology type for four scenarios at a granular level.

1. Baseline:

Data is collected on the current installed capacity, or number of installed units, for each individual technology type. This is based on WPD data, planning applications and other data sources, such as Feed-in Tariff registers and Department for Transport data.

2. Pipeline

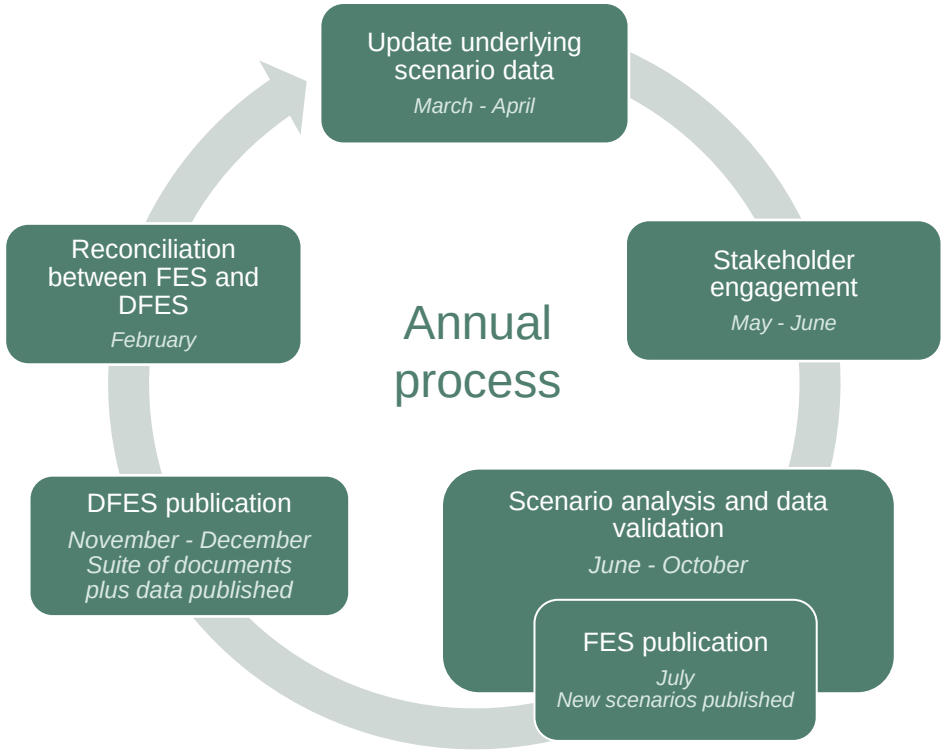
Proposed sites that may connect in the near term are individually researched and assessed. Where possible, individual site developers are contacted as part of this process.

3. Stakeholder engagement

Local information is collected from consultation with regional stakeholders and engagement with every local authority in WPD's licence areas. This is combined with analysis of existing trends and spatial data.

4. Scenario projections

The baseline, pipeline, local evidence and National Grid FES assumptions are combined to create the projections spanning from a 2021 baseline to 2050. Projections are produced at an Electricity Supply Area (ESA) level based on local, regional and national factors.



Electricity Supply Areas

Spatial granularity

DFES analysis is produced at a high granularity, using small geographic areas called 'Electricity Supply Areas' (ESAs).

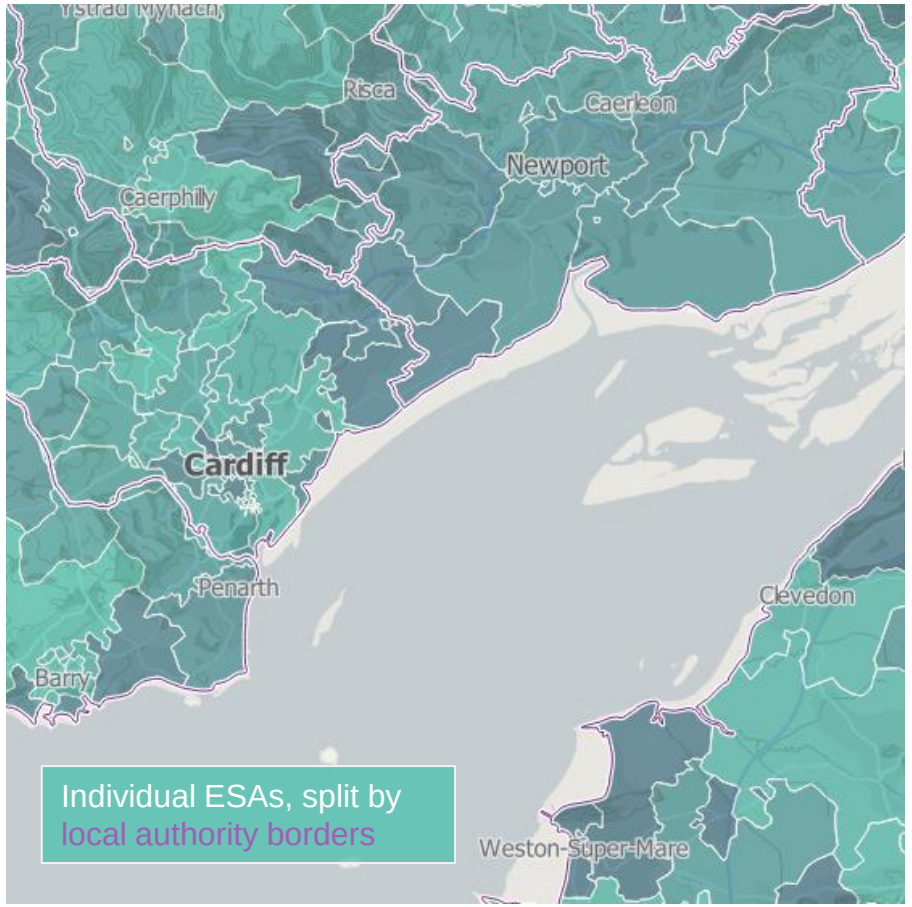
An ESA is defined as:
'The geographical area supplied by a primary substation (which contains WPD-owned distribution substations) providing supplies at a voltage below 33 kV; or a customer directly supplied at 132, 66 or 33 kV or by a dedicated primary substation.'

