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Distribution Future Energy Scenarios 2024

Results and assumptions report

West Midlands licence area

nationalgrid DSO



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Glossary

Short form	Definition	Short form	Definition
ACT	Advanced Conversion Technologies	GW	Gigawatt
AD	Anaerobic Digestion	HGV	Heavy Goods Vehicle
AONB	Area of Outstanding Natural Beauty	HNDU	Heat Network Delivery Unit
ASHP	Air Source Heat Pump	HNIP	Heat Network Investment Project
CCGT	Combined Cycle Gas Turbine	HVO	Hydrotreated Vegetable Oil
CCUS/CCS	Carbon Capture, Utilisation and Storage / Carbon Capture and Storage	IDNO	Independent Distribution Network Operator
CfD	Contract for Difference	kW	Kilowatt
CHP	Combined Heat and Power	LA	Local Authority
DEFRA	Department for Environment, Food and Rural Affairs	LAEP	Local Area Energy Plan
DESNZ	Department for Energy Security and Net Zero	LCT	Low Carbon Technology
DFES	Distribution Future Energy Scenarios	LGV	Light Goods Vehicle
DfT	Department for Transport	LPG	Liquefied Petroleum Gas
DNO	Distribution Network Operator	LV	Low Voltage
DSO	Distribution System Operator	MCPD	Medium Combustion Plant Directive
EfW	Energy from Waste	MW	Megawatt
EMR	Electricity Market Reform	NGED	National Grid Electricity Distribution
ENA	Energy Networks Association	OCGT	Open Cycle Gas Turbine
EPC	Energy Performance Certificate	ONS	Office for National Statistics
ESA	Electricity Supply Area	OS	Ordnance Survey
ESO	Electricity System Operator	PHEV	Plug-in Hybrid Electric Vehicle
EU	European Union	PV	Photovoltaic (solar)
EV	Electric Vehicle	REMA	Review Of Electricity Market Reform
FES	Future Energy Scenarios	RIIO-ED3	Revenue = Incentives + Innovation + Outputs – Electricity Distribution 3 (price control period)
FiT	Feed-in Tariff	RHI	Renewable Heat Incentive
GB	Great Britain	STOR	Short-Term Operating Reserve
GSHP	Ground Source Heat Pump	TLO	Technical Limit Offer
GSP	Grid Supply Point	TMO4+	Target Operating Model 4

Introduction to the National Grid Electricity Distribution DFES 2024

Background

The National Grid Electricity Distribution (NGED) Distribution Future Energy Scenarios (DFES) outline the range of credible futures for electricity load on the distribution network, providing granular scenario projections for:

- ▶ Distributed electricity generation, such as solar, wind, hydropower, fossil-fuelled generation and bioenergy
- ▶ Distributed electricity demand, such as heat pumps, electric vehicle chargers, new housing developments, business space and hydrogen electrolyzers
- ▶ Distributed electricity storage, including electricity storage and domestic thermal storage
- ▶ For 2024, the DFES also models the future electricity demand connecting to the distribution network as a result of the decarbonisation and electrification of maritime, aviation, agriculture and rail sectors.

The DFES projections are directly informed by stakeholder engagement to reflect local and regional drivers, the ambitions of local authorities (including reviewing local area energy plans (LAEPs), where available) and national government targets and policies. The analysis is also influenced by the views of other sector stakeholders, such as project developers, technology companies, trade associations and community groups.

For NGED and other electricity distribution network companies, the DFES allows network planners to model and analyse different future load scenarios for their network. This data then informs integrated network planning and investment appraisal processes. The DFES also provides a key data resource and evidence base to enable NGED to appraise different investment options and develop the business case necessary to support future investment and regulated business plans. NGED and other networks are under way with their preparations for the RIIO-ED3 business planning process, and the data and evidence held within the DFES 2024 assessments will be one of the key inputs to NGED’s ED3 business plan.

Scenarios

The NGED DFES uses the National Energy System Operator’s (NESO) Future Energy Scenarios (FES) 2024 as a framework, adopting the same national-level societal, technological and economic assumptions as the FES:

Holistic Transition, Electric Engagement, Hydrogen Evolution and the **Counterfactual**.

However, the DFES is a bottom-up analysis of a changing energy system at a more granular level, reflecting specific regional and local factors and the impact on the distribution network. The DFES seeks to recognise and reflect that distributed generation, demand and storage will develop in different ways, and at different paces, across the country.

Pathways framework 2024

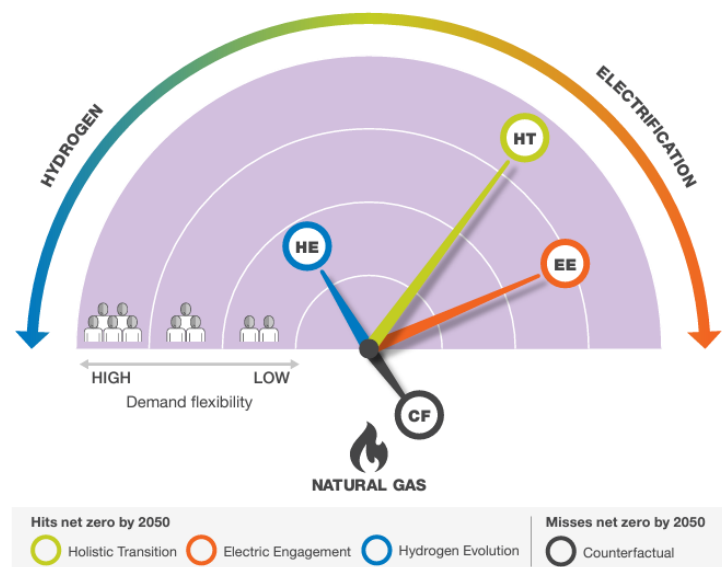


Figure 1 - The FES 2024 pathways framework

Scope

The NGED DFES 2024 scope encompasses technologies that directly connect to, or interact with, the distribution network in the four NGED licence areas: **South Wales, South West, East Midlands and West Midlands**. The scenario projections for these technologies are reported in standardised technology 'building blocks' developed by the Energy Networks Association (ENA).

The DFES scope does not include large-scale assets connecting directly to the National Grid electricity transmission system, such as conventional nuclear power, most offshore wind, large-scale pumped hydropower and many gas-fired power stations.

Annual cycle

The NGED DFES is produced annually, allowing scenario projections to be regularly updated to reflect the latest information available. The DFES is published around the end of the calendar year following the release of the FES. This allows the DFES analysis to integrate the high-level scenario framework and assumptions from the latest FES and undertake a reconciliation between the FES and the DFES outcomes by technology, scenario and licence area. This annual cycle also allows for data sharing between the NGED DFES and the NESO FES teams, facilitating a continuous improvement of the data quality, processes and scenario modelling between both annual studies.

In addition to the FES, LAEPs produced by local authorities also interact with the DFES. LAEPs are used as a source of input data to feed into the DFES spatial analysis, reflecting specific local plans and ambitions. DFES data points are also being used to inform LAEPs when local authorities are planning for future energy generation, demand and storage.

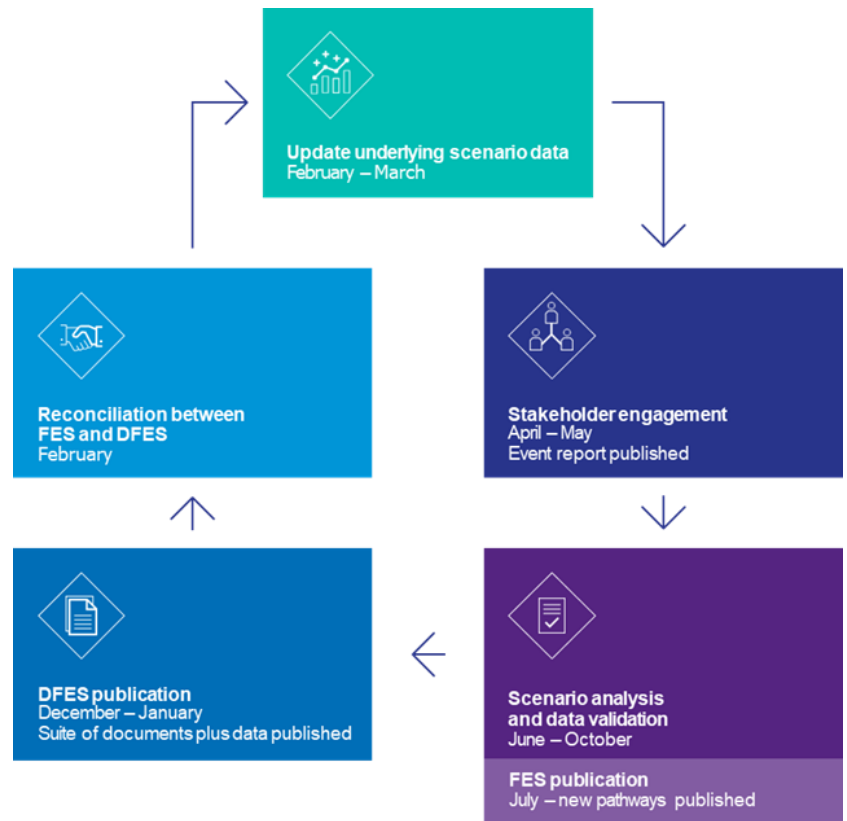


Figure 2 - The NGED DFES annual process

The annual DFES outputs also feed into wider NGED strategic planning processes, such as Network Development Plans and Distribution Network Options Assessments.

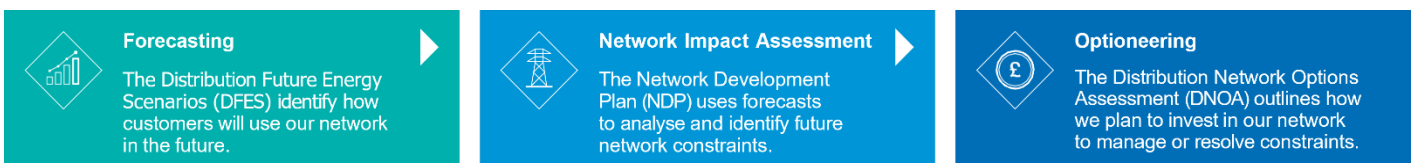


Figure 3 - NGED's strategic network planning process

Results

The NGED DFES 2024 analysis is produced to granular geographic areas known as Electricity Supply Areas (ESAs), of which there are four types:

- ▶ **Geographic ESA:** the geographic area fed by a primary substation providing electricity connections at the 11 kV or 6.6 kV level.
- ▶ **Single customer ESA:** reflecting a customer directly supplied at 132 kV, 66 kV, 33 kV or 25 kV (or by a dedicated primary substation). This also includes some large 11 kV customers, which require detailed modelling for electrical studies.
- ▶ **IDNO ESA:** an independent DNO which connects to the NGED network. These embedded customers generally do not hold a traditional connection agreement.
- ▶ **Low voltage ESA:** the geographic area fed by a low voltage transformer, providing electricity connections at less than 11 kV. In the NGED DFES 2024, domestic-scale rooftop PV and batteries, electric heating technologies and EV charger projections are produced at this highly granular level.

These ESAs are also split by local authority boundaries, allowing DFES data to be aggregated up to the local authority or primary substation level. This data can then be used for developing LAEPs and other local planning activities.

Depending on the technology building block, the DFES provides projections of electrical power capacity (MW) or installation numbers (e.g. number of EVs or heat pumps) but does not include analysis of network loads, load profiles, consumption or peak demand. This network load analysis is undertaken by NGED’s System Planning team as a follow-on stage in the analysis process. The results of this process are published [on the National Grid website](#).

The West Midlands licence area

The key features of the West Midlands licence area are detailed in the following table and shown in the maps in Figure 4 and Figure 5.

Aspect	Characterisation
Geography	<p>The NGED West Midlands licence area runs from Stroud in the south to Stoke-on-Trent in the north and ranges from highly urban areas, such as Birmingham, to many rural and protected areas, such as the Peak District.</p> <p>There are a number of towns and cities along the M5 and M6, which run south to north through the licence area. The large urban and industrial conurbation in the centre of the licence area includes Birmingham, the UK’s second-most populous city, Wolverhampton and Solihull.</p> <p>The licence area also encompasses many rural areas, as well as national parks and AONBs such as the Cotswolds, the Wye Valley, the Peak District, Cannock Chase and the Shropshire Hills.</p>
Distributed electricity generation	<p>Distributed electricity generation has increased significantly over the last five-to-six years. Over 50% of capacity has connected since the beginning of 2016. Solar PV has the most installed distributed electricity generation capacity in the licence area, followed by fossil gas-fired power and waste processing sites. The largest individual site is the 99.9 MW Dunlop OCGT in Birmingham.</p>

Energy resources	Despite having lower solar irradiance than more southern areas of the UK, the West Midlands is proving attractive to solar developers. Other forms of renewables, such as onshore wind and hydropower, have less resource potential.
Distributed electricity demand	Currently, around 3% of vehicles registered in the West Midlands are EVs, and less than 1% of households have an electric heat pump.
Major energy users	The West Midlands is an industrial hub with a number of large energy-consuming customers, including Jaguar Land Rover, Severn Trent Water and Birmingham International Airport.
Policy and government	The West Midlands licence area contains c. 30 local authorities, including city region councils like Birmingham City Council and Lichfield City Council. The licence area also has the West Midlands Combined Authority, covering 7 local authorities.

West Midlands licence area – Baseline Generation and Storage Connections

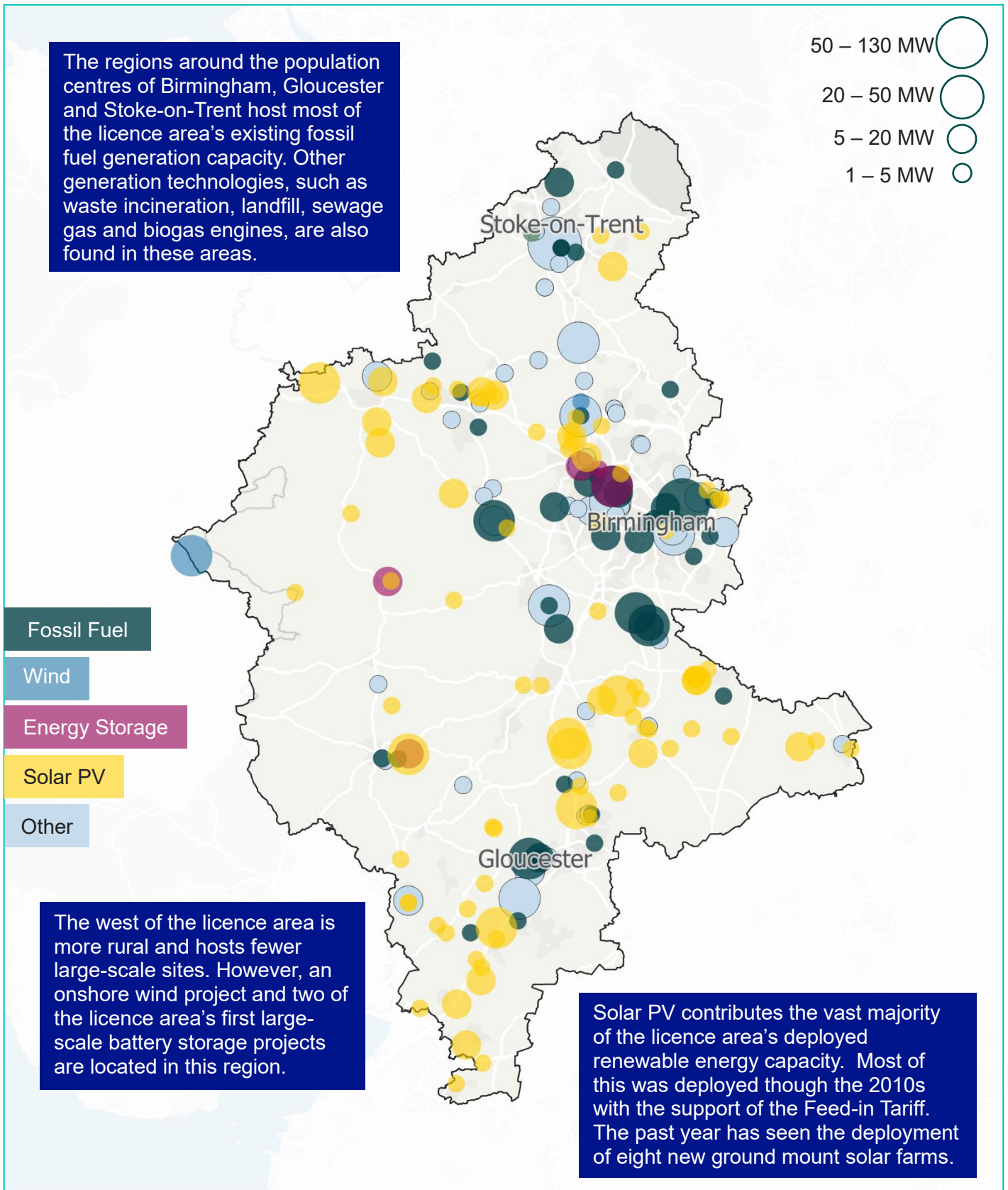


Figure 4: The NGED West Midlands licence area, with the location of existing 'baseline' large-scale generation and storage sites.

West Midlands licence area – Pipeline Generation and Storage Connections

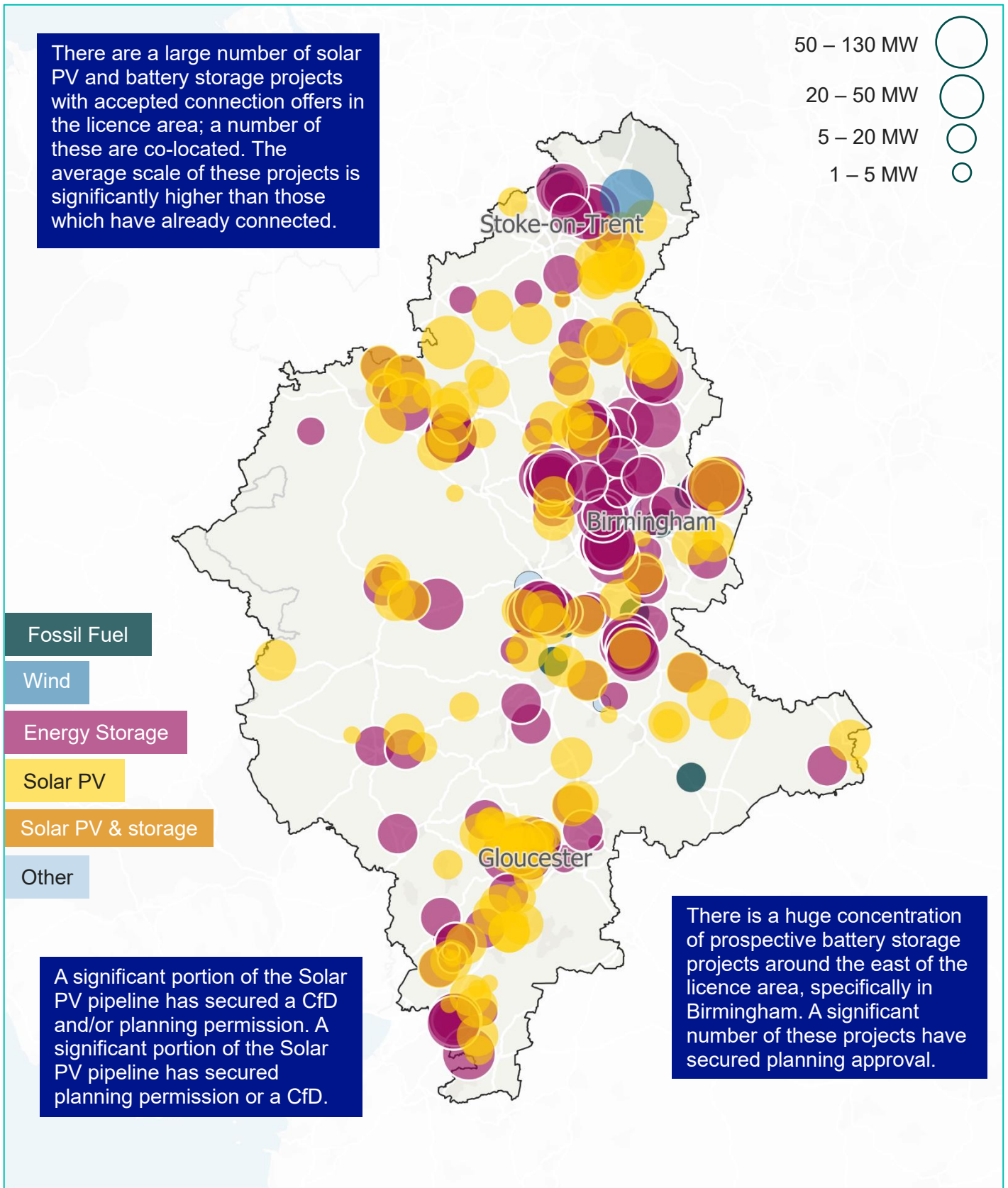


Figure 5: The NGED West Midlands licence area, with the location of proposed 'pipeline' large-scale generation and storage sites.

Methodology

This report details the analysis, assumptions and scenario outcomes for each individual technology in the West Midlands licence area. While a detailed methodology of the overall DFES process is available on the [National Grid website](#), a high-level overview is described below.

DFES component	Characterisation
Baseline analysis	Existing generation, storage and demand connected to the distribution network is analysed to produce a baseline for the licence area. The 2024 baseline year represents the 2023/24 fiscal year, ending on 31 March 2024. This is based on NGED connection data, supplemented with project and energy subsidy programme registers, Department for Transport (DfT) statistics, planning data, EMR Delivery Body Capacity Market registers and other national datasets.
Pipeline analysis	Once a baseline is established, projects that are currently in development are assessed to understand the likely changes to generation and demand in the near term. This mainly comprises sites that have accepted a connection offer from NGED but that have not yet connected. The pipeline also includes sites that have other forms of development evidence, such as spatial planning approvals or applications, housing developments and proposed commercial development space identified in local authority planning documents.
Scenario projections	Key assumptions from the FES 2024 are combined with pipeline analysis, resource assessments, building stock analysis, local and sectoral stakeholder engagement and other modelling assumptions to produce scenario projections out to 2050 for the technologies included in the DFES scope for each ESA. These are detailed in the technology-specific sections of this report.

Local stakeholder influences

The development of the DFES has enabled NGED to take a more proactive approach to network planning. Stakeholders such as local authority planners, project developers, policymakers, energy technology companies, asset owners, major energy users, generation operators and community energy representatives are consulted via a series of consultation events, surveys and one-to-one engagements.

Stakeholder engagement	Description of how feedback is fed into the DFES
Consultation webinars	Four consultation events, one per licence area, were held online in June 2024. These webinars aimed to allow a wide range of local stakeholders to engage directly with NGED and Regen and to provide views on the regional analysis. Reports summarising how the feedback has been directly incorporated into the DFES analysis are available on the National Grid website .
Local authorities	An online data exchange was shared with local authorities to capture their decarbonisation plans and local plans for new housing and commercial developments. In addition, where LAEP reports were available, these were obtained and compared against the DFES scenarios to ensure the LAEP pathways were within the envelope of DFES scenario outcomes, where

applicable. A separate overview of this comparison analysis was reviewed by NGED and Regen to inform the spatial distribution and uptake of relevant technology capacity projections within relevant local authority regions.

Developer engagement

Companies developing pipeline projects in NGED’s licence areas were directly contacted, seeking views on the status and development timeline of key large-scale renewable energy, battery storage and hydrogen electrolysis projects.

Major energy user engagement

A selection of large energy-consuming customers connected to NGED’s network were contacted to seek views around their plans regarding future electricity demand, onsite generation and storage, and areas where more information from NGED could be of use.

Eleven customers representing 20 sites across NGED’s network responded to this call for input. Separately, Regen contacted the Energy Intensive User Group and Major Energy Users Council for input and insights.

The sample size was small and based on site-specific circumstances, so wider trends should not be extrapolated. However, the responses provide anecdotal insight into the changes in energy use and generation for large energy users:

- Several customers confirmed they will require supply capacity increases, driven mainly by EV charging and heat electrification
- One customer indicated that a significant load currently met by behind-the-meter CHP would need to be met by an increased import capacity
- Several customers have plans to install significant amounts of onsite solar generation to reduce grid electricity imports and energy costs and meet their decarbonisation targets. Other customers are still developing their plans for onsite generation, considering a range of technologies.

Key areas where more information was requested included:

- Flexible network connections
- Participation in and the future of flexibility services
- Connections policy changes.

DFES-specific aspects

While the scenario framework and high-level assumptions are driven by the FES 2024, a number of specific aspects of the current energy system have been considered in the DFES 2024 analysis.

Aspect	Impact on DFES
<p>Retained capacity for decommissioning assets</p>	<p>Across the four DFES scenarios, assets that are incompatible with net zero targets, such as unabated fossil fuel power generation, decommission by 2050.</p> <p>However, when an asset ceases operation, the connection agreement with NGED and the associated agreed export capacity held by the operator is not automatically relinquished. It is, therefore, likely that some sites will retain their connection capacity, either with a view to participating in network ancillary services such as reserve services or stability services, or for the potential future</p>

connection of an alternative generation or storage technology that is more compatible with a net zero energy system.

To address this, the DFES analysis has assumed that any connection capacity 'freed up' by the mothballing of an existing fossil-fuel site, the removal of a generation asset or the significant reduction of onsite operating hours, is retained either for ten years or until a newly commissioned technology has been modelled to take its place. This assumption is based on direct engagement with stakeholders and internal system planning teams at NGED.

Reflecting upstream constraints on the transmission network

Across the transmission and distribution networks in GB, hundreds of GW of prospective electricity generation and storage projects have secured connection offers with the transmission and distribution network operators. A historic queue-based system for these projects has resulted in projects in some areas of the GB electricity grid being given connection dates well into the 2030s.

Upstream constraints on the transmission network continue to impact the timescale of projects in the distribution network connection pipeline. This has been confirmed through discussions with project developers who are currently being directly impacted in NGED's licence areas. The DFES process typically seeks to model scenarios based on an unconstrained grid to allow unbiased future network planning to be undertaken. However, constraints on the transmission network, such as those identified via the Statement of Works process, are not within the remit or control of NGED or distributed generation developers.

As such, these constraints have been reflected in the **Counterfactual** scenario. This allows the net zero scenarios to represent a range of potential future connections to the distribution network, including the fast-tracking of network investment and the early releasing of capacity headroom to enable connections.

Reflecting grid connections reform

In response to the impact of upstream transmission constraints on projects in the distribution network connection pipeline, a range of grid connections reform initiatives have been explored in the last 12 months.

As part of the ENA's 3-step Action Plan for reforming grid connections, NGED DSO launched a Technical Limits initiative, giving DNOs the ability to accelerate the connection of generators subject to wider Transmission Reinforcement Works. Technical Limit Offers (TLOs) provide distribution customers with the option of an interim non-firm connection arrangement, enabling more agile and 'shovel-ready' customers to connect earlier.

The DFES process typically seeks to model scenarios based on an unconstrained grid to allow unbiased future network planning to be undertaken. However, the near-term projections are impacted by current network constraints and proposed reforms, as these predominantly rely on the pipeline of accepted connections. As such, where pipeline sites have accepted a Technical Limit Offer, the updated connection date has been reflected in the scenario envelope as the earliest possible date of connection.

NESO has also proposed a number of significant changes to help accelerate the connection queue. The revised approach is an enhanced version of their 'Target Operating Model 4' (TMO4+), which requires projects to meet certain criteria related to land rights and planning permission to be given a queue

position. This could result in effective fast-tracking for projects that are 'shovel ready'. This reflects the existing DFES process used to assess the stage of development of pipeline sites.

Clean Power 2030 technology capacity requirements

Building on the reforms to manage the grid connections queue, the UK Government has published a detailed action plan for a Clean Power 2030 system and the requirements to enable it. This Clean Power 2030 plan discusses specific technology capacity requirements, including allocations to both regional and network tier levels. It also reinforces the significant reforms being proposed to connection application and queue management processes.

Whilst these reforms will likely have a significant impact on the energy project pipelines in NGED's licence areas, the DFES 2024 has not directly modelled or reflected any specific Clean Power 2030 outcomes for any technologies. The DFES methodology and near-term load growth scenarios, particularly for energy generation and storage, has considered development evidence, developer feedback and site-specific information and timeframes around TLOs and Statement of Works.

Energy policy and wider context

Similar to the network planning consideration, several areas of energy policy and wider energy sector context have been considered in the DFES analysis. High energy prices driven by geopolitical factors and post-Covid economic recovery have resulted in a number of energy policy shifts and announcements. A new Labour Government in 2024 has also reframed energy, with the aforementioned Clean Power 2030 being one of the Government's core missions. Other policy developments, such as the Review of Electricity Market Arrangements (REMA), could also have a significant impact on energy project development and consumer adoption of low-carbon technologies.

The global energy crisis, driven by increased prices in oil, gas and electricity markets, is compounding an ongoing cost of living crisis in the UK. This is already impacting the uptake of DFES technologies, such as an increase in rooftop solar installations, and potentially creating challenges for consumers to adopt heat pumps and electric vehicles.

The DFES analysis is, in the near term, based on the current pipeline of projects, which reflects the current situation in the existing electricity market structure. Over the medium and longer term, the framework of four future scenarios aims to capture a range of credible energy system futures, which reflect changes to society, technology and the economy, in some cases markedly above and beyond current energy policy.

As a result, any immediate impacts of energy policy and the wider energy sector context are considered to be reflected in the detailed analysis of the known pipeline of potential connections, while the potential long-term impacts are assumed to be captured in this envelope of potential futures rather than being explicitly modelled in the DFES 2024.

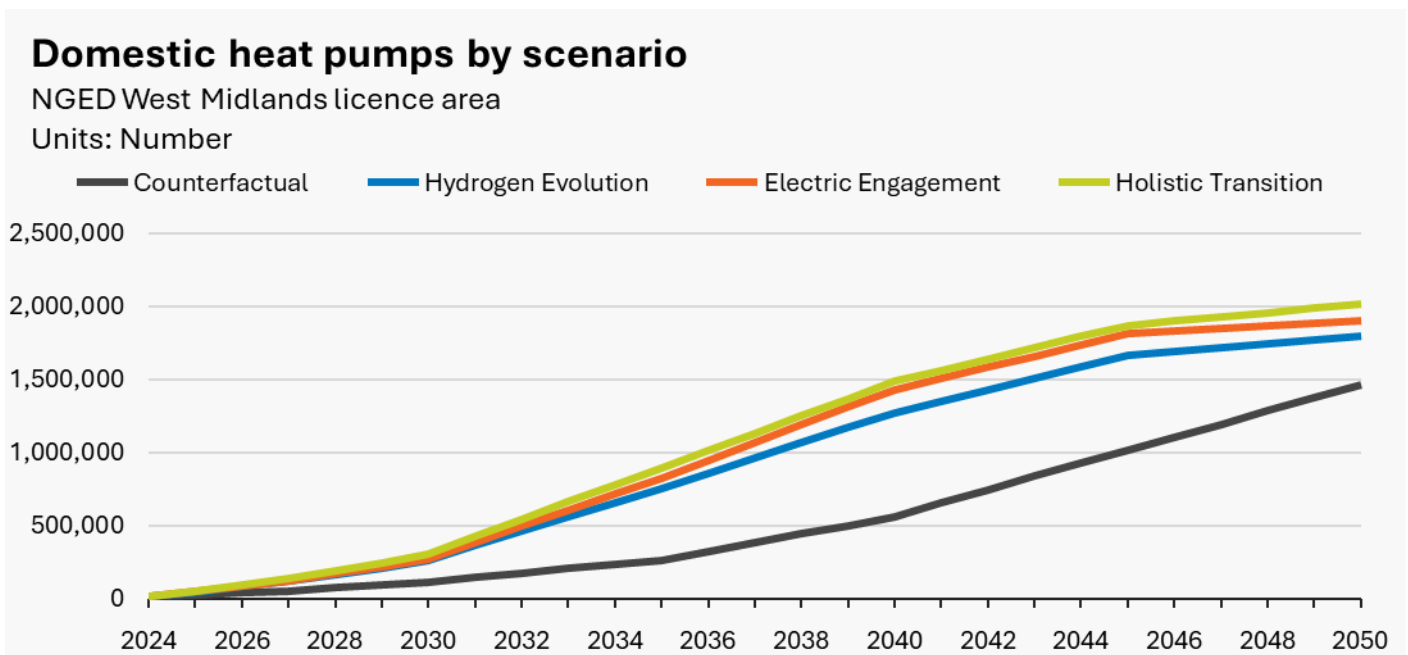
Demand technologies

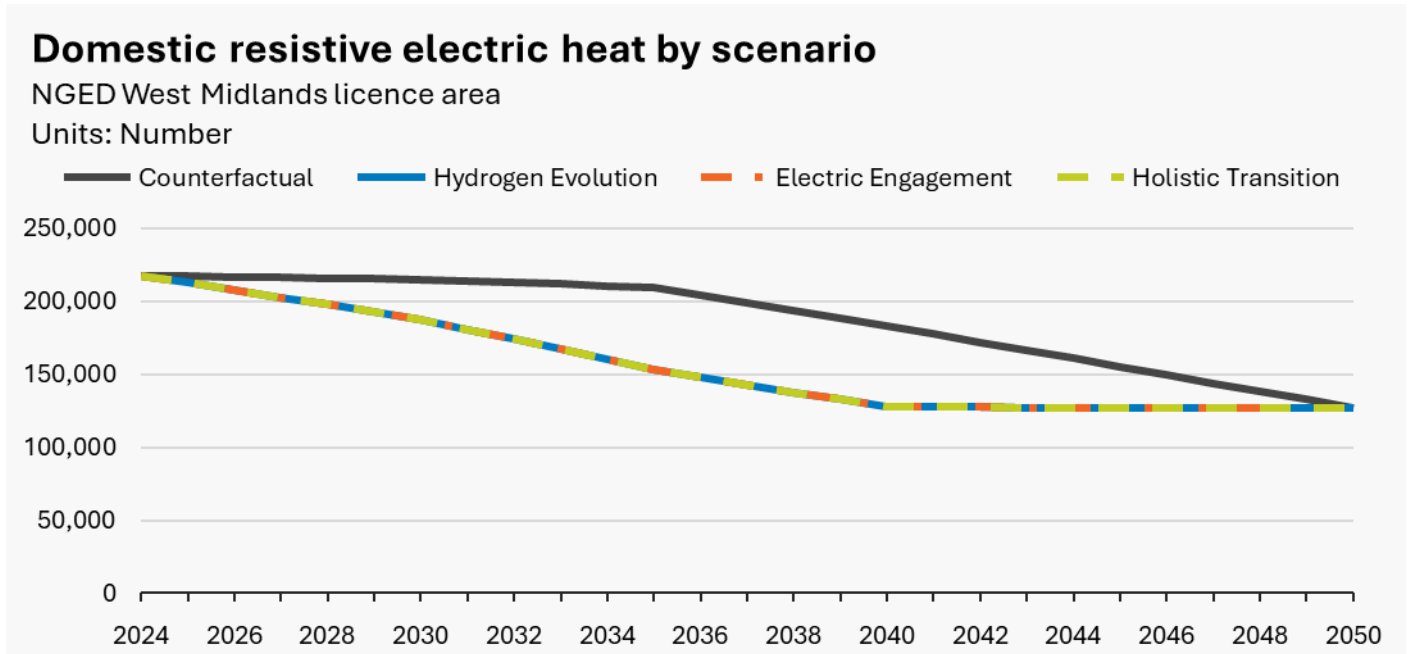
Results and assumptions

Domestic electric heat

Summary

- ▶ The West Midlands licence area has a high proportion of homes located in dense urban environments but also features more rural, off-gas areas along the west of the licence area, bordering Wales. Overall, the building stock in the licence area is similar to the GB average in terms of current heating technology use, housing types and tenure.
- ▶ Under **Holistic Transition** and **Electric Engagement**, domestic heating is mostly decarbonised through heat pumps in the West Midlands licence area, in line with national trends. Initial uptake in the 2020s is modelled to occur more commonly in off-gas houses and new-build homes. This is a reflection of anticipated energy performance and new build housing regulations, which is in line with the UK government’s target of 600,000 heat pump installations per year by 2028. In the medium and long term, a wider-scale rollout is modelled, with the majority of housing stock having heat pumps by 2050. In a medium and longer term, a wider-scale rollout is modelled, with the majority of housing stock having heat pumps by 2050. This results in between 2 million and 1.9 million homes using a form of heat pump by 2050 in these scenarios.
- ▶ Under **Hydrogen Evolution**, domestic heating is mostly decarbonised through a combination of non-hybrid heat pumps and low-carbon hydrogen in the form of standalone hydrogen boilers or hybrid heat pump. Hybrid and non-hybrid heat pumps total 1.8 million by 2050, alongside 0.5 million homes modelled to connect to a heat-pump driven district heat network under this scenario.
- ▶ Under the **Counterfactual**, progress towards heat decarbonisation is slow despite some uptake of heat pumps in the late 2030s and 2040s. This results in c. 1.5 million homes using a form of heat pump by 2050.
- ▶ The number of households on resistive electric heating decreases in all scenarios, replaced by more efficient heat pumps and district heating. Direct electric heating, as the most expensive form of resistive electric heating, sees the greatest reduction in the near term. There is a shift from direct electric heating to storage heating in homes where a boiler or heat pump is less suitable.





Modelling assumptions and results

Baseline

Source: EPC certificates, MCS installations data and NGED connections data

	Heating technology	Number of homes	Description
Baseline	Non-hybrid heat pumps	24,000	Most heat pumps in existing homes in the West Midlands licence area were supported by the Renewable Heat Incentive scheme, which ran from 2014 to 2022. This has since been succeeded by the Boiler Upgrade Scheme, which moves support to an upfront grant payment to reduce the capital costs of installing a heat pump.
	Hybrid heat pumps	<1,000	
	Resistive electric heating	218,000	The 1.0% of homes in the licence area have a heat pump, which is broadly in line with the national average. Resistive electric heating is marginally less common in the West Midlands compared to the national average, heating around 9% of homes compared to 10% nationally.
	Connections to heat pump-driven district heat networks	0	Much of these resistive electric heating homes are flats in Birmingham, as tower blocks in urban areas are more likely to be electrically heated.

Projections

Scenario	Description
<p>Holistic Transition</p>	<p>Homes are mostly decarbonised with heat pumps in the Holistic Transition scenario. Initial uptake in the 2020s is modelled to occur more commonly in off-gas houses and new-build homes due to anticipated energy performance and new-build housing regulations, before a wider-scale rollout is modelled on the majority of housing stock by 2050. In the West Midlands licence area, this results in c. 2.0 million homes using a form of heat pump by 2050 under Holistic Transition and c. 1.9 million under Electric Engagement.</p> <p>District heating plays a role in domestic heat decarbonisation in urban areas across the West Midlands, especially after 2030. Where a district heat network area has been identified, the majority of flats and terraces, and a substantial proportion of semi-detached and detached homes, in the area are modelled to connect. New-build homes in district heat network areas are also projected to connect to the network in most cases. This results in c. 0.6 million homes connected to heat pump-driven heat networks by 2050 under these scenarios.</p>
<p>Electric Engagement</p>	<p>The number of households on resistive electric heating decreases in all scenarios, replaced by more efficient heat pumps and district heating. Direct electric heating, as the most expensive form of resistive electric heating, sees the greatest reduction in the near term. There is a shift from direct electric heating to storage heating in homes where a boiler or heat pump is less suitable. However, around 60% of the baseline remains on resistive heating in 2050, particularly in smaller flats where a heat pump may not be suitable or economical.</p>
<p>Hydrogen Evolution</p>	<p>Homes are decarbonised in the Hydrogen Evolution scenario via a combination of non-hybrid heat pumps and low-carbon hydrogen options, through the use of standalone hydrogen boilers or hybrid heat pumps. In the West Midlands licence area, where there is a high proportion of on-gas homes, this results in the vast majority of homes being heated by hydrogen hybrid heat pumps or standalone heat pumps (totalling 1.8 million by 2050). A minority of homes decarbonise their heating through hydrogen boilers.</p> <p>District heating plays a role in domestic heat decarbonisation in urban areas across the West Midlands, especially after 2030. Where a district heat network area has been identified, the majority of flats and terraces, and a substantial proportion of semi-detached and detached homes, in the area are modelled to connect. New-build homes in district heat network areas are also projected to connect to the network in most cases. This results in c. 0.4 million homes connected to heat pump-driven heat networks by 2050 under this scenario.</p> <p>Resistive heating declines throughout the scenario timeframe due to the uptake of heat pumps and district heating. Direct electric heating, as the most expensive heating method, sees a greater reduction in the near term. There is a shift from direct electric heating to next-generation storage heating in homes where a boiler or heat pump is less suitable. However, around 60% of the baseline remains on resistive heating in 2050, particularly in smaller flats where a heat pump may not be suitable or economical.</p>

Counterfactual

Under the **Counterfactual** scenario, progress towards heat decarbonisation is slow, despite some uptake of heat pumps in the late 2030s and 2040s. In this scenario, many homes remain heated by fossil gas boilers in 2050, and the UK fails to meet its carbon emissions reduction targets. In the West Midlands licence area, this results in only 1.5 million homes using a form of heat pump by 2050.