Each ESA geographically represents a block of demand and/or generation based on the distribution network substation that it is connected to.

This way, projected new connections are linked to specific parts of the network, allowing for more granular network analysis.

The attributes of the land, buildings and people within an ESA inform the future deployment of each individual technology type. These attributes include the number of cars registered in an ESA, the number of homes, the amount of farmland, the level of solar irradiance or the average wind speed.

These network-informed spatial areas are subdivided by local authority borders. This means the WPD DFES 2021 results can be directly aggregated up to local authority areas.



Stakeholder engagement

Overview

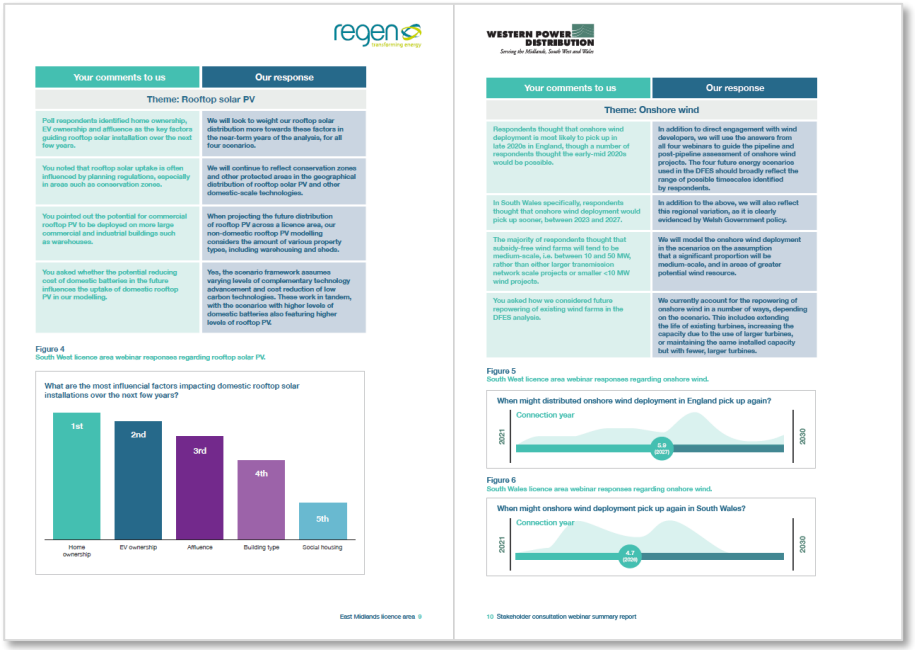
WPD and Regen ran four consultation webinars in June and July 2021. Each session focused on elements of distributed energy generation, demand and storage that were particularly relevant or active in the region.

After the events, a summary report was published, detailing the content covered, as well as how the comments raised would be incorporated into the DFES analysis.

Regen also contacted every local authority in WPD's licence areas to collate data and information on new developments and local policies, plans and ambitions to support low carbon energy and infrastructure.

Developers of sites in the pipeline were contacted to augment the detailed desk-based research of each pipeline site and discuss the key development factors and drivers in their respective industries.

Wider industry consultation was also completed for each technology where possible, with a particular focus on emerging technology sectors. This included trade bodies, landowners, asset operators, technology companies and other relevant organisations. Information was gathered predominantly through direct conversations, as well as through existing industry networks and events.



Your comments to us	Our response
Theme: Rooftop solar PV	
Poll respondents identified home ownership, EV ownership and affluence as the key factors guiding rooftop solar installation over the next few years.	We will look to weight our rooftop solar distribution more towards these factors in the near-term years of the analysis, for all four scenarios.
You noted that rooftop solar uptake is often influenced by planning regulations, especially in areas such as conservation zones.	We will continue to reflect conservation zones and other protected areas in the geographical distribution of rooftop solar PV and other domestic-scale technologies.
You pointed out the potential for commercial rooftop PV to be deployed on more large commercial and industrial buildings such as warehouses.	When projecting the future distribution of rooftop PV across a licence area, our non-domestic rooftop PV modelling considers the amount of various property types, including warehousing and sheds.
You asked whether the potential reducing cost of domestic batteries in the future influences the uptake of domestic rooftop PV in our modelling.	Yes, the scenario framework assumes varying levels of complementary technology advancement and cost reduction of low carbon technologies. These work in tandem, with the scenarios with higher levels of domestic batteries also featuring higher levels of rooftop PV.

Figure 4
South West licence area webinar responses regarding rooftop solar PV.