District heat networks also see lower uptake under this scenario, as progress towards net zero is slower. As a result, only c. 0.1 million homes are connected to a heat network by 2050 under this scenario.

Resistive heating declines after 2035 due to the uptake of heat pumps and district heating. Direct electric heating, as the most expensive heating method, sees a greater reduction in the near term. There is a shift from direct electric heating to next-generation storage heating in homes where a boiler or heat pump is less suitable. However, around 60% of the baseline remains on resistive heating in 2050, particularly in smaller flats where a heat pump may not be suitable or economical.

Uptake modelling factors

The below factors are used to inform the overall uptake of domestic electric heating in the West Midlands licence area.

Factor	Modelling impact	Source
New developments	Domestic heating in new homes has been modelled in line with The Future Homes and Buildings Standards: 2023 consultation, with heat pumps or district heating installed for the vast majority of new homes. ¹	Future Homes and Buildings Standards, DFES new developments projections
National uptake trends	The overall GB uptake of heating technologies modelled in the DFES reflects the overarching FES 2024 trends, such as a focus on electrified heat under Holistic Transition and Electric Engagement (which meet the UK government’s target of 600,000 heat pump installations per year by 2028) and the availability of hydrogen for heating under Hydrogen Evolution .	FES 2024

Spatial factors

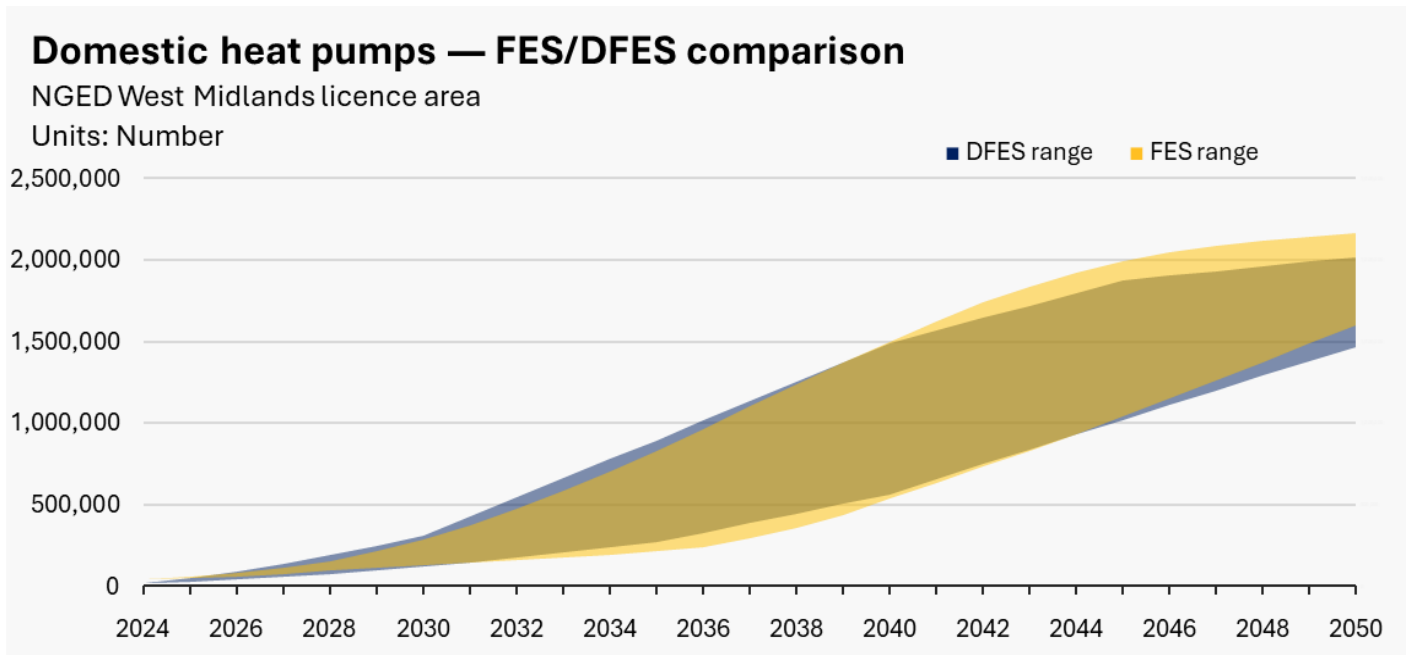
The below factors are used to inform the spatial distribution of domestic electric heating capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Current heating technology	Current heating technology, categorised into on-gas, resistive electric heating and off-gas, affects when the uptake of decarbonised heating technology is projected to occur and what type of heating technology is likely to be installed.	EPC data, ONS Census

Building type	Building type, categorised into semi-detached, detached, terraced and flats, affects when the uptake of decarbonised heating technology is projected to occur and what type of heating technology is likely to be installed.	EPC data, ONS Census
Tenure	Tenure, categorised into owner-occupied, privately rented and socially rented, affects when uptake of decarbonised heating technology is projected to occur.	EPC data, ONS Census
Construction age band	Construction age band, categorised into pre-1930 and post-1930 construction, affects when the uptake of decarbonised heating technology is projected to occur and what type of heating technology is likely to be installed. This banding aligns with the findings of the NGED DEFENDER project.	EPC data
Areas with potential for district heat networks, or an existing heat network pipeline project	Areas with potential for district heat networks or an existing heat network pipeline project affects the likelihood of properties connecting to a district heat network as opposed to decarbonising with other heat technologies.	Heat network pipeline data, and Opportunity Areas for District Heat Networks in the UK - DESNZ
Hydrogen supply for domestic heating	<p>In FES 2024, the Holistic Transition scenario features a small proportion of homes heated by hydrogen boilers or hydrogen hybrid heat pumps. The location of these homes has been modelled primarily on the east coast, in line with the East Coast Hydrogen project from Humber to Teesside, and the north west, in line with the HyNet North West project. Therefore, in this scenario, it is assumed that hydrogen supply for domestic heating does not extend to the West Midlands licence area.</p> <p>Under Hydrogen Evolution, it is assumed that hydrogen supply follows the existing gas distribution network.</p>	East Coast Hydrogen, HyNet North West, NESO FES engagement
Local Area Energy Plans	Data from Local Area Energy Plans has been obtained where available and reconciled against the DFES outcomes.	Local authority engagement

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area. The DFES baseline, modelled as 2024, coincides with the first year of projections for the FES. This may result in a projection range in 2024 in the FES data.



- ▶ For all scenarios, the DFES outcomes and FES 2024 data for total heat pumps are aligned.
- ▶ There is no regional level data in FES 2024 for resistive electric heating and, therefore, a direct comparison is not possible.

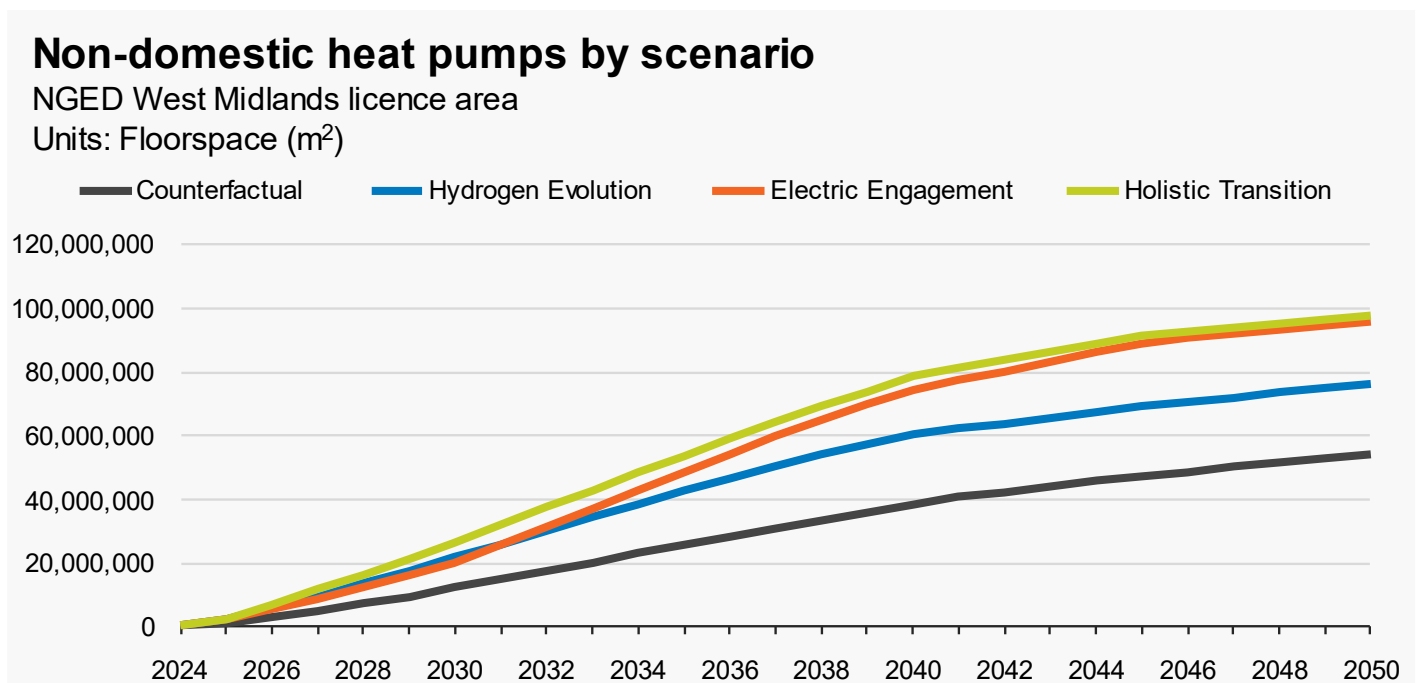
Comparison to DFES 2023

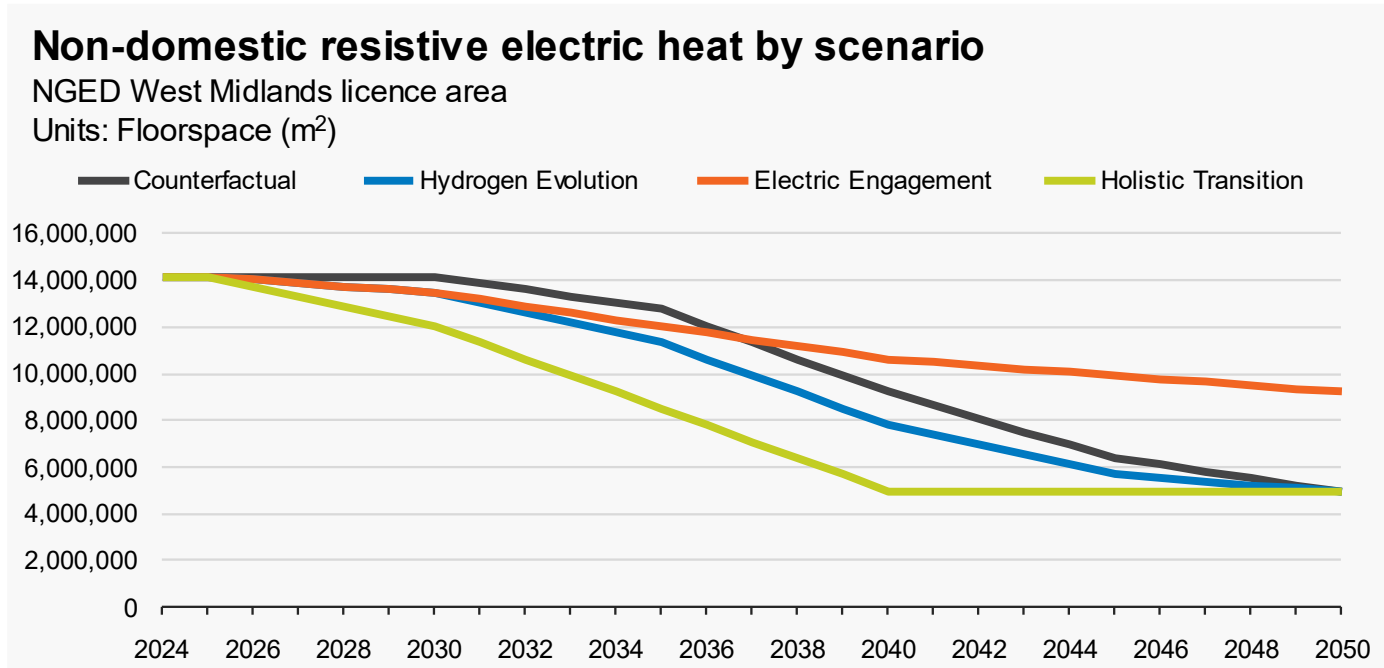
- ▶ The DFES 2024 scenario projections for **Hydrogen Evolution** differ the most when compared to DFES 2023 System Transformation. This is due to an updated FES 2024 framework which has increased the number of heat pumps and reduced the amount of hydrogen for domestic heating under this scenario.
- ▶ The **Holistic Transition** and **Electric Engagement** scenario projections for heat pumps are lower than the projections from DFES 2023 until the early 2040s. This is due to an updated FES 2024 framework which has reduced the uptake of heat pumps in the near term, reflecting current national uptake trends.
- ▶ The **Counterfactual** scenario is broadly aligned with the DFES 2023 projections, although slightly higher in the long term. This is due to the more ambitious uptake of heat at a national level modelled in FES 2024, which has been reflected in the DFES 2024 modelling.
- ▶ Resistive electric heating follows a similar trend in all scenarios in both DFES 2023 and DFES 2024. An earlier shift away from resistive electric heating, and matching outcomes in all three net zero scenarios, have been modelled to align with the national FES 2024 assumptions.

Non-domestic electric heat

Summary

- ▶ Heating in non-domestic buildings is currently dominated by gas-fired central heating, resistive electric heating and air conditioning for cooling.
- ▶ An evidence update from DESNZ on low-carbon heating and cooling in non-domestic buildings² found that non-domestic building decarbonisation pathways are strongly influenced by the existing heating system and HVAC environment.
- ▶ In all four scenarios, the near-term uptake of heat pumps in non-domestic buildings is focused on buildings heated with off-gas and direct electric heating systems due to the higher operational costs of these technologies.
- ▶ In the medium to long term, buildings currently heated by gas, oil or LPG are modelled to move to an air-source or ground-source heat pump, or connect to a district heat network, while most buildings with resistive electric heating are modelled to move to more efficient air-to-air heat pumps, operating similarly to air conditioners.
- ▶ Non-domestic buildings are primarily decarbonised with heat pumps in the three net zero scenarios, resulting in heat pumps heating 76-97 million sqm of floorspace by 2050.
- ▶ In all scenarios, resistive heating declines substantially from 2025 through to 2050 in non-domestic buildings, due to the uptake of more efficient heat pumps and district heating. Direct electric heating, as the most expensive heating method, sees a greater reduction in the near term. Under the **Electric Engagement** scenario, a higher proportion of non-domestic buildings remain on resistive electric heating in the long term due to the particularly strong focus on electrification of heat and limited low-carbon alternatives under this scenario.





Modelling assumptions and results

Baseline

Source: NDEPC and DEC certificates and MCS installations data

Heating technology	Total floorspace (million sqm)*	Description
Heat pumps	0.4	Analysis of EPC and DEC data suggests that 15 million square meters of non-domestic floorspace is currently heated by resistive electric heating. This does not include buildings with air conditioning that are recorded as predominantly providing cooling.
Resistive electric heating	14	EPC and DEC data does not record whether a building is heated by a heat pump. As a result, the heat pump baseline is informed by MCS installation data.

* This is a proportion of the total floorspace in non-domestic EPC and DEC data. This total includes unheated or air-condition-only properties, which make up around 25% of total floorspace.

Projections

Scenario	Description
Holistic Transition	Non-domestic buildings are primarily decarbonised with heat pumps in the Holistic Transition scenario. Similar to heating in domestic buildings, near-term decarbonisation of heat in non-domestic buildings is focussed on buildings heated with off-gas and direct electric heating systems, due to the higher operational costs of these

technologies. In the West Midlands licence area, this results in c. 97 million sqm of floorspace heated using a form of heat pump by 2050.

Resistive heating declines sharply throughout the scenario timeframe from 2025 to 2040, due to the uptake of heat pumps and district heating. Around 35% of the baseline remains on resistive heating in 2050. Direct electric heating, as the most expensive and least flexible electric heating method, sees a greater reduction in the near term.

Electric Engagement

Non-domestic buildings are primarily decarbonised with heat pumps in the **Electric Engagement** scenario. Similar to heating in domestic buildings, near-term decarbonisation of heat in non-domestic buildings is focused on buildings heated with off-gas and direct electric heating systems. In the West Midlands licence area, this results in c. 96 million sqm of floorspace heated using a form of heat pump by 2050.

Resistive heating declines at a slower rate throughout the scenario timeframe, when compared to the other three scenarios, resulting in a higher proportion of non-domestic buildings remaining on resistive electric heating in the long term. This is due to the particularly strong focus on the electrification of heat and limited low-carbon alternatives under this scenario. Around 65% of the baseline remains on resistive heating in 2050. Direct electric heating, as the most expensive and least flexible electric heating method, sees a greater reduction in the near term.

Hydrogen Evolution

Non-domestic buildings are primarily decarbonised with heat pumps in the **Hydrogen Evolution** scenario. Similar to heating in domestic buildings, near-term decarbonisation of heat in non-domestic buildings is focussed on buildings heated with off-gas and direct electric heating systems. In the West Midlands licence area, this results in c. 76 million sqm of floorspace heated using a form of heat pump by 2050.

Resistive heating declines throughout the scenario timeframe from 2025 to 2050, due to the uptake of heat pumps and district heating. Around 35% of the baseline remains on resistive heating in 2050. Direct electric heating, as the most expensive and least flexible electric heating method, sees a greater reduction in the near term.

Counterfactual

Although to a lesser extent, non-domestic buildings are still primarily decarbonised with heat pumps in the **Counterfactual** scenario. Similar to heating in domestic buildings, near-term decarbonisation of heat in non-domestic buildings is focussed on buildings heated with off-gas and direct electric heating systems. In the West Midlands licence area, this results in c. 54 million sqm of floorspace heated using a form of heat pump by 2050. This is the lowest level of heat pump uptake in non-domestic buildings of the four scenarios, with a number of properties likely still remaining on fossil fuel heating systems by 2050.

Resistive heating declines throughout the scenario timeframe from 2025 to 2050, due to the uptake of heat pumps and district heating. Around 35% of the baseline remains on resistive heating in 2050. Direct electric heating, as the most expensive and least flexible electric heating method, sees a greater reduction in the near term.

Uptake modelling factors

The below factors are used to inform the overall uptake of non-domestic electric heat in the West Midlands licence area.

Factor	Modelling impact	Source
New developments	Heating in new non-domestic buildings has been modelled in line with The Future Homes and Buildings Standards: 2023 consultation, with heat pumps or district heating installed for the vast majority of new buildings. ¹	Future Homes and Buildings Standards, DFES new developments projections
Existing baseline of non-domestic heat pump installations	Provides baseline numbers of non-domestic heat pump installations.	MCS installation data
National uptake trends	The overall GB uptake of heating technologies modelled in the DFES reflects the overarching FES 2024 trends, such as a focus on electrified heat under Holistic Transition and Electric Engagement and the availability of hydrogen for heating under Hydrogen Evolution , although the availability of hydrogen predominantly impacts domestic buildings.	FES 2024

Spatial factors

The below factors are used to inform the spatial distribution of non-domestic electric heat capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Current building environment of non-domestic buildings (heating, cooling and ventilation requirements)	Current building heating environment, including heating, cooling and ventilation requirements, affects when uptake of decarbonised heating technology is projected to occur and what type of heating technology is likely to be installed. This is based on DESNZ’s ‘Evidence update of low carbon heating and cooling in non-domestic buildings’. ³	NDEPC and DEC data
Current heating technologies of non-domestic buildings	Current heating technology affects when uptake of decarbonised heating technology is projected to occur and what type of heating technology is likely to be installed. This is also based on DESNZ’ ‘Evidence update of low carbon heating and cooling in non-domestic buildings’.	NDEPC and DEC data
Areas with potential for district heat networks, or an	Areas with potential for district heat networks or an existing heat network pipeline project affects the likelihood of properties connecting to a district heat	Heat network pipeline data, Opportunity Areas for District Heat

existing heat network pipeline project	network as opposed to decarbonising with other heat technologies.	Networks in the UK - DESNZ
Areas with potential for hydrogen zones	Areas with potential for hydrogen zones around industrial clusters affects when the uptake of decarbonised heating technology is projected to occur and what type of heating technology is likely to be installed under Holistic Transition and Hydrogen Evolution .	East Coast Hydrogen, HyNet North West, FES engagement

Large-scale heat pumps for district heating

Once the buildings connecting to the heat network in the baseline and into the future under the different scenarios have been identified, peak heating demand assumptions are applied, and a COP of 3 is assumed to calculate the size of heat pump that would be installed to support the demand of the heat network customers. Where heat network zones exist, it is assumed that energy centres are located in these zones and serve neighbouring areas. Where heat network zones do not exist, it is assumed that energy centres will be located in areas with the highest district heating demand and serve neighbouring areas.

Reconciliation to FES 2024

As the FES non-domestic heat outputs are reported in number of installations rather than heated floorspace, it is not possible to directly reconcile the DFES with it. The modelling aims to mirror the high-level outcomes from non-domestic heating in each of the four FES scenarios.

Comparison to DFES 2023

- ▶ The DFES 2023 heat pump baseline was higher than DFES 2024 numbers. This is due to reallocation of building environments using air conditioning for cooling only, rather than for heating and cooling, to not be classified as heat pumps in the baseline.
- ▶ The four scenarios all see higher overall projections over the scenario timeframe compared to DFES 2023. This is due to the implementation of assumptions from the Future Homes and Buildings Standard 2023 consultation, which specifies heat pumps or district heating will be required in the vast majority of new non-domestic buildings. Prior to the publication of this consultation, at the time of the DFES 2023 modelling, the assumptions had a wider range of potential low-carbon heating technologies in new non-domestic buildings, including resistive electric heating, bioenergy and hydrogen.

Electric vehicles (EVs) and EV chargers

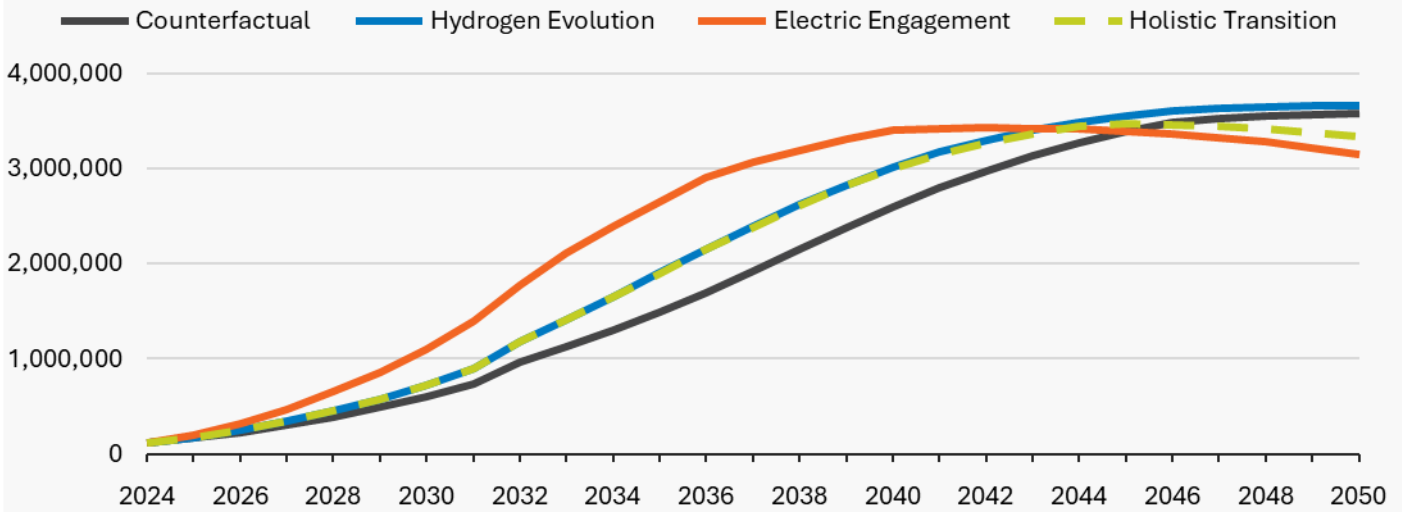
Summary

- ▶ Around 3% of vehicles in the West Midlands licence area are currently battery electric or plug-in hybrid. This is anticipated to increase substantially under every scenario, as the UK looks to decarbonise the transport sector through electrification.
- ▶ In **Hydrogen Evolution** and **Holistic Transition**, the electrification of vehicles reflects the current Zero Emission Vehicle (ZEV) mandate of no new petrol or diesel cars to be sold after 2035.⁴
- ▶ Under **Electric Engagement**, EV uptake has been modelled to align with an accelerated ZEV mandate, with no new petrol or diesel cars sold after 2030, which has been discussed but has not yet been legislated.⁵ Under this scenario, passenger vehicles such as cars and LGVs are rapidly electrified over the 2020s and the early 2030s. Non-passenger vehicles, such as HGVs and buses, follow suit, though over a longer timeframe. By 2050, almost all road vehicles are electrified – with the vast majority of EVs being fully battery electric.
- ▶ A greater availability of low-carbon hydrogen, including in cities, under the **Hydrogen Evolution** scenario results in harder-to-electrify vehicles, such as buses and HGVs, adopting hydrogen-fuelled alternatives, resulting in a more limited EV uptake.
- ▶ The electrification of transport is slowest overall under the **Counterfactual** scenario; however, the vast majority of vehicles are still electrified by 2050.
- ▶ **Electric Engagement** and **Holistic Transition** both see a fall in overall vehicle ownership as car sharing, active travel and greater use of public transport reduce the need for private vehicle ownership.
- ▶ Regen's DFES transport model determines the charger capacity that is required for the number of vehicles projected under each of the four DFES scenarios. The future charger requirement is split across a number of different domestic and non-domestic charger types, such as domestic off-street chargers, rapid en-route chargers and chargers in public car parks. eHGV chargers are also modelled, with deployment centred around HGV service stations along major highways.
- ▶ The near-term deployment of EV chargers is representative of the pipeline of commercial EV charging points which have an accepted connection offer from NGED. In the West Midlands, this totals 153 MW, the majority of which is categorised as en-route and destination chargers.
- ▶ The scenarios see the greatest variation in the medium term, with between 7.3 GW and 14.1 GW of EV charging capacity connected in the licence area in 2035. The scenarios converge in the longer term as road transport electrification progresses, resulting in a minimal range of outcomes around 18 GW by 2050.

Electric cars, LGVs and motorcycles by scenario

NGED West Midlands licence area

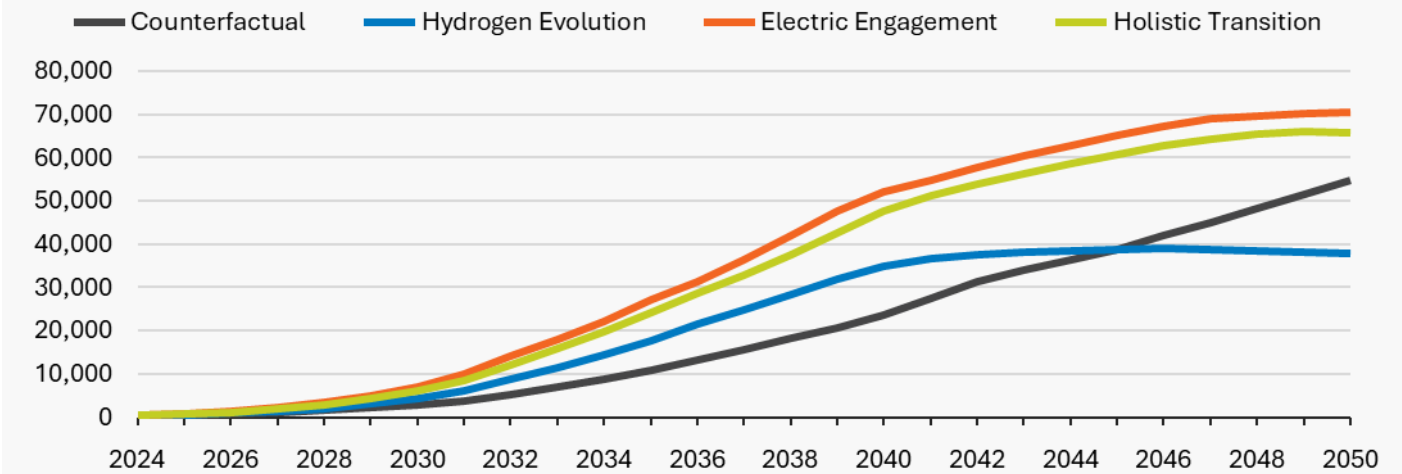
Units: Number



Electric buses, coaches and HGVs by scenario

NGED West Midlands licence area

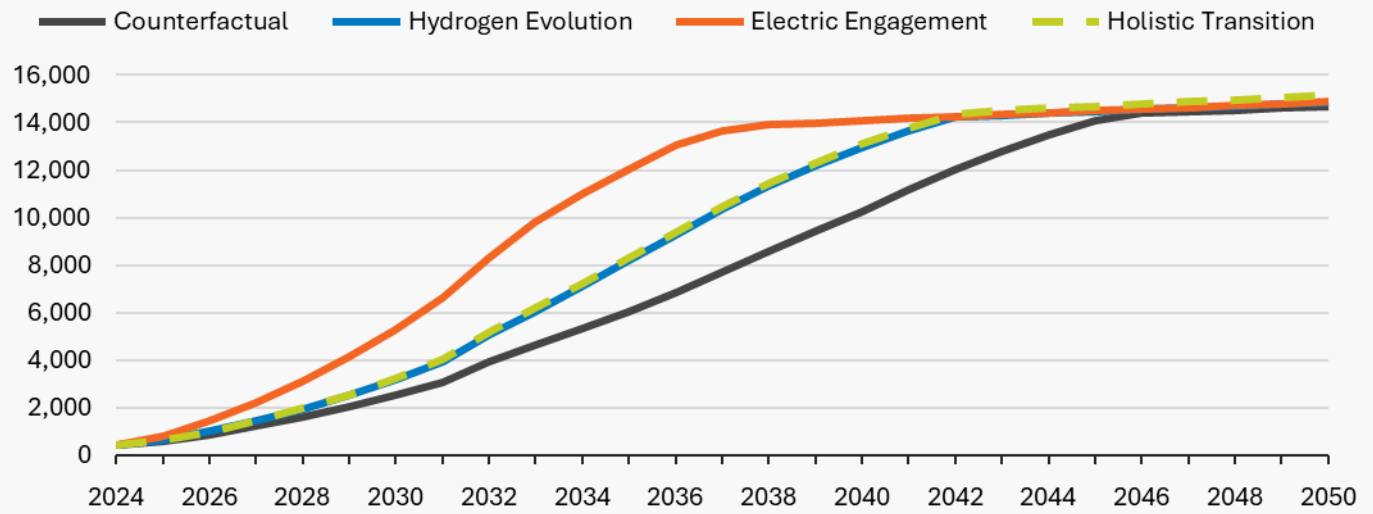
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Domestic EV charger capacity by scenario

NGED West Midlands licence area

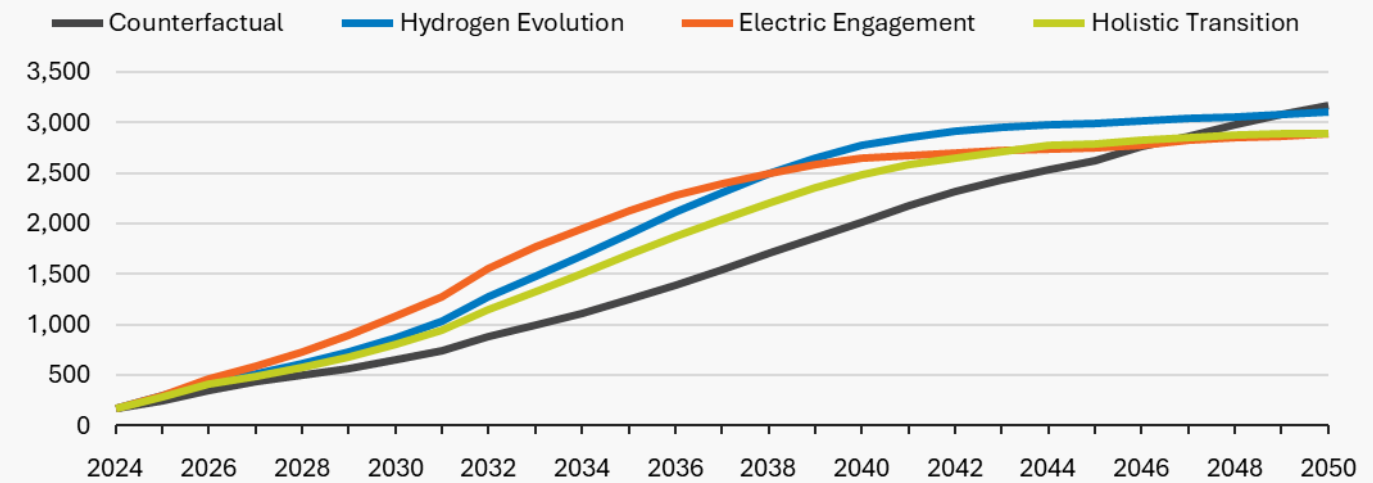
Units: MW



Non-domestic EV charger capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: DfT data, OpenChargeMap data, Workplace Charging Scheme data, NGED connections data

Type	Vehicles (000s)/ Capacity (MW)	Description	
Electric vehicles			
Baseline	Pure electric car	64	The uptake of EVs across the UK has been steadily accelerating. The current EV baseline represents 3.1% of all vehicles registered in the West Midlands licence area, up from 2.5% in DFES 2023.
	Plug-in hybrid car	35	This has been due to a number of factors, including favourable tax benefits and grant funding support, increasing consumer confidence and the electrification of commercial vehicle fleets.
	Pure electric LGV	10	While the vast majority of EV uptake has centred on cars, other vehicles are beginning to see uptake. In particular, sales of electric LGVs have significantly increased in the last two years.
	Other EVs	1	
EV chargers			
Baseline	Domestic	426	As the number of EVs has increased, the number and capacity of installed EV chargers has similarly risen. In addition to most domestic EV owners having a home charger, non-domestic chargers in the form of car park chargers, workplace chargers and rapid en-route chargers at forecourts have also seen an increased rollout in recent years. There is currently 426 MW of domestic EV chargers and 166 MW of non-domestic EV chargers operating in the West Midlands licence area.
	Non-domestic	166	Due to a lack of high-granularity data for domestic EV charger installations, baselines were calculated based on the number of EVs and the housing stock within the licence area. The non-domestic EV charger baseline was calculated using OpenChargeMap data and data from the Workplace Charging Scheme, supplied by NGED.
Pipeline	Domestic	n/a	Domestic EV charger installations often commission quickly and, therefore, are unlikely to hold their connection offer for long before being installed. In addition, NGED has recently introduced a 'connect and manage' scheme for domestic low-carbon installations, which means that households do not need

		to apply for a grid connection ahead of installing EV chargers. Therefore, no clear view of the pipeline of domestic EV chargers has been considered to inform the DFES projections
Non-domestic	153	<p>The pipeline of new EV chargers therefore comprises commercial EV charging points which have an accepted connection offer with NGED. There are currently 59 sites within the West Midlands licence area, totalling 153 MW. The majority of this capacity is associated with en-route chargers.</p> <p>This pipeline is modelled to connect between 2025 and 2027, depending on the scenario and when the connection offer was accepted.</p>

Projections

- ▶ The acceleration in the uptake of EVs seen over the past few years is anticipated to continue under every scenario, particularly between the mid-2020s and 2040.
- ▶ In the longer term under the three net zero scenarios, EV adoption approaches saturation and the sale of new EVs slows in most areas. Harder-to-electrify vehicles, such as HGVs, that saw lower uptake in the near term, see a higher uptake out to 2050.
- ▶ The total number of EVs reduces in some scenarios in the long term, reflecting a lower level of car ownership and higher use of public transport.
- ▶ EV charger uptake is closely tied to EV adoption, with domestic and non-domestic chargers continuing to be installed to meet demand. This is augmented by the known pipeline of accepted connections for non-domestic EV charger installations connecting to the NGED distribution network, predominantly in the form of en-route charging hubs at service stations on major motorways and A roads.
- ▶ By 2035, the installation rate of EV chargers slows. It is assumed that homes with multiple EVs don't purchase a second charger at the same rate as their first, leading to a levelling out of domestic EV charger capacity under all scenarios. The demand for additional public charging also reduces, as the majority of vehicles are electrified by this point. It is also assumed that, while EV numbers may reduce in the 2040s under some scenarios, installed EV chargers will remain in place, but with lower utilisation as the overall number of vehicles on the road decreases.

Scenario	Description
Holistic Transition	A high proportion of new car and LGV sales are EVs in the late 2020s and early 2030s. Harder-to-electrify vehicles, such as buses and HGVs, see some uptake in the medium-term, but hydrogen-fuelled alternatives also begin to be adopted, limiting EV uptake for these as heavier vehicles, particularly under Hydrogen Evolution .
Hydrogen Evolution	<p>Plug-in hybrid vehicles see moderate uptake under both scenarios, with battery electric vehicles being the dominant EV technology across all vehicle classes.</p> <p>While domestic charging is most common, rapid en-route charging also sees significant uptake under these scenarios.</p> <p>Car ownership falls under Holistic Transition in the mid-2040s as car sharing via autonomous vehicles, active travel and greater use of public transport reduce the need for private vehicle ownership.</p>

By 2050, under **Holistic Transition**, there are 3.4 million EVs, with an associated charger capacity of 18.0 GW.

By 2050, under **Hydrogen Evolution**, there are 3.7 million EVs, with an associated 17.9 GW.

Electric Engagement

EVs dominate new car and LGV sales from the late 2020s under this scenario and from 2030 almost all new cars are electric. Harder-to-electrify vehicles, such as buses and HGVs, also see uptake in the medium-term, with the majority of all road vehicles electrified by 2040.

With such a rapid shift toward battery electric vehicles, plug-in hybrid vehicles see relatively low uptake, and the number of hybrid vehicles declines in the late 2030s.

EV uptake is facilitated by a widespread rollout of domestic and non-domestic charging. This includes 350 kW and 1 MW eHGV chargers at major service stations.

Overall vehicle ownership falls in the mid-2040s, as car sharing via autonomous vehicles, active travel and greater use of public transport moderately reduces private vehicle ownership.

By 2050, there are 3.2 million EVs, with an associated 17.7 GW.

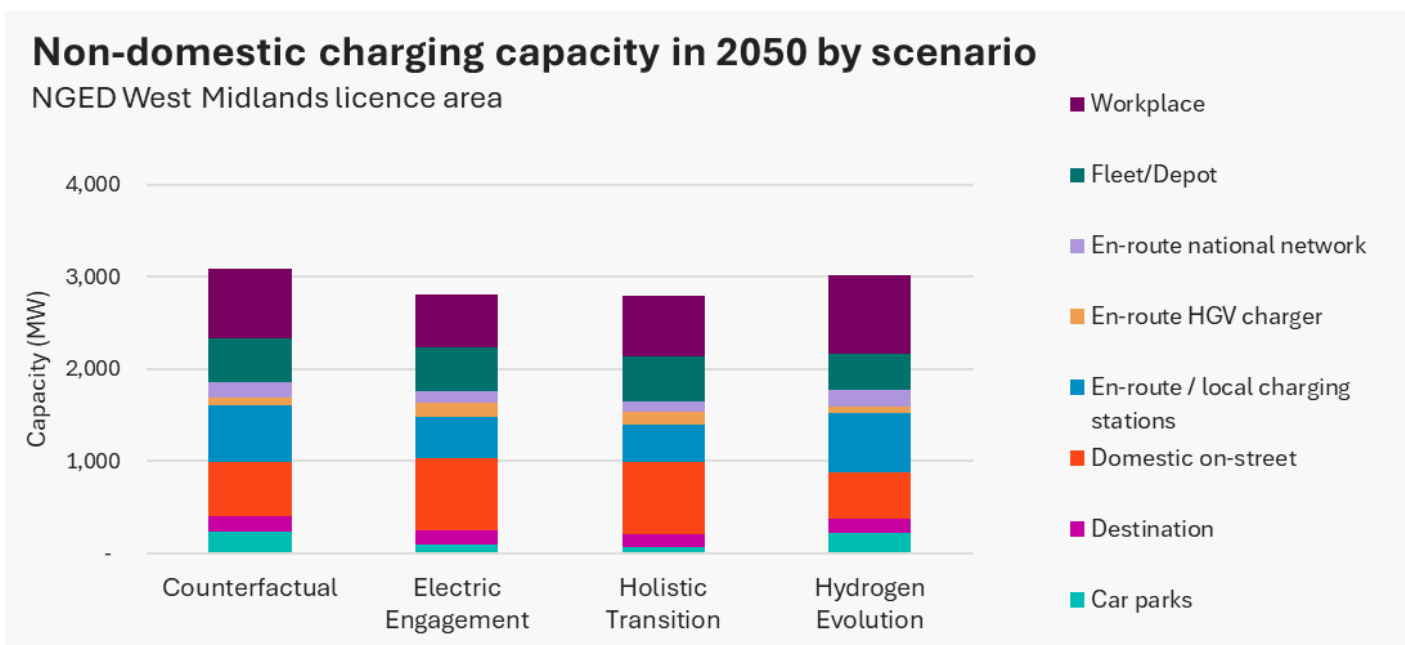
Counterfactual

A high proportion of new car and LGV sales are EVs by the early 2030s. Harder-to-electrify vehicles, such as buses and HGVs, see limited uptake in the medium-term.