East Midlands licence area 9

Your comments to us	Our response
Theme: Onshore wind	
Respondents thought that onshore wind deployment is most likely to pick up in late 2020s in England, though a number of respondents thought the early-mid 2020s would be possible.	In addition to direct engagement with wind developers, we will use the answers from all four webinars to guide the pipeline and post-pipeline assessment of onshore wind projects. The four future energy scenarios used in the DFES should broadly reflect the range of possible timescales identified by respondents.
In South Wales specifically, respondents thought that onshore wind deployment would pick up sooner, between 2023 and 2027.	In addition to the above, we will also reflect this regional variation, as it is clearly evidenced by Welsh Government policy.
The majority of respondents thought that subsidy-free wind farms will tend to be medium-scale, i.e. between 10 and 50 MW, rather than either larger transmission network scale projects or smaller <10 MW wind projects.	We will model the onshore wind deployment in the scenarios on the assumption that a significant proportion will be medium-scale, and in areas of greater potential wind resource.
You asked how we considered future repowering of existing wind farms in the DFES analysis.	We currently account for the repowering of onshore wind in a number of ways, depending on the scenario. This includes extending the life of existing turbines, increasing the capacity due to the use of larger turbines, or maintaining the same installed capacity but with fewer, larger turbines.

Figure 5
South West licence area webinar responses regarding onshore wind.

Figure 6
South Wales licence area webinar responses regarding onshore wind.

10 Stakeholder consultation webinar summary report

A report summarising the consultation webinars and the feedback received are available on the WPD website: www.westernpower.co.uk/distribution-future-energy-scenarios-regional-information

Engagement with local authorities

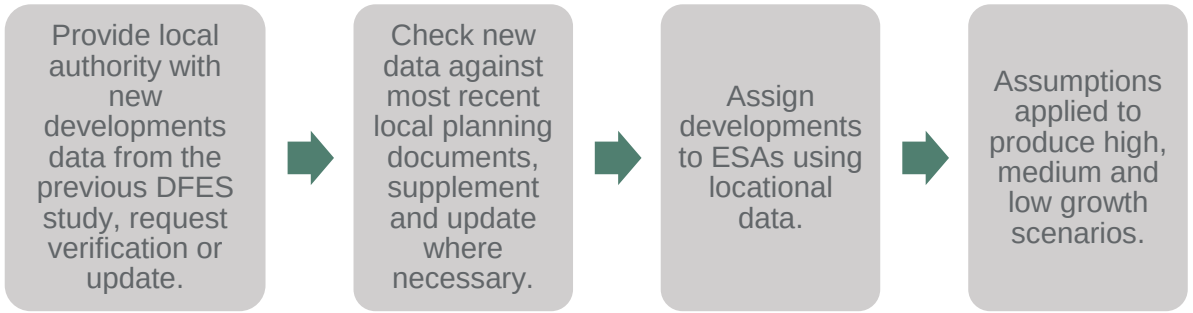
Using local authority plans in DFES

Housing and non-domestic developments are sources of new demand on the electricity network. Local authority development plans are incorporated into DFES to reflect the localised impact of this on the distribution network.

Regen works with local authorities to maintain an online database of all new development data collected during earlier DFES studies. This was shared with the local authority planners to provide updated data. These updates were then verified against the most recent local planning documents, with the following data collected for each site:

- Use class, such as domestic, office, industrial, retail etc.
- Total number of homes, or non-domestic floorspace
- Location, based on address or coordinates
- Development stage, based on planning status
- The timeframe covered by the local planning document
- Greenfield or brownfield land, if known.

New developments process overview



Over 10,000 new development records were processed as part of WPD DFES 2021

Engagement with local authorities

Assessment of local authority plans

Once processed and verified, the individual developments are modelled to be built at a schedule based on the data provided.

A delay in this schedule is applied to sites in the medium and long term, which varies by scenario, to capture an envelope of uncertainty.

The delay methodology means that the precise spatial data and scale of development is maintained, but the period over which the sites are built out varies, reflecting a realistic range of building rates over the coming years.

Historic trends in new developments are used to provide estimates for low, medium, and high levels of deployment. These are then assigned to the FES 2021 scenarios as detailed below:

Leading the Way
High deployment

Consumer Transformation
Medium deployment

System Transformation
Medium deployment

Steady Progression
Low deployment

Engagement with local authorities

Assessment of local authority plans

For planned new developments, each individual development is assigned to an ESA. This creates highly granular scenarios for domestic and non-domestic developments in the near and medium term.

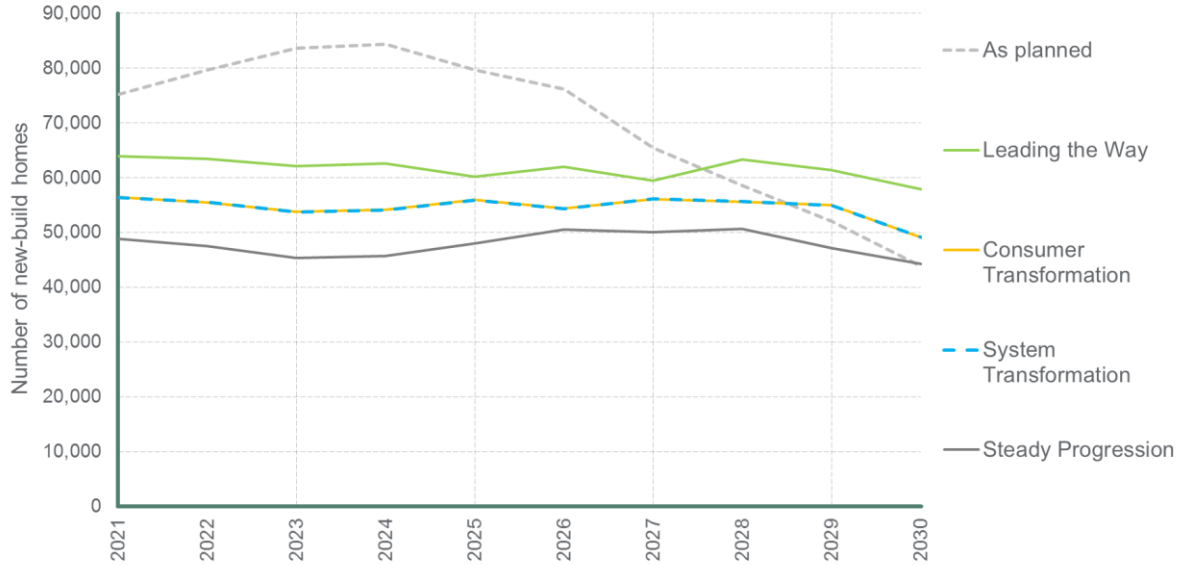
Though some of these sites are already visible to WPD through accepted demand connection offers, many are not.

Not all local authority plans extend out to 2030 or later, hence there is a natural reduction in the data available for the analysis of planned developments.

To compensate for this reduction, additional dwellings and commercial floorspace were modelled, with locations weighted towards areas of similar characteristics to those that have seen recent deployment of new developments.

New build deployment also feeds into the rest of the DFES modelling, such as for heat pump uptake, rooftop solar PV deployment and electric vehicle uptake.

Homes built per year across all WPD licence areas
Comparison between data collected from local plans and DFES scenarios



Planned housebuilding was converted into numbers of new homes for each of the four scenarios, benchmarked against historic housebuilding rates.

Engagement with local authorities

Survey of local policies and ambitions

Local authorities in the WPD area were surveyed for local plans, targets and policies which may affect the uptake of low carbon technologies included in the DFES analysis.

This included electric vehicle charging infrastructure or clean air zones, planned heat networks, waste treatment policies or specific policies supporting renewable energy deployment.

The surveys provided valuable insight into multiple factors which fed into future projections and technology uptake.

Local policies are expected to change significantly year-on-year. Through the annual iteration of the DFES, this process will be expanded to make these surveys more comprehensive over time.

The local factors and policies will therefore be updated and verified annually with relevant local authorities.

Local authority ambitions, such as Bristol's aim to become carbon neutral by 2030, were reflected in the analysis within the context of the four scenarios

Creating the DFES projections

Overview and process

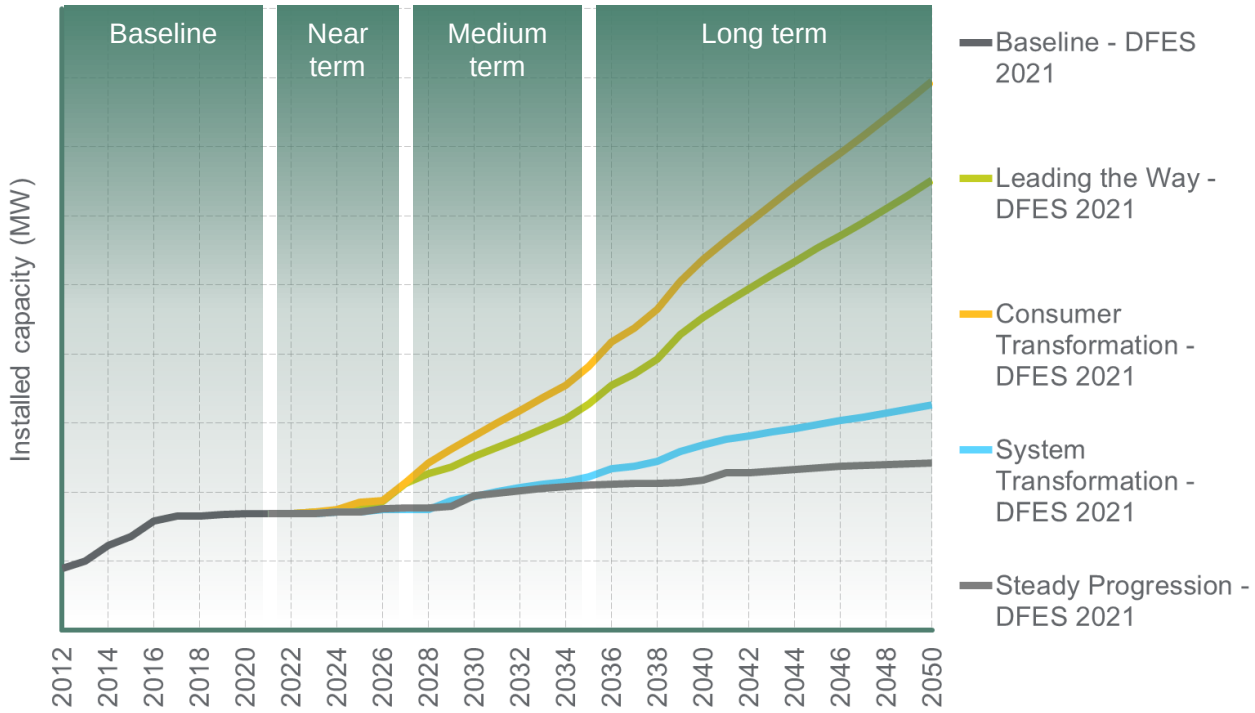
Baseline (April 2021)
The baseline process establishes the deployment of each technology to date and identifies historic growth trends and local factors.