Plug-in hybrid vehicles see moderate uptake, but battery electric vehicles remain the dominant EV technology across all vehicle classes.

There is a much lower rate of domestic off-street charging under this scenario, with a higher number of car park, workplace and local charging stations being rolled out in the 2030s.

By 2050, there are 3.6 million EVs, with an associated 17.8 GW.



Uptake modelling factors

The below factors are used to inform the overall uptake of onshore wind in the West Midlands licence area.

Factor	Modelling impact	Source
Current number of EVs and petrol/diesel vehicles	The baseline of existing EVs and the total number of all vehicles in the licence area strongly informs the projected uptake of EVs.	DfT statistics
New developments	EV charging points in new domestic homes have been modelled in line with The Future Homes and Buildings Standards: 2023 consultation, with EV charging points installed in 75% of new build properties with parking provision.	Future Homes and Buildings Standards, DFES new developments projections

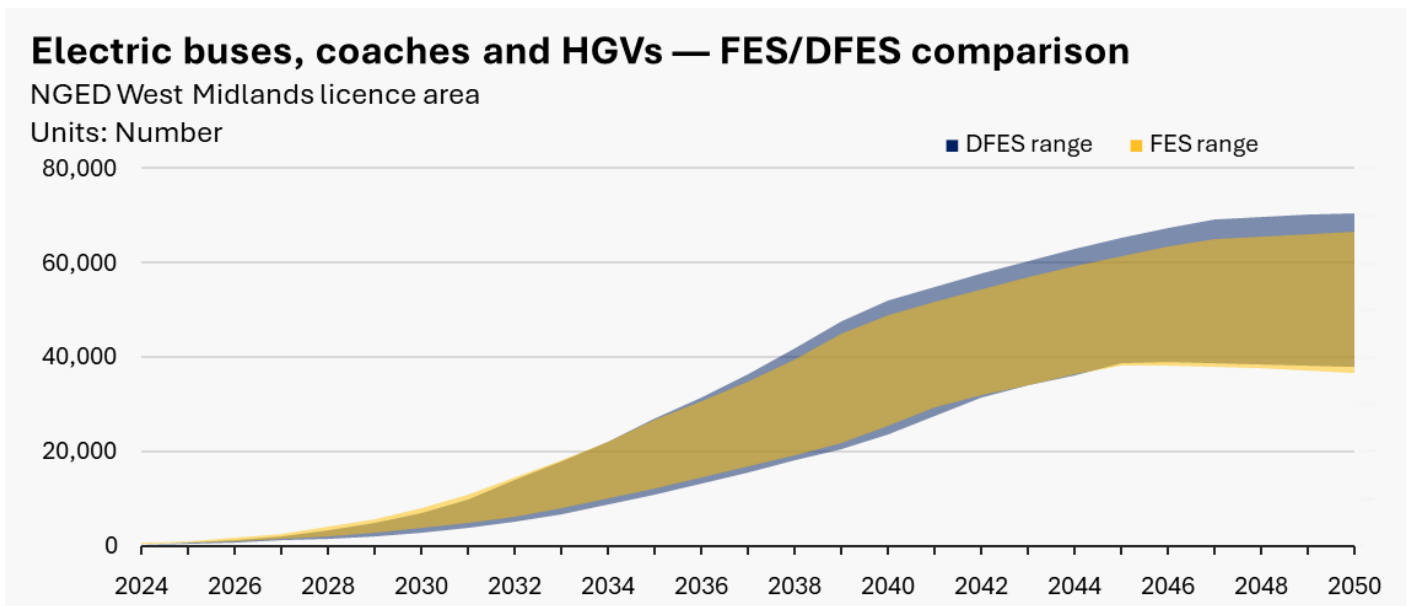
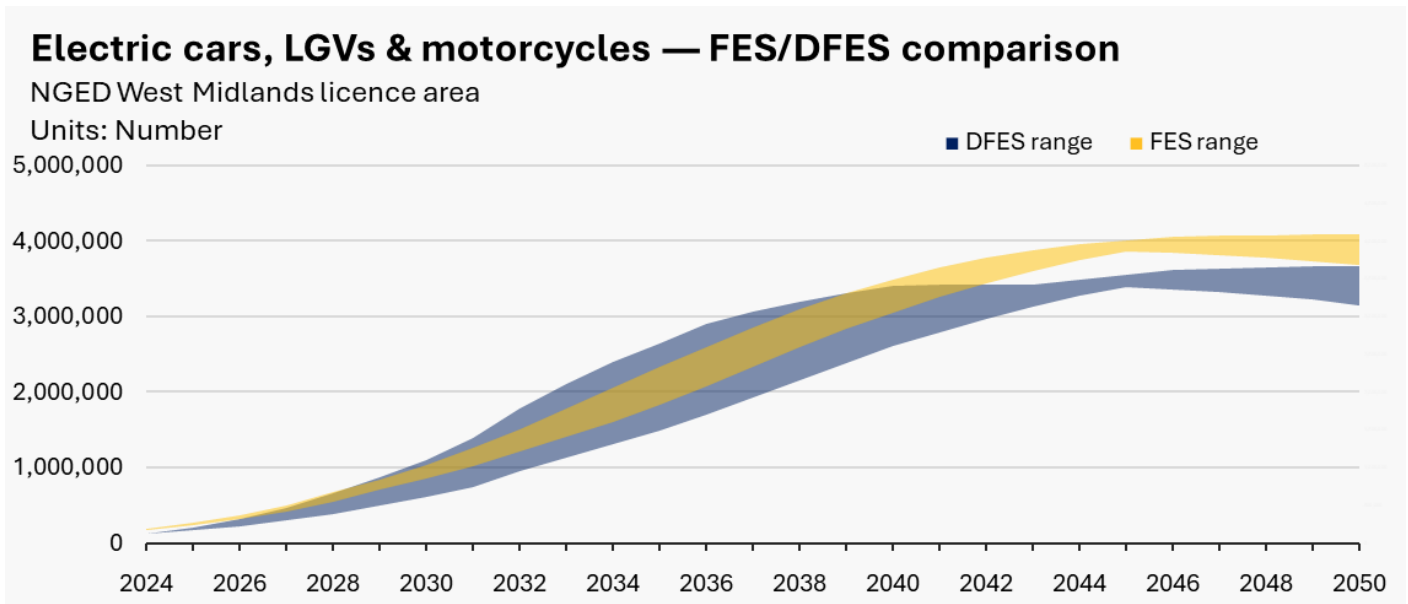
Spatial factors

The below factors are used to inform the spatial distribution of onshore wind capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Access to off-street and on-street parking, affluence and rurality	These factors influence the near-term location of EVs and the associated off-street and on-street domestic EV chargers.	ONS Census data
Location of petrol/diesel fuelling stations	The location of petrol/diesel fuelling stations are used to indicate the location for projected en-route EV chargers.	OS Addressbase
Location of car parks, workplaces and fleets/depots	The location of car parks, workplaces and fleets/depots are used to indicate the projected location of car park, workplace and fleet/depot chargers.	OS Addressbase
Ambition of local authority	Local authorities which indicated having a low carbon transport plan in the local authority survey are assumed to have a slightly accelerated uptake of electric buses and coaches, as well as en-route / local charging stations. Specific LAEP targets for the rollout of EV charger capacity have also been reviewed and incorporated where available and where possible.	Regen DFES local authority survey LAEP publications

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ As the uptake of EVs and provision of EV charging infrastructure are heavily driven by national trends and factors, the DFES projections for EVs and EV chargers in the licence area strongly mirror the national FES 2024 outcomes. The exception to this is **Electric Engagement**, which has an accelerated uptake for cars and vans, tailored to reflect recent policy uncertainty around the ZEV mandate being applicable in 2030 or 2035. This creates a larger envelope of scenario outcomes in the DFES, compared to FES.
- ▶ Uptake of plug-in cars, LGVs and motorcycles is marginally higher in the FES compared to the DFES. The reason for this variance is unclear, but is likely to be due to differences in the modelled existing vehicle stock. The DFES modelling uses DfT vehicle licencing data to inform the overall number of different vehicle types in the licence area, which subsequently guides the uptake of

electric vehicles. As the adjoining South West licence area sees an opposite divergence from the FES, it is possible that the discrepancy is due to the allocation of vehicles on the border of the South West and West Midlands licence areas around Bristol and South Gloucestershire.

- ▶ The different EV charger technologies are not broken down in the FES 2024 data at a GSP, licence area or national level. As such, reconciliation of EV charger capacity in the licence area is not possible. However, FES assumptions on vehicle efficiencies, mileage and vehicle numbers are used to inform the DFES analysis where possible.

Comparison to DFES 2023

- ▶ The envelope of values remains broadly similar to DFES 2023, with the overall methodology remaining unchanged. A key difference this year is the divergence of **Electric Engagement** from FES 2024, in order to reflect a proposed change to the ZEV mandate. Any other changes reflect the updated projections from FES 2024, which includes a more ambitious uptake of EVs in the **Counterfactual** and greater alignment between **Hydrogen Evolution** and **Holistic Transition**.

Hydrogen electrolysis

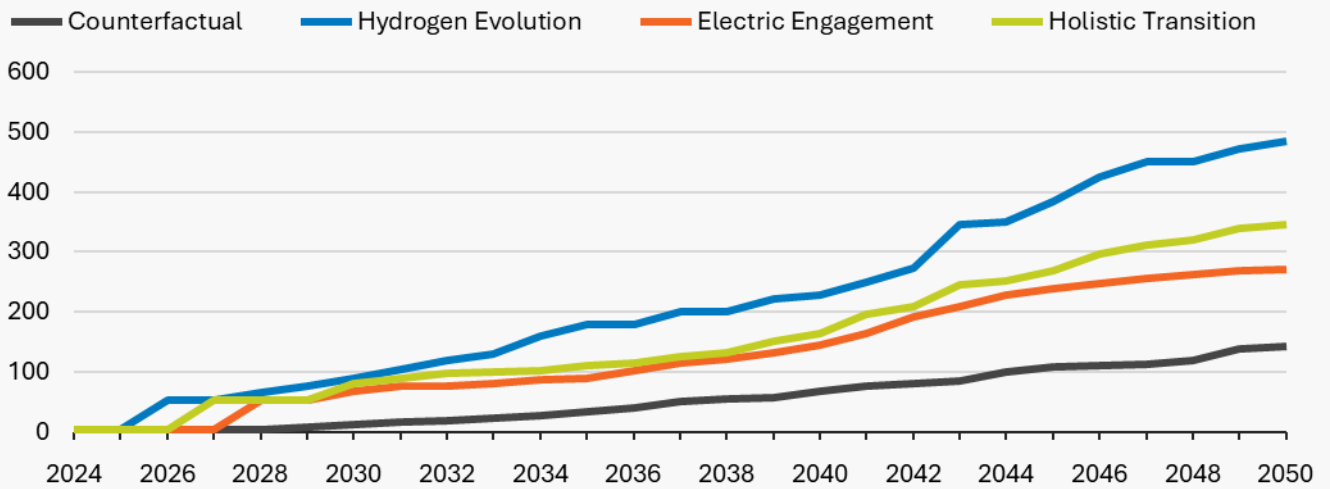
Summary

- ▶ Whilst some development is starting to emerge, hydrogen electrolysis is still an emerging technology with uncertainty around its future role in the energy system. The extent to which hydrogen electrolysis will scale-up and make use of transmission connections is one such uncertainty. This results in a wide range of projections at the licence area level.
- ▶ The 2022 British Energy Security Strategy outlined a target of 10 GW of low-carbon hydrogen production by 2030, of which 5 GW is to be from electrolysis (also known as ‘green hydrogen’). In addition, the government has set an interim aim for 1 GW of electrolytic production capacity to be in construction or operation by 2025.
- ▶ Funding has been committed in support of this target:⁶
 - 11 electrolysis projects are receiving funding through the first Hydrogen Allocation Round (HAR 1), totalling 125 MW of green hydrogen production capacity
 - 875 MW of additional hydrogen production capacity will be supported through the second allocation round (HAR 2), with winning projects announced in the first half of 2025
 - An additional 1.5 GW of hydrogen production capacity will be funded across both HAR 3 and HAR 4, launched in 2025 and 2026, respectively
 - Subsequent allocation rounds will be held annually between 2025 and 2030.
- ▶ Engagement with electrolyser developers and hydrogen industry groups has highlighted the importance of these allocation rounds in enabling the near-term deployment of commercial-scale projects. The development of commercial electrolysis projects outside of this support mechanism is not considered feasible in the near term. The results of HAR 2, and subsequent allocation rounds, will give greater certainty to the near-term development of hydrogen electrolysis capacity in the licence area and across GB.
- ▶ In the West Midlands, there are two sites in development with accepted connection offers with NGED, totalling 49 MW. These sites are modelled to build out in all scenarios other than the **Counterfactual**, with the earliest connection in 2026 under **Hydrogen Evolution**.
- ▶ Beyond the known pipeline, the potential for additional new capacity out to 2050 is based on FES 2024 projections for national networked electrolysis, paired with a regional analysis of potential supply and demand drivers for hydrogen.
- ▶ In the West Midlands, HGV demand is higher than the national average due to its central location with many strategic roads passing through the area. The region also has higher existing gas network coverage than the national average and significant industrial energy usage. National Gas’ proposed future hydrogen backbone transmission network, Project Union, could also run through parts of the south of the licence area, and is another locational factor within the analysis.⁷
- ▶ By 2050, under the most ambitious scenario, **Hydrogen Evolution**, 480 MW of hydrogen electrolysis is deployed in the licence area. In the least ambitious scenario, the **Counterfactual**, 130 MW is deployed.

Hydrogen electrolysis capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data and desktop research

	Development status	Capacity (MW)	Description
Baseline	Operational	3	There is currently 3 MW of hydrogen electrolysis deployed in the licence area, all from a single site at Tyseley Energy Park, Birmingham. This site is a hydrogen refuelling station servicing local busses and commissioned in 2021.
Pipeline	Accepted to connect	49	<p>There are currently two sites with connection offers in the licence area totalling 49 MW.</p> <p>While there is no evidence of either of these sites progressing through planning, projects do not need to have prior planning permission to be eligible for HAR support. Due to sector engagement indicating the importance of HAR support for near-term commercial viability, an assumption has been made that these sites will be applying for HAR support and subsequently secure planning permission.</p> <p>HAR 2 requires projects to demonstrate they can become commercially operational by between 2026 and 2029. This range of dates has been reflected in the DFES scenarios.</p> <p>The sites see deployment in 2027 under Hydrogen Evolution. 2028 under Holistic Transition and 2029 under Electric Engagement. Failure to build out is reflected in the Counterfactual. This scenario order aligns with FES assumptions for electrolysis project buildout timeframes.</p>

Projections

Scenario	Description
<p>Hydrogen Evolution</p>	<p>Under this scenario, a major driver for the growth of hydrogen electrolysis capacity in the medium term is the high-levels of hydrogen blending through the gas network. This means the coverage of the existing gas network infrastructure is an important regional supply consideration. Demand from industrial decarbonisation in the licence area is also a key medium-term driver. In the long term, a core hydrogen transmission network is built out and links with regional distribution networks, such as those proposed by HyNet and Hyline Cymru.^{8,9} This reduces the need for demand and production to be so locally tethered and allows hydrogen production sites to be developed in areas that are most suitable. This results in a balance between the proximity to any future hydrogen gas network, renewable energy projects (including for co-location) and sources of low-carbon hydrogen demand.</p> <p>As a result of this analysis, by 2050, 480 MW of hydrogen electrolysis is deployed in the West Midlands licence area.</p>
<p>Holistic Transition</p>	<p>Under this scenario, high-levels of hydrogen blending means that the coverage of the existing gas network infrastructure is an important regional consideration for the development of hydrogen electrolysis projects. Demand from industrial decarbonisation is also a key medium-term driver.</p> <p>A core hydrogen transmission network is developed, but to a lesser extent than seen under Hydrogen Evolution, and without regional distribution networks. This makes the route of the core transmission network an important locational factor for electrolysis, alongside existing gas fired electricity generation and industrial activity.</p> <p>By 2050, 350 MW of hydrogen electrolysis is deployed in the West Midlands licence area under this scenario.</p>
<p>Electric Engagement</p>	<p>With less hydrogen blending, the demand from industrial decarbonisation, heavy transport and existing gas-powered electricity generation are the main medium-term drivers for electrolysis development under this scenario.</p> <p>A core hydrogen transmission network is developed, but to a similarly lesser extent than Hydrogen Evolution, as seen in Holistic Transition, including no regional distribution networks. This makes the route of the core transmission network an important locational factor, alongside existing gas-fired electricity generation and industrial activity.</p> <p>By 2050, 270 MW of hydrogen electrolysis is deployed in the West Midlands licence area under this scenario.</p>
<p>Counterfactual</p>	<p>Hydrogen production and demand are more directly matched at a regional level, as hydrogen networks are not developed. Electrolyser projects are therefore limited and only developed close to hydrogen demand.</p> <p>In the medium and long term, this demand is primarily driven by the industrial sector, heavy road transport and power generation.</p> <p>By 2050, only 130 MW of hydrogen electrolysis demand is deployed in the West Midlands licence area under this scenario.</p>

Uptake modelling factors

The below factors are used to inform the overall uptake of hydrogen electrolysis in the West Midlands licence area.

Factor	Modelling impact	Source
Proportion of hydrogen electrolysis projects that connect to the distribution network	<p>A number of anomalies within the FES 2024 GSP level projections for hydrogen electrolysis have led to them being removed as an input to the DFES model.</p> <p>As a result, post-pipeline projections for distribution network-connected electrolysis are based upon the FES 2024 GB total networked electrolysis projections, with an assumed ratio of deployment on the distribution network.</p> <p>This ratio is 20% within Hydrogen Evolution, Holistic Transition, and Electric Engagement and 60% under the Counterfactual, where the industry does not scale-up and deploy transmission network scale connections.</p>	FES 2024
Hydrogen distribution factors	<p>An assessment of hydrogen supply and demand factors for all GB licence areas was completed. These factors were used to inform the level of electrolytic hydrogen production and projected capacity of hydrogen electrolysis in the licence area by scenario.</p> <p>These factors include the presence of:</p> <ul style="list-style-type: none"> • Industrial energy demand • Heavy transport demand • Planned hydrogen network coverage • Gas distribution network coverage • Gas-fired electricity generation • Hydrogen innovation projects • Aviation activity • Existing grey hydrogen production • Renewable energy generation 	Various

Spatial factors

The below factors are used to inform the spatial distribution of hydrogen electrolysis capacity across the West Midlands licence area, down to 11 kV electricity supply areas (ESAs).

Factor	Modelling impact	Source
Industrial sites	Post pipeline capacity is assigned to areas surrounding industrial energy users, in line with plans for a core hydrogen network.	OS Addressbase

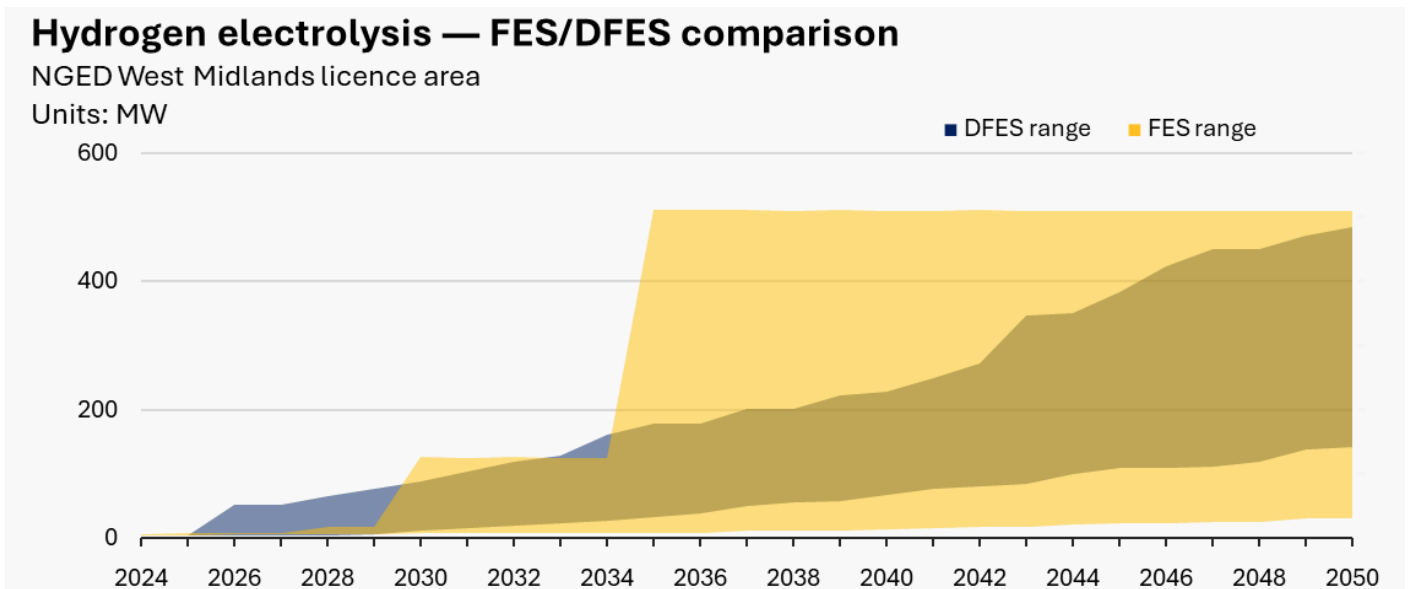
Local authority ambition

Local authorities that have hydrogen strategies or targets in place are assigned a greater proportion of post-pipeline capacity.

DFES local authority engagement survey

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ The FES 2024 projections for hydrogen electrolysis in the West Midlands licence area contain significant step changes in capacity. The reason for this is unclear and has been queried with the FES team.
- ▶ Baseline and 2050 deployed capacity for the **Hydrogen Evolution** and **Holistic Transition** scenarios do align relatively closely however.

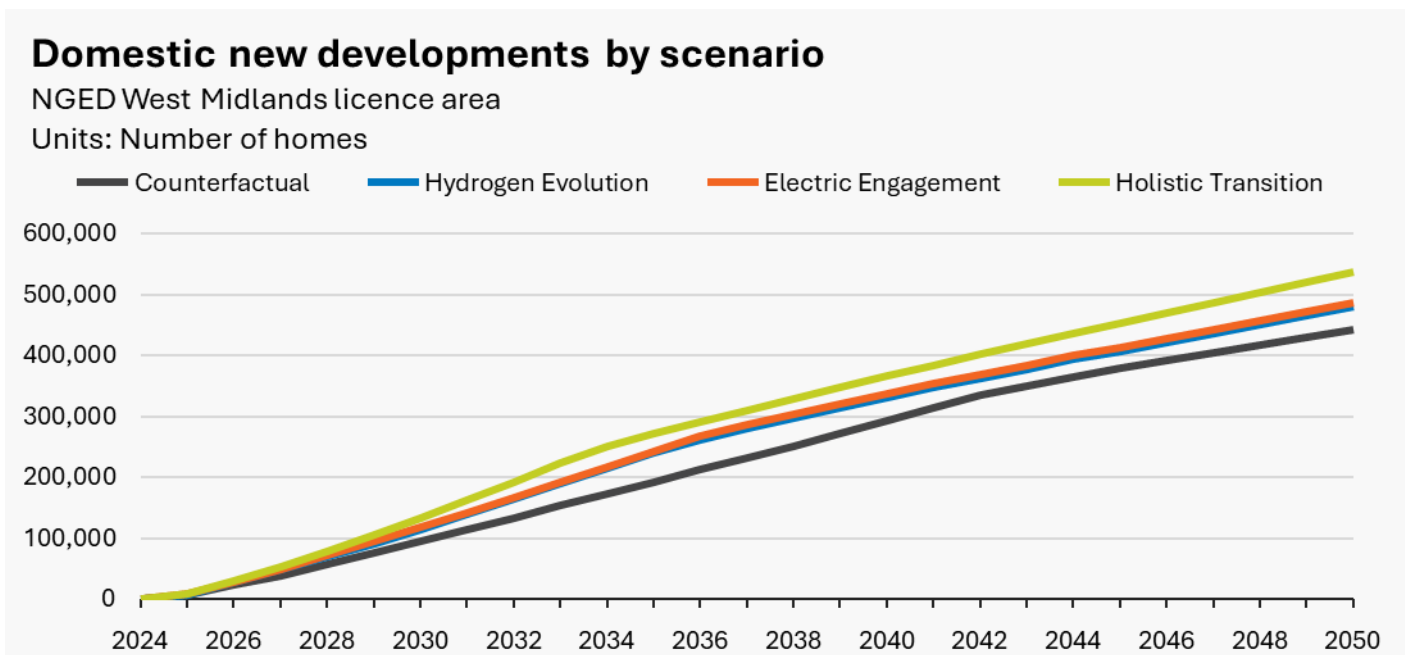
Comparison to DFES 2023

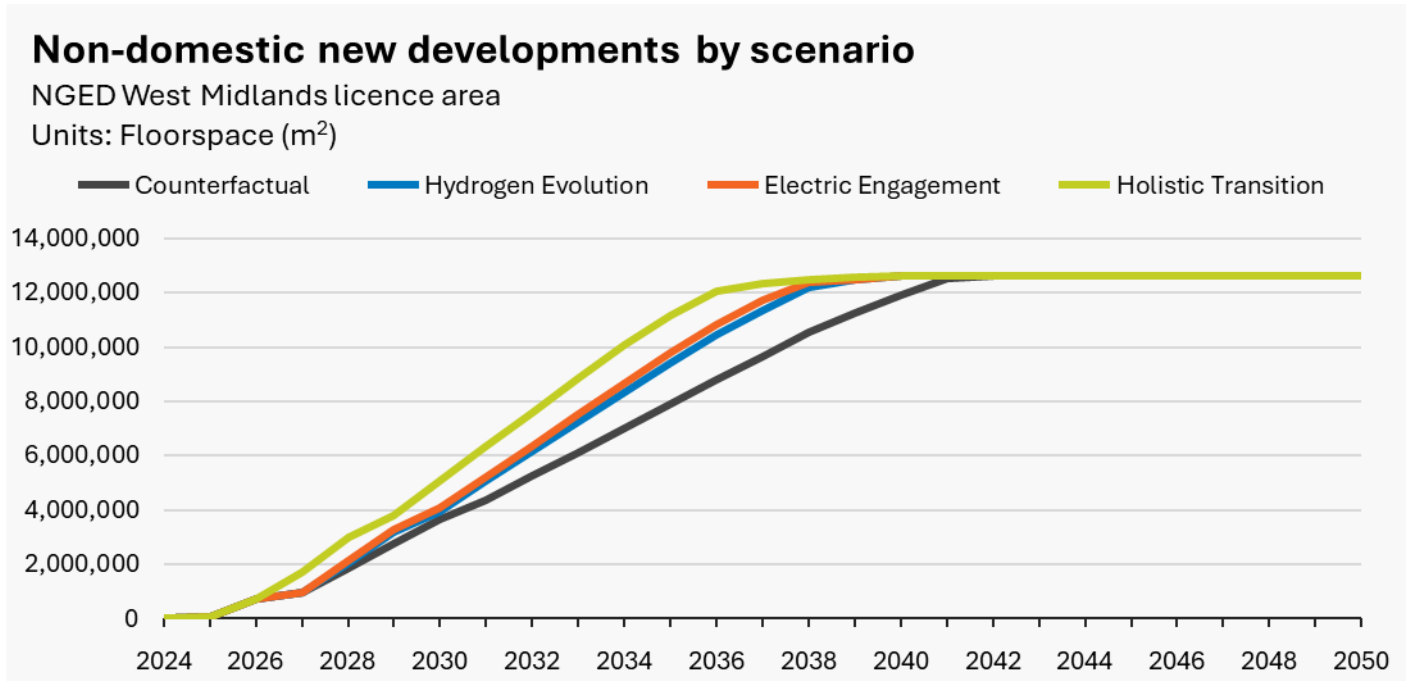
- ▶ Compared to DFES 2023, DFES 2024 projects more distribution network connected electrolysis in the licence area across the period to 2050.
- ▶ In the near-term this is driven by updated pipeline evidence. In the medium and long term this is driven by significant increases in the FES projections for networked electrolysis capacity and more consolidated evidence of a future potential for hydrogen transmission network infrastructure in the licence area.
- ▶ The DFES 2024 projections also reflect changes to how electrolysis is supported in the FES 2024 scenario framework. **Hydrogen Evolution** is now the most ambitious scenario for grid-connected hydrogen electrolysis, followed by **Holistic Transition**, **Electric Engagement** and finally the **Counterfactual**, which sees limited development.

New developments

Summary

- ▶ The new developments modelling within the DFES is based on direct engagement with local authority planning departments and an analysis of local planning documents submitted to Regen.
- ▶ Over the last three years, Regen has received domestic datasets from 76% of local authorities across the West Midlands licence areas, and non-domestic datasets from 66% of these local authorities. A third of local authorities updated these datasets for this year’s modelling.
- ▶ The domestic data is supplemented with information from local planning portals and updated local development plans for local authorities that have not engaged in the last four or more years.
- ▶ By 2050, the domestic modelling results in between 444,000 and 539,000 new homes in the West Midlands licence area across the scenarios, representing a 16-19% increase in the number of domestic houses, compared to today.
- ▶ By 2050, an additional 13.3 million square meters of non-domestic floorspace is also modelled in the licence area under each DFES scenario.
- ▶ The UK government is currently consulting on a new methodology to establish localised housing targets. While the impact that this may have on future new developments is recognised, this has not been directly reflected in the analysis, as it is still in the consultation phase. The DFES modelling does, instead, use the most recently compiled ONS housing projections and historical buildout rates for each scenario.
- ▶ Birmingham (83,105), Stroud (16,251) and Stoke-on-Trent (15,567) have the most new homes projected by 2050.
- ▶ Notable non-domestic sites included a new the West Midlands Interchange¹⁰ in South Staffordshire, the conversion of the Royal Ordnance Factory to a business park (South Staffordshire) and the Chatterley Valley Development¹¹ Site (Newcastle-Under-Lyme).





Modelling assumptions and results

Baseline and pipeline

Source: Local authority engagement and local planning portals

	Development status	Number of domestic sites (homes)	Number of non-domestic sites (sqm)	Description
Baseline				As the scope of the new developments analysis in the DFES is focused on future additional/new domestic and non-domestic buildings, no baseline is defined for this technology. There are currently around 2.8 million customers and 200 thousand non-domestic customers in the West Midlands licence area.
Pipeline	Buildout Provided	966 (213,400)	325 (4,047,158)	These sites are modelled according to the buildout rate provided by local authorities. The only exception to this is that only sites that are under construction or those that hold an accepted connection offer are modelled to connect in the first year of the analysis (2025).
Sites with no buildout provided				
Pipeline	NGED accepted connection offer	23 (6,150)	38 (1,439,714)	These sites have an accepted grid connection offer with NGED and connect in 2025 under all scenarios.
	Under Construction	29 (2,809)	72 (438,642)	Sites that have been identified as under construction are modelled to build out in 2026 under all scenarios.

Granted	173 (21,302)	105 (1,327,191)	Approved planning permission is strong evidence that a site is moving toward construction. All new development sites which have been granted planning permission are modelled to connect between 2027 and 2029.
Outline or Reserved Matter	1 (299)	14 (163,418)	Outline planning applications are less detailed than a full planning application and are only applicable to new buildings (or extensions to existing buildings). While outline planning may be approved, developers still need to obtain approval on specific details, which are referred to as 'reserved matters'. Once all reserved matters are approved the site is considered to have full planning approval. These sites are modelled to connect between 2028 and 2030.
Submitted	31 (3,680)	0	A submitted planning application demonstrates a site has been identified and progressed but is waiting for approval from the local authority. These sites are modelled to connect between 2030 and 2033.
Allocated/ Pre-planning	143 (14,543)	71 (1,601,934)	Allocated and pre-planning sites are those typically identified by local authorities as areas for specific development. As allocated sites are often not yet at the planning stage, they are the latest sites modelled to connect, doing so between 2031 and 2034.
No Information	0	329 (4,327,552)	Residual sites with no development stage information provided by the local authority are modelled to connect between 2030 and 2032.

Projections

- ▶ Projections are only modelled for domestic new developments due to no reliable data sources for non-domestic targets. The ONS household projections provide a baseline to model domestic housing.

Scenario	Description
Holistic Transition	Under this scenario, sites are modelled to connect at the earliest possible date based on their development stage. In addition to the planned development sites, ONS household projections from 2018 are used to uplift the long-term projections. A 16% increase over the yearly ONS projections is added to this scenario, based on analysis

of building rates over the last 10 years. This scenario is also modelled to dampen ambitious developer data and maintain yearly buildouts to below the 3rd quartile of historic yearly builds. This reflects the increase in low-carbon technologies (including EV chargers, rooftop solar and heating technologies) that is expected to occur at new developments under this scenario.

Electric Engagement

This scenario is modelled to reflect a moderate range of new builds for both domestic and non-domestic developments. The **Electric Engagement** scenario uses the fastest build-out rate, the same as **Holistic Transition**. In addition to the planned development sites, ONS household projections from 2018 are used to uplift the long-term projections. This scenario is also modelled to reflect less ambitious yearly buildouts, aligned to below the average of historic yearly builds. This reflects the increase in low-carbon technologies (including EV chargers, rooftop solar and heating technologies) that are expected to occur at new developments under the **Electric Engagement** scenario.

Hydrogen Evolution

This scenario also models a moderate range of new builds for both domestic and non-domestic developments. Using the same ONS 2018 long-term uplift and alignment to average historic yearly build as **Electric Engagement**. **Hydrogen Evolution** uses a slower build-out rate, i.e. fewer homes connected per year.

Counterfactual

This scenario models sites to connect at the slowest buildout rate and in the last year of the connection range in each case. In addition to the planned development sites, ONS household projections from 2018 are used to uplift the long-term projections. A 22% decrease over the yearly ONS projections is added to this scenario, based on analysis of building rates over the last 10 years. This scenario is also modelled for unforeseen delays in longer-term developments and maintain yearly buildouts to below the 1st quartile of historic yearly builds. This scenario is the only one that does not connect every home or all floorspace provided by local authorities, with some allocation sites not assumed to be completed by 2050.

Uptake modelling factors

The below factors are used to inform the overall uptake of domestic new developments in the West Midlands licence area.

Factor	Modelling impact	Source
Known local authority developments	Regen engages with all local authorities within the West Midlands licence area to acquire data on known new developments, both domestic and non-domestic.	Local authority SharePoint
Residual developments*	These are small-scale developments of less than 20 homes, which are not included in the data collection from local authorities. Analysis of previous new housing suggests that these developments could account for c.5% of total new-build housing. As a result, a 5% uplift is applied to the planned projections throughout the scenario timeframe.	Local authority SharePoint

Post-plan developments	This accounts for housing developments that could occur in the medium and long term, beyond the current timescales of local authority planning and known developments. As planned developments tail off in the 2030s, post-plan developments are modelled to account for additional future housebuilding out to 2050. These projections are tailored to each local authority, based on ONS household data.	2018 ONS household projections by local authority
Historical new development builds benchmark	The timeline and build-out rate of new developments are key sources of uncertainty. Regen applies scenario-specific delay factors to allow for these uncertainties in the completion of local authority plans. This data set is used as the scenario benchmark to capture unforeseen delays and to reprofile significantly ambitious development numbers.	Ministry of Housing, Communities and Local Government: Net Additional Dwellings, Table 122

**Residual developments of 5% of the total new builds are added to all scenarios except Year 1.*

Spatial factors

The below factors are used to inform the spatial distribution of domestic new developments across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Planned sites	Planned sites are located based on their address or the description of their location.	Local authority SharePoint
Housing density	Modelled sites (domestic houses only) are distributed across all areas, weighted to areas with moderate housing density such as town and city suburbs, as analysis of historic housing development shows these areas see higher levels of housebuilding than denser city centres or highly rural areas.	Census 2021
NGED customer count	The customer count is used along site census data to determine the customer density (for domestic projections only).	NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.

- ▶ There is no variation for future housing growth under the four FES scenarios. In contrast, the DFES models a range of projections for future housing across the scenario pathways. This provides an envelope of future outcomes to inform network planning, as new domestic housing connections can represent significant bulk loads of conventional future demand on the network.
- ▶ Non-domestic floorspace is not detailed in the FES data and so no comparison could be made.
- ▶ As a result of these factors, the new developments outputs have not been fully reconciled against the FES 2024 data.

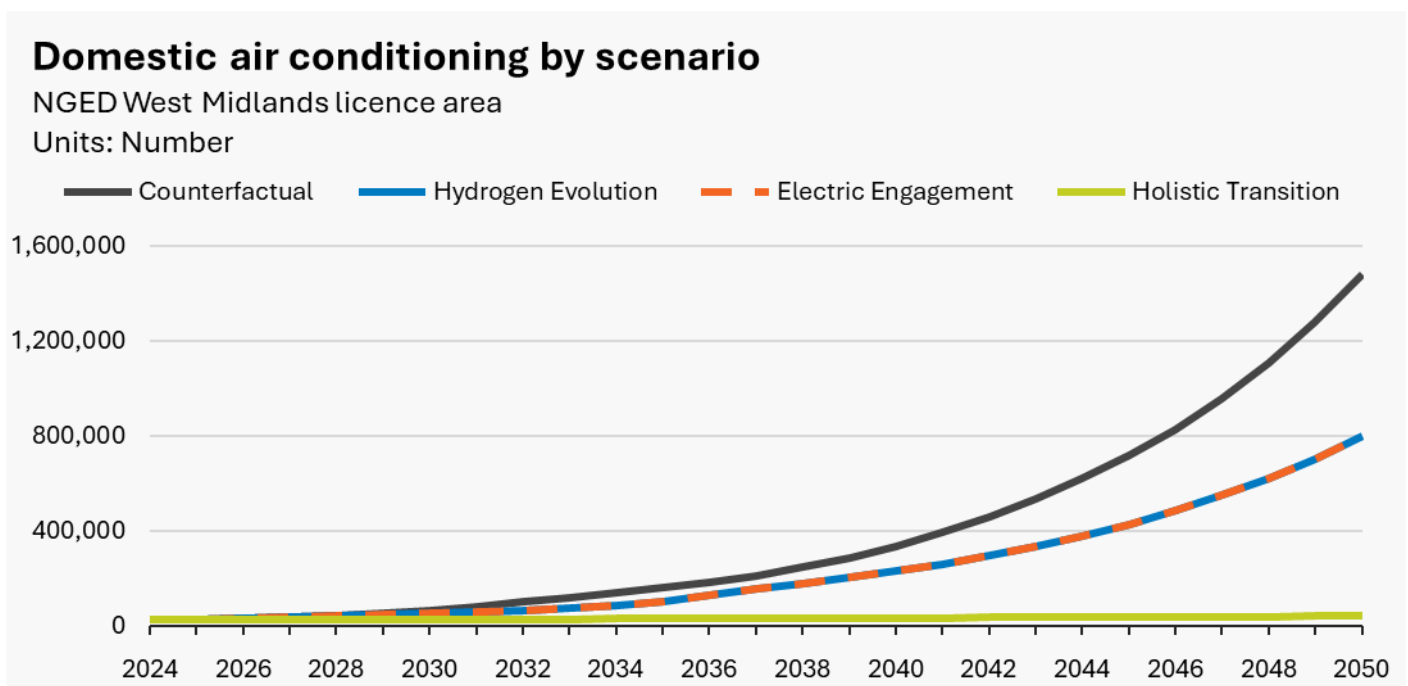
Comparison to DFES 2023

- ▶ The total DFES 2024 housing projections out to 2050 have decreased by up to 15% compared to DFES 2023. This is in part due to a error in DFES 2023 when considering planned local authority developments in comparison to housing projections from ONS. The modelling has been further refined in DFES 2024 to better reflect these ONS housing projections and additional checks have been included in the analysis and modelling process.
- ▶ There are several contributing factors to the decreased numbers, including updated SharePoint data and modelling method improvements:
 - For DFES 2024, the only sites that have been modelled to connect in Year 1 (2025) are those with an accepted connection offer with NGED or those identified by local authorities as being under construction. In addition, no residual or projected sites are modelled in 2025.
 - DFES 2024 has changed the method of assigning scenarios to local authority provided data. DFES 2023 did not use a range of connection years, based on site development status, but instead developments were assigned to scenarios based on historical build-out rates to benchmark future development. For sites where no buildout data was provided, the DFES 2024 analysis used development status to assign the year buildout would commence.
 - Domestic new developments use the three historical new development builds benchmarks (1st quartile, average, and 3rd quartile). This is because known developments result in a higher annual buildout rate than historically experienced, and delay factor has been applied. However, this is mostly applied to sites which have a lack of evidence, rather than all sites being delayed as it was in DFES 2023.