Near term (2021 - 2027)
Sites which may connect in the near term are individually assessed for planning applications, network connection offers, and developer progress. This gives a precise view of where new connections are likely to be located over the next few years.

Medium term (2027 - 2035)
Key regional and local growth factors are combined with stakeholder perspectives and used to create four scenario projections, referencing assumptions from FES 2021.

Long term (2035 - 2050)
Uncertainties in future technology improvements and costs are reflected in an envelope of longer-term scenario projections out to 2050. Projections are reported on a five-yearly basis from 2035 to 2050.

Example results, showing a typical range of scenario projections



Creating the DFES projections

Data sources for deployment to date

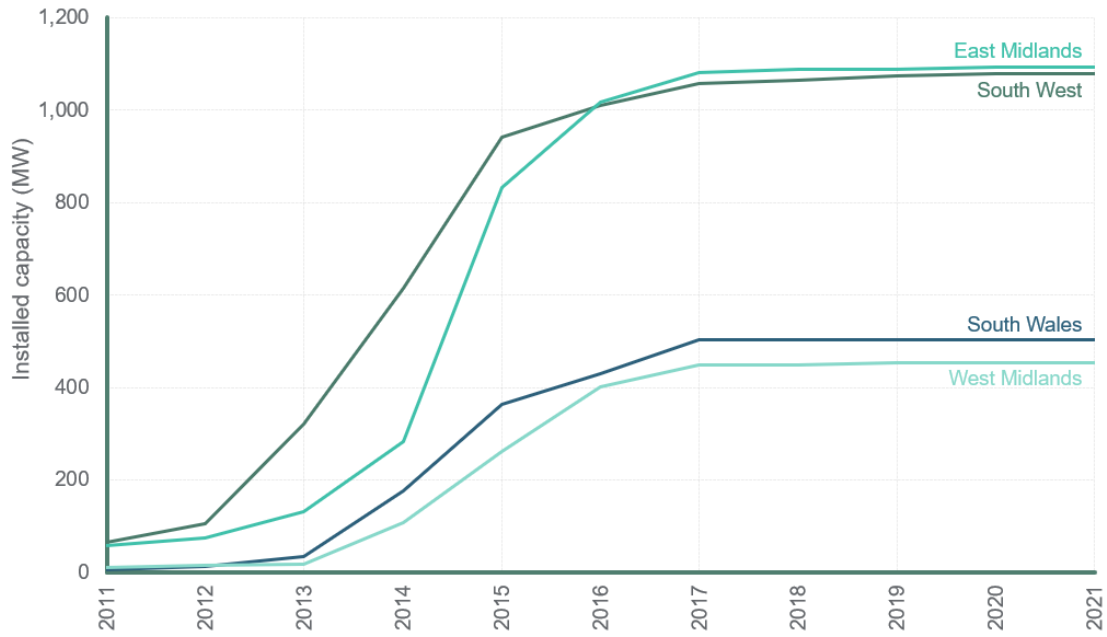
The primary source of data for the baseline of connected generation and storage sites is WPD connection agreement data. For the WPD DFES 2021 study, the cut-off data for this data is the 31st March 2021.

Additional data is sourced from public registers, records and other databases such as the Feed-in Tariff registers, Capacity Market data, Contracts for Difference auction data and the Renewable Energy Planning Database. Each of these sources contains detailed geographical information, which allows analysis at an ESA level.

The baseline registrations for electric vehicles are based on Department for Transport data at local authority level. This information is then distributed to ESAs based upon demographic factors that reflect the characteristics of early adopters.

The baseline of heat pump and direct electric heating installations is based on analysis of Energy Performance Certificates, Census 2011 data and Renewable Heat Incentive registers. This allows highly granular analysis of the building stock in each licence area.

Deployment of large-scale solar PV over time
By WPD licence area



Creating the DFES projections

The pipeline analysis process

Sites with an accepted network connection offer are individually assessed to establish if, and when, they could connect under each scenario. Records of planning applications, network connection offers and other online information is used to assess progress.

In addition to this, where possible, direct discussions are held with the developers of the pipeline sites to identify the stage of development and any plans that could affect the year of connection. These discussions are also used to gather broader information about the developer's sector, to inform the scenario projections.

Some technologies have specific factors that were also included in the pipeline research. For example, Capacity Market activity is a key factor determining how flexible generation and storage pipeline sites are treated in the near/medium term.

The planning applications of the individual pipeline sites are also assessed. The weighting given to a successful or undecided planning application varies by technology, as planning is a larger barrier for some generation technology types than others. This was backed by analysis of historic planning outcomes and timeframes for each technology.

Over 1,000 individual pipeline sites were assessed, across a range of generation, demand and storage technologies, with a potential capacity of over 12 GW.

Creating the DFES projections

Technology-specific projections are created at ESA level to create the DFES projections.

Key:

- ● Core factor
- ● Secondary factor
- ○ Unused

Projections driven by:	Wind	Solar	Hydro power	Biogas and biomass	Fossil gas	Diesel	Heat pumps	Electric vehicles	Energy storage	Marine energy	Hydrogen electro-lysis
Analysis of pipeline sites	●	●	●	●	●	●	●	○	●	●	●
ESA-level resource availability	●	●	●	●	○	○	○	○	●	●	●
The business-case for development	●	●	●	●	●	●	●	●	●	●	●
ESA-level social factors	○	●	○	●	○	○	●	●	●	○	○
FES 2021 assumptions	● In line	● In line	● In line	● In line	● In line	● In line	● Led by	● Led by	● In line	● In line	● In line
Local authority factors	●	●	●	●	●	○	●	●	●	●	●
National and devolved policies and regulations	●	●	●	●	●	●	●	●	●	●	●
Local stakeholder input	●	●	●	●	●	●	●	●	●	●	●

Creating the DFES projections

Demographic and social factors

Projections for household-scale technologies, such as heat pumps, rooftop solar PV and electric cars, are heavily affected by demographic and social factors.

For example, heat pump deployment is impacted by whether a building is on the gas network, the building type and the tenure of the building. These factors interact with further aspects, such as affluence and population density.

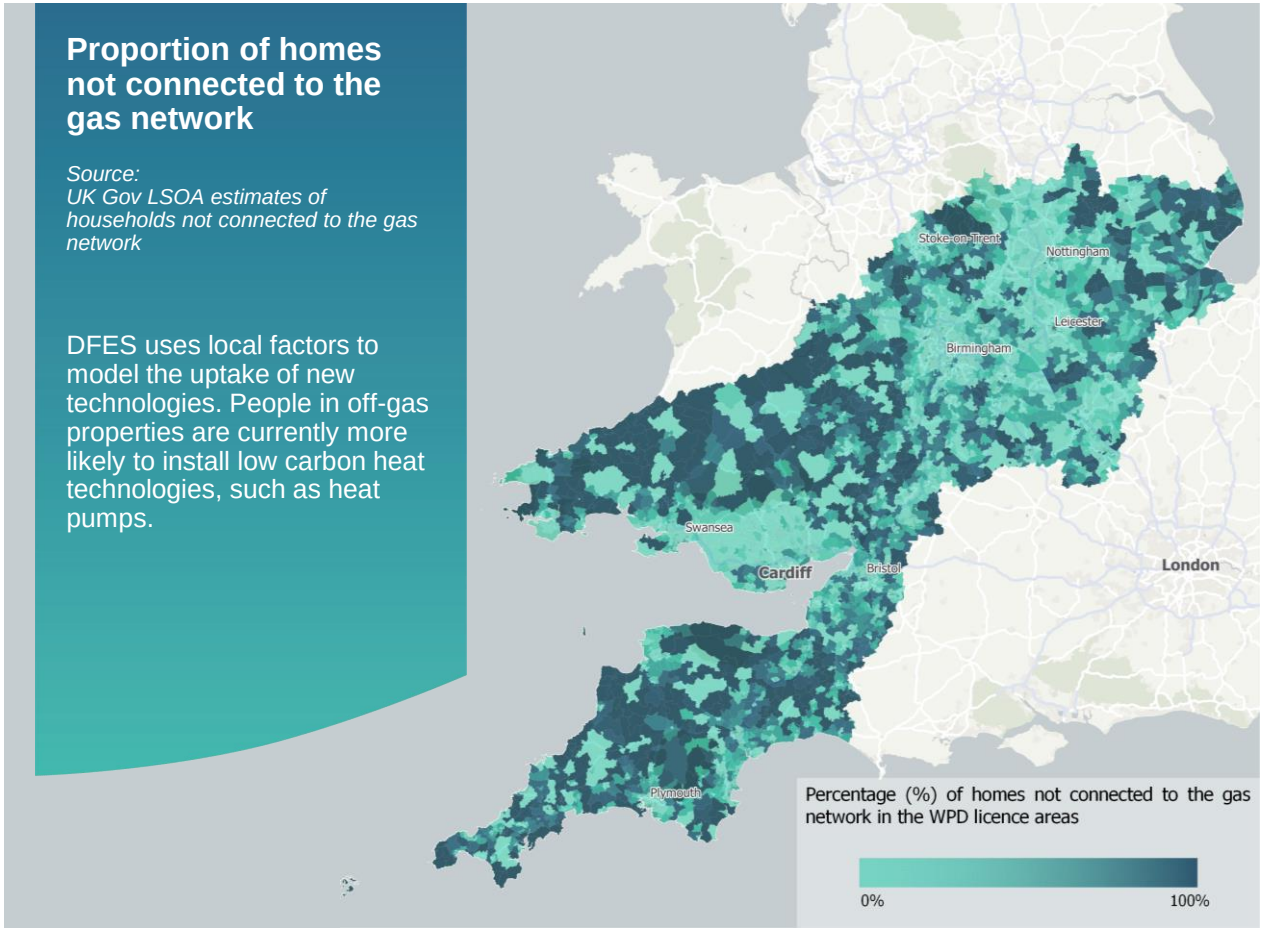
These demographic and social factors are assumed to have a greater impact in the near term, especially for low carbon technologies that are relatively niche, such as heat pumps and electric vehicles. This can be seen in the locations of existing low carbon technologies.

In the medium and long term, as low carbon technologies become more widespread, uptake is much more widely distributed.

Proportion of homes not connected to the gas network

Source:
UK Gov LSOA estimates of households not connected to the gas network

DFES uses local factors to model the uptake of new technologies. People in off-gas properties are currently more likely to install low carbon heat technologies, such as heat pumps.



Creating the DFES projections

Geographic resource assessments

Projections for generation technologies, such as onshore wind, solar farms and anaerobic digestion, are based on resource assessments that use geographical factors.

Renewable generation is particularly reliant on areas of good resource, for instance high wind speeds, solar irradiance, or presence of biological feedstocks.

Other considerations include protected areas such as National Parks and Areas of Outstanding Natural Beauty, which are typically avoided due to planning considerations.

Distance from housing, proximity to the distribution network, the angle and steepness of the land, and agricultural land grades are also included in the spatial analysis, as well as a number of other factors.