Domestic air conditioning

Summary

- ▶ Domestic air conditioning (A/C) is not currently common in the UK - an estimated 1% of UK homes are thought to have an installed domestic A/C unit. As no public or DNO register of domestic A/C installations has been found, the regional baseline has been modelled as a proportion of the FES 2024 figures for current domestic A/C across GB.
- ▶ Increased summer temperatures and extended heat waves are likely to result in an increased uptake of domestic A/C in the future. The UK building stock is not optimised around passive cooling, which could see the uptake of A/C increase more significantly under scenarios with limited retrofit.
- ▶ Given the limited visibility of the baseline and high-level of uncertainty around how homes in the UK will be cooled in the future, there is a broad range of scenario outcomes. Uptake is modelled to be more prevalent in urban areas due to the 'heat island effect' under which denser urban areas experience higher temperatures than less built-up areas.
- ▶ By 2050, up to 1.5 million domestic A/C units are installed under the **Counterfactual** scenario. This is equivalent to 64% of existing homes in the West Midlands, although there is potential for some homes to have multiple units. Minimal domestic A/C units are installed under **Holistic Transition** by 2050, with effective passive cooling measures being much more prevalent across homes.



Modelling assumptions and results

Baseline and pipeline

Source: FES 2024

	Development status	Total units	Description
Baseline	Connected	26,042	There is limited baseline data on domestic A/C levels in the UK. The DFES modelling aligns with FES 2024's estimate of 370,000 domestic air conditioners in GB in 2024.
Pipeline	n/a	n/a	There is no pipeline for domestic A/C.

Projections

Scenario	Description
Holistic Transition	Uptake is minimal, with households opting for passive cooling methods such as shading, ventilation and insulation. This results in the equivalent of just 2% of homes having A/C in 2050 under this scenario.
Electric Engagement	Uptake accelerates, particularly in urban areas due to heat island effects and the prevalence of smaller dwellings such as flats that may be more susceptible to overheating. However, uptake and awareness of passive cooling methods mean that active cooling via A/C remains relatively uncommon. This results in the equivalent of 35% of homes having A/C in 2050 under this scenario.
Hydrogen Evolution	Uptake accelerates, particularly in urban areas due to heat island effects and the prevalence of smaller dwellings such as flats that may be more susceptible to overheating. However, uptake and awareness of passive cooling methods mean that active cooling via A/C remains relatively uncommon. This results in the equivalent of 35% of homes having A/C in 2050 under this scenario.
Counterfactual	Increasing frequency of heat waves and low uptake and awareness of passive cooling methods leads to high uptake of A/C to achieve comfortable internal temperatures in homes. This results in the equivalent of 64% of homes having A/C in 2050 under this scenario.

Uptake modelling factors

The below factors are used to inform the uptake of domestic A/C in the West Midlands licence area.

Factor	Modelling impact	Source
FES 2024 domestic air conditioning demand	Total GB domestic A/C electricity demand is converted into total units using kW rating and operating hours assumptions per A/C unit detailed in the FES 2024 data workbook. These calculations dictate the overall trend under each scenario.	FES 2024
Population density	Domestic A/C uptake is modelled to occur more commonly in regions with denser urban areas.	Census 2021
Cooling demand	Domestic A/C uptake is modelled to occur more commonly in regions with higher cooling demand, such as South East England and the Midlands, using data on cooling degree days.	Met Office

New-build homes	UK government statutory guidance stipulates that mechanical cooling can only be used to meet building regulations where passive cooling and mechanical ventilation are not sufficient to avoid overheating. As a result, there is no A/C uptake modelled in new-build homes under any scenario.	Overheating: Approved Document O
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Spatial factors

The below factors are used to inform the spatial distribution of A/C installations across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Population density	Domestic A/C uptake occurs in all types of household, but is distributed towards denser urban areas in towns and cities.	Census 2021

Reconciliation to FES 2024

FES 2024 does not detail domestic A/C projections by region so no direct comparison could be made.

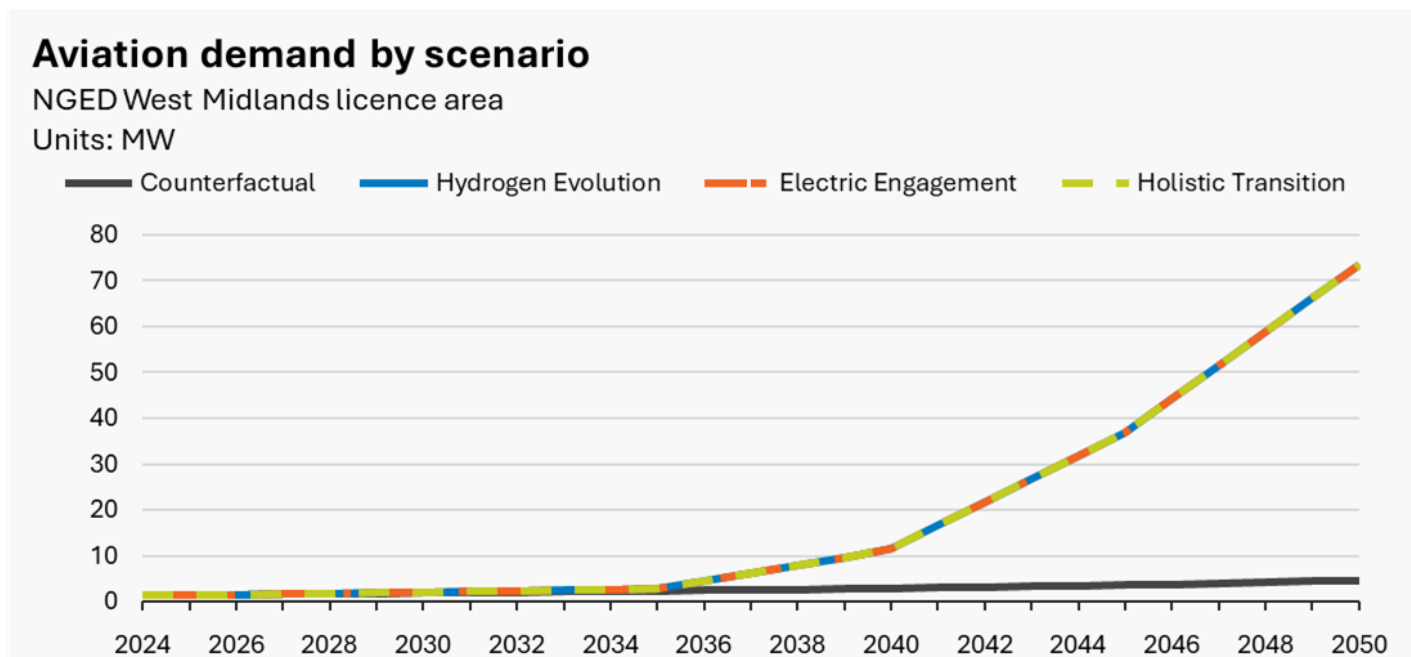
Comparison to DFES 2023

There are no major differences between DFES 2023 and DFES 2024 modelling methods or outcomes.

Aviation

Summary

- ▶ The decarbonisation of the aviation sector, and its resultant impact on the distribution network, is a new area of modelling for DFES 2024. Electricity demand associated with on-site buildings and passenger EV charging is already modelled in the DFES, as well as on-site solar generation.
- ▶ UK aviation emissions have doubled since 1990, representing 7% of the UK’s total emissions. The aviation sector is considered to be 'hard to decarbonise', due to the vast amount of energy required to fuel aircraft. There are a range of technological pathways to reduce aviation emissions, including sustainable aviation fuels, hydrogen or hydrogen derivatives, and electric aircraft. However, there is no single solution to decarbonising the aviation sector yet confirmed. Any potential solution is likely to have implications for electricity demand at airports, but not until the 2030s at the earliest.
- ▶ The DFES analysis has been informed by work completed by IBA, an aviation intelligence and advisory company, that was commissioned by National Grid Group to explore electricity use at UK airports.¹² The DFES modelling focuses on electricity demand from airport vehicles, aircraft ground power, aircraft charging and on-site hydrogen liquefaction.
- ▶ There are two commercial airports operational in the West Midlands licence area: Birmingham International Airport and Gloucestershire Airport. The projections for airports in the West Midlands licence area have been developed and adapted based on these individual airports, incorporating data on existing electricity demand, specific decarbonisation plans and direct engagement with airports.
- ▶ Under the three net zero scenarios, peak electricity demand at airports in the licence area increases slowly from a baseline of c. 1.4 MW in 2024 to c. 2.8 MW by 2035, before rapidly increasing in the 2040s to reach c. 73.5 MW by 2050 due to the liquefaction and storage of hydrogen onsite. Under the **Counterfactual** scenario, onsite hydrogen liquefaction does not occur until after 2050, hence peak electricity demand only reaches c. 4.6 MW by 2050. This still represents a 300% increase.
- ▶ The airport with the highest electricity demand is Birmingham International Airport, due to its size and higher proportion of international flights.



Modelling assumptions and results

Baseline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Peak capacity	1.36	The West Midlands licence area has a total of 1.36 MW of peak electricity demand at airports for charging airport vehicles and providing aircraft ground power. This is included within existing NGED connection agreements at airports.

Projections

The IBA modelling archetypes airports as either ‘local’, ‘regional’, ‘large international’ or ‘major international’.

- ▶ Birmingham International Airport has average annual aircraft movements of c. 109,000, classed as a ‘large international’ airport.
- ▶ Gloucestershire Airport has average annual aircraft movements of c. 74,000, classed as a ‘regional’ airport. However, it has been modelled as a ‘local’ airport due its proportion of commercial flights (which is only 3% and significantly lower than a typical regional airport).

Scenario	Description
Holistic Transition	<p>The net zero scenarios abide by the UK government’s net zero targets for aviation by 2050, as published by the DfT Jet Zero Road Map. Commercial aviation traffic grows in line with the DfT’s central scenario, but is constrained by no new runways at London Heathrow or London Gatwick. This scenario represents strong political and social support and technology development for zero-emission technology for large commercial aviation. This also reflects stated ambitions of ATI’s FlyZero, Rolls-Royce, Airbus, ZeroAvia and Universal Hydrogen aircraft that are in development. In particular, the Airbus NB hydrogen aircraft is modelled to enter service by 2035.</p>
Electric Engagement	<p>In the near term, an increase in electricity demand at airports will be driven by additional electricity usage from terminal buildings and ground infrastructure, in line with many airport’s targets to be ‘operationally net zero’. Birmingham International has committed to being a net zero carbon airport by 2033, prioritising airport operations and minimising carbon offsets. This will include EV charging provision for airport vehicles.</p> <p>In the longer term, large international airports are likely to switch to sustainable aviation fuels and liquefied hydrogen for aircraft, as these airports typically have high-frequency large jet traffic and are close to densely populated areas, meaning that growth in advanced air mobility is unlikely. This will result in significant electricity demand at airports for on-site hydrogen liquefaction and storage. These are energy-intensive processes, requiring 13.33 kWh/kg of hydrogen.</p>

Hydrogen Evolution

In comparison, local airports are more likely to favour electric aircraft as the majority of their operations are general aviation or small passenger aircraft. However, some local airports are looking at gaseous hydrogen, which has been reflected in the modelling. In 2023, Gloucestershire Airport joined the ‘Project Heart’ initiative to trial a green hydrogen refuelling facility to cut carbon emissions.¹³ Project Heart will initially focus on smaller aircraft with a range of 500 miles for aircraft up to 19 passengers. This results in a higher overall electricity demand than for other local airports, as the storage of hydrogen is an energy-intensive process.

Under the three net zero scenarios, peak electricity demand at airports in the West Midlands increases slowly from a baseline of c. 1.4 MW in 2024 to c. 1.9 MW by 2035, before rapidly increasing in the 2040s to reach c. 73.5 MW by 2050, linked to the liquefaction and storage of hydrogen onsite. This represents an increase in electricity demand of over 5000%.

The onsite production and use of low carbon hydrogen will require onsite hydrogen storage infrastructure, which, depending on the volume of hydrogen required, could require significant land space on site.

Counterfactual

UK aviation growth follows DfT’s central forecast, with modest development of the advanced air mobility market, with large zero-emission turboprop aircraft not expected to enter service until between 2040 and 2045. This scenario assumes a new runway is built in 2030 at either London Heathrow or London Gatwick and that annual aircraft traffic movements increase.

Under this scenario, significant decarbonisation doesn’t happen until after 2050, therefore, electricity demand up until this point is mostly through airport vehicles and some aircraft charging. This is directly proportional to the size of the airport, based on its archetype and annual aircraft traffic movements. By 2050, peak electricity demand from airports in the West Midlands licence area reaches c. 4.6 MW.

Uptake modelling factors

The below factors are used to inform the decarbonisation of aviation in the West Midlands licence area.

Factor	Modelling impact	Source
IBA UK Airport Power demand projections	IBA’s analysis has been used to inform airport archotyping, the underlying scenario assumptions and projected power demand by airport classification. IBA’s analysis identified seven areas of electricity demand in airports: buildings, surface access vehicles, on-site solar PV, airport vehicles, aircraft ground power, aircraft charging and hydrogen liquefaction and storage. The first three categories are already modelled as part of existing DFES technologies and, therefore, do not form part of this aviation electrification analysis.	IBA study for National Grid
Aircraft traffic movements	IBA’s projections have been scaled based on the average annual aircraft traffic movements of individual airports in the licence area.	UK Civil Aviation Authority annual airport data, 2019

Current grid connection arrangements

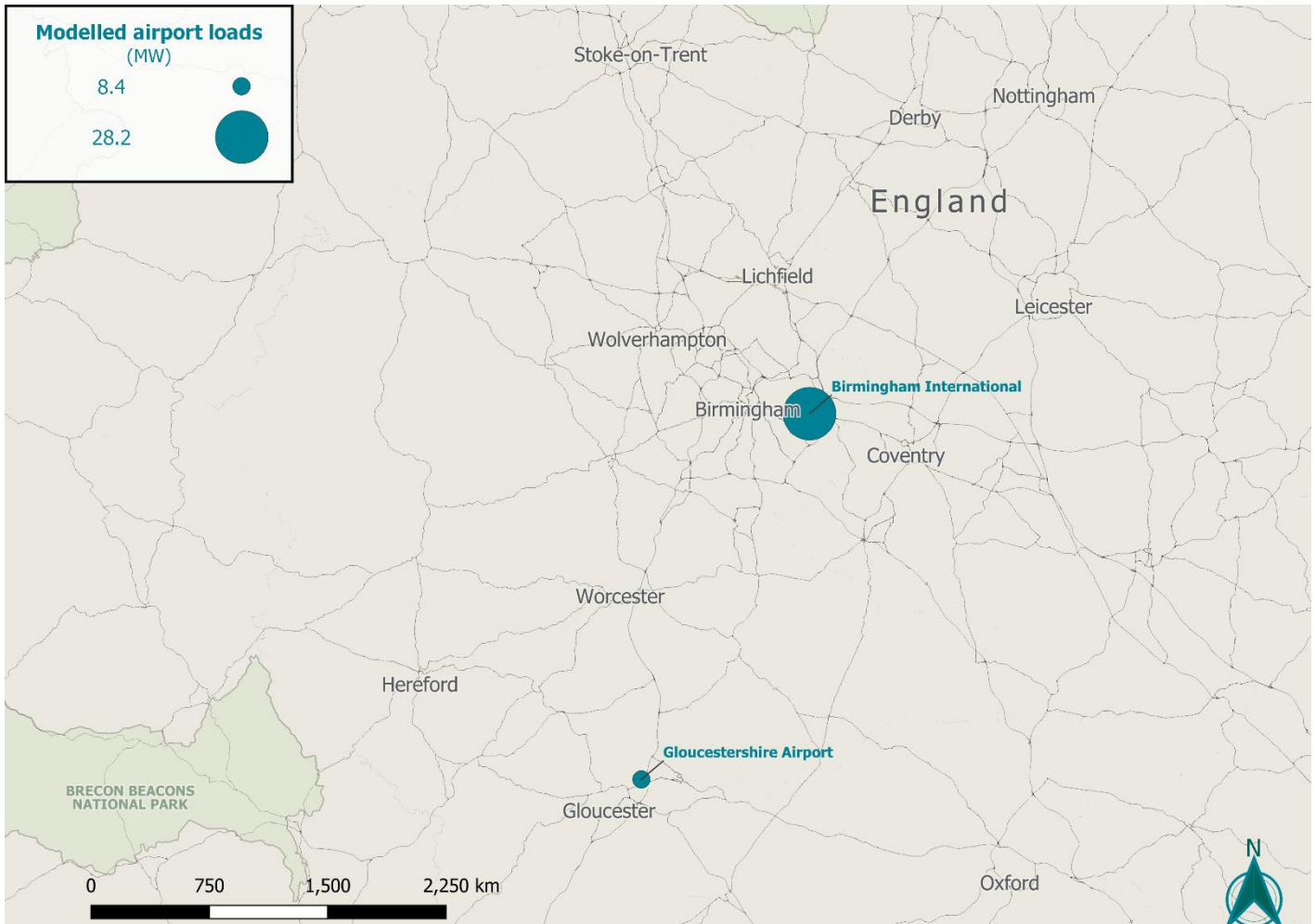
The current electricity demand for different end uses has been calculated from IBA’s analysis scaled to individual airports’ grid connection with NGED.

NGED connections data

Desk-based research of airport decarbonisation plans

Where information has been identified, the projections for that airport have been tailored to reflect their net zero plans. Direct engagement with airports in other parts of NGED’s network has informed the modelling.

Airport websites and press releases



Map of electricity demand impacting the distribution network at key airport locations in the licence area in 2050.
 Note: Size of circles represent the scale of future capacity.

Spatial factors

The below factors are used to inform the spatial distribution of electricity demand at airports across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Location of commercial airports	DFES aviation modelling is done on a site-specific basis, engaging directly with relevant airports and scaled to the air traffic movements of each airport.	UK Civil Aviation Authority annual airport data, 2019

Reconciliation to FES 2024

- ▶ Aviation is not modelled within the FES, but is considered within its total energy demand modelling.
- ▶ In **Holistic Transition**, **Electric Engagement** and **Hydrogen Evolution**, the FES assumes that aviation emissions are aligned to the CCC’s Balanced Pathway.¹⁴ The CCC models a smaller role for hydrogen aircraft in the timeframe to 2050, assuming that even if hydrogen aircraft were commercialised in the 2040s, it would be challenging to immediately achieve a large share of aircraft sales and is unlikely to lead to a significant fleet penetration before 2050. This differs from the Net Zero scenario modelled by IBA, which reflects the stated ambitions of some of the largest aircraft manufacturers.
- ▶ In the **Counterfactual**, aviation emissions are modelled based on the FES 2023 Falling Short scenario, representing a world where decarbonisation takes place, but at a slower pace than required to achieve net zero and the carbon budgets.

Comparison to DFES 2023

- ▶ Aviation was not modelled in DFES 2023.

Maritime transport

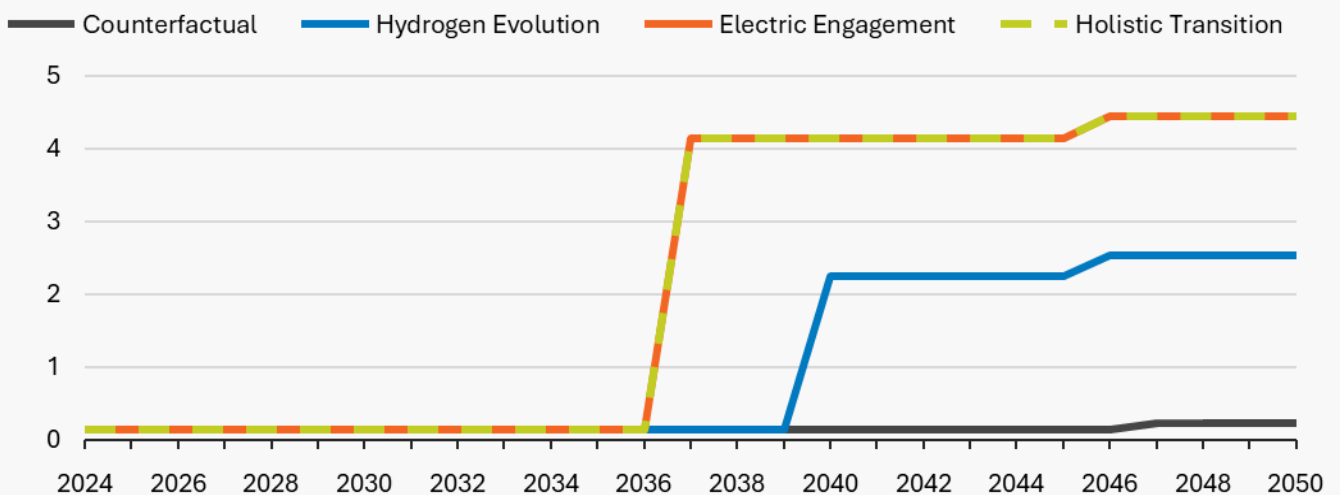
Summary

- ▶ The decarbonisation of the maritime sector, and its resultant impact on the distribution network, is a new area of modelling for DFES 2024. This includes shore power requirements, vessel charging and the electrification of other port operations. Electricity demand associated with on-site buildings and passenger EV charging is already modelled in the DFES, as well as on-site solar generation.
- ▶ The International Maritime Organization (IMO) has agreed to reduce global international shipping emissions by at least 50% by 2050, compared to 2008 levels.¹⁵ There are a range of technological pathways to reduce maritime emissions, including hydrogen or hydrogen derivatives, and battery-electric propulsion. However, there is currently no single solution favoured for the whole sector.
- ▶ Electricity will primarily be used in ports to provide shore power, also known as ‘cold ironing’, where ships temporarily connect to the local grid to power onboard systems when docked. Container, passenger and cruise ships are most likely to be shore-power-ready in the near term.
- ▶ As a net zero propulsion option, electricity is estimated to play a much smaller role than that of alternative fuels, mainly adopted by vessels that operate short voyages, such as short ferry routes.
- ▶ In 2023, the EU set out an agreement that container and passenger ships will be obliged to use onshore power supplies for all electricity needs while moored at the quayside in major EU ports, as of 2030. This will also apply to the rest of EU ports as of 2035.¹⁶ The UK has no equivalent policy.
- ▶ There is one commercial port operational in the West Midlands licence area – Sharpness Port. Smaller marinas have not been included in this analysis, due to a lack of DfT’s port-level data.
- ▶ Under **Holistic Transition** and **Electric Engagement**, peak electricity demand at Sharpness in the West Midlands increases from a baseline of c.0.1 MW in 2024 to 4.5 MW by 2050. Under **Hydrogen Evolution**, vessels are expected to favour hydrogen fuel cell technology, and less electricity is modelled to be required for shore power, resulting in 2.5 MW by 2050.
- ▶ Under the **Counterfactual** scenario, full maritime decarbonisation does not occur until after 2050, so peak electricity demand only reaches c. 0.2 MW by 2050. This still represents a 170% increase.

Maritime demand by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Peak capacity	0.14	The West Midlands licence area has c. 0.14 MW of peak electricity demand at ports for onsite operations. This has been calculated as a percentage of the overall peak demand of these ports via their existing connection agreements with NGED.

Projections

Scenario	Description
Holistic Transition	<p>These scenarios abide by the UK government’s Clean Maritime Plan and reflect the ambition of EU policies, which are assumed to be replicated by the UK.¹⁷ In the near term, an increase in electricity demand at ports will be driven by shore power which, under these scenarios, is modelled to be in place at major ports for container ships, passenger ferries and cruise ships by 2030. This also reflects the plans of key operators like Brittany Ferries.¹⁸ Shore power provision for other vessels is modelled to be in place at major ports by 2035 and minor ports by 2040.</p> <p>This results in an increased uptake of shore power as one of the first emissions reduction options. In addition to shore power, a shift to electric propulsion is modelled for short-hop ferries and small vessels under these scenarios. This is intended to represent an illustrative upper-bound estimate of the potential demand for electricity to charge electric vessels at key ports in the licence area.</p>
Electric Engagement	<p>The UK Emissions Trading Scheme opened a consultation¹⁹ around the inclusion of emissions from the maritime sector. This could drive further policy and commercial impetus to the decarbonisation and electrification of maritime vessels</p> <p>Under Holistic Transition and Electric Engagement, peak electricity demand at ports in the West Midlands increases rapidly from a baseline of c. 0.14 MW in 2024 to 4.5 MW by 2050.</p>
Hydrogen Evolution	<p>Similar timescales for decarbonisation and shore power provision are modelled under Hydrogen Evolution, but with lower overall projected capacity. This represents fewer vessels using battery-electric propulsion technology, in favour of hydrogen fuel cells, and less demand for shore power, potentially in favour of more innovative hydrogen-based solutions, like the one being developed by the Port of Leith.²⁰</p> <p>This results in peak electricity demand at ports in the West Midlands increasing to 2.5 MW by 2050 under this scenario.</p>
Counterfactual	<p>Under this scenario, significant decarbonisation of the maritime transport sector doesn’t happen until after 2050. As a result, electricity demand before 2050 mostly comes from onsite operations and some limited shore power provision.</p> <p>Passenger ferries are the first vessels to be shore-power-ready, by 2040, followed by container and cruise ships by 2045.</p>

This scenario is intended to represent an illustrative lower-bound estimate of the potential demand for electricity from vessels at key ports.

By 2050, peak electricity demand from ports in the West Midlands licence area reaches c. 0.2 MW, solely driven by an increase in electricity demand for onsite port operations, due to a lack of passenger ferries, containers and cruise ships.

Uptake modelling factors

The below factors are used to inform the decarbonisation of ports in the West Midlands licence area.

Factor	Modelling impact	Source
Current grid connection arrangements	The current electricity demand for different end uses has been calculated by interrogating the existing grid connections held by key ports. This informs the potential future electricity demand for onsite operations.	NGED connections data
Annual port ship arrivals	For the ports that are in scope for this analysis, the number of ship arrivals, the breakdown of these by vessel type and the categorisation of each port (major or minor) are obtained from DfT's PORT data. This data is analysed and used to inform the potential future shore power requirements at these port locations.	DfT PORT data
Number of berths	The projections for electricity demand at ports are based directly on the number of berths and the type of vessels these serve.	Desk-based research, individual port websites
Average power demand per vessel	Various data sources have been compiled, comparing shore power and charging requirements for different vessel types at different ports. These have been used to represent a low, medium and high estimation of shore power requirement by vessel type.	Desk-based research and academic studies ^{21 22 23 24 25}

Spatial factors

The below factors are used to inform the spatial distribution of electricity demand at ports across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Location of commercial ports	DFES maritime modelling is done on a site-specific basis, scaled to the number of berths and vessel movements at each port.	DfT PORT data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.

- ▶ Maritime decarbonisation is not modelled within the FES, but is considered within its total energy demand modelling.
- ▶ In **Holistic Transition**, **Electric Engagement** and **Hydrogen Evolution**, the FES assumes that maritime emissions are aligned to the CCC's Balanced Pathway.²⁶ The CCC expects that the shipping sector can achieve very close to full decarbonisation by 2050. Electricity is used in a limited number of niche hybrid and full electric propulsion vessels (using onboard batteries and motors), and more widely used to provide shore power. This has generally been reflected in the DFES modelling; however, an augmented view of **Hydrogen Evolution** has been considered, whereby maritime decarbonisation is partially delivered through low-carbon hydrogen propulsion systems, hydrogen fuel cells or other hydrogen derivatives.
- ▶ In the **Counterfactual**, maritime emissions are modelled based on the FES 2023 Falling Short scenario, representing a world where decarbonisation takes place, but at a much slower pace than required to achieve net zero and the carbon budgets.

Comparison to DFES 2023

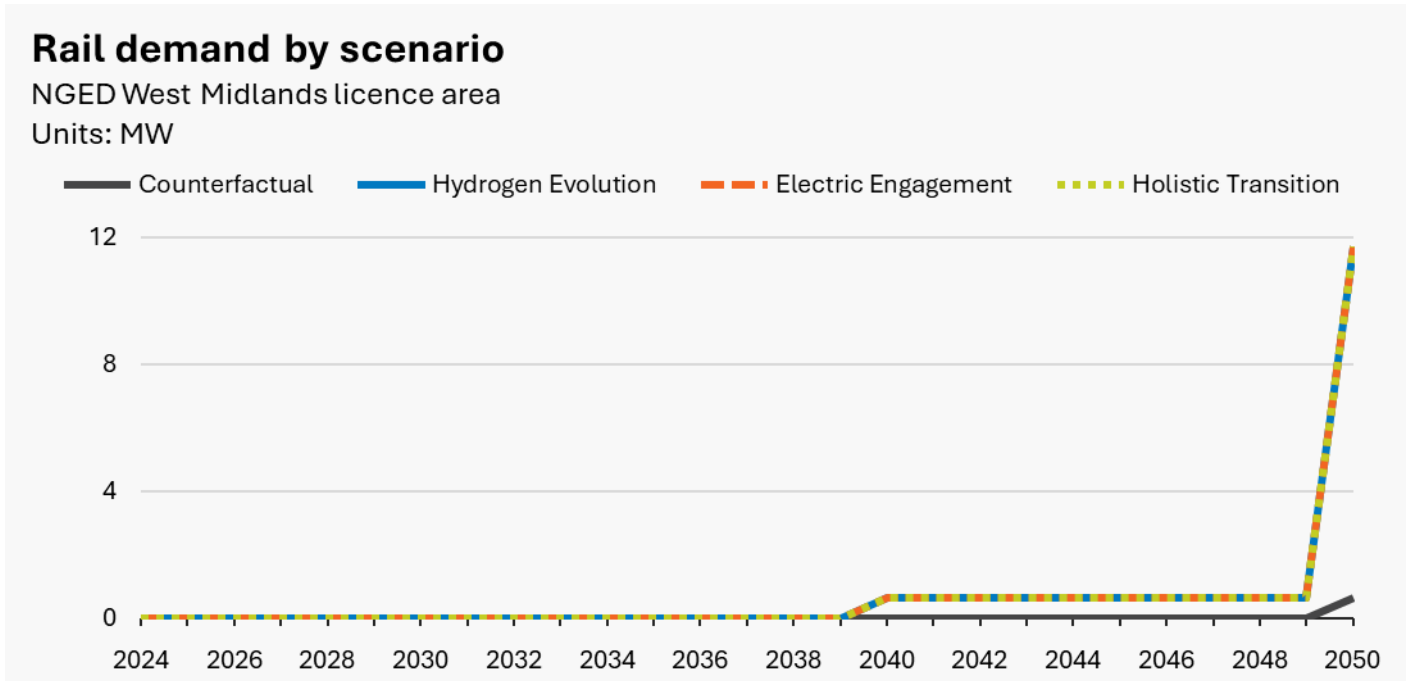
- ▶ Maritime decarbonisation was not modelled in DFES 2023.

Rail

Summary

- ▶ The decarbonisation of the rail sector is a new area of modelling for DFES 2024.
- ▶ 6,000 kilometres of railway are currently electrified across the UK, accounting for 38% of the total rail network by length. Power supply for existing electrified rail infrastructure has historically been fed by transmission connections, with some exceptions.
- ▶ There are two decarbonisation targets for the rail sector, both of which will have a direct impact on future electricity requirements²⁷:
 - By 2040, all diesel-only trains will be removed from the network
 - By 2050, the railway will have net zero emissions
- ▶ In 2020, Network Rail published the Traction Decarbonisation Network Strategy (TDNS), an interim business case outlining its plan for a fully decarbonised railway. The TDNS identified decarbonisation solutions for each route on the network and recommended over 11,700 single-track kilometres of Overhead Line Electrification (OLE). Since then, Network Rail has developed further region-specific decarbonisation strategies which allocate the routes into sequenced delivery tranches.
- ▶ Four Network Rail regions overlap with NGED's licence areas: Eastern, North West & Central, Southern and Wales & Western.
- ▶ It is estimated that, by 2050, 11.7 MW of additional load for traction demand will be connected to the distribution network in the West Midlands under the three net zero scenarios, by 2050.
- ▶ The additional capacity comes from the battery electrification of three routes:
 - Worcester to Smethwick in Birmingham (6.0 MW)
 - Birmingham to Stratford-upon-Avon and Hatton (5.0 MW)
 - Heart of Wales (Llanelli to Craven Arms, 0.64 MW)
- ▶ The capacity projections presented here only include demand anticipated to connect to the distribution network. Significant further grid capacity is likely to be required by the rail sector for overhead line equipment (OLE) connecting to the transmission network.
- ▶ Under the **Counterfactual** scenario only 0.6 MW of additional capacity is considered, reflecting a much slower delivery of rail electrification and overall rail sector decarbonisation.

Note: These projections carry a high degree of uncertainty due to the significant unknowns surrounding rail decarbonisation.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MVA)	Description
Baseline	Operational	94.9	<p>The West Midlands licence area currently has 95 MVA of Network Rail demand connections across various voltage levels. There are three existing rail feeders with capacity exceeding 10 MVA each.</p> <p><i>Note: The scenario projections under this technology only consider future additional MW capacity requirements and do not include this baseline figure.</i></p>

Projections

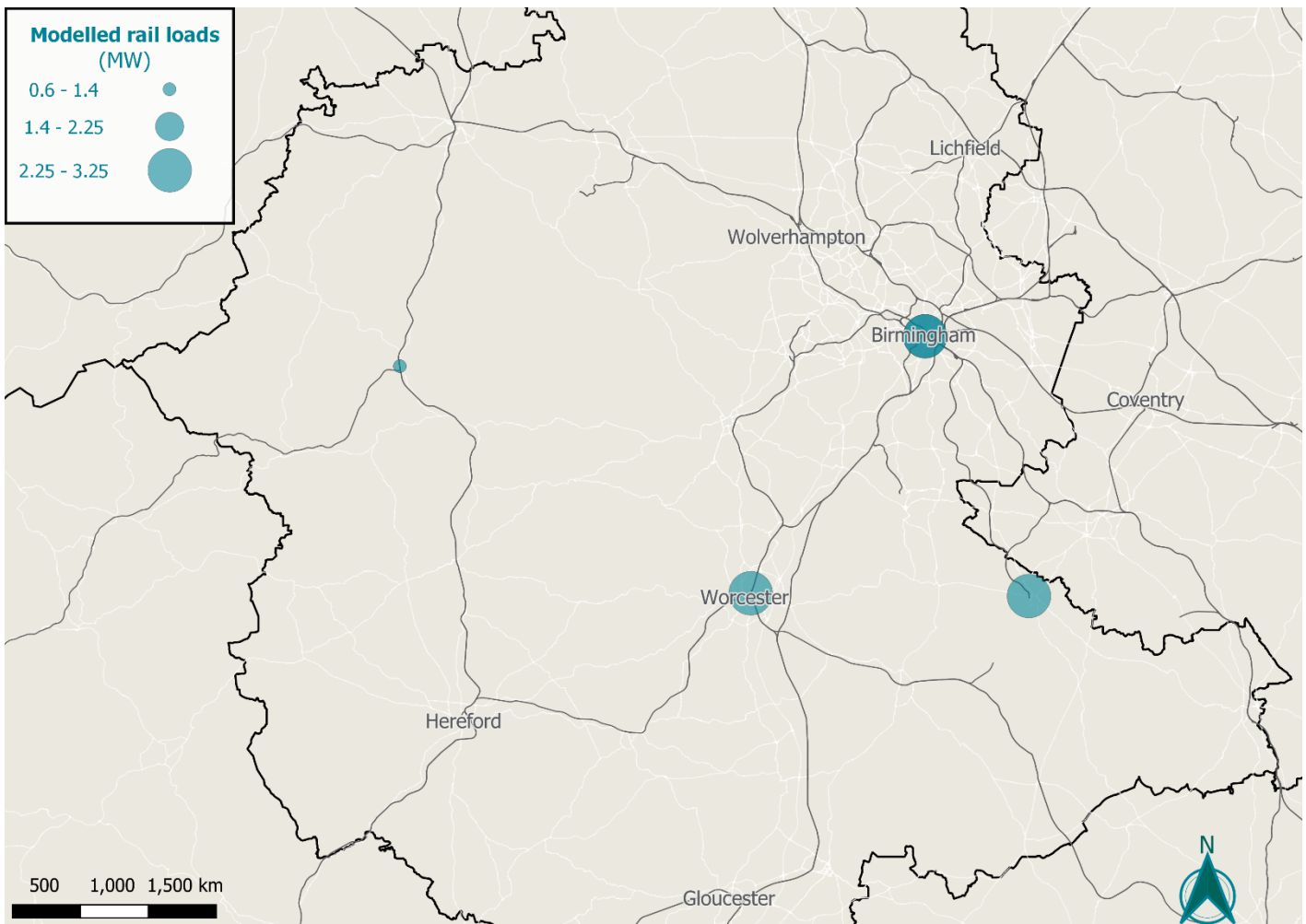
Scenario	Description
Holistic Transition	In the net zero scenarios, all routes are assumed to have infrastructure enabling a net zero railway by 2050, which considers battery electrification and increased electricity demand. In addition, the infrastructure enabling the removal of diesel-only trains is modelled to be in place by 2040. This additional requirement brings forward the decarbonisation of the Heart of Wales line, compared to a slower deployment under the Counterfactual .
Electric Engagement	
Hydrogen Evolution	The projection shown under these scenarios is focused on battery electrification lines connecting to the distribution network as a focused tranche of work. Overall, rail electrification is likely to be a phased process, both in time and geographically, as Network Rail and rail line operators coordinate on capital projects.

Also, various aspects of rail electrification works will be subject to local and national planning regimes, so planning timelines could be variable by region.

Counterfactual In this scenario, electrification is assumed to progress at a slower rate with projects delivered c. 10 years later than in the net zero scenarios. Full decarbonisation of the GB rail network is achieved, however, not under the 2040 or 2050 timescales currently set out by the DfT.

Route	Route length (km)	Trains per day	Net Zero scenario delivery year	Counterfactual delivery year	Estimated load (MW)
Worcester to Smethwick (Birmingham)	48	70	2050	2060	6.05
Birmingham to Stratford-upon-Avon to Hatton	40	70	2050	2060	5.04
Heart of Wales*	143	5	2040	2050	0.64

*Note: The Heart of Wales line crosses between the South Wales and West Midlands licence areas. Loads are located at Llanelli in South Wales and Craven Arms in the West Midlands (total 1.3 MW).



Map of additional rail sector loads on the distribution network in 2050 in the net zero scenarios. Size of circles represent the scale of capacity required.

Uptake modelling factors

The below factors are used to inform the decarbonisation of rail in this licence area.

Factor	Modelling impact	Source
Route identification	52 routes within NGED’s licence areas requiring decarbonisation were identified.	Network Rail Traction Decarbonisation Network Strategy
Route decarbonisation solutions	For each route, solutions were identified from Network Rail’s regional decarbonisation strategy documents, which classified routes as requiring Overhead Line Electrification (OLE) or an alternative solution. Alternative solutions include battery-electric (including those powered in part or wholly by overhead lines) or hydrogen-fuelled traction. Routes requiring an alternative solution with lengths less than 200 km were assumed to use battery-electric solutions.	Wales and Western Regional Traction Decarbonisation Strategy Network Rail Traction Decarbonisation Network Strategy

		Engagement with Network Rail
Delivery sequence	Decarbonisation sequencing was sourced from Network Rail's strategies. Since delivery dates weren't published, Regen set approximate completion dates to align with rail decarbonisation targets.	Wales and Western Regional Traction Decarbonisation Strategy
Network connection	<p>For routes needing OLE, spatial analysis determined whether a connection would be made to the transmission or distribution network based on two criteria:</p> <ul style="list-style-type: none"> • Routes within 10 km of a transmission substation are assumed to connect to transmission. • Transmission feeders are assumed to power trains 100 km in both directions. 	Autotransformer Fed Traction Power Supply System: Analysis, Modelling and Simulation
Energy requirement	<p>The energy required by all trains travelling on each route per day was calculated from the route distance, number of trains travelling each day and specific energy consumption of battery trains. Key assumptions included:</p> <ul style="list-style-type: none"> • Specific energy consumption for battery trains: 6 kWh per train km • Maximum battery electric train range: 240km 	<p>Table 8, JET Onboard energy storage in rail transport</p> <p>Economic, environmental and grid-resilience benefits of converting diesel trains to battery-electric</p>
Charging period	Charging capacity was derived assuming energy needs are met in four hours of charging per day (in motion or whilst stopped).	Desk research
Location of railway routes	The estimated capacity was allocated to locations at either end of branch lines.	Desk research

Spatial factors

The below factors are used to inform the spatial distribution of electricity demand for rail across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Location of railway routes	DFES rail modelling is done on a bottom-up, route-specific basis and so the locations of modelled loads are defined by the location of each route.	Network Rail

Reconciliation to FES 2024

- ▶ FES includes projections of annual rail electricity demand (TWh). Under **Holistic Transition**, GB demand more than doubles over the period from around 5 TWh in 2023 to 10.6 TWh in 2050.

- ▶ FES does not publish projections of grid capacity used by the rail sector or regionally-specific projections, so reconciliation was not possible.

Comparison to DFES 2023

- ▶ Rail was not modelled in DFES 2023.

Agriculture

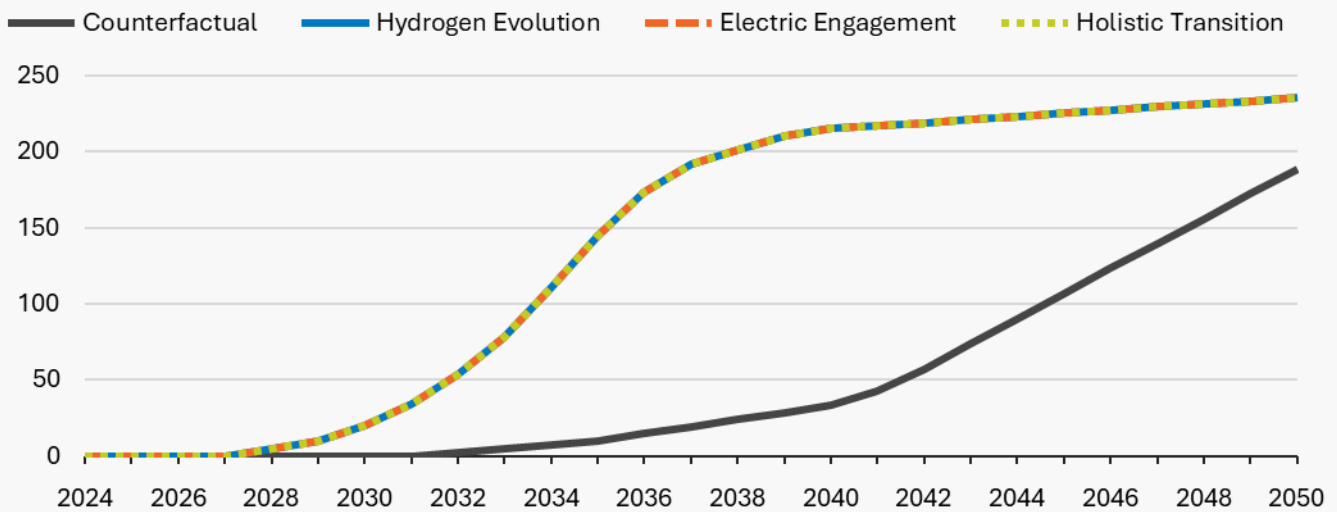
Summary

- ▶ The decarbonisation of agricultural machinery, and its resultant impact on the distribution network, is a new area of modelling for DFES 2024. On-site solar generation, fossil fuel electricity generation and anaerobic digestion electricity generation, which may all be located at farms, are already reflected as separate technologies in the DFES, as is building heat and road transport.
- ▶ Stakeholder engagement revealed that electrification of agricultural machinery is at a very early stage, especially for mobile machinery such as farm vehicles. This is reinforced by vehicle registrations data from the DfT, encompassing vehicles registered for use on public roads, which suggests that there are currently less than 100 electric agricultural vehicles in the West Midlands licence area. This equates to 0.2% of registered agricultural vehicles, the vast majority of which are currently fuelled by diesel.
- ▶ The FES 2024 does not include agricultural energy demand within its modelling, instead deferring to the decarbonisation pathways presented in the CCC's Sixth Carbon Budget.²⁸ The DFES scenarios have been modelled based on the CCC's Balanced Pathway, which assumes that the majority of agricultural machinery will be fuelled by hydrogen or bioenergy, rather than electricity, by 2050.
- ▶ Stakeholder engagement aligned with these Balanced Pathway assumptions, with stakeholders highlighting some limitations of electrification, such as the impact of increased vehicle weight on farmland for larger machinery and requirements for long ranges/operating hours on peak days during key harvest seasons.
- ▶ Stakeholders felt that agricultural machinery electrification is most likely to be limited to smaller 'utility' tractors and telehandlers, with larger farm machinery likely to employ biodiesel, biomethane or hydrogen solutions to decarbonise. Stakeholders identified that farms with typically smaller machinery and denser operations are more likely to adopt electric agricultural machinery, including fruit and vegetable farming, dairy herds, pigs and poultry.
- ▶ The West Midlands licence area hosts a range of arable and livestock farms, particularly in the more rural western reaches of the licence area. This includes cattle in Herefordshire, Shropshire and Staffordshire, arable crops in Warwickshire and Worcestershire, and a high proportion of poultry farms relative to the rest of England and Wales.
- ▶ To calculate potential future demand on the distribution network, the national demand for electricity for agricultural machinery under the CCC's Balanced Pathway has been disaggregated to local authority level. This has been based on the presence of the farm types that could be suited to electrification in the near term, as identified by stakeholders, combined with current petroleum consumption for agriculture as a longer-term driver. Future demand capacity connecting to the network has been determined using electrical energy demand, peak day requirements and assumptions around charging windows for machinery and vehicles.
- ▶ Under **Holistic Transition**, **Electric Engagement** and **Hydrogen Evolution**, capacity connected to the distribution network in the West Midlands licence area reaches 235 MW by 2050 with the majority of capacity connecting in the 2030s.
- ▶ Under the **Counterfactual** scenario, agriculture sector electrification progress is slower and occurs mostly in the 2040s, reaching just under 190 MW by 2050.

Agricultural machinery demand by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: DfT Vehicle Statistics

	Development status	Capacity (MW)	Description
			The installed capacity of electric agricultural machinery would be comprised of chargers for mobile farm machinery and direct connections for non-mobile machinery. Data for this is not currently available, due to it being a very specific subset of wider farm grid connections and equipment.
Baseline	Operational	n/a	Stakeholder engagement highlighted that the electrification of agricultural machinery is at a very early stage, especially for mobile machinery. This is reinforced by vehicle registrations data from the DfT, encompassing vehicles registered for use on public roads, which suggests that there are less than 60 electric agricultural vehicles in the West Midlands licence area. This equates to 0.1% of registered agricultural vehicles, the vast majority of which are instead currently fuelled by diesel.

Projections

The three net zero scenarios are modelled based on the outcomes for agricultural machinery electrification in the CCC's Sixth Carbon Budget Balanced Net Zero Pathway. This states that "completely decarbonising the agricultural sector is not possible (on current understanding) due to the inherent biological and chemical processes in crop and livestock production". Of the current and projected emissions associated with agriculture, machinery decarbonisation is small compared to reducing food waste, changing diets and implementation of low-carbon farming measures (see below).

Based on this CCC analysis and Energy Consumption in the UK data, agricultural machinery currently consumes c. 12 TWh of fuel per year, mainly in the form of diesel and other petroleum products, with a small contribution from bioenergy.²⁹ In the CCC's Balanced Pathway, the majority of agricultural machinery is decarbonised via bioenergy in the near term and via low carbon hydrogen in the longer term, with electricity providing only 11% of final energy demand by 2050.

This outcome was tested with industry stakeholders, including agricultural machinery sector experts, local authorities and a consultancy with experience in rural decarbonisation studies. Two major limitations for the electrification of agricultural machinery were identified. Firstly, the greater weight of battery electric vehicles would be expected to make electrification of larger tractors, combine harvesters and other large mobile machinery unfeasible due to the resultant soil compaction and impact on farmland. Secondly, the requirements of agricultural machinery on peak days, such as during harvest season, can require up to 16 hours of continual use for a single piece of machinery over a single day. Current electric agricultural machinery, and foreseeable developments in the near term, are not expected to address these excess weight or charge duration/range barriers, thus limiting uptake.

As a result, stakeholders felt that agricultural machinery electrification is most likely to be limited to smaller 'utility' tractors and telehandlers, with larger machinery likely to employ biodiesel, biomethane or low carbon hydrogen solutions. This is particularly likely where farms can produce their own biofuel on-site. Current developments in the agricultural vehicle market are focused on these biofuels, with many new agricultural vehicles currently being delivered with biodiesel fuel capabilities included.

To calculate potential future demand on the distribution network, the national demand for electricity from agricultural machinery under the CCC's Balanced Pathway has been disaggregated to local authority level. This has been based on the presence of suitable farm types in the near term, as identified by stakeholders, combined with current petroleum consumption for agriculture in the longer term. This electrical energy demand has then been converted to a potential network connection capacity, calculated using the proportion of annual consumption that may be required on a peak day and an assumed eight-hour charging window.

The electrification of specific agricultural machine 'implements', such as irrigators, was identified as an area of current development. However, these implements are expected to be powered by a generator fuelled by diesel, biodiesel or hydrogen rather than a battery. As a result, this specific aspect equipment electrification would not result in any distribution network facing demand.

Potential future evolutions in agricultural practices, such as using fleets of autonomous 'drone' machinery for crop spraying and seeding, or controlled-environmental vertical farming, could be highly suited to electrification. However, the trajectory for these technologies is currently highly uncertain. As a result, the DFES modelling and subsequent projections are based on a continuation of conventional farming practices and machinery requirements between now and 2050. Depending on how this area develops over the coming years, a 'deep electrification' scenario projection may be justified.

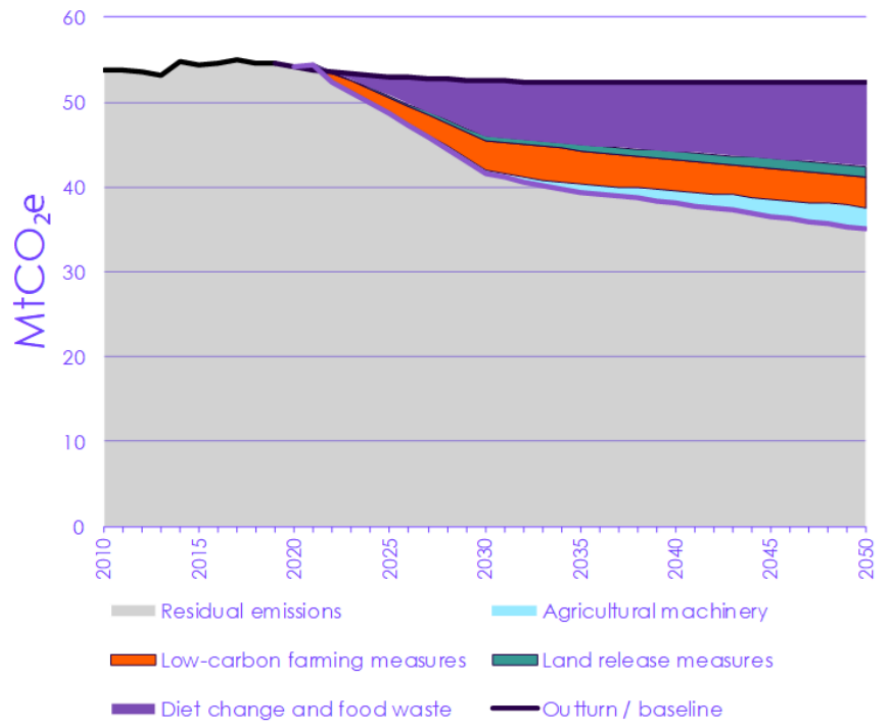


Figure 6 - Sources of abatement in the Balanced Net Zero Pathway for the agriculture sector, CCC Sixth Carbon Budget Report, Dec 2020

Overall, the West Midlands hosts 10% of total farmed area in England and Wales. The West Midlands licence area hosts a range of arable and livestock farms, particularly in the more rural western reaches of the licence area. This includes cattle in Herefordshire, Shropshire and Staffordshire, arable crops in Warwickshire and Worcestershire, and a high proportion of poultry farms relative to the rest of England and Wales.

Scenario	Description
Holistic Transition	Stakeholders suggested that the CCC Balanced Pathway for agricultural electrification, published in 2020, was overly ambitious in the near term compared to current uptake and developments in the agricultural machinery market. As a result, the DFES projections are based on a slightly delayed uptake in the near term, with the majority of electrification occurring from the 2030s onwards. Under the net zero scenarios, this results in c. 235 MW of capacity of agricultural machinery connected to the distribution network by 2050 in the West Midlands licence area.
Electric Engagement	
Hydrogen Evolution	These projections carry a high degree of uncertainty due to a very wide range of potential outcomes for the decarbonisation of the agricultural sector in the UK.
Counterfactual	This scenario is intended to represent an illustrative lower-bound estimate of the potential demand for electricity from agricultural machinery. Uptake is delayed by approximately ten years compared to the net zero scenarios, as progress on transport electrification and wider carbon emissions reductions measures are more limited under this scenario. By 2050, this results in c. 190 MW of capacity of agricultural machinery in the West Midlands licence area, with the majority of electrification occurring in the 2040s.

Uptake modelling factors

The below factors are used to inform the overall uptake of electrified agricultural machinery in the West Midlands licence area.

Factor	Modelling impact	Source
Trajectory and magnitude of UK agricultural machinery electrification	The Balanced Net Zero pathway from the CCC's Sixth Carbon Budget has been used to guide the overall uptake of agricultural machinery electrification under the three net zero scenarios.	CCC Sixth Carbon Budget
Typical annual and peak day operating hours for utility tractors and telehandlers	To estimate the connection capacity required to meet annual electricity consumption for agricultural machinery presented in the CCC Sixth Carbon Budget, a number of assumptions have been made based on engagement with sector stakeholders and reinforced by desk research. For a smaller utility tractor of under c. 100 horsepower or telehandler, annual operating hours can vary significantly but average around 300 hours per year.	Stakeholder engagement

Due to the timing necessities of agricultural work, a peak day during harvest season could require at least 12 hours of machinery use for a small tractor or telehandler, and up to 16 hours for larger machinery.

As a result, the connection capacity has been calculated based on 4% of annual demand being delivered in an eight-hour overnight charging period before or after a significant harvest day, driving peak utilisation.

This is likely to be a conservative estimate and does not account for top-up charging of vehicles within the peak day or rotation of equipment during the day. Using these assumptions, the utilisation factor of the connection capacity is just over 2%. There is potential for greater utilisation of this capacity through smart charging, autonomous machinery and vehicle-to-grid technology.

Land use, crop areas and livestock populations by local authority

Stakeholder engagement identified that farms with typically smaller machinery and denser operations are more prospective for electric agricultural machinery, as the market currently stands. This includes fruit and vegetable farming, dairy herds, pigs and poultry. In contrast, other arable crops, cereals, grassland and sheep/lamb farming were seen as less suited to significant levels of electrification.

The near-term uptake of electric agricultural machinery has been based on the presence of these farm types by local authority. This aims to reflect the potential development of the electric agricultural machinery market over time to tackle a wider variety of uses. The focus of capacity towards specific farm types is reduced in the longer term, as other farm types consider some degree of electrification.

DEFRA structure of the agricultural industry data³⁰

Current petroleum consumption for agriculture by local authority

The uptake of electric agricultural machinery has been based on current agricultural petroleum consumption by local authority. This aims to reflect the potential development of the electric agricultural machinery market over time to tackle a wider variety of uses.

DESNZ sub-national total final energy consumption data³¹

Spatial factors

The below factors are used to inform the spatial distribution of electrified agricultural machinery capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Land use, crop areas and livestock populations by local authority	Mirroring its use as an uptake factor, local authority data on farm type, informed by hectares of crops and numbers of livestock, is used to model the locations for agricultural electrification, particularly in the near and medium term.	DEFRA structure of the agricultural industry data ³²
Current petroleum consumption for agriculture by local authority	Mirroring its use as an uptake factor, local authority data on current petroleum consumption from the agricultural sector, down to local authority level, is used to model the locations for agricultural electrification in the longer term.	DESNZ sub-national total final energy consumption data ³³
Location of agricultural premises	Following the distribution to local authorities through the two factors above, the location of agricultural premises, identified through analysis of OS Addressbase use classes, has been used to distribute local authority projections down to individual 11 kV ESAs.	OS Addressbase

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.

- ▶ Agricultural machinery is not modelled within the FES.
- ▶ The FES uses emissions pathways from the CCC Balanced Pathway for sectors that are not modelled, such as agriculture. This has been reflected in the DFES in the three net zero scenarios, alongside delayed progress under the **Counterfactual** scenario.

Comparison to DFES 2023

- ▶ Agricultural machinery was not modelled in DFES 2023.

Generation technologies

Results and assumptions

Large-scale solar

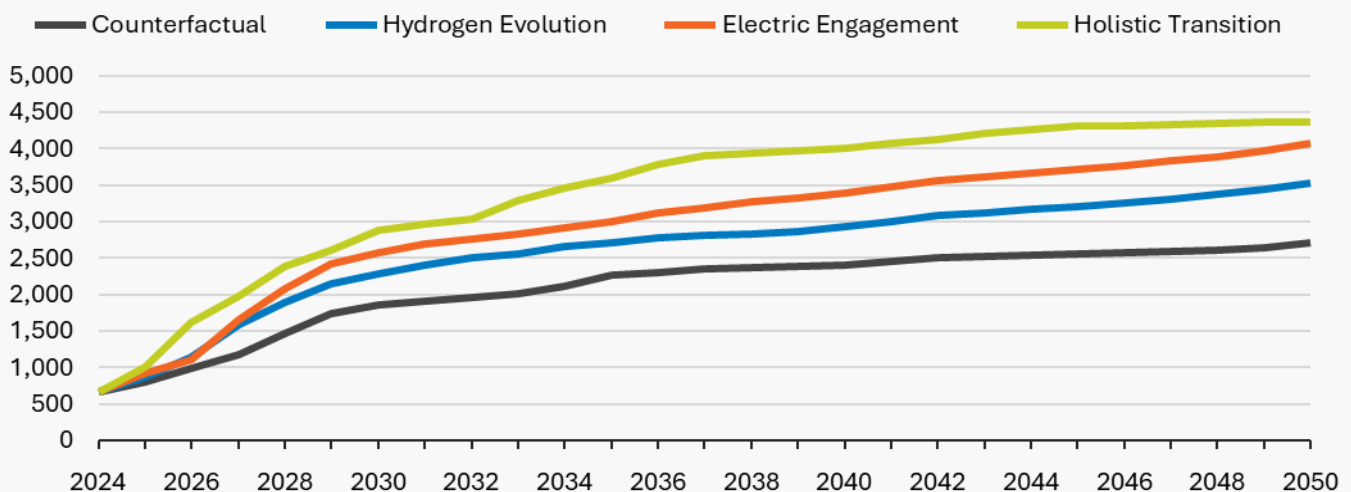
Summary

- ▶ Solar power is one of the critical enablers for a net zero electricity system, with the UK government aiming to treble solar generation as part of its plan to achieve 'Clean Power' by 2030, from 15 MW to 47 MW. Under this plan, the distribution networks will play a key role in the deployment of new solar projects, expected to account for 90% of solar capacity by 2030.³⁴
- ▶ The West Midlands licence area has historically seen a moderate level of large-scale solar PV deployment, with 675 MW of capacity connected over the past decade. In the past year alone, 85 MW of new projects have connected in the licence area.
- ▶ In addition to this, there is currently 4.3 GW of large-scale solar PV, across 134 projects, with an accepted connection offer in the West Midlands licence area. 64% of these sites have planning evidence, with 32% having been granted full planning permission.
- ▶ The Contract for Difference Allocation Round 6 awarded 13 sites in West Midlands with contracts, totalling 502 MW of installed capacity.
- ▶ The West Midlands is host to a significant amount of suitable land for solar farm development, moderately high solar irradiance and a history of planning friendliness by regional local authorities. Therefore, the installed capacity of large-scale solar in the West Midlands is projected to increase substantially out to 2050 in all scenarios.
- ▶ By 2050, the capacity of large-scale solar PV in the West Midlands ranges from 2.7 GW under the **Counterfactual** scenario, four times the current baseline, to 4.4 GW under **Holistic Transition**, six and a half times the baseline.

Large-scale solar PV capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	675	<p>131 MW of large-scale solar has connected in the West Midlands licence area in the last year. This is the most large-solar added in a single year since 2017.</p> <p>This increase is contributed to eight sites, two of the largest located in Wychavon, Bishampton Solar (35 MW) and Croome Airfield Solar Farm (46 MW).</p>
Contract for Difference Allocation Round 6	Won contract	502	<p>Thirteen sites (502 MW) were identified as having been awarded a Contract for Difference in Allocation Round 6.</p> <p>All sites were modelled to connect by the delivery years (2026/28), except for sites that are in areas of grid constraint. These sites were modelled to connect by the delivery year under Holistic Transition and Electric Engagement modelled to connect by the year that statement of works upstream network reinforcement is set to complete under Hydrogen Evolution and Counterfactual.</p>
	Granted	1,156	<p>In addition, there are 41 sites, totalling 1.2 GW which have granted planning permission.</p> <p>This included 9 sites that are individually greater than 49 MW. The two largest sites, Peplow PV Farm in Shropshire, is 100 MW and Maisemore Court Farm in Gloucestershire is 53 MW.</p>
Pipeline	Submitted	478	<p>There are 16 sites in the West Midlands licence area, totalling 478 MW, that have submitted planning applications.</p> <p>Of these, ten sites are modelled to connect under Holistic Transition.</p> <p>Under Electric Engagement, ten sites with installed all with capacity 40MW or less were modelled to connect, except those with a CfDs.</p> <p>Nine sites were modelled to connect under Hydrogen Evolution based on an analysis of the level of local ambition and historic planning permission.</p> <p>Under the Counterfactual scenario, only sites in areas with CfDs or high-levels of historic planning success for large-scale solar PV are modelled to connect.</p>
	Pre-planning	695	<p>Pre-planning includes sites with evidence of pre-development beyond an accepted connection offer, such</p>

as a screening opinion for the need for an environmental impact assessment (EIA) or early-stage community engagement.

Sites in the pre-planning stages are only modelled to connect under the three net zero scenarios. Under **Electric Engagement** and **Hydrogen Evolution**, 25% of the 695 MW capacity is modelled to connect based on local ambition and historic planning permission success rates. Under **Holistic Transition**, this is increased to 50%.

No information	1,770	There are a number of sites with no evidence of development. While this could be an indication that the site is unlikely to connect, many of these sites have only recently accepted a connection offer with NGED. Therefore, 30% of these sites are modelled to connect under Holistic Transition and Electric Engagement .
Rejected/withdrawn /expired/abandoned	204	Sites that have been rejected in planning (204 MW), withdrawn their planning applications or have abandoned development are not modelled to connect under any scenario.

Projections

Scenario	Description
Holistic Transition	<p>This scenario sees the largest growth in large-scale solar PV, driven by a high proportion of the known pipeline being modelled to connect.</p> <p>Baseline sites are modelled to repower with an additional 50% capacity at the end of a 20-year operational life. Solar capacity resultantly reaches 4.4 GW by 2050 in the licence area under this scenario.</p>
Electric Engagement	<p>Solar PV deployment increases substantially under this scenario, reaching 4.1 GW by 2050. Repowering of baseline sites at the end of a 25-year operational life is modelled to increase capacity by 25%.</p>
Hydrogen Evolution	<p>Solar PV deployment increases steadily under this scenario, driven by high-levels of local ambition, reaching over 3.5 GW by 2050. Repowering of baseline sites at the end of a 25-year operational life is also modelled to increase capacity by 25%.</p>
Counterfactual	<p>Whilst the least ambitious of the four scenarios for renewable energy development, the DFES still models a capacity increase of nearly four times the baseline by 2050. This is driven by the high proportion of known sites with granted planning permission connecting with longer development timelines, pushing development up to the late 2030s, where growth in new connected solar capacity levels off, reaching 2.7 GW by 2050.</p> <p>Repowering is assumed to have a minimal impact under this scenario, with most site owners choosing to extend the life of their existing panels rather than increase capacity.</p>

Uptake modelling factors

The below factors are used to inform the uptake of large-scale solar PV in the West Midlands licence area.

Factor	Modelling impact	Source
Existing and prospective projects with grid connections	The number, location and capacity of projects currently connected or with a connection offer in NGED's West Midlands licence area are used to model the near-term projections.	NGED connections data
Planning progress	The development status of individual projects, including their status within the local planning authority, is used to inform which of these projects are modelled to connect under which scenarios and on what timeline.	Renewable Energy Planning Database, Contracts for Difference auctions, public consultations, desk research
Repowering assumptions	Baseline sites > 5 MW are modelled to repower at the end of their operational life with +25% capacity in Electric Engagement and Hydrogen Evolution and +50% in Holistic Transition .	Developer engagement
Historical planning friendliness	The proportion of solar sites that have received planning approval with relevant local planning authorities is used to help determine which projects with planning status submitted or pre-planning are modelled to connect.	Renewable Energy Planning Database
Local ambition	Similar to historical planning friendliness for Electric Engagement and Holistic Transition , local planning authorities who have explicitly stated local ambition in solar power (through LAEPs or stated targets) are used to determine which projects are modelled to connect.	DFES local authority energy strategy survey Local Area Energy Plans
Technical limits offers	Where a project has accepted a technical limit offer with NGED, this anticipated energisation date is used as the minimum year of connection for that project under any scenario.	NGED connections data
Statement of Works transmission reinforcement timelines	Where a project is impacted by a transmission-level Statement of Works, the anticipated completion year this is used as the minimum year of connection for that project under the Counterfactual .	NGED connections data

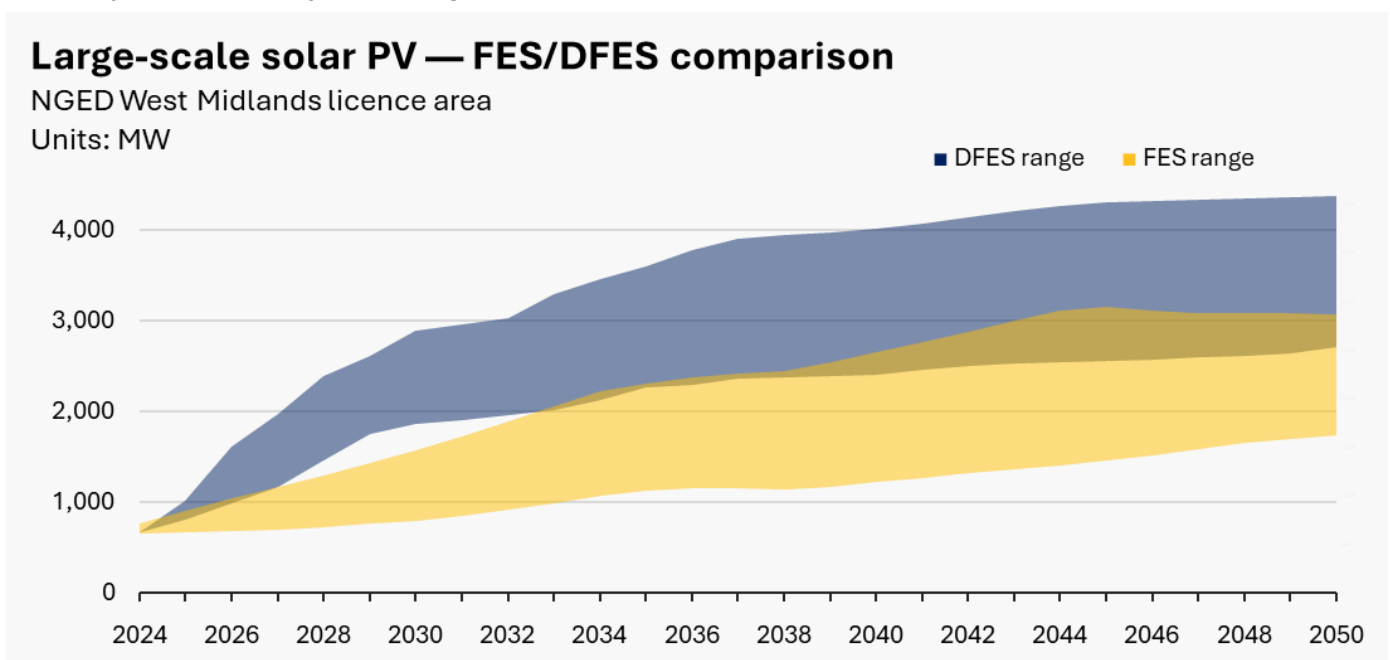
Spatial factors

The below factors are used to inform the spatial distribution of large-scale solar capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Solar resource assessment	Regen's in-house resource assessment, taking into consideration solar resource, land availability and planning constraints in the licence area, is used to identify potential future areas for large-scale solar development.	Solar irradiance data, Natural England, OS Addressbase
Local ambition	Local ambition, including the local authority policy landscape and commitment to renewable energy and net zero goals, is reflected in the large-scale solar projections at a local authority level.	Climate Score Cards, DFES local authority energy strategy survey, Local Area Energy Plans

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared against the FES 2024 projection for the same licence area. The DFES baseline, modelled as 2024, coincides with the first year of projections for the FES. This may result in a projection range in 2024 in the FES data.



- ▶ The FES 2024 baseline is closely aligned with the DFES 2024 baseline for the West Midlands licence area.
- ▶ The DFES 2024 near-term uptake, which is significantly higher than the FES in every scenario, reflects a significant proportion of the very large pipeline of projects being found to have strong evidence for near-term deployment, such as full planning permission or being awarded Contracts for Difference.

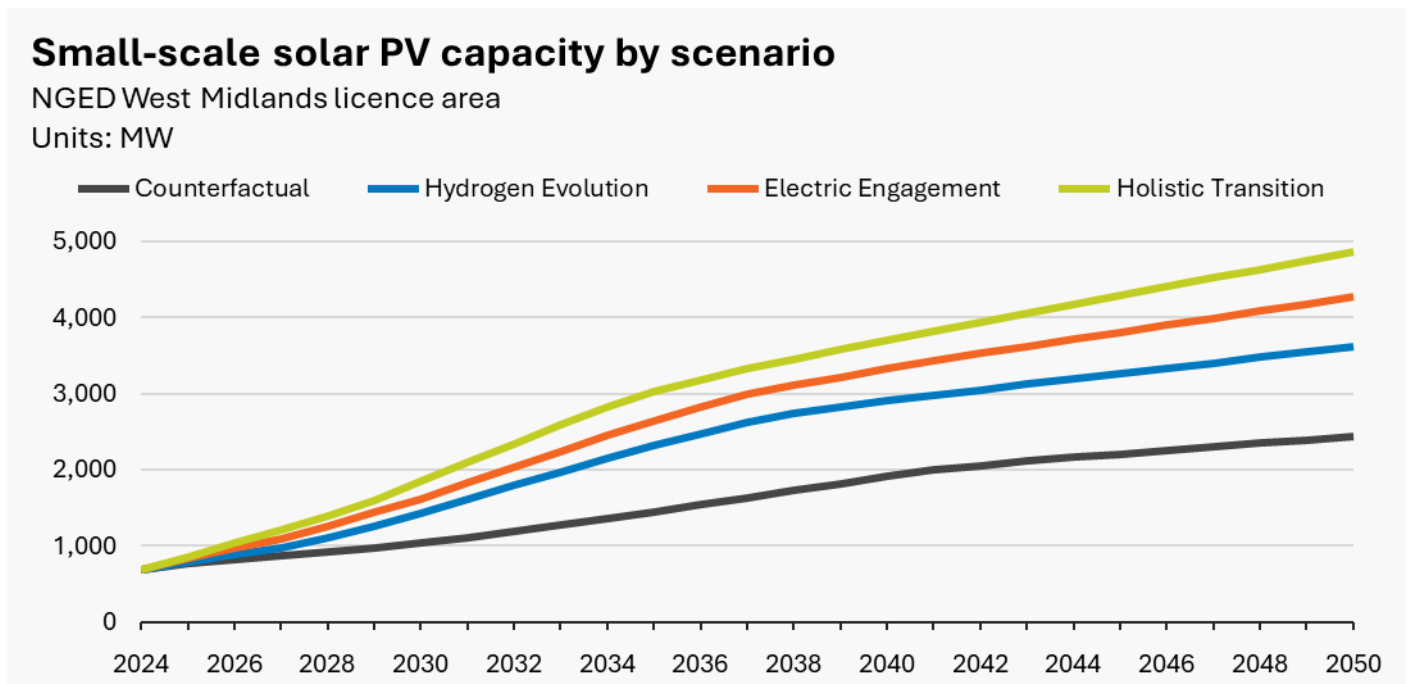
Comparison to DFES 2023

- ▶ There are no major differences between DFES 2023 and DFES 2024 outcomes.

Small-scale solar

Summary

- ▶ High energy prices over the past few years have resulted in small-scale increase in solar PV deployment across GB, reaching its highest level in over a decade. The West Midlands baseline totals nearly 700 MW, with approximately half originating from domestic rooftop solar and the other half from commercial rooftop solar.
- ▶ This trend is projected to continue as solar panel and installation costs continue to fall and domestic solar generation remains attractive for households and businesses, especially when paired with a domestic battery or EV.
- ▶ High electrification of transportation and heating drives the uptake of small-scale solar in homes and businesses under the net zero scenarios. By 2050, 4.9 GW of small-scale solar PV capacity connects in **Holistic Transition**, 4.3 GW **Electric Engagement** and 3.6 GW **Hydrogen Evolution**.
- ▶ The **Counterfactual** reflects lower levels of electrification but still shows significant growth in small-scale solar, with c. 2.4 GW of capacity deployed by 2050 under this scenario.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections database and MCS installations data

	Installation type	Capacity (MW)	Description
Baseline	Domestic rooftop (<10 kW)	436	The majority of small-scale solar was deployed in the FiT era in the 2010s, with over 300 MW connecting during this period. The West Midlands is currently seeing a consistently high

	Commercial rooftop (10 kW – 1 MW)	242	ongoing deployment of small-scale solar, with at least 70 MW of new capacity connecting in the last year. This growth is driven by a number of factors, including continued high electricity and gas prices and a recent decrease in solar installation costs.
Pipeline	Domestic rooftop (<10 kW)	0.3	The majority of small-scale solar sites with accepted connection offer with NGED are commercial rooftop arrays of between 10 kW and 1 MW. There is only 300 kW of domestic rooftop capacity with equivalent accepted connection offers. All pipeline sites are modelled to connect in 2025 under all scenarios, due to the small scale and clear evidence of ongoing solar deployment – many of which are under permitted development, not requiring planning approval.
	Commercial rooftop (10 kW – 1 MW)	48	Domestic solar sites often commission quickly and, therefore, are unlikely to hold their connection offer for long before being installed. In addition, NGED has recently introduced a ‘connect and manage’ scheme for domestic low-carbon installations, which means that households do not need to apply for a grid connection ahead of installing rooftop solar.

Projections

Scenario	Description
Holistic Transition	<p>Very high-levels of consumer engagement with smart electricity usage, dynamic electricity tariffs and high green ambition help boost small-scale solar deployment under the Holistic Transition scenario. This is augmented by solar deployment on new-build homes, which is modelled to occur on 80% of new homes and a high proportion of new non-domestic buildings. This is in line with the Future Homes Standard, once it is fully implemented.</p> <p>This results in 4.9 GW of small-scale solar by 2050 under this scenario.</p>
Electric Engagement	<p>High-levels of consumer engagement with smart electricity usage, dynamic electricity tariffs and high green ambition help to boost small-scale solar deployment under the Electric Engagement scenario. This is augmented by solar deployment on new-build homes, which is modelled to occur on 80% of new homes and a high proportion of new non-domestic buildings. This is in line with the Future Homes Standard, once fully implemented.</p> <p>This results in 4.3 GW of small-scale solar by 2050 under this scenario.</p>
Hydrogen Evolution	<p>With the need to decarbonise electricity demand quickly to meet carbon reduction targets, solar PV uptake is also high under the Hydrogen Evolution scenario. However, due to customers being less engaged and an overall lower level of electrification of heat and transport, uptake of rooftop PV is not as high as in the other net zero scenarios. This is augmented by solar deployment on new-build homes, which is modelled to occur on 80% of new homes and a high proportion of new non-domestic buildings, in line with Future Homes Standard, once fully implemented.</p> <p>This results in 3.6 GW of small-scale solar by 2050 under this scenario.</p>

Counterfactual Reflecting a lower uptake of low carbon technologies, smart tariffs and less engaged customers, the **Counterfactual** scenario results in lower demand for small-scale solar. This is augmented by solar deployment on new-build homes, which is modelled to occur on around 50% of homes and a moderate proportion of new non-domestic buildings by the 2030s. This results in 2.4 GW of small-scale solar by 2050 under this scenario.

Uptake modelling factors

The below factors are used to inform the overall uptake of onshore wind in the West Midlands licence area.

Factor	Modelling impact	Source
Recent small-scale solar PV uptake trends	Nearly 600,000 solar installations have occurred in GB since January 2020. With such a large sample size, the DFES has modelled uptake trends at a regional level based on the uptake of small-scale solar PV in the region relative to the national uptake over the past four years.	MCS Data Dashboard
New-build housing	New-build housing is modelled to include rooftop solar PV in line with the Future Homes Standard consultation. As such, the outputs of the DFES new housing projections directly influence the location of future small-scale solar PV installations.	DFES new developments projections, Future Homes Standard consultation

Spatial factors

The below factors are used to inform the spatial distribution of onshore wind capacity across the West Midlands licence area, and 11 kV ESAs.

Factor	Modelling impact	Source
Building type	The building type of domestic homes, such as detached, terraced and flats, is the primary distribution factor for domestic rooftop solar PV, used as a proxy for available roof space.	ONS Census
Tenure	The tenure of domestic homes, such as owner-occupied, social-rented or private-rented, is a secondary distribution factor for domestic rooftop solar PV, with more uptake on owner-occupied and social-rented homes.	ONS Census
Affluence	Affluence plays a minor role in the distribution of domestic solar PV in the near term, as stakeholder feedback and analysis of baseline trends show that the cost of solar PV is still a major contributing factor to uptake. Affluence is modelled using the ONS census Socio-economic Classification (NS-SEC) variable.	ONS Census

Non-domestic buildings with potential for rooftop solar PV

Based on engagement with stakeholders, we have identified existing non-domestic buildings with potential for rooftop solar to be included in the modelling. This includes schools, universities, warehouses, hospitals, shopping centres and offices.

OS Addressbase

Reconciliation to FES 2024

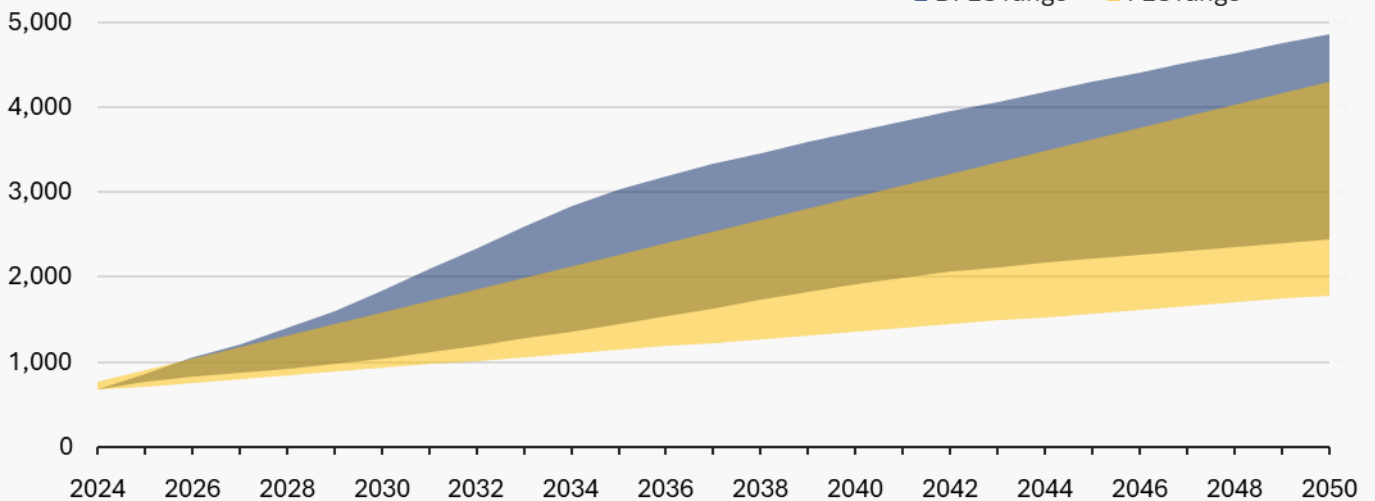
The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area. The DFES baseline, modelled as 2024, coincides with the first year of projections for the FES. This may result in a projection range in 2024 in the FES data.

Small-scale solar PV — FES/DFES comparison

NGED West Midlands licence area

Units: MW

■ DFES range ■ FES range



- ▶ The DFES 2024 projections are comparable to FES 2024, but have a higher overall projected capacity out to 2050. This is most likely due to the assumptions made in the DFES modelling around solar PV on new-build homes and non-domestic properties, which see a substantial uptake of rooftop solar in all scenarios.