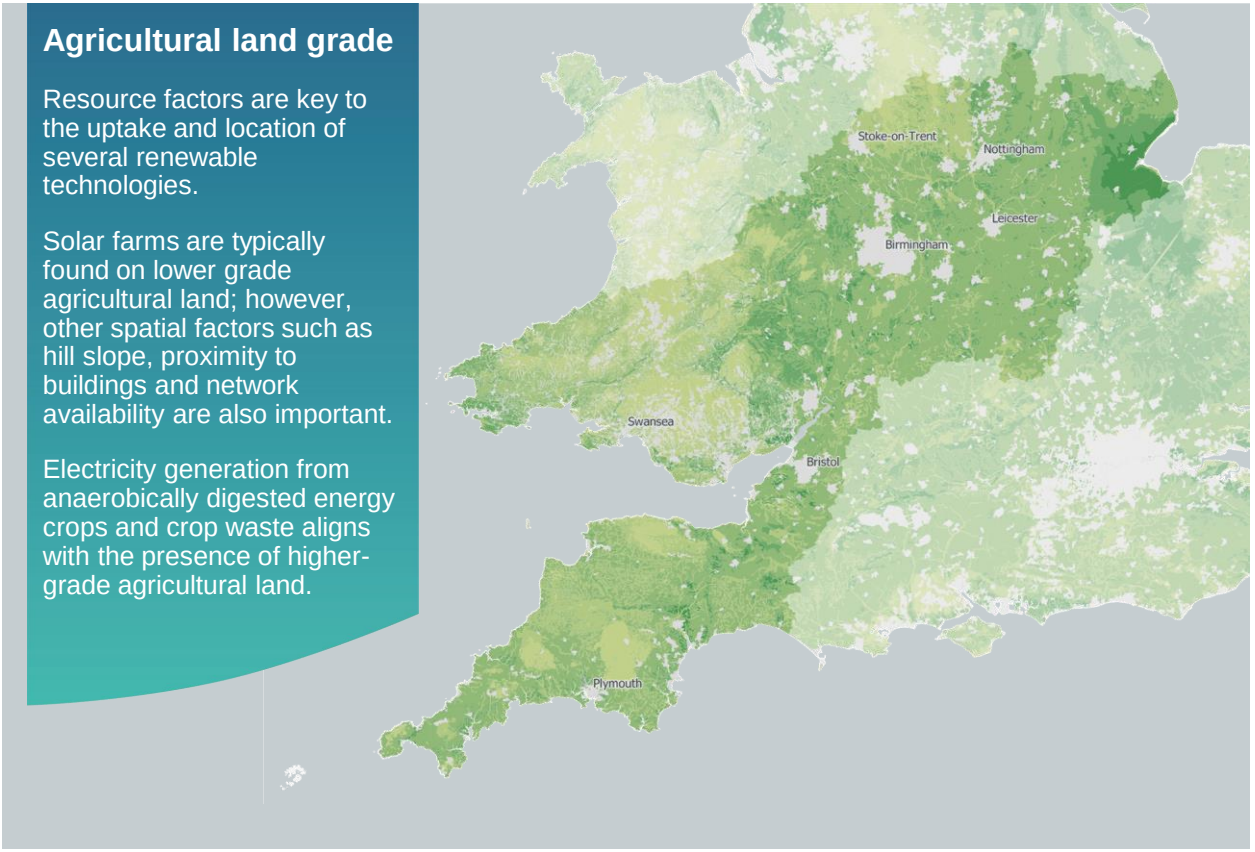
These spatial resource assessments are verified against existing projects, pipeline sites and conversations with developers.

Agricultural land grade

Resource factors are key to the uptake and location of several renewable technologies.

Solar farms are typically found on lower grade agricultural land; however, other spatial factors such as hill slope, proximity to buildings and network availability are also important.

Electricity generation from anaerobically digested energy crops and crop waste aligns with the presence of higher-grade agricultural land.



DFES reconciliation with FES

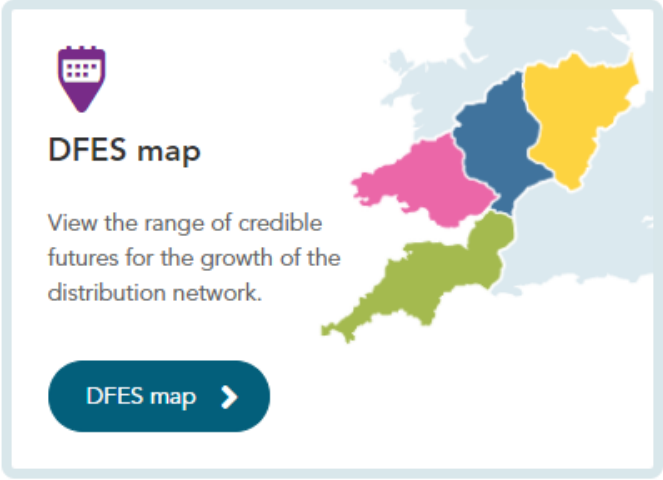
Reporting consistency across DFES and FES

The WPD DFES 2021 uses the same scenario framework as the National Grid ESO FES 2021. This means there is a common and consistent set of assumptions that allow for comparison between the studies. The scenarios are updated annually by the FES team.

The technology types used in DFES and FES data have been standardised for better consistency. In some areas, Regen and WPD have included greater detail. For example, the standard 'I&C' demand technology type is divided into 10 sub-technologies for WPD DFES, as these developments can have wide ranging impacts on the network.