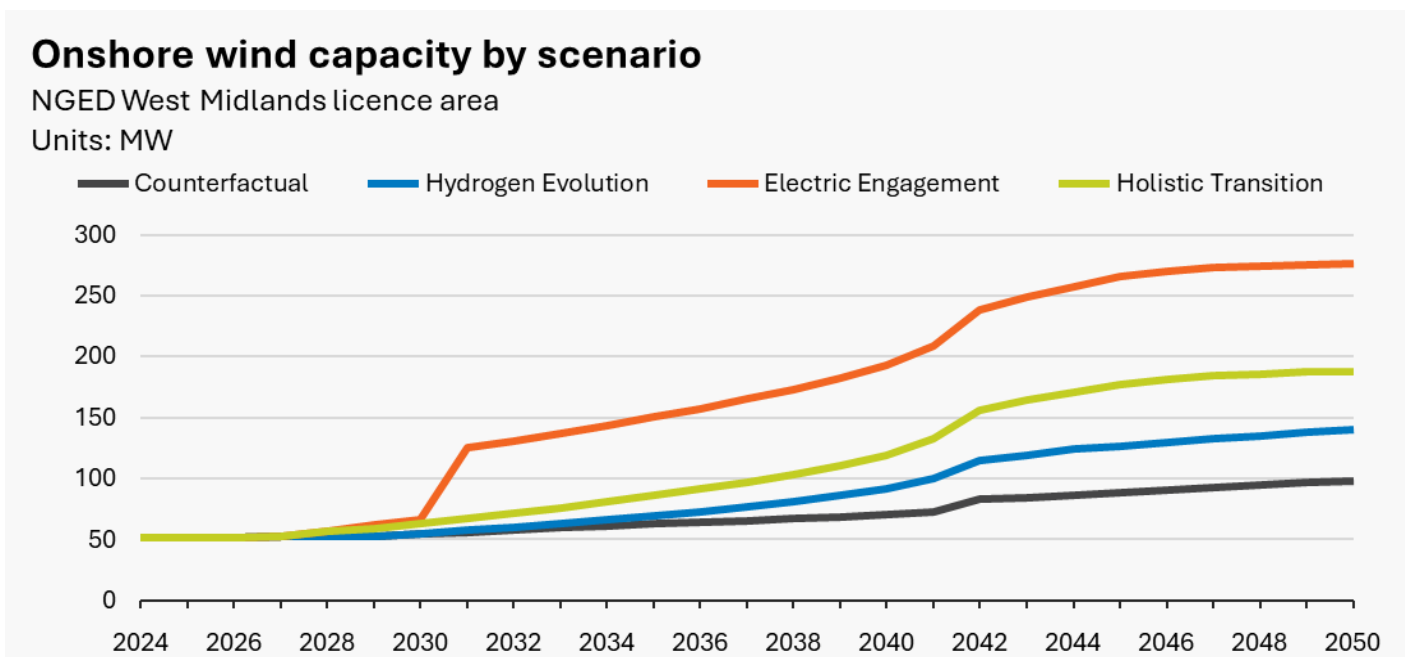
Comparison to DFES 2023

- ▶ DFES 2024 projections are broadly comparable to DFES 2023, though similarly have a higher overall projected capacity out to 2050. This is due to an increase in the number of new-build homes and non-domestic properties that have solar PV deployed reflecting the Future Homes Standard consultation, which was published in late 2023, meaning it was not directly reflected in DFES 2023 modelling.

Onshore wind

Summary

- ▶ The West Midlands licence is the NGED licence area that hosts the lowest level of connected onshore wind capacity at 55 MW. In addition to a relative low level of wind resource, planning application success for onshore wind projects has been historically low, with less than 35% of historic applications securing planning approval.
- ▶ In July 2024, the UK government revised onshore wind planning policy, as set out in the ‘Policy statement on onshore wind’, removing this barrier to deployment in the national planning policy framework.³⁵ While the full effect of this reform is yet to be seen in the pipeline of in-development onshore wind projects in England, the impact of this policy change has been reflected in an increase to the lower bounds of the DFES projections for onshore wind, relative to previous years’ analysis.
- ▶ There is a single onshore wind site with an accepted connection offer in the licence area, the 54 MW ‘Padwick Farm’ site in Leek. However, due to a lack of evidence of this site progressing through the planning system, it is modelled to connect only under the most ambitious scenario, **Electric Engagement**, in 2031.
- ▶ Engagement with the onshore wind sector has confirmed that development of new onshore wind capacity is expected to be limited before 2029. Long connection queues and uncertainty around the impact of aforementioned planning reforms are cited as remaining barriers to near-term deployment.
- ▶ A renewed deployment of new onshore wind sites is projected in all scenarios post-2029. The repowering of existing sites at the end of their operational life at increased capacities also contributes to continued growth through the 2040s.
- ▶ This results in 270 MW deployed across the licence area by 2050 under the most ambitious scenario, **Electric Engagement**, with 100 MW deployed under the same timeframe in the least ambitious scenario, the **Counterfactual**.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	52	The largest onshore wind site in the licence area is the 34 MW Garreg Lwyd Wind Farm, located over the border in Powys, Wales but connecting in the West Midlands licence area in 2017. All other baseline sites are small-scale sites of 2 MW or less, averaging under 25 kW.
Pipeline	No information	54	A 54 MW site, Padwick Farm in Leek, is the only site with an accepted connection offer in the licence area. With no evidence of progress through the planning system, it is assumed to build out in 2031 under the Electric Engagement scenario only.

Projections

Scenario	Description
Holistic Transition	<p>The modelling under this scenario assumes a renewed deployment of new onshore wind sites in the licence area through the 2030s and 2040s. Existing sites larger than 5 MW are also modelled to repower with an additional 40% capacity, reflecting to more efficient and larger turbines when these sites reach the end of their operational life. This results in an additional 31 MW of capacity in the licence area by 2050.</p> <p>This scenario sees 200 MW deployed by 2050, which is four times the existing baseline, but is a small overall deployment of onshore wind, relative to that being projected in neighbouring NGED licence areas under this scenario.</p>
Electric Engagement	<p>This scenario also sees a continued deployment of new sites through the 2030s and 2040s. Repowering of baseline sites with an additional 50% capacity provides an additional 35 MW of capacity in the licence area by 2050.</p> <p>This scenario sees the largest growth in onshore wind capacity, with just over 260 MW deployed by 2050.</p>
Hydrogen Evolution	<p>This scenario sees a greater focus on transmission network-connected electricity generation to achieve net zero targets, resulting in limited onshore wind deployment on the distribution network.</p> <p>Despite this, a renewed deployment of new onshore wind sites is projected post-2029 due to an improved planning environment. Repowering of baseline sites with an additional 25% capacity results in an additional 17 MW connecting at these sites in the 2030s and 2040s.</p> <p>By 2050, nearly 150 MW of onshore wind capacity is deployed in the licence area under this scenario.</p>

Counterfactual As the least ambitious scenario, the **Counterfactual** has the least amount of growth in onshore wind capacity. However, due to the improved planning environment, a renewed deployment of onshore wind is still considered in the licence area, resulting in 100 MW deployed by 2050, approximately double the current baseline.

Uptake modelling factors

The below factors are used to inform the overall uptake of onshore wind in the West Midlands licence area.

Factor	Modelling impact	Source
NGED accepted offer pipeline	The number, location and capacity of projects currently with a connection offer in the licence area form the basis of near-term projections.	NGED connections data
Technical limits offers	Where a project has accepted a technical limit offer with NGED, this anticipated energisation date is used as the minimum year of connection for that project under any scenario.	NGED connections data
Statement of Works transmission reinforcement timelines	Where a project is impacted by a transmission-level Statement of Works, the anticipated completion year this is used as the minimum year of connection for that project under the Counterfactual .	NGED connections data
Planning progress	The status of a project within local, regional and/or national planning processes, alongside the results of CfD auctions, is used to inform when a project is modelled to connect and under which scenarios.	Local authority planning platforms, CfD auction results.
Repowering assumptions	Baseline sites over 5 MW are modelled to repower at the end of their operational life with additional capacity in all scenarios. This is modelled as 50% in Electric Engagement , 40% in Holistic Transition , and 25% in Hydrogen Evolution and the Counterfactual .	Network connections data, desktop research

Spatial factors

The below factors are used to inform the spatial distribution of onshore wind capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Wind resource assessment	Regen's in-house resource assessment, taking into consideration wind resource, land availability and planning constraints in the licence area, is used to inform the distribution of post-pipeline capacity.	Numerical Objective Analysis of Boundary Layer (NOABL) wind speed data, Natural England, OS Addressbase

Local ambition factors

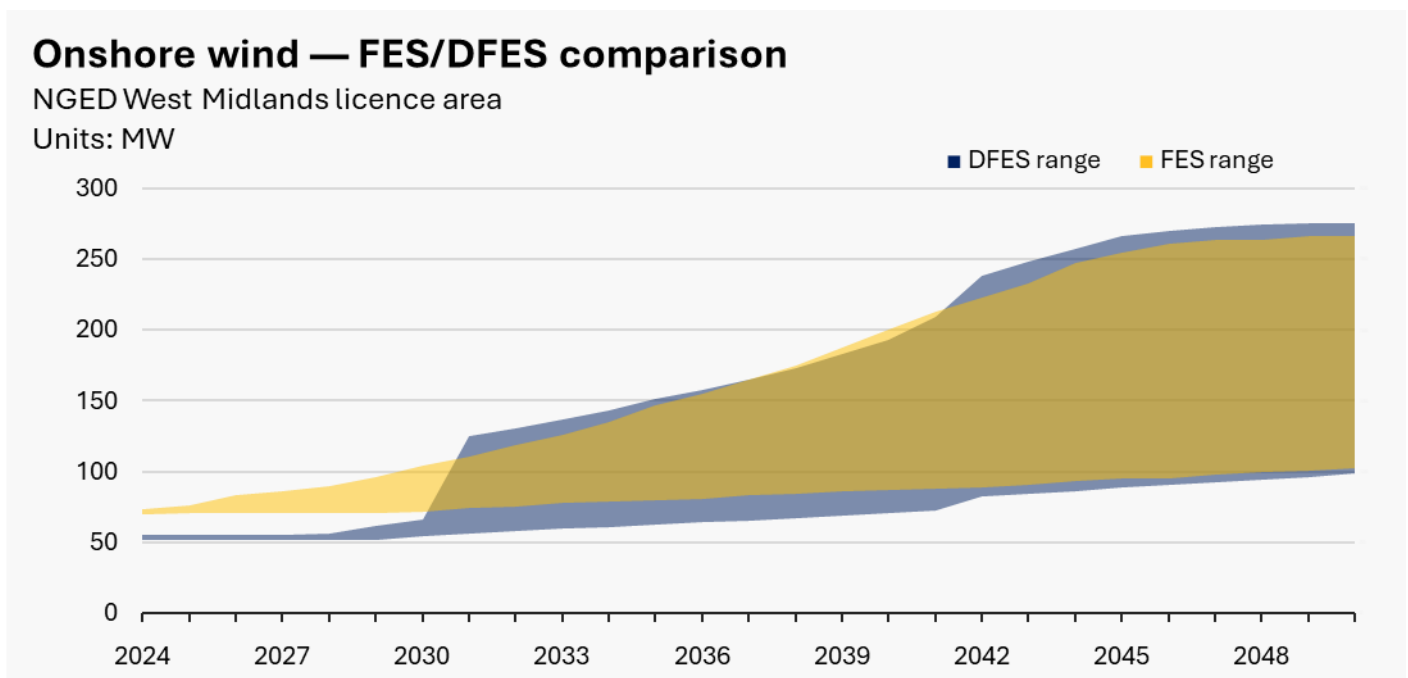
Local ambition, including the local authority policy landscape and commitment to renewable energy and net zero goals, is reflected in the distribution of post-pipeline capacity.

Explicitly stated local targets for wind power (through LAEPs or otherwise) inform the distribution of post-pipeline capacity. DFES projections are checked against these targets to ensure they are captured within the envelope of scenarios where applicable.

Climate Score Cards, DFES local authority energy strategy survey, LAEPs

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area. The DFES baseline, modelled as 2024, coincides with the first year of projections for the FES. This may result in a projection range in 2024 in the FES data.



- ▶ As was the case with FES 2023, The FES 2024 baseline of 70 MW is higher than the DFES 2024 baseline of 52 MW. The FES 2022 baseline of 48 MW was more closely aligned with the DFES values. The reason for this recent variance is unclear. It is possible that a baseline site was misallocated to the West Midlands licence area in the FES analysis.
- ▶ The FES 2024 projects greater pre-2030 growth in onshore wind capacity than in DFES 2024. The DFES near term projections are based on sites with accepted connection offers and reflects the remaining barriers to an earlier revival of onshore wind deployment in the licence area.
- ▶ In the longer term, the DFES and FES scenario projections are well aligned. The DFES projects moderately high-level of deployment beyond 2040, which accounts for the repowering of existing sites in this timeframe.
- ▶ The less ambitious DFES scenarios, **Hydrogen Evolution** and the **Counterfactual**, both project higher long-term installed capacity than their equivalent FES 2024 projections. This is due to the

reflection of recent onshore wind planning reform in the DFES 2024 modelling. The FES 2024 was published prior to the announcement of this reform.

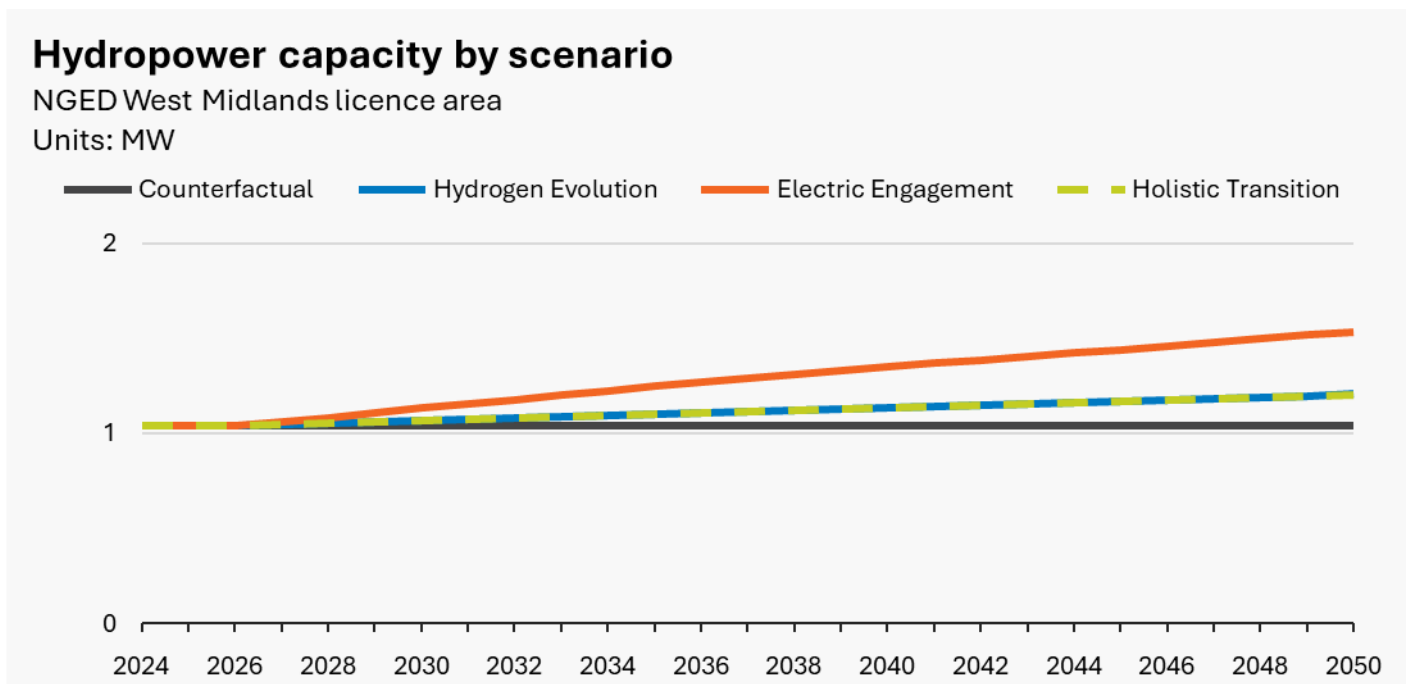
Comparison to DFES 2023

- ▶ DFES 2024 projects only limited, small-scale deployment of new onshore wind prior to 2031, where DFES 2023 projected slightly more near-term development. This is due to a reduction in the number of sites with connection offers from three to one in the licence area.
- ▶ Development evidence obtained through desktop research has resulted in the modelling of a 52MW site, connecting in 2031 under the most ambitious scenario, **Electric Engagement**. This site was not modelled in DFES 2023 as it had not accepted a connection offer with NGED.
- ▶ This site impacts what is otherwise a close alignment between the ambitious **Electric Engagement** and **Holistic Transition** scenarios, and the most ambitious scenarios within DFES 2023.
- ▶ The less ambitious DFES scenarios, **Hydrogen Evolution** and the **Counterfactual**, both project higher long-term growth than the DFES 2023's less ambitious scenarios. This is due to the reflection of recent onshore wind planning reform in the DFES 2024 modelling.

Hydropower

Summary

- ▶ The West Midlands has limited hydropower resource, with only 1 MW currently operational.
- ▶ Following the closure of the FiT scheme in 2019, deployment of small-scale hydropower has stalled. There are currently no hydropower pipeline sites in the West Midlands licence area.
- ▶ Due to this lack of subsidy support and increased abstraction licencing costs, the deployment of new hydropower is limited the licence area under all scenarios out to 2050.³⁶ Some additional capacity is modelled to connect in the licence area, representing existing sites repowering at a larger capacity, thought to be between 10% and as much as 30% of current installed capacity.³⁷
- ▶ The scenario with the highest deployment, **Electric Engagement**, sees an additional 0.5 MW of hydropower modelled to connect, reaching 1.5 MW by 2050.
- ▶ Due to a lower drive for decarbonisation and distributed sources of renewable electricity generation, such as hydropower, the **Counterfactual** does not project any additional capacity by 2050.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	1	There are 59 small-scale hydropower sites currently operational in the West Midlands, totalling 1 MW. Most of this capacity is located in Shropshire and Wychavon and was deployed between 2011 and 2016 with support from the FiT scheme.

Projections

- ▶ Hydropower deployment in the West Midlands has stalled in recent years, with no projects in the pipeline. High abstraction licence costs in England and a lack of subsidy support result in limited deployment of hydropower in the licence area, across all scenarios.

Scenario	Description
Holistic Transition	Only 0.2 MW of additional capacity is modelled to connect under this scenario, reflecting the repowering of existing sites with up to 15% extra capacity.
Electric Engagement	Electric Engagement represents a focus on distributed sources of renewable energy technologies, such as hydropower. Therefore, an additional 0.5 MW is modelled to connect by 2050, reflecting the repowering of existing sites with up to 30% extra capacity and new capacity at other developable locations with an appropriate head difference for hydropower deployment.
Hydrogen Evolution	Only 0.2 MW of additional capacity is modelled to connect under this scenario, reflecting the repowering of existing sites with up to 15% extra capacity.
Counterfactual	Due to a lower drive for decarbonisation and distributed sources of renewable electricity generation, such as hydropower, the Counterfactual does not project any additional hydropower capacity in the licence area by 2050.

Uptake modelling and spatial distribution factors

The below factors are used to inform the overall uptake and spatial distribution of hydropower capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Existing operational sites	Known hydropower projects in the licence area are used to inform the likelihood of future site capacity being developed. Where additional capacity is projected, this is distributed to existing sites to reflect future repowering and to represent watercourses with an appropriate head difference for hydropower deployment.	NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.

- ▶ The FES does not model any hydropower capacity in the West Midlands; therefore reconciliation is not possible.

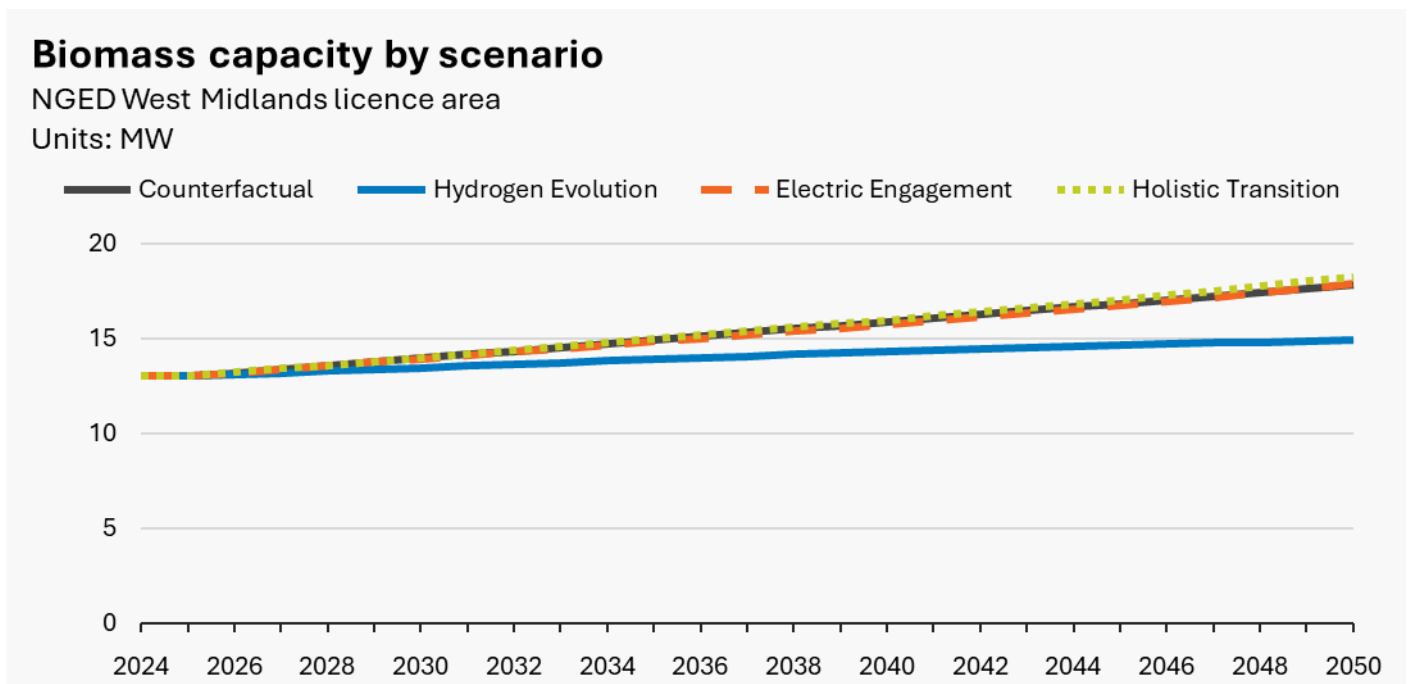
Comparison to DFES 2023

- ▶ The DFES baseline is slightly higher than last year, due to updates to the source connections data. In addition, some additional capacity has been modelled to connect by 2050 in the West Midlands to represent the repowering of existing sites.

Biomass

Summary

- ▶ Biomass power generation in the West Midlands consists entirely of small-scale sites of under 5 MWe. This includes sites providing Combined Heat and Power (CHP) at business parks, airports, universities and other non-domestic buildings.
- ▶ Small-scale biomass CHP sees limited growth in all four scenarios as a means of decarbonising local heat and industrial energy. **Hydrogen Evolution** sees lower uptake compared to the other three scenarios due to the greater availability of hydrogen for CHP in this scenario.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	13	There are 22 operational biomass baseline sites in the West Midlands, which all appear to use biomass for CHP. This includes a 4.2 MWe site at Thorn Business Park in Hereford, and a 2.7 MWe site in Stafford.
Pipeline	n/a	0	There are no biomass pipeline sites with accepted connections in the West Midlands licence area.

Projections

Scenario	Description
Holistic Transition	None of the four scenarios see a major role for distribution connected biomass in heat decarbonisation. As shown by the lack of pipeline and minimal biomass generation deployment in the West Midlands licence area to date, there is limited potential for growth in biomass generation capacity. However, there is still some deployment, particularly for heating at business parks and industrial sites – similar to the current baseline.
Electric Engagement	
Hydrogen Evolution	
Counterfactual	
	Hydrogen Evolution sees slightly uptake compared to the other three scenarios due to the greater availability of hydrogen for CHP in this scenario.

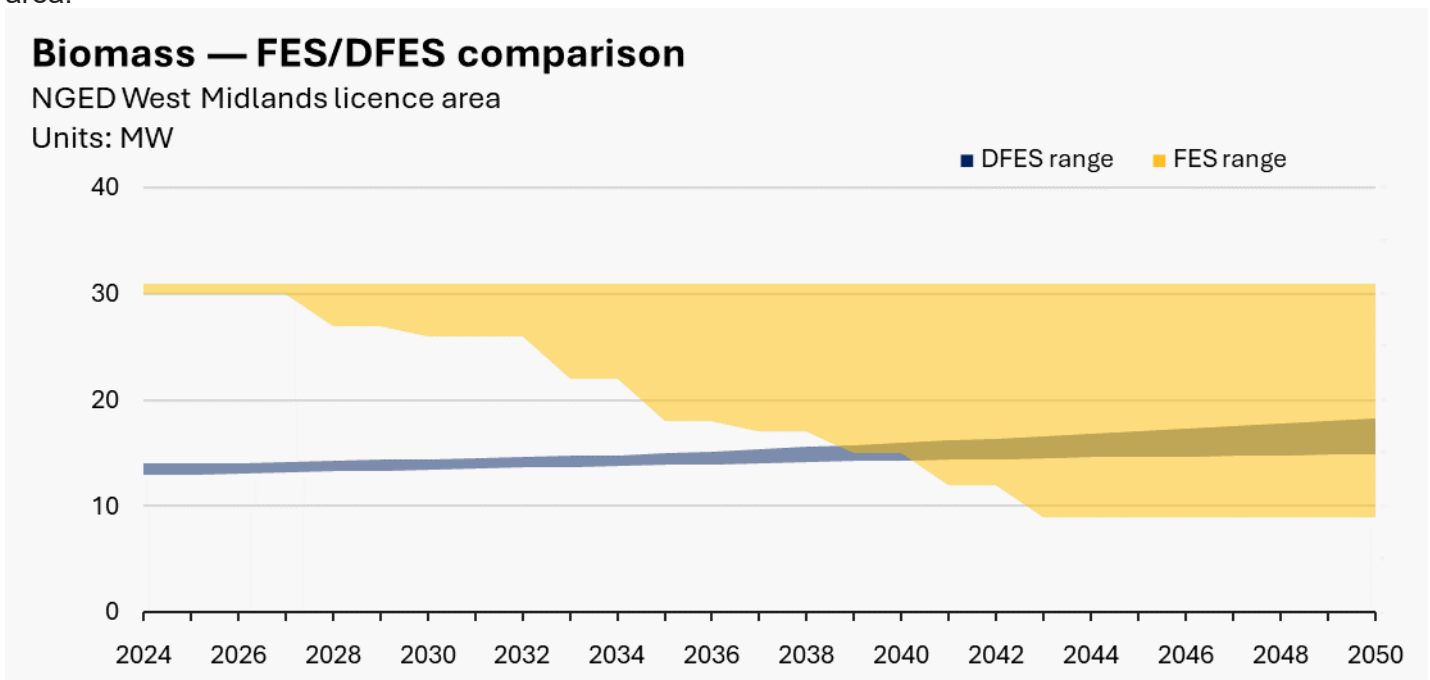
Uptake modelling and spatial distribution factors

The below factors are used to inform the overall uptake and spatial distribution of biomass capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Existing baseline and pipeline sites	Alongside the existing baseline, growth in small-scale biomass CHP capacity is distributed to existing small-scale biomass connections.	NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ There is a major difference between the FES and DFES baselines, with the FES baseline (30 MW) totalling around double the DFES baseline (13 MW). The reason for this is unclear.

- ▶ As a result of this baseline discrepancy, the future outcome of biomass generation capacity in the licence area is also notably different across the scenarios between the DFES and FES. The DFES follows the FES 2024 trends for small-scale biomass CHP generation, with a small amount of growth in new capacity in the three net-zero scenarios. However, the overall FES scenario outcomes for biomass in the West Midlands reflects trends in large-scale biomass, which sees progressive decommissioning between the baseline year and 2050 under the net zero scenarios. Whereas the DFES projections retain a fairly narrow envelope and development activity for the biomass sector in the licence area.

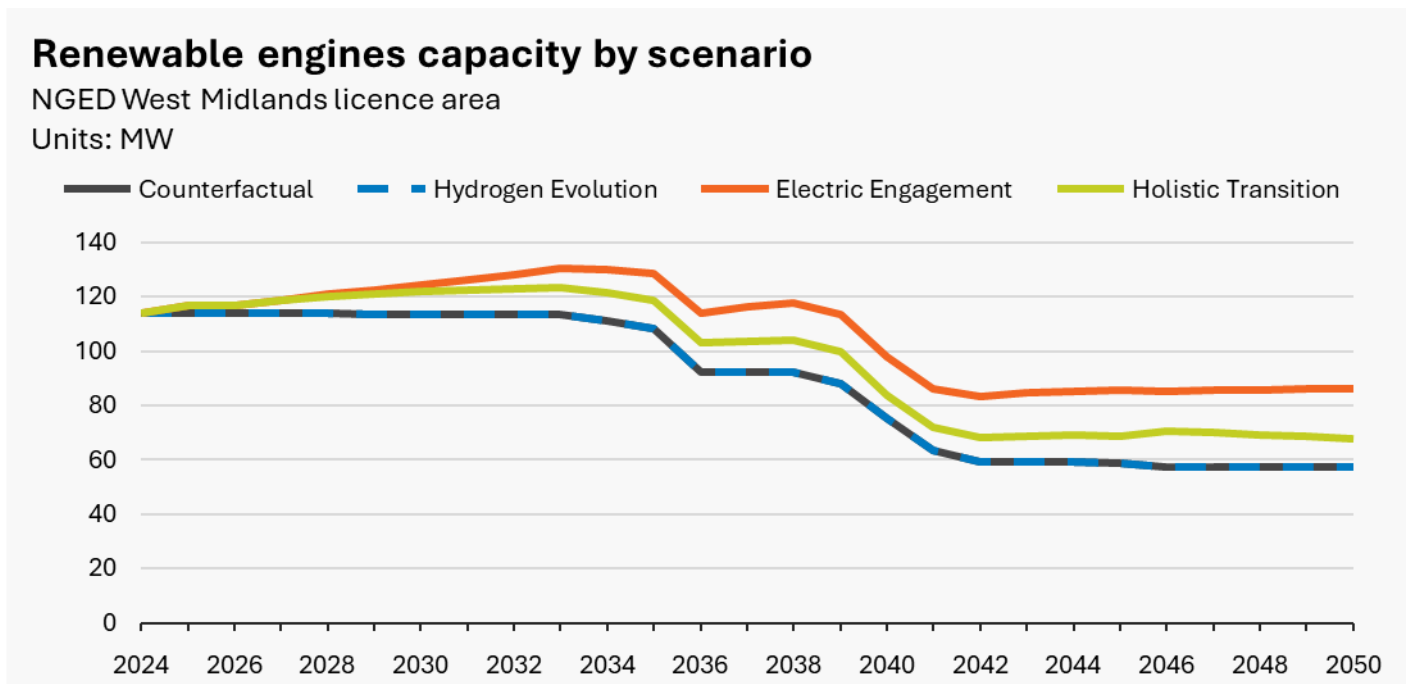
Comparison to DFES 2023

- ▶ The outcomes and modelling methods for biomass are similar between DFES 2023 and DFES 2024.

Renewable engines

Summary

- ▶ Renewable engines as a technology sector is divided into three types of sites: landfill gas, the anaerobic digestion of farm and food waste, and sewage gas at sewage treatment plants.
- ▶ Landfill gas, which makes up over half of the baseline capacity in the West Midlands, is modelled to decommission over time in every scenario, as the UK moves towards more sustainable waste treatment and an overall reduction in the volume of waste produced as a society.
- ▶ Anaerobic digestion, accounting for around one-third of the renewable engines baseline capacity, is projected to increase under the **Electric Engagement** and **Holistic Transition** scenarios. However, bioenergy resource is prioritised where possible in all scenarios for harder-to-decarbonise sectors such as industry, aviation and shipping, thereby limiting its role in electricity generation.
- ▶ Sewage gas, which makes up the remainder of the baseline capacity, is assumed to remain relatively stable in all scenarios, with much of the sewage gas resource already being captured and used for electricity and CHP generation at sewage treatment works.
- ▶ Combining these trends results in an overall reduction in renewable engines capacity in the West Midlands licence area, from 114 MW currently operational to between 93 MW in **Electric Engagement** and 59 MW in the **Hydrogen Evolution** and **Counterfactual** scenarios.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	114	The majority of anaerobic digestion baseline sites, which total 34 MW across 57 sites, are less than 2 MW in capacity and typically at farms in the more rural areas of the West Midlands licence area.
			The landfill gas baseline, totalling 59 MW across 27 sites, consists of sites near urban areas. The vast majority of these sites were connected between 1994 and 2016.
			The sewage gas baseline consists of generation at Severn Trent and Thames Water sewage treatment works. All of these sites are relatively small scale, with a maximum capacity of 5 MW, and all but one were connected between 1995 and 2018.
Pipeline	Accepted to connect	3	There are just two projects in the pipeline. The largest site, a 3 MW anaerobic digester in Wychavon, is already operational but as a gas-to-grid site. This is projected to switch to providing electricity under Electric Engagement and Holistic Transition in the mid-2020s, as these scenarios features a reduced role of the gas network in the coming years. The remaining site, a 0.15 MW anaerobic digestion project, is projected to connect in the near term under all four scenarios due to its small scale.

Projections

Scenario	Description
Holistic Transition	Landfill gas sites that are operational or in development are modelled to have an operational lifespan of 30 years under every scenario, after which point the connection is decommissioned. This reflects desk research on landfill gas output over the lifetime of the project.
Electric Engagement	Sewage gas sites that are operational or in development are modelled to remain connected at a consistent capacity out to 2050 under every scenario. The lack of projects being developed indicates there is low potential for growth in sewage gas capacity but that existing sites have long operational lifespans. Previous engagement with water companies suggested that further development of sewage gas resources would be focussed on on-site heat and power generation rather than exporting to the grid.
Hydrogen Evolution	
Counterfactual	The West Midlands has some potential for anaerobic digestion deployment due to the amount of farmland, particularly in the more rural western side of the licence area. Under Electric Engagement and Holistic Transition , anaerobic digestion sees a small amount of deployment throughout the scenario timeframe, whereas under

Hydrogen Evolution and **Counterfactual** there is no further deployment beyond the pipeline.

This results in a range of outcomes for renewable engines capacity from 56 MW under the **Counterfactual** and **Hydrogen Evolution** to 91 MW under **Electric Engagement**, compared to the 112 MW baseline.

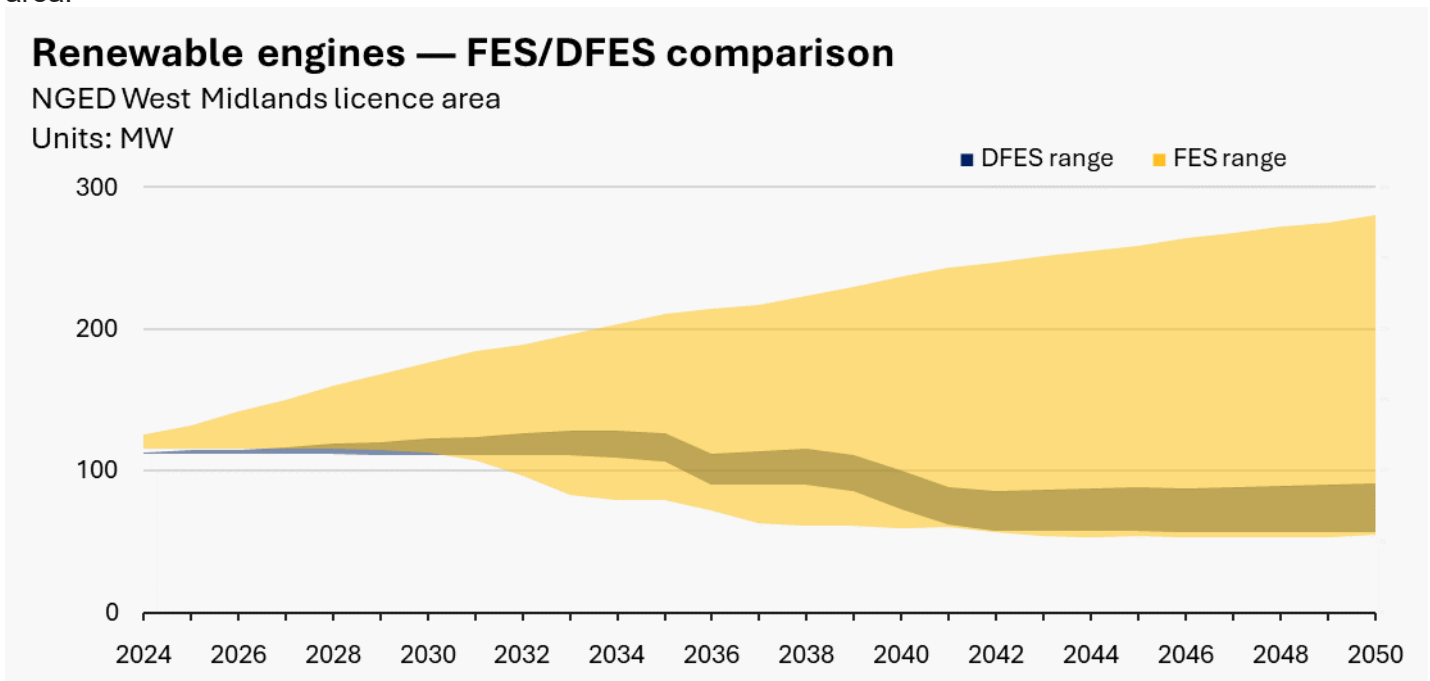
Uptake modelling and spatial distribution factors

The below factors are used to inform the overall uptake and spatial distribution of renewable engines capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Existing baseline and pipeline sites	<p>The baseline, pipeline and decommissioning are modelled directly on a site-by-site basis.</p> <p>Growth in anaerobic digestion capacity is distributed to existing anaerobic digestion sites.</p>	NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ The FES and DFES baselines in the West Midlands are closely aligned.
- ▶ The majority of the renewable engines baseline in the West Midlands is landfill gas, which is modelled to decommission at the end of its operational life under all four scenarios in the DFES. Sewage gas also has the same modelling assumptions under all four scenarios. This results in the DFES outcomes presenting a much narrower range of possible outcomes than the FES, as the only variance between the four DFES scenarios is the level of anaerobic digestion capacity growth. The lack of pipeline for this technology and requirements for bioenergy in other harder-to-decarbonise

sectors results in the projected growth in anaerobic digestion in the DFES not reflecting the amount projected in the higher FES scenarios.

Comparison to DFES 2023

- ▶ The modelling methods for renewable engines are similar between DFES 2023 and DFES 2024, resulting in a comparable range of outcomes.
- ▶ The near-term growth in anaerobic digestion capacity under the three net zero scenarios has been reduced in DFES 2024, reflecting the relatively small pipeline of developing projects. This results in lower overall capacity by 2050 in all scenarios, particularly under **Electric Engagement** and **Holistic Transition** which had substantially higher anaerobic digestion growth modelled in DFES 2023.

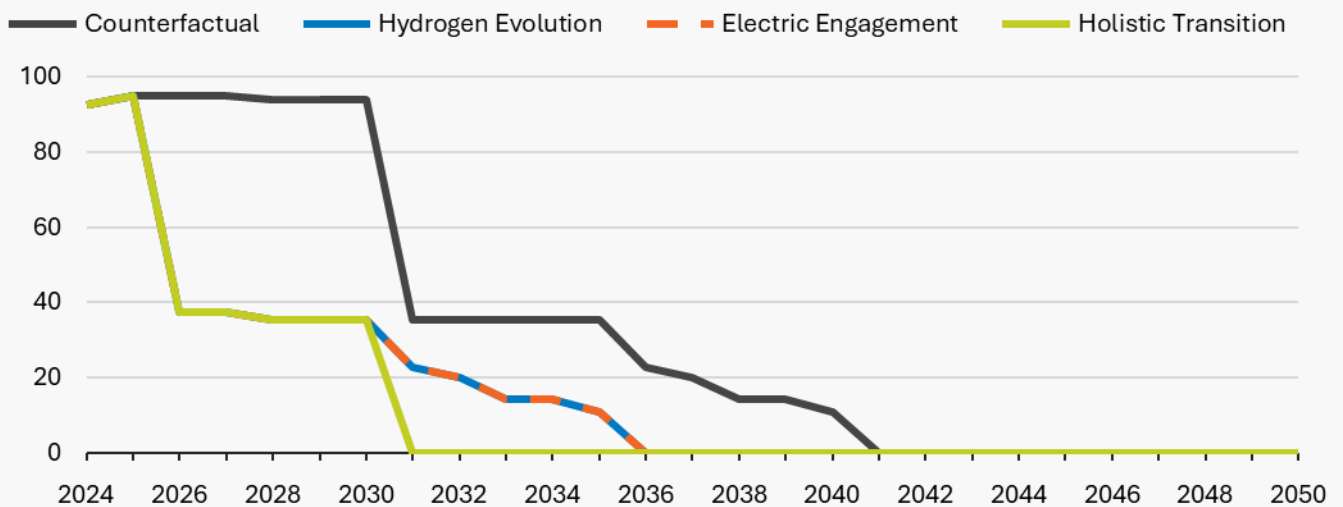
Diesel-fired electricity generation

Summary

- ▶ As one of the most polluting forms of electricity generation, diesel-fired electricity generation is being phased out across GB as generators respond to policies designed to minimise air pollution in the short term and meet carbon targets in the longer term. Overall diesel generation capacity has been decreasing across NGED’s licence areas over the last few years.
- ▶ The operation of unabated diesel generation is at odds with net zero emissions targets and is restricted by the UK’s implementation of the EU Medium Combustive Plant Directive (MCPD), which requires diesel generation plants with capacity over 5 MWth (c. 2 MWe) to adhere to stringent air quality limits unless they operate for 500 hours or fewer per year. Generators identified as being impacted by the MCPD are modelled to decommission after 2025 in all three net zero scenarios.
- ▶ Backup diesel generators are expected to remain connected to the network for longer under all scenarios, as they are unlikely to meet the MCPD threshold of 500 hours of operation. These backup generators are modelled to decommission later in the scenario timeframes, by 2031 under **Holistic Transition** and 2036 under **Electric Engagement** and **Hydrogen Evolution**.
- ▶ Under the **Counterfactual** scenario, commercial and backup diesel generation remains connected for longer, as progress towards low carbon flexibility and backup power solutions is slower.

Diesel capacity by scenario

NGED West Midlands licence area
Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational (commercial)	58	Commercial diesel generation in the licence area is limited to just two large-scale sites, at 20 MW and 38 MW.

	Operational (backup)	35	Backup diesel generation is located mainly at hospitals, water treatment works and other industrial premises. These sites are much smaller, averaging 1.5 MW per site.
Pipeline	Accepted to connect	2	Two pipeline sites, expected to operate as backup generation, are modelled to connect in 2025 under all four scenarios.

Projections

Scenario	Description
Holistic Transition	The MCPD was passed into UK law in 2019. This requires plants with a thermal capacity of over 5 MWth (c. 2 MWe) to adhere to stringent air quality limits through environmental permitting, unless they operate for fewer than 500 hours per year. Unabated commercial diesel generation falls within this regulation and, therefore, will no longer be able to operate after 2025 without exhaust abatement technologies, such as catalytic reduction technology. The combination of high diesel prices and the cost of fitting exhaust abatement has made diesel generation financially unattractive.
Electric Engagement	As a result of the MCPD, commercial diesel baseline sites are modelled to decommission by 2026 at the latest under all three net zero scenarios. Backup diesel generators are exempt from these environmental permit requirements, due to their limited operational hours. Additionally, backup generators are allowed to extend their annual operating hours to 1,000 hours if needed in an emergency. Engagement with major energy users also suggests that biodiesel such as hydrotreated vegetable oil (HVO) may be used as a transition fuel to decarbonise backup power generation.
Hydrogen Evolution	These backup generators are modelled to decommission later in the scenario timeframes, either at the end of their assumed operational life of 20 years or by 2031 at the latest under Holistic Transition and 2036 under Electric Engagement and Hydrogen Evolution . The technology that replaces these assets varies, depending on the scenario. This could be a form of bioenergy generator or an electricity storage technology.
Counterfactual	This scenario assumes less stringent emissions limits and less ambitious decarbonisation strategies for generators. Commercial diesel falling under the MCPD is not modelled to decommission until 2030, unless its operational life is reached before this point, and backup diesel remains connected into the 2040s.

Uptake modelling factors

The below factors are used to inform the overall uptake of diesel generation in the West Midlands licence area.

Factor	Modelling impact	Source
Medium Combustion Plant Directive	The MCPD dictates the decommissioning timescales for commercial diesel plants, from 2026 under the net zero scenarios and 2031 under the Counterfactual .	Environment Agency DEFRA

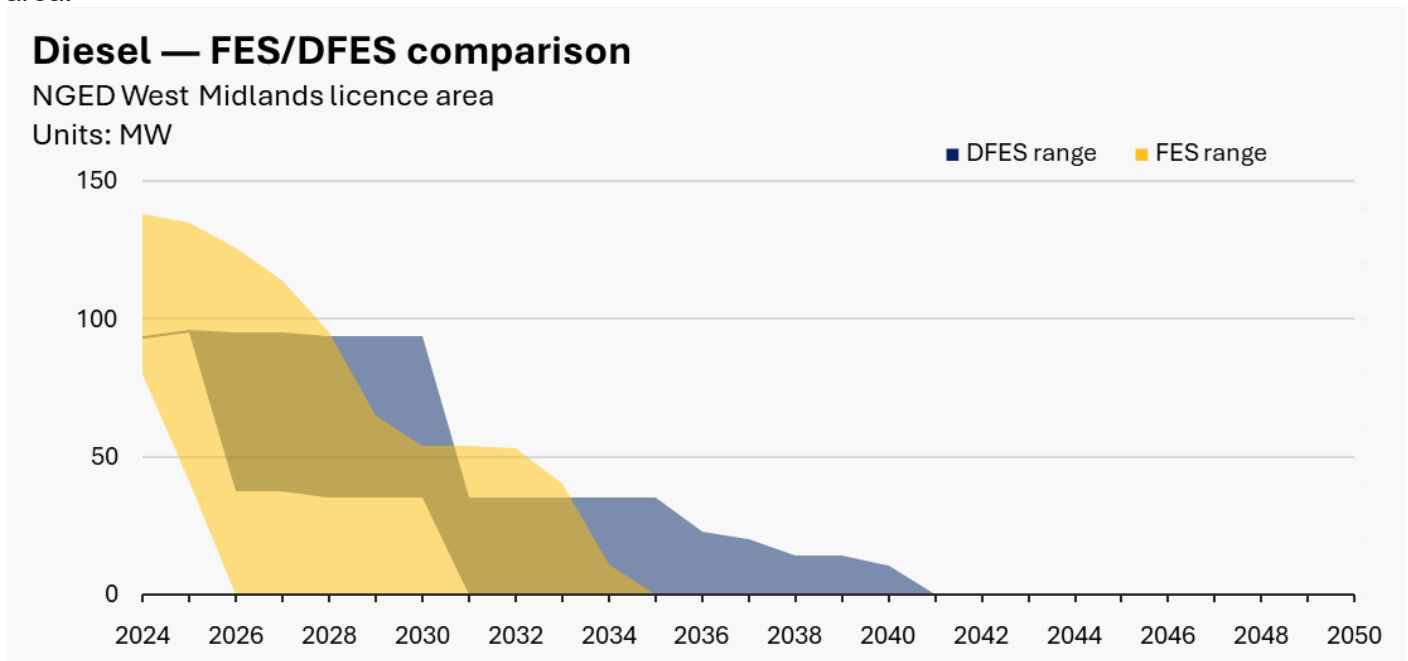
Spatial factors

The below factors are used to inform the spatial distribution of diesel generation capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Existing baseline and pipeline sites	The DFES projections are modelled directly on a site-by-site basis.	NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ There is some difference between the FES and DFES baseline for diesel. The reason for this is unclear, as in other licence areas the DFES baseline has typically been above the FES for diesel generation. The FES and DFES baselines for diesel are well aligned. Note that the FES data has a variance between scenarios in 2024 due to the FES 2024 baseline year being 2023.
- ▶ The assumptions applied in the DFES modelling result in diesel generation decommissioning over a longer timescale than in the equivalent FES pathways. This is likely due to the explicit modelling of backup generation that is not anticipated to be impacted by the MCPD, as there is no clear driver for these sites to decommission in the short term.

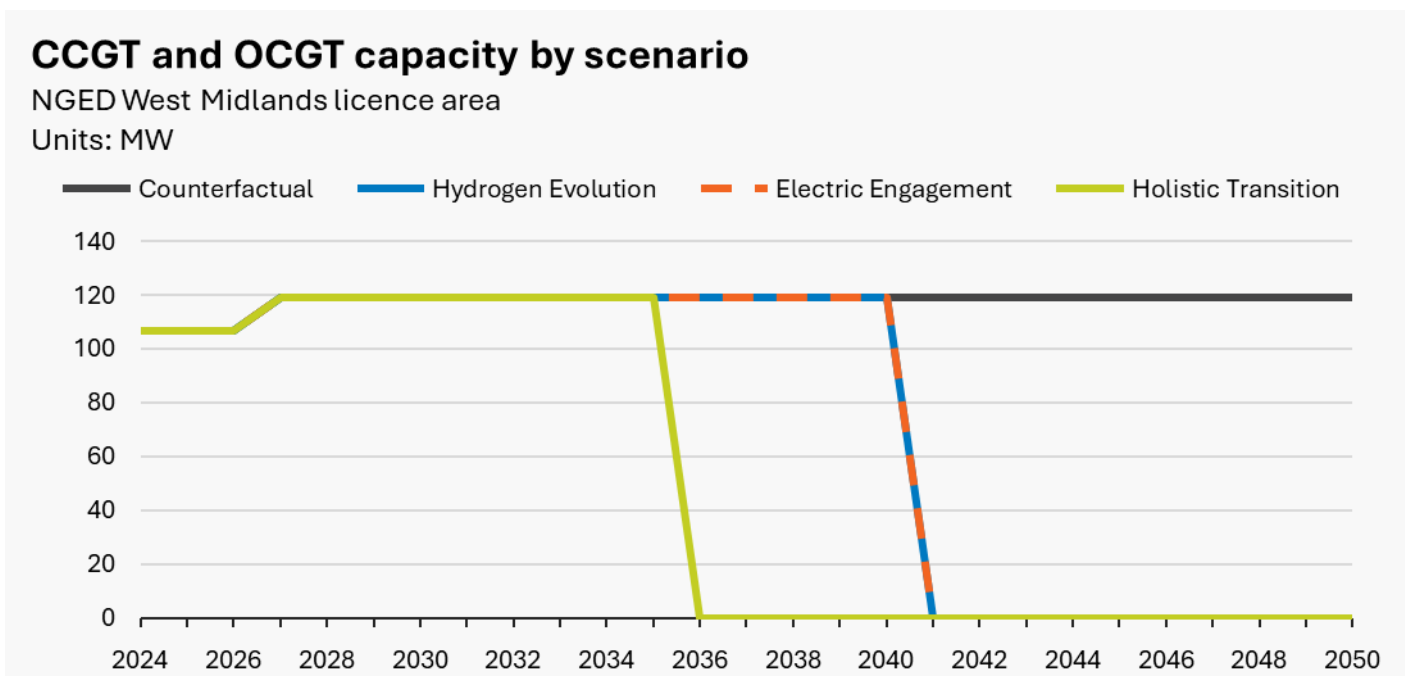
Comparison to DFES 2023

- ▶ The outcomes and modelling methods for diesel generation are similar between DFES 2023 and DFES 2024. However, backup diesel has been modelled to remain connected for longer into the medium term under all scenarios in DFES 2024, following desktop research and stakeholder engagement around the operational life of backup diesel plant and use of alternative fuels such as HVO/biodiesel.

Fossil gas-fired electricity generation

Summary

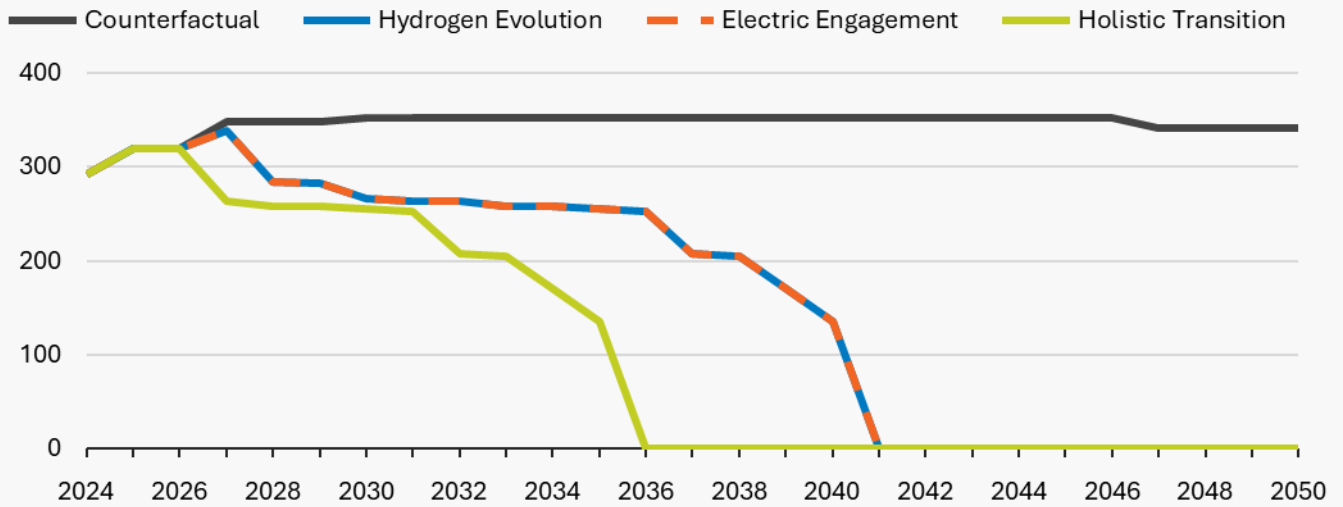
- ▶ There is nearly 600 MW of fossil gas-fired electricity generation capacity in the West Midlands licence area, mostly in the form of reciprocating engines, as well as OCGTs and gas CHPs.
- ▶ Deployment of gas-fired generation is slowing overall as GB looks to decarbonise its electricity system. There are only 16 mainly small-scale projects, totalling 87 MW of capacity, with an accepted connection offer with NGED. Around two-thirds of this capacity has planning approval and positive Capacity Market activity, and has therefore been modelled to progress under every scenario.
- ▶ In the net zero scenarios, fossil gas generation capacity is modelled to decrease across the late 2020s and 2030s as GB moves to lower carbon forms of dispatchable generation such as batteries, hydrogen-fuelled generation and bioenergy, alongside demand-side flexibility. This aligns with the FES 2024 scenario framework, under which the three net zero scenarios achieve net zero power by 2035 at the latest (though some gas-fired power remains connected for backup purposes).
- ▶ All three net zero scenarios model some fossil gas sites to repower as hydrogen-fuelled generation plants, particularly under **Hydrogen Evolution** where hydrogen is most readily available across GB.
- ▶ Under the **Holistic Transition** scenario all fossil-gas generation is decommissioned by 2036, and by 2041 under **Electric Engagement** and **Hydrogen Evolution**, as GB moves to net zero power. Note that this aligns with 2035 and 2040 years in FES 2024 respectively, due to NGED’s DFES modelling financial years.
- ▶ Slower progress towards decarbonisation results in most gas-fired electricity generation capacity remaining online beyond 2050 under the **Counterfactual** scenario.



Gas reciprocating engines capacity by scenario

NGED West Midlands licence area

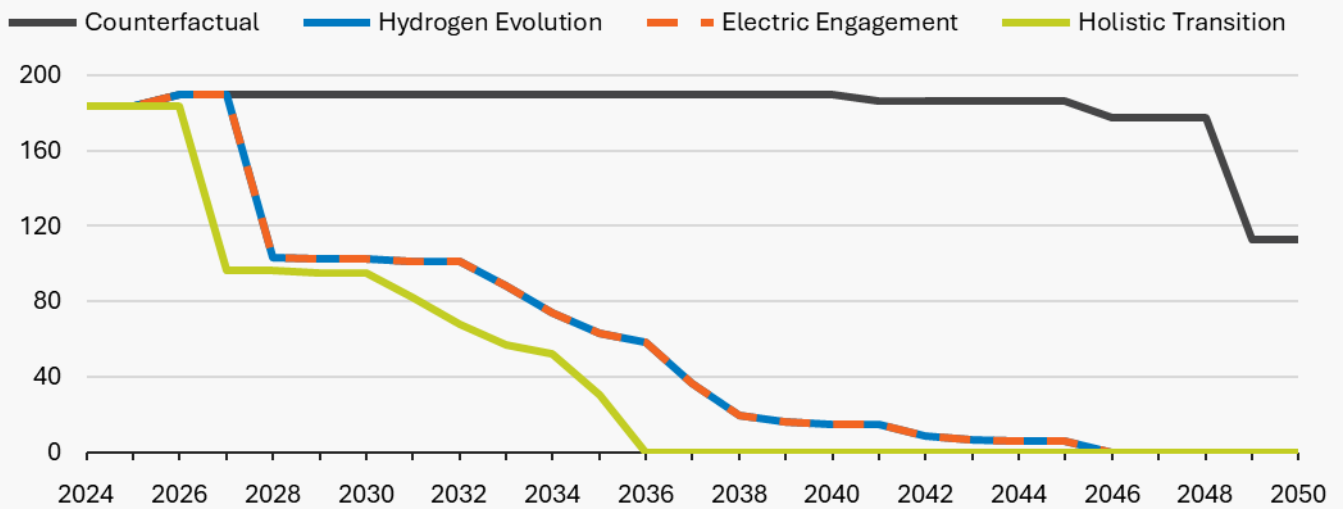
Units: MW



Gas CHP capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Technology type	Capacity (MW)	Description
Baseline	CCGT	0	There are 117 operational fossil gas generation sites in the West Midlands licence area. This includes two large-scale OCGT and CHP plants located in Birmingham and Stoke, at 100 and 65 MW respectively. Over 70% of this baseline capacity has been installed since 2010, mainly reciprocating engines and CHP sites.
	OCGT	107	
	Reciprocating engines	296	
	CHP	183	
Pipeline	CCGT	0	Six pipeline sites, totalling 60 MW, have been granted planning permission or are under construction, alongside positive Capacity Market activity, such as winning a Capacity Agreement or prequalifying in an auction. These sites are modelled to go ahead in every scenario.
	OCGT	13	One small-scale site has been granted planning permission but was not found to be active in the Capacity Market. This site is modelled to go ahead under all scenarios except Holistic Transition .
	Reciprocating engines	68	Seven further sites, totalling 13 MW, were not found in planning or the Capacity Market, and as such are only modelled to progress under the Counterfactual .
	CHP	6	One final remaining site (7 MW) was found to be abandoned based on developer engagement, and therefore is not modelled to progress under any scenario.

Projections

Scenario	Description
Holistic Transition	Fossil gas generation capacity decommissions quickly in the late 2020s and early 2030s as GB looks to achieve a rapidly decarbonised electricity system. Sites are modelled to decommission at the end of their operational life, ranging from 15 years for reciprocating engines to 20 years for OCGTs, or by a backstop date of 2036.
Electric Engagement	Fossil gas generation capacity decommissions in the late 2020s and throughout the 2030s as GB looks to achieve a rapidly decarbonised electricity system. Sites are modelled to decommission at the end of their operational life, ranging from 20 years for reciprocating engines and CHPs to 25 years for OCGTs, or by backstop dates of 2041 for electricity-only generation and 2046 for gas CHPs.
Hydrogen Evolution	

Counterfactual

Fossil gas generation remains online as progress towards net zero is slow and low-carbon alternatives to fossil gas generation see low uptake. Only older projects reaching the end of an extended operational life are modelled to decommission, resulting in a limited reduction in fossil gas capacity in the 2040s.

Uptake modelling factors

The below factors are used to inform the overall uptake of fossil gas generation in the West Midlands licence area.

Factor	Modelling impact	Source
Operational life of fossil gas plant	The operational life of a fossil gas plant informs the logic used to model site-by-site decommissioning for baseline and pipeline sites.	Desk research, analysis of previous baseline sites
Backstop decommissioning dates	The overall timeframe for the decommissioning of unabated fossil gas generation under each scenario has been mirrored from the FES 2024 scenario framework.	FES 2024

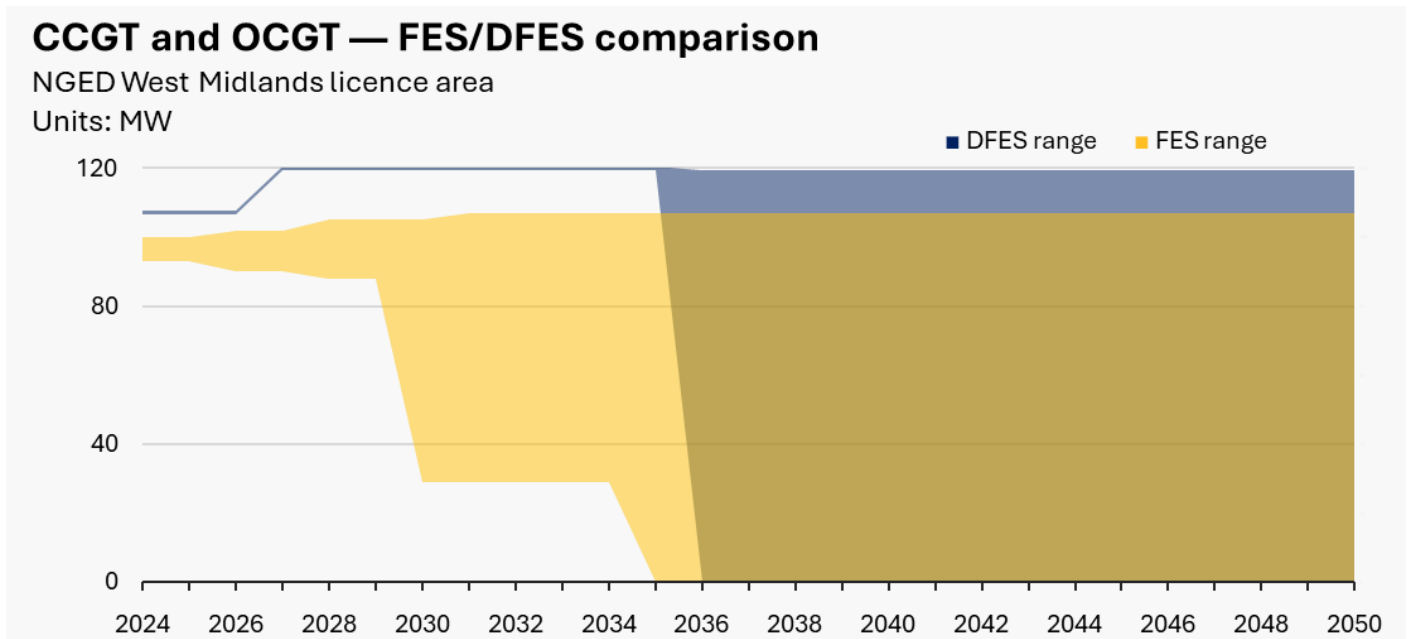
Spatial factors

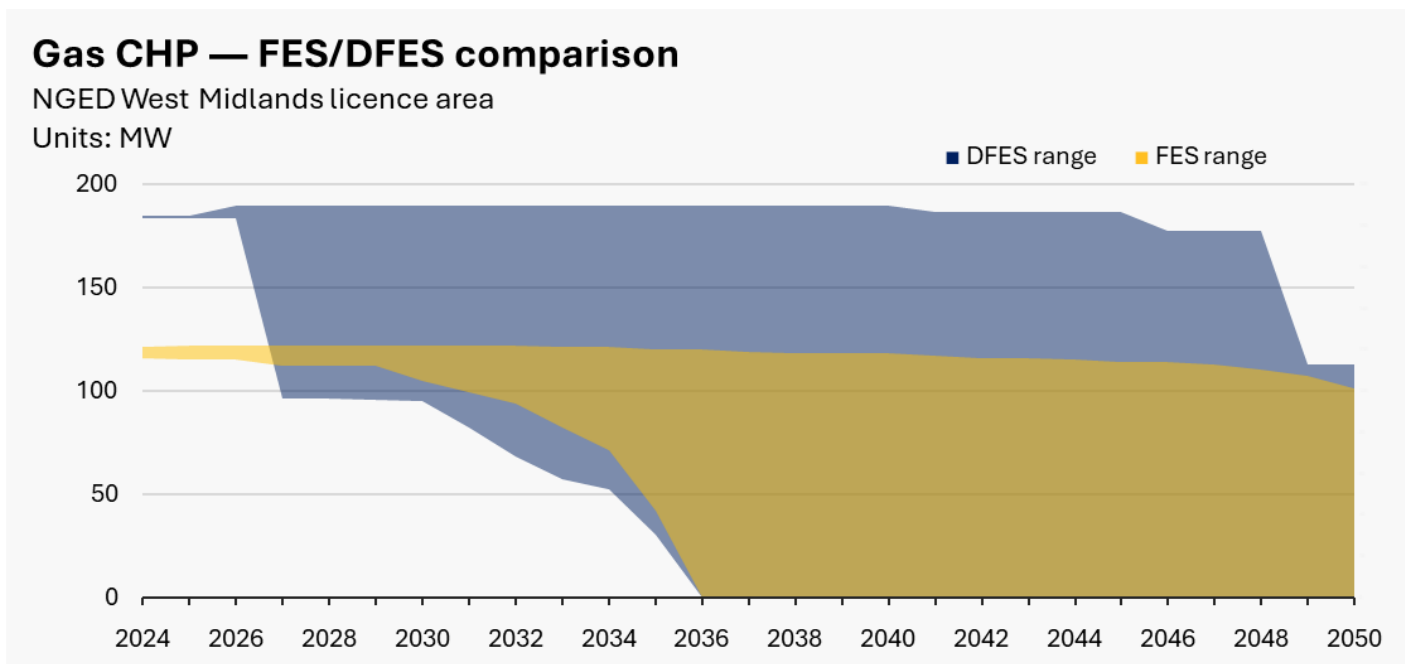
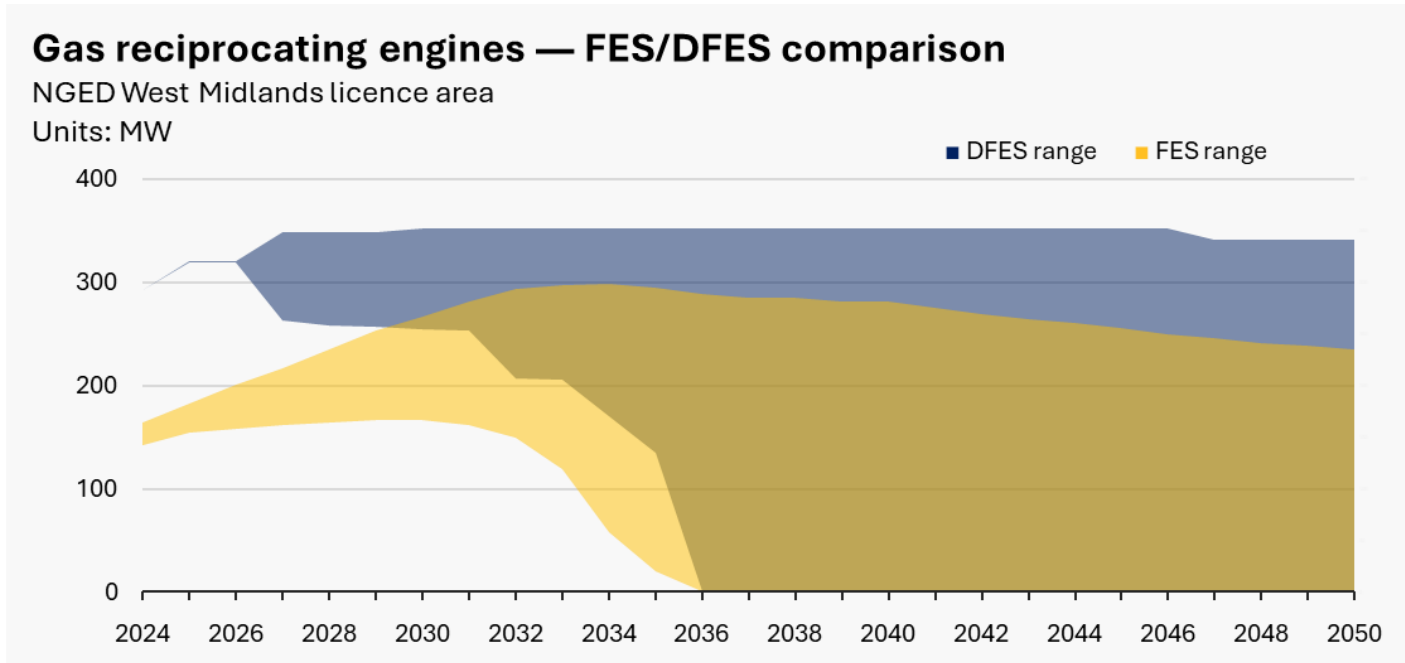
The below factors are used to inform the spatial distribution of fossil gas generation capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Existing baseline and pipeline sites	The DFES projections are modelled directly on a site-by-site basis.	NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.





- ▶ Overall, the DFES follows similar trends to the FES for fossil gas generation, as the final decommissioning year for each technology type is inherited from the FES 2024 framework.
- ▶ The DFES baseline for gas CHP is substantially higher than FES. The reason for this is unclear, but may be due to classification of subtechnologies or the DFES having greater visibility of behind-the-meter generation.
- ▶ The DFES baseline for reciprocating engines is substantially above the FES. In the neighbouring West Midlands licence area, this trend is reversed by a similar magnitude. Therefore, this baseline misalignment may be due to differences in allocation of baseline sites to licence areas in bordering areas.

- ▶ For gas reciprocating engines, the DFES does not project as much growth in the near and medium term as the FES. This is due to the site-by-site analysis of the pipeline, which shows that the development pipeline for fossil gas generation in the West Midlands is limited to under 90 MW of viable projects. Ongoing policy reforms being implemented by NESO suggest that the development of new unabated fossil fuel generation could be very limited, which reinforces the limited, pipeline-based DFES projection.

Comparison to DFES 2023

- ▶ The outcomes and modelling methods for fossil gas are similar between DFES 2023 and 2024.
- ▶ 2028 has been considered as the earliest possible decommissioning year for fossil gas generation in the DFES 2024 modelling process. This is to reflect the current trends around some new fossil gas generation being deployed rather than significant decommissioning.
- ▶ Compared to DFES 2023, the assumed operational lifespan of each technology type has been extended to reflect the likelihood of gas plants remaining online at very low load factors during the transition to net zero power. As a result, more capacity decommissions at the 'backstop years' for each net zero scenario in DFES 2024, rather than the more gradual decline modelled in DFES 2023.

Hydrogen-fuelled electricity generation

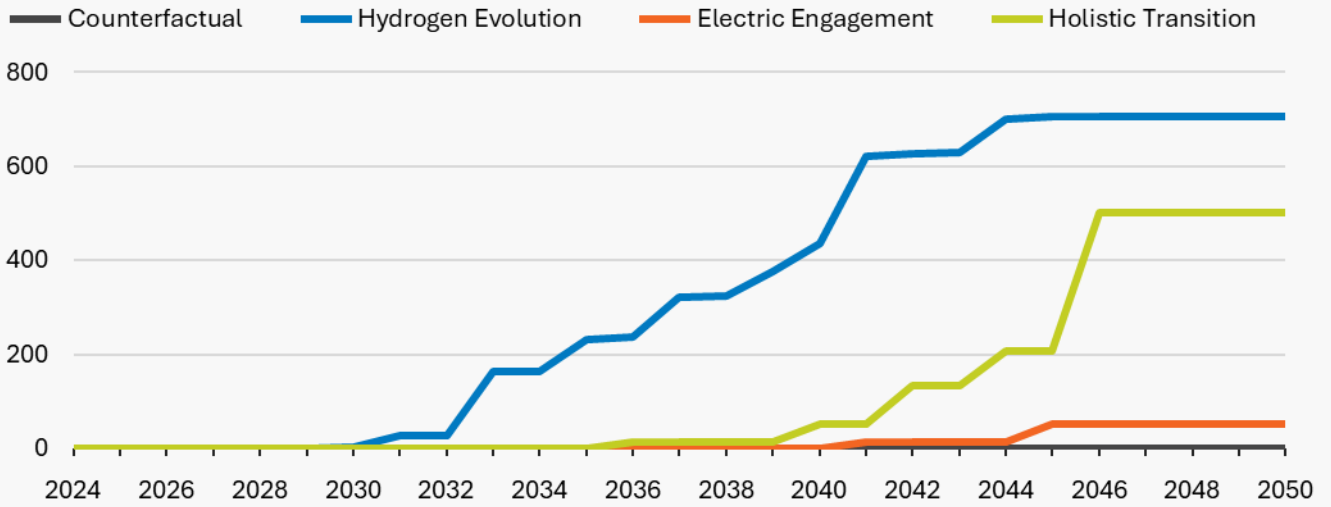
Summary

- ▶ Hydrogen-fuelled electricity generation is modelled based on the conversion of existing operational and in-development fossil gas generation sites to hydrogen-fuelled generation. This is modelled based on an analysis of if and when low-carbon hydrogen becomes regionally and locally available under each of the four scenarios.
- ▶ In 2023, the UK Government consulted on hydrogen-to-power business model support, publishing their response in late 2024. This proposed commercial support to enable hydrogen power generation through a 'dispatchable power agreement' arrangement and enabling hydrogen power generation to bid into the Capacity Market. This support could endorse the development of hydrogen power generation in the UK, in line with the three net zero scenarios.
- ▶ Dispatchable low-carbon electricity supply such as hydrogen-fuelled generation is seen as a key component in achieving a net zero power system based predominantly on variable renewables like solar PV and wind power, which occurs under all three net zero scenarios.
- ▶ Hydrogen becomes widely available in the 2030s and 2040s across GB under the **Hydrogen Evolution** scenario, resulting in a high proportion of existing and pipeline fossil gas generation sites converting to hydrogen-fuelled generation in the longer term. By 2050, over 700 MW of hydrogen-fuelled generation capacity is projected in the West Midlands licence area under this scenario.
- ▶ Under **Holistic Transition**, hydrogen only becomes widely available in and around industrial clusters rather than across most of GB. Even lower levels are available under **Electric Engagement**. This results in less hydrogen-fuelled generation both nationally and in the licence area under these scenarios.
- ▶ The West Midlands hosts some of the gas National Transmission System, which under National Gas' Project Union plan would be converted to transport hydrogen. This results in uptake in the early 2030s under the **Hydrogen Evolution** scenario, under which a national hydrogen transmission network is developed. However, the lack of major industrial clusters in the West Midlands means that uptake is slower under the **Holistic Transition** and **Electric Engagement** scenarios.
- ▶ There is no distribution-scale hydrogen-fuelled electricity generation anywhere in GB under the **Counterfactual** scenario as progress towards decarbonisation is slow under this scenario.

Hydrogen-fuelled generation capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	n/a	0	There are no baseline or pipeline hydrogen-fuelled generation projects in the licence area. For modelling purposes, the existing baseline and pipeline of fossil gas-fired generation projects are effectively used as a pipeline of prospective locations for future distributed hydrogen-fuelled power generation in the medium and longer term.
Pipeline	n/a	0	

Projections

Scenario	Description
Holistic Transition	<p>Operational and pipeline fossil gas-fired generation sites are modelled to convert to hydrogen once hydrogen is locally available and the gas-fired plant has been decommissioned.</p> <p>Hydrogen availability is modelled based on distance to an anticipated hydrogen or industrial cluster, such as the HyNet or East Coast Hydrogen projects. The FES framework assumes that hydrogen transmission is limited under these scenarios.</p>
Electric Engagement	<p>Under Holistic Transition, sites within 20 km of a cluster are able to convert to hydrogen from the early 2030s, expanding to over 150 km by the late 2040s. This results in over 500 MW of capacity connecting by 2050.</p> <p>Under Electric Engagement, the development of hydrogen-fuelled generation is more limited, starting in the mid-2030s and only occurring at sites within 50 km of an anticipated cluster. This results in under 100 MW of capacity connecting by 2050 due to the licence area’s relatively large distance from industrial or hydrogen clusters.</p>
Hydrogen Evolution	<p>Existing and pipeline fossil gas-fired generation sites are modelled to convert to hydrogen once hydrogen is locally available and the gas-fired plant has been decommissioned.</p> <p>Hydrogen availability is modelled based on the distance to a planned transmission hydrogen network, namely Project Union, or an anticipated hydrogen or industrial cluster, such as the HyNet or East Coast Hydrogen projects.</p> <p>Sites within 20 km of a cluster are able to convert to hydrogen from the early 2030s, expanding to over 150 km by the late 2040s. In addition, due to the wider availability of hydrogen under this scenario and the benefits of hydrogen as a high-capacity, low-utilisation ‘peaking’ technology, current gas reciprocating engines are modelled to replant with an additional 50% capacity. This results in over 700 MW of capacity connecting by 2050.</p>
Counterfactual	<p>In alignment with the FES 2024 framework, there is no development of hydrogen-fuelled generation at any point under this scenario.</p>

Uptake modelling factors

The below factors are used to inform the overall uptake of hydrogen-fuelled generation in the West Midlands licence area.

Factor	Modelling impact	Source
Existing baseline and pipeline of gas-fired generation	Modelled conversion of gas-fired generation sites to hydrogen-fuelled generation forms the basis of the capacity, timing and location of hydrogen-fuelled generation.	NGED DFES 2024
Location of industrial clusters and planned hydrogen clusters	Timing of the modelled conversion of gas-fired generation sites is based on the distance from industrial clusters and planned hydrogen clusters in all three net zero scenarios.	Regen analysis, DESNZ Track-1 CCUS clusters
Location of planned hydrogen networks	Timing of the modelled conversion of gas-fired generation sites is based on the distance from planned hydrogen networks under the Hydrogen Evolution scenario.	Regen analysis, National Gas

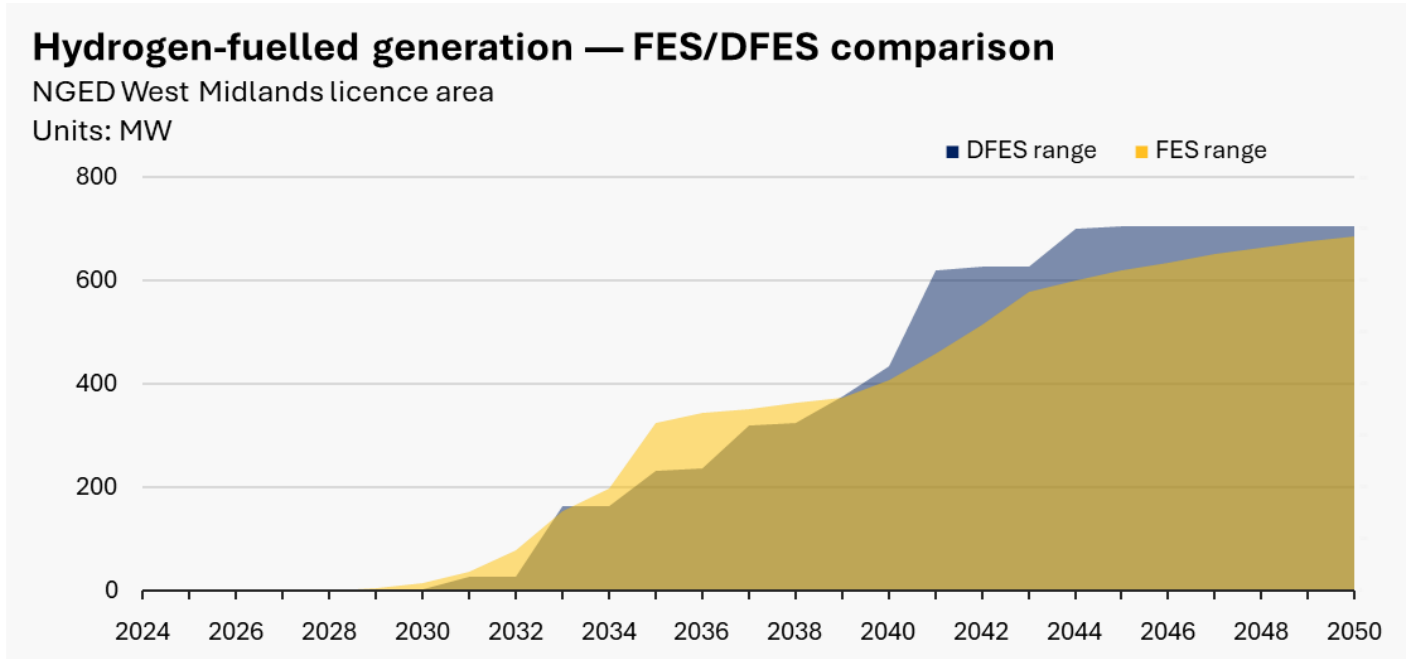
Spatial factors

The below factors are used to inform the spatial distribution of hydrogen-fuelled generation capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Existing baseline and pipeline of gas-fired generation	The location of future hydrogen-fuelled generation sites is based solely on the location of baseline and pipeline gas-fired generation sites in the licence area.	NGED DFES 2024

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ The envelope of DFES outcomes in the West Midlands licence area are very closely aligned to the FES data at a licence area level.
- ▶ The uptake of hydrogen-fuelled generation under **Holistic Transition** and **Electric Engagement** occurs later in the DFES compared to the FES, due to the modelling assumption that cluster-based supply of hydrogen takes longer to occur in the West Midlands due to the lack of major industrial and hydrogen clusters in the licence area.

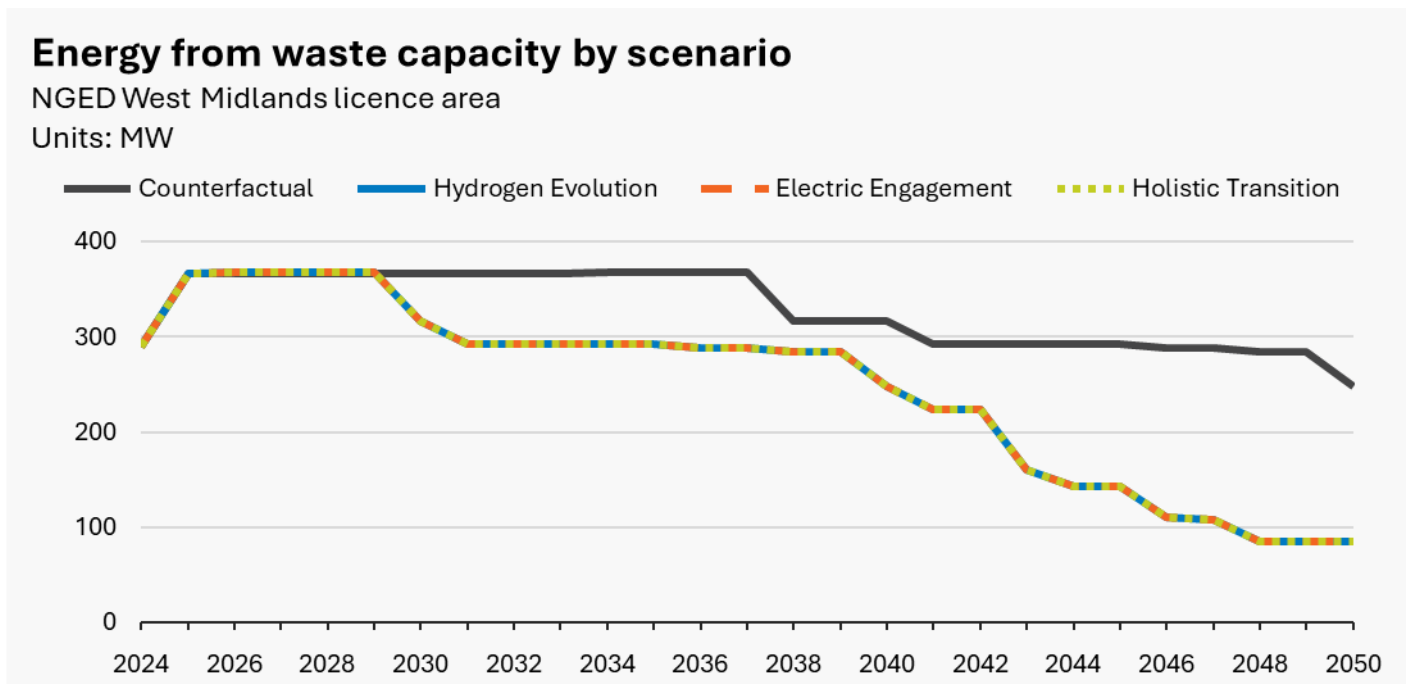
Comparison to DFES 2023

- ▶ The outcomes for **Hydrogen Evolution** and **Holistic Transition** have been inverted compared to DFES 2023, mirroring the same change in the FES 2024 framework.
- ▶ Sites are no longer limited by a maximum ‘mothballing period’ of ten years between gas-fired plant decommissioning and hydrogen-fuelled generation commissioning. This aims to represent existing sites as prospective site locations for thermal generation (including hydrogen-fuelled generation), regardless of whether the site is a conversion of an existing plant or a new build project.

Energy from waste

Summary

- ▶ Energy from waste, conventionally in the form of waste incineration, has historically been used alongside the landfill of waste that has not been reused or recycled. There is a substantial 290 MW baseline of energy from waste projects currently operating in the West Midlands licence area. There is also a pipeline of new energy from waste projects currently in development, totalling 78 MW.
- ▶ In the near term, energy from waste capacity increases in all scenarios as a number of projects with existing planning permission are commissioned.
- ▶ Waste incineration is highly carbon intensive and, therefore, sites are modelled to decommission under the three net zero scenarios out to 2050 as cleaner approaches to waste management become commonplace. More efficient energy from waste plants, such as Advanced Conversion Technology (ACT) gasification plants, operate beyond 2050 under all four scenarios.
- ▶ In contrast, only a handful of older waste incineration plants are modelled to decommission under the **Counterfactual**, with c. 250 MW of energy from waste capacity still operating in 2050.



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	290	Operational energy from waste capacity in the West Midlands ranges from sites built in the early 1990s to sites commissioned in 2022, although no large-scale capacity over 10 MW has been

			built since 2018. There are three sites of over 30 MW located in Stafford, Birmingham and Sandwell. Almost all of the baseline is located around major urban population centres to deal with municipal waste.
Pipeline	Under construction	76	Two large-scale pipeline sites are already under construction and are therefore modelled to connect in the next year under all four scenarios.
	Granted planning permission	2	One smaller pipeline site has been granted planning permission but is subject to a Statement of Works. This is modelled to connect in the near term under all three net zero scenarios, and on its Statement of Works date under Counterfactual .

Projections

Scenario	Description
Holistic Transition	Under the net zero scenarios, conventional waste incineration sites are projected to decommission after 30 years of operational life ³⁸ , reflecting a reduced volume of waste in these scenarios and the drive to reduce carbon emissions.
Electric Engagement	More efficient sites, using ACT gasification or sites classified as ‘Energy Recovery Facilities’ (incineration sites that meet higher energy efficiency criteria), are not projected to come offline under any scenario out to 2050. This assumes that any remaining waste in the 2030s and 2040s is processed at less carbon-intensive, highly efficient ACT sites under these scenarios.
Hydrogen Evolution	Due to the many of the baseline sites being build pre-2000 and reaching the end of their operational life during the scenario timeframe, 85 MW of energy from waste capacity remains operational in the West Midlands in 2050 under these scenarios.
Counterfactual	Lower levels of societal change and limited progress towards carbon emission reduction means that waste incineration sites continue to operate up to 40 years after their commissioning date. This results in 248 MW remaining online in 2050.

Uptake modelling and spatial distribution factors

The below factors are used to inform the overall uptake and spatial distribution of energy from waste capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Decommissioning timescales	The potential operating lifespan of incineration energy from waste plants determines the projected decommissioning dates of individual sites under each scenario.	Desk research

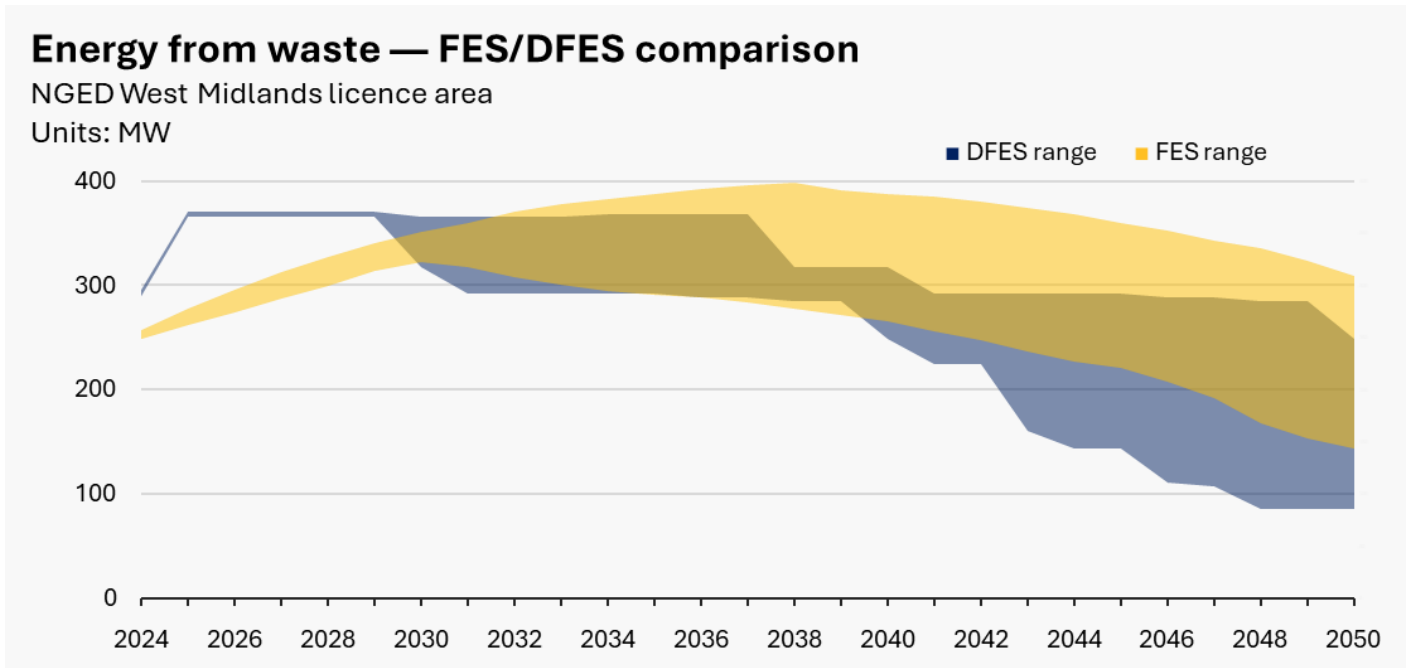
Location of existing baseline and pipeline sites

All energy from waste spatial modelling is based on existing baseline and pipeline sites.

NGED connections data

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ The DFES baseline is slightly higher than the FES, by around 50 MW.
- ▶ The DFES energy from waste projections for the West Midlands exceed the FES projections in each scenario across the 2020s. This is driven by the pipeline of energy from waste sites with strong evidence of development that are modelled to commission in the next few years.
- ▶ In the longer term the DFES and FES trends closely align as older sites decommission and energy from waste capacity decreases overall by 2050. The age of sites in the West Midlands results in a large proportion of baseline capacity decommissioning, resulting in the DFES projections falling slightly below the FES scenario range by 2050.

Comparison to DFES 2023

- ▶ The outcomes and modelling methods for energy from waste are closely aligned between DFES 2023 and DFES 2024.

Other generation

Summary

- ▶ There are 23 connected sites in the licence area that have not been categorised as a particular technology, totalling 2.8 MW. These are likely to be small-scale fossil-fuel generation sites, but they could not be specifically identified as such in the NGED connections data.
- ▶ There are two additional other generation sites with an accepted connection offer, totalling 0.3 MW. These pipeline sites have been modelled to connect in 2025 under every scenario.
- ▶ There are no projections for other generation beyond the pipeline of accepted connections, resulting in 3.1 MW under all scenarios by 2050.

Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	2.8	There are 23 connected sites in the West Midlands licence area that could not be categorised as a particular technology.
Pipeline	In development	0.3	There are two additional sites with accepted connection offers that could not be categorised as a particular technology. Due to the lack of information, and the small size of the projects, these have been modelled to connect in 2025 under every scenario.

Uptake modelling and spatial distribution factors

The below factors are used to inform the overall uptake and spatial distribution of other generation in the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Location of connected and in-development sites	The DFES projections are wholly based on operational and in-development sites, as identified through NGED’s connection data.	NGED connections data

Comparison to DFES 2023

- ▶ Both the baseline and pipeline capacity of other generation in DFES 2024 is significantly less than in DFES 2023, due to the successful reclassification of sites to a modelled technology.

Storage technologies

Results and assumptions

Small-scale battery storage

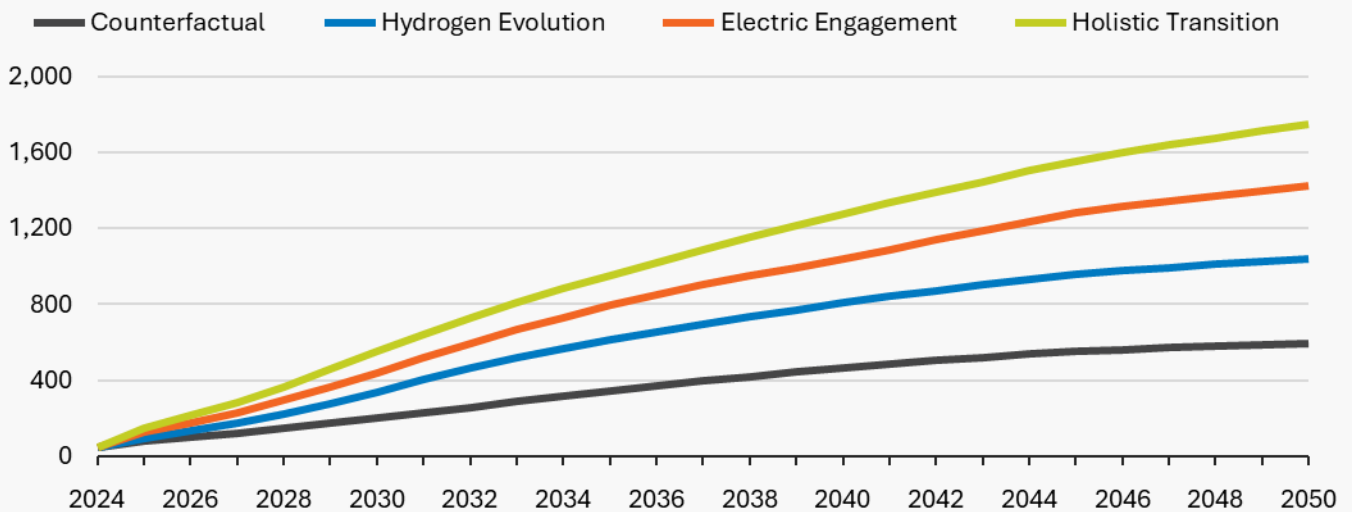
Summary

- ▶ Small-scale battery storage, in the form of domestic batteries and batteries installed at commercial and industrial properties with high energy demand, has a relatively small baseline in the West Midlands but a high potential to grow under every scenario.
- ▶ Domestic battery uptake is closely tied to the uptake of domestic rooftop solar PV. In the past two years, over half of domestic PV installations have been installed alongside a domestic battery. This trend is modelled to continue in the near term under all four scenarios. In the longer term, adoption of domestic batteries reduces, as other forms of demand flexibility are favoured.
- ▶ Installations of behind-the-meter batteries at ‘high energy user sites’, such as factories, hospitals and universities, are projected to increase under all four scenarios. This is a reflection of businesses seeking to maximise the self-consumption of onsite renewable generation, as well as using batteries for onsite energy management and participating in commercial balancing services.
- ▶ There is some uncertainty around how prevalent domestic and non-domestic batteries will be in the future, compared to alternative sources of flexibility such as smart charging, V2X and thermal storage. As a result, there are a range of outcomes modelled for small-scale battery storage in the licence area, from 0.6 GW under the **Counterfactual** to 1.7 GW under **Holistic Transition**.

Small-scale battery storage capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data and SolarPower Europe market outlook report

Installation type	Capacity (MW)	Description
Baseline	Domestic (<10 kW)	<p>The lack of available data for domestic battery storage installations means that the true baseline capacity is not well understood. This is due to the majority of home batteries being installed alongside a solar PV installation and only one of the technology types typically being recorded. There is no complete national database for domestic battery installations.</p> <p>Engagement with domestic solar and battery installers suggests that over half of domestic solar PV installed in 2023 and 2024 were installed alongside a home battery. This aligns with a market outlook report by SolarPower Europe, which suggests a UK residential battery storage fleet of 1.1 GWh.³⁹</p> <p>The domestic battery baseline has therefore been modelled based on a disaggregation of this market outlook to licence areas based on domestic solar PV uptake, since the two technologies are very often installed in tandem.</p>
	Commercial (10 kW – 1 MW)	<p>There are 32 ‘high energy user’ battery storage sites in the baseline. These are defined as sites with an export capacity of 10 kW to 1 MW. While a large number of these sites have been installed in the last two years, the baseline of commercial and industrial battery storage assets in the licence area dates back as far as 2016.</p>
	Domestic (< 10 kW)	<p>In part due to NGED’s new ‘connect and manage’ scheme for domestic low-carbon installations, there is currently no pipeline data for domestic battery storage installations.</p>
Pipeline		<p>The pipeline of small-scale battery storage consists entirely of high energy user installations, between 10 kW and 1 MW.</p>
	Commercial (10 kW - 1 MW)	<p>This 16-site pipeline totalling 5 MW, is modelled to connect in 2025 under all four scenarios due to the small scale of the sites, that can be deployed quickly under permitted development.</p> <p>Additional domestic-scale battery capacity, not represented by known connection applications data, is likely to be deployed in the very near term. This has been considered in the DFES modelling under all scenarios.</p>

Projections

- ▶ Domestic battery projections are directly tied to domestic rooftop solar PV projections in the DFES modelling.

- ▶ High energy user battery storage projections are driven by the scale of commercial and industrial premises in the licence area. The West Midlands licence area has a significant number of high energy users with the potential for a battery, based on the classification of existing businesses.

Scenario	Description
<p>Holistic Transition</p>	<p>Under this scenario, the proportion of domestic solar installations being installed with an accompanying domestic battery starts at 55% in the near term, reflecting current market reports, and decreases to 25% by 2050 as uptake of EVs (potentially with V2X capability) and thermal storage reduces the case for standalone domestic storage. Overall uptake still remains highest of all the scenarios due to the number of highly engaged consumers.</p> <p>Deployment at high energy user sites increases significantly over the scenario timeframe as more businesses seek to manage their onsite energy use and costs through flexibility technologies.</p> <p>Small-scale battery capacity, therefore, reaches 1.7 GW by 2050 under this scenario.</p>
<p>Electric Engagement</p>	<p>Under this scenario, the proportion of domestic solar installations being installed with an accompanying domestic battery starts at 55% in the near term, reflecting current market reports, and decreases to 20% by 2050 as uptake of EVs (potentially with V2X capability) and thermal storage reduces the case for standalone domestic storage. Uptake still remains high due to the number of highly engaged consumers.</p> <p>Deployment at high energy user sites increases over the scenario timeframe as more businesses seek to manage their onsite energy use and costs through flexibility technologies.</p> <p>Small-scale battery capacity, therefore, reaches 1.4 GW by 2050 under this scenario.</p>
<p>Hydrogen Evolution</p>	<p>Under this scenario, the proportion of domestic solar installations being installed with an accompanying domestic battery starts at 55% in the near term, reflecting current market reports, and decreases to 12% by 2050 as uptake of EVs (potentially with V2X capability) and thermal storage reduces the case for standalone domestic storage and consumers are not strongly engaged in demand flexibility.</p> <p>Deployment at high energy user sites increases moderately over the scenario timeframe as a limited number of businesses seek to manage their onsite energy use and costs through flexibility technologies.</p> <p>Small-scale battery capacity, therefore, reaches 1.0 GW by 2050 under this scenario.</p>
<p>Counterfactual</p>	<p>Under this scenario, the proportion of domestic solar installations being installed with an accompanying domestic battery starts at 55% in the near term, reflecting current market reports, and decreases to 10% by 2050 as uptake of EVs (with V2X capability) and thermal storage reduces the case for standalone domestic storage and consumers are not engaged in demand flexibility.</p> <p>Deployment at high energy user sites increases slowly over the scenario timeframe as only a small number of businesses seek to manage their onsite energy use and costs through flexibility technologies.</p> <p>Small-scale battery capacity, therefore, reaches 0.6 GW by 2050 under this scenario.</p>

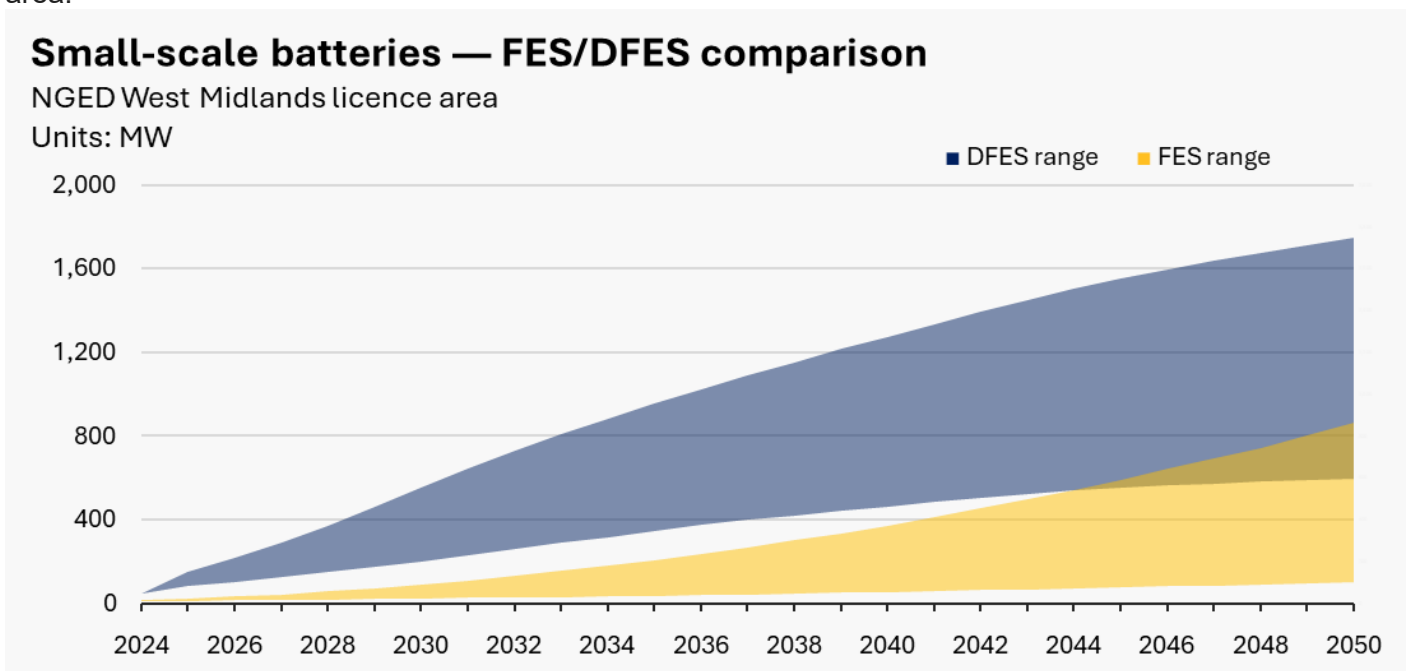
Uptake modelling and spatial distribution factors

The below factors are used to inform the overall uptake and the spatial distribution of small-scale batteries in the West Midlands licence area, down to LV and 11 kV ESAs.

Factor	Modelling impact	Source
Domestic rooftop solar PV uptake	Domestic battery storage uptake and the location of installations are directly tied to the uptake of domestic solar PV uptake.	DFES modelling
Number and location of 'high energy user' commercial and industrial sites	High energy user battery storage uptake and distribution is based on the number and location of existing energy-intensive non-domestic properties, such as industrial estates, hospitals, universities and factories.	OS Addressbase

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ The DFES outcomes for small-scale batteries are significantly higher than the FES 2024, driven by modelling differences regarding domestic batteries.
- ▶ Based on engagement with domestic solar and battery installers, combined with market report data and domestic solar PV projections, the DFES small-scale battery baseline is significantly above the FES. This reflects high-levels of domestic battery installations over the past two years.
- ▶ These currently occurring trends are projected to continue into the near term, reflecting real-world uptake of domestic battery storage systems over the past several years. They are then modelled to decline in the longer term as other domestic flexibility options, such as smart charging, V2X and thermal storage, become more prevalent. This is opposite to the FES trend, where domestic battery

uptake continues to accelerate over the scenario timeframe out to 2050. The DFES analysis aims to reflect current trends in domestic battery uptake as informed by industry stakeholders.

Comparison to DFES 2023

- ▶ The small-scale battery projections have changed significantly since DFES 2023, in both the baseline and the magnitude of projections over the scenario timeframe.
- ▶ Previous DFES small-scale battery projections were closely tied to the FES projections. As such, the changes detailed in the reconciliation to FES above also apply to this comparison.

Large-scale battery storage

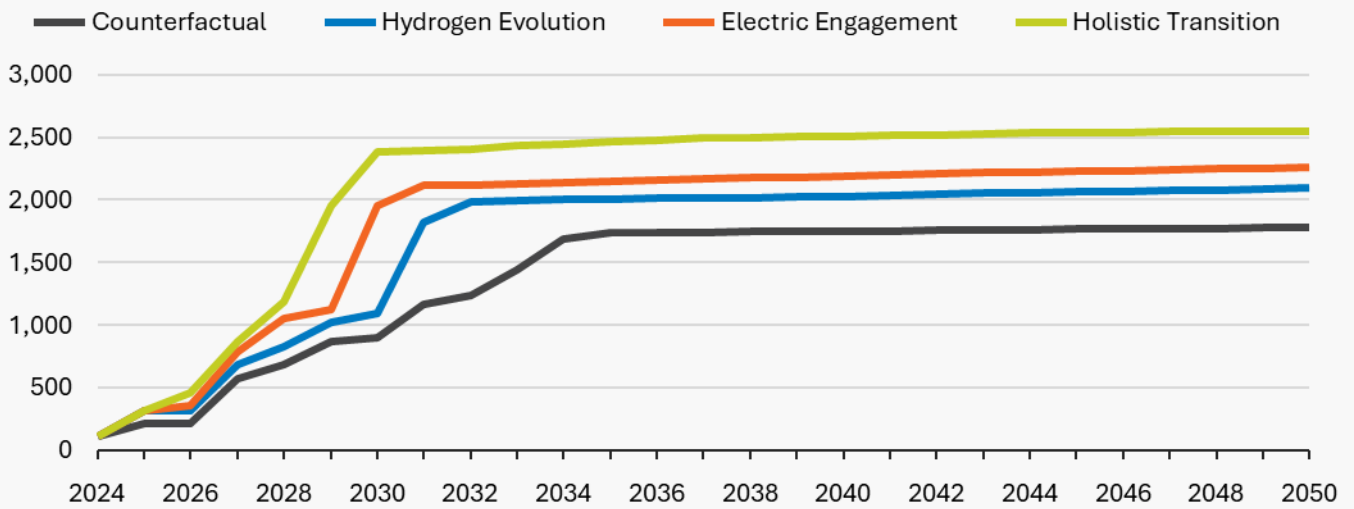
Summary

- ▶ Grid-scale battery storage has become one of the most active development sectors in the UK, with numerous developers and four listed capital investment funds seeking to develop battery storage projects at various scales across the country.
- ▶ In the context of the wider GB energy system, low-carbon dispatchable power and flexibility are required to manage variable generation, meet peak demand, ensure security of supply, manage network constraints and maximise the economic value of abundant renewable energy when it is available. As GB looks to achieve Clean Power by 2030 and a net zero power system by 2035, the rapid deployment of new large-scale (almost entirely Lithium-Ion based) battery storage is projected under every scenario as a key component to achieving these goals.
- ▶ There is a huge pipeline of prospective battery storage projects across the UK, and NGED's licence areas are no exception. In the West Midlands licence area alone, the pipeline of battery storage sites that hold accepted connection offers currently totals nearly 10 GW.
- ▶ However, with significant reforms to network connection policy and battery storage asset revenues becoming challenging for new entrants, it is likely that only a limited proportion of this pipeline will progress through to development, even in the longer term. This is partially evidenced by only 2.2 GW being found to have obtained planning approval to date.
- ▶ As a result of these factors, the modelled deployment of the more advanced battery storage pipeline projects results in a range of scenario outcomes by 2030. **Holistic Transition** is the scenario that supports the highest uptake of decentralised battery storage, reaching 2.4 GW by 2030, while the **Counterfactual** reaches c. 0.9 GW in the same timeframe.
- ▶ Sites with submitted planning applications, pre-planning activity or no evidence planning activity have only been modelled to progress under the **Storage Planning** scenario. This scenario does not aim to represent a credible projection of storage development in the licence area, but instead models the connection of all batteries, with reasonable connection timelines assessed on a per-project basis, to provide NGED with added insight into the scale of the current battery storage pipeline.
- ▶ Beyond 2035, deployment of large-scale battery storage is projected to slow as the market becomes further saturated and alternative sources of flexibility such as small-scale battery storage, thermal storage and V2G see increased uptake. In addition, the development of a new market mechanism for long-duration electricity storage (LDES) creates the potential for other storage technologies to begin to build out in the longer term, though many of these may end up connecting to the transmission network, due to their scale (e.g. new strategic pumped hydropower sites).
- ▶ In all scenarios, deployment of new large-scale battery storage beyond the known pipeline is mostly limited to battery assets co-located with large-scale solar PV and onshore wind projects.
- ▶ As a result, the total amount of large-scale battery storage connected to the distribution network in the West Midlands licence area in 2050 ranges from 1.8 GW under the **Counterfactual** to 2.5 GW under **Holistic Transition**.

Large-scale battery storage capacity by scenario

NGED West Midlands licence area

Units: MW

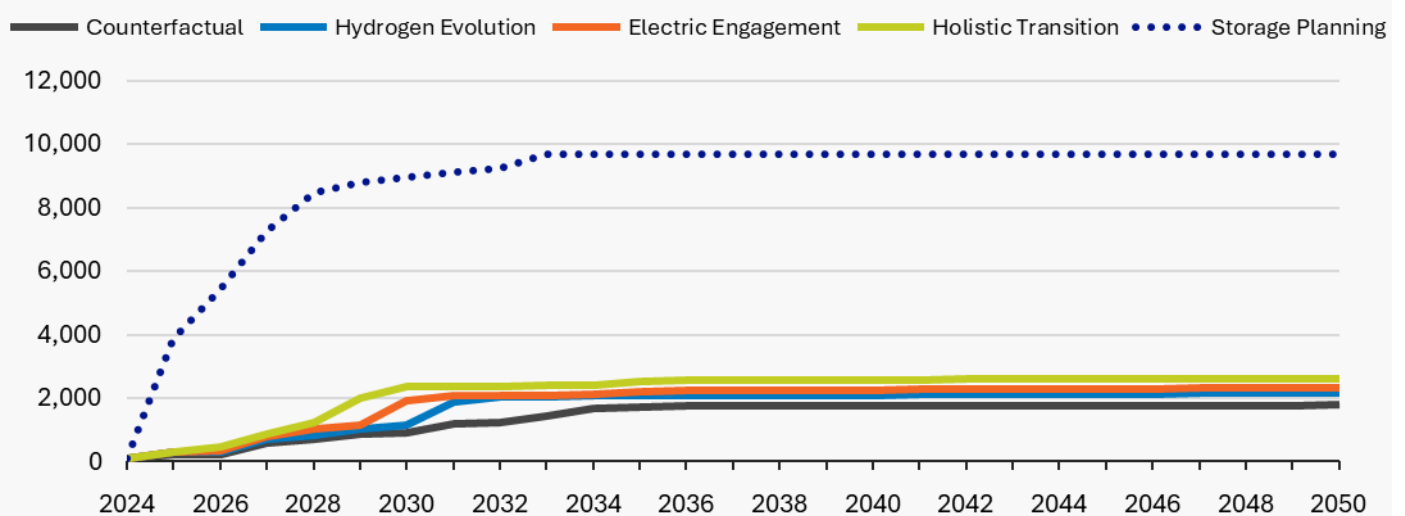


Sites with submitted planning applications, pre-planning activity or no evidence planning activity have only been modelled to progress under the **Storage Planning** scenario. This scenario does not aim to represent a credible projection of storage development in the licence area, but instead models the connection of all batteries, with reasonable connection timelines assessed on a per-project basis, to provide NGED with added insight into the scale of the current battery storage pipeline. The cumulative impact of this scenario at a licence area level is illustrated in the graph below.

Large-scale battery storage capacity by scenario

NGED West Midlands licence area

Units: MW



Modelling assumptions and results

Baseline and pipeline

Source: NGED connections data

	Development status	Capacity (MW)	Description
Baseline	Operational	112	<p>The 112 MW of operational large-scale battery storage projects in the West Midlands licence area comprises mostly of standalone batteries providing grid services. The remaining capacity is comprised of battery assets co-located with electricity generation sites.</p> <p>Despite the major pipeline, no new sites have connected in the licence areas since 2022.</p>
	Under construction	280	<p>A single 280 MW site at located in Staffordshire Moorlands began construction in early 2024 and is projected to connect by 2027 in all scenarios.</p>
Pipeline	Granted planning permission	1,906	<p>45 pipeline sites, totalling nearly 2 GW, have been granted planning permission and are all modelled to connect under the Holistic Transition and Storage Planning scenarios. Some of these projects are individually 150 MW in size. The majority of these sites are also modelled to connect in the remaining three scenarios, with the exception of five sites that either failed to prequalify or were rejected in Capacity Market auctions.</p> <p>Where a site has won a Capacity Market contract, it is modelled to connect in the contract delivery year in every scenario.</p> <p>Where a site has only prequalified in the Capacity Market, it is still projected to connect, but delayed by a couple of years.</p> <p>Projects without Capacity Market information, which make up the majority of the sites with planning approval, are projected to connect between five and seven years from the date they obtained planning permission.</p>
	Submitted planning application	1,029	<p>Due to the size of the battery storage pipeline, only a small proportion of sites are likely to progress to installation and commissioning. Based on the FES 2024 outcomes at a GB level, and early information around NESO’s Clean Power 2030 advice to the UK government, sites with granted planning permission are likely to represent enough capacity to meet 2030 and 2035 targets for large-scale battery storage capacity in NGED’s licence areas.</p>
	Pre-planning	1,455	<p>As a result, sites with submitted planning applications, pre-planning activity or no information have only been modelled to progress under the Storage Planning scenario. This scenario does not aim to be representative or credible at a licence area level, but instead models the connection of all batteries, with</p>

No information	5,015	reasonable connection timelines, assessed on a per-project basis, to provide NGED with added insight into the scale of the current battery storage pipeline. In the four main DFES scenarios, only the very small proportion of sites that have positive Capacity Market activity, but have not yet obtained planning permission are modelled to progress to build out, all within the late 2020s.
Rejected or withdrawn in planning, or abandoned	339	Sites that have been rejected in planning, withdrawn their planning application or been abandoned, do not progress under any scenario, including Storage Planning .

Projections

Scenario	Description
Holistic Transition	In the four main DFES scenarios, the individual pipeline project evidence drives the vast majority of large-scale battery storage capacity deployment in the licence area.
Electric Engagement	Additional deployment beyond the pipeline, starting in the early 2030s under the three net zero scenarios and the mid-2030s under the Counterfactual , is modelled as battery storage that is co-located with the deployment of large-scale solar PV and onshore wind generation in the licence area across the 2030s and 2040s.
Hydrogen Evolution	Overall, post-pipeline development of large-scale battery storage is limited, owing to the high-levels of deployment in the 2020s and early 2030s as GB aims to achieve Clean Power by 2030 and a net zero power system by 2035. However, the deployment of battery storage continues in the licence area, through the uptake of small-scale battery storage installations in homes and businesses, as detailed in the small-scale battery storage section of this report.
Counterfactual	By 2050, in the West Midlands licence area, installed large-scale battery storage capacity reaches 2.5 GW under Holistic Transition , 2.2 GW under Electric Engagement , just over 2 GW under Hydrogen Evolution and c. 1.8 GW under the Counterfactual .
Storage Planning	This scenario reflects an estimated connection year for the full pipeline of prospective projects only and does not project further capacity beyond this.

Uptake modelling factors

The below factors are used to inform the overall uptake of large-scale battery storage in the West Midlands licence area.

Factor	Modelling impact	Source
Progress in planning	The planning status and date of planning activity are used as key factors to determine whether battery	Local planning portals NSIP database

	storage pipeline sites progress through to connection, and in what year, under each scenario.	
Capacity Market activity	Activity of individual battery storage projects in the T-4 and T-1 Capacity Market auctions is used as an indicator of when projects are likely to be ready to connect, rather than the likelihood of them being deployed. This is in response to stakeholder engagement that suggests that the Capacity Market is no longer a key component of the revenue stack for battery storage business models.	EMR Capacity Market Registers
Technical limits offers	Where a project has accepted a technical limit offer from NGED, this anticipated energisation date is used as the minimum year of connection for that project, under any scenario.	NGED connections data
Statement of Works transmission reinforcement timelines	Where a project is impacted by a transmission-level Statement of Works, the anticipated completion year this is used as the minimum year of connection for that project under the Counterfactual .	NGED connections data
Pipeline of Co-located generation	Where battery assets are co-located with generation sites, typically wind and solar, the year of connection for the generation component has been used to guide the year of connection of the battery component.	NGED DFES 2024 large-scale solar PV and onshore wind modelling
Future projections of co-located generation	Beyond the pipeline, further deployment of battery storage capacity in the late 2030s and 2040s is linked to the development of large-scale solar PV and onshore wind generation.	NGED DFES 2024 large-scale solar PV and onshore wind modelling

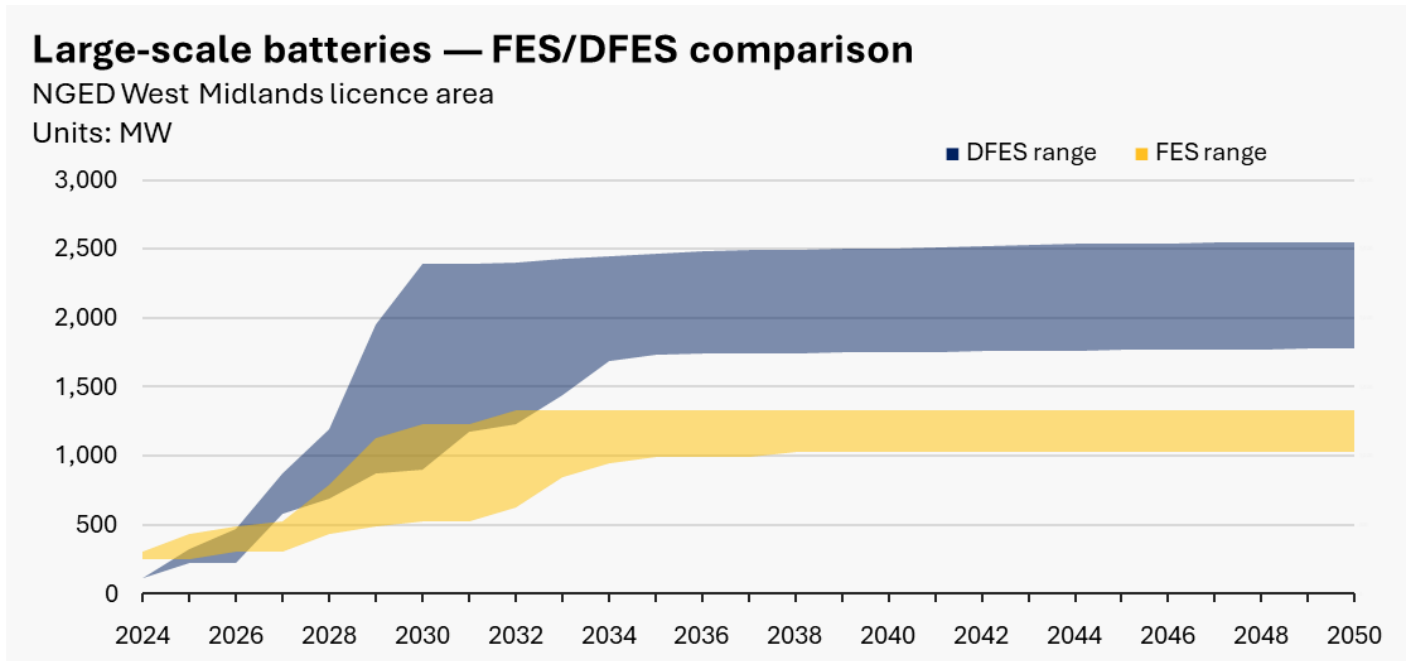
Spatial factors

The below factors are used to inform the spatial distribution of large-scale battery storage capacity across the West Midlands licence area, down to 11 kV ESAs.

Factor	Modelling impact	Source
Location of existing baseline and pipeline sites	The vast majority of projected large-scale storage capacity is based on existing baseline and pipeline sites.	NGED connections data
Distribution of large-scale solar PV and onshore wind	Beyond the pipeline, the location of additional battery storage capacity in the later 2030s and 2040s is aligned to the distribution of large-scale solar PV and onshore wind capacity.	NGED DFES 2024 large-scale solar PV and onshore wind modelling

Reconciliation to FES 2024

The outcomes of the DFES modelling have been compared to the FES 2024 outcomes for the same licence area.



- ▶ The DFES baseline is substantially lower than the FES baseline in the West Midlands. The reason for this is not clear, but may be due to the FES modelling assuming some battery projects came online in 2024 that may not have transpired. Site-by-site research into the NGED battery