The set of underlying assumptions in FES 2021 are incorporated wherever possible in WPD DFES. Further technology-specific assumptions are made in WPD DFES, for example around the deployment of projects in the pipeline or where the region displays different characteristics to Great Britain as a whole.

Like the range of FES documents, the suite of WPD DFES publications is designed to suit a variety of stakeholder needs. A summary of the results and underlying assumptions of each technology is published for each licence area, alongside the data available through the WPD DFES map hub. A summary of the stakeholder consultation events, these methodology slides and summary 'Regional View' reports are also published.



DFES results are available online at the WPD map hub

DFES reconciliation with FES

Data reconciliation across DFES and FES

The WPD DFES results are produced at ESA level. As part of the analysis, the outputs are aggregated to allow comparison with FES data published at both national and GSP level.

The WPD DFES uses FES as a framework and benchmark but reflects the regional and local factors for each technology and scenario. Therefore, some variance between the DFES and FES views is expected.

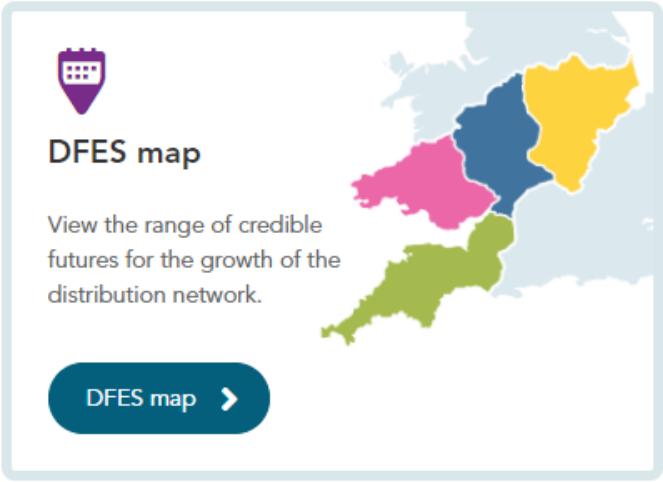
This variation is typically greatest in the near term as the DFES projections are based primarily on analysis of the pipeline sites.

In the medium and long term, there is more convergence, as the outcomes for many technologies are based on national-level outcomes and strategies. However, specific local resource availability or factors raised by stakeholders continue to affect the DFES results out to 2050.

Any technology specific assumptions and reasons for variance between the local DFES and FES results are published in the WPD DFES summary reports for each licence area.

Typical regional and local variations include:

- Existing generation and demand
- Pipeline analysis
- Resource availability
- Political factors
- Stakeholder input
- Socio-demographic factors



DFES results are available online at the WPD map hub

Next steps

The WPD DFES 2021 suite of output documents is now available online:

- Stakeholder feedback summary reports – available here
- Data available through the map hub
- Technology results and assumptions reports
- This methodology walkthrough
- DFES Regional View summary reports

If you have any questions in relation to WPD's Network Strategy work, please contact WPD on the details below:

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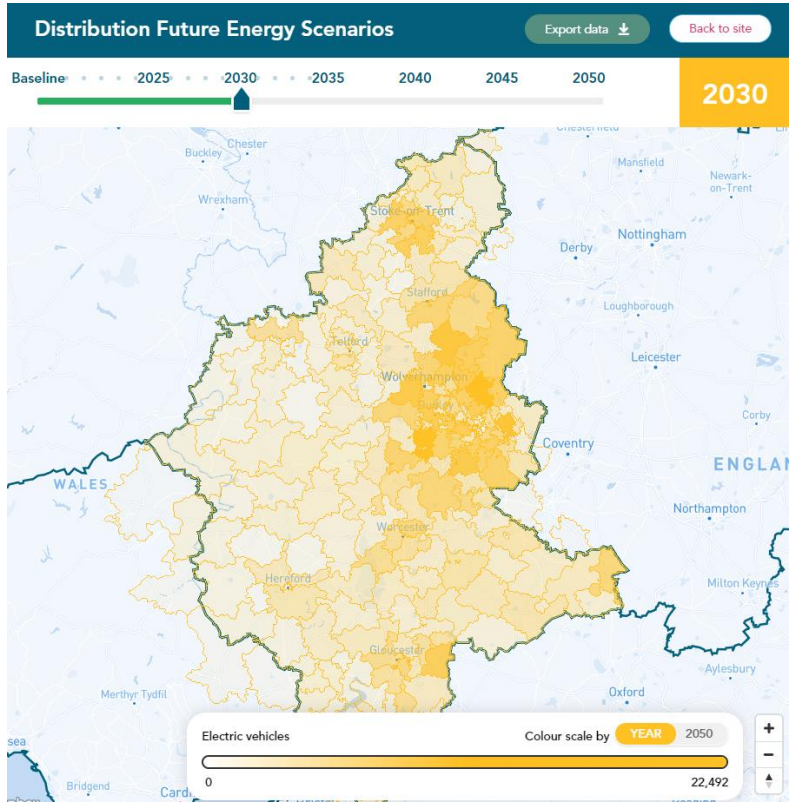

DFES results are available online at the WPD map hub

The DFES is an annual process; the WPD DFES 2022 will begin in Spring 2022.

WPD Distribution Managers are in contact with local authorities to discuss the results of the WPD DFES 2021.

The stakeholder engagement process runs from February to July 2022. If you have information to feed into the creation of the local factors for the WPD DFES 2022, please get in contact using the above details.

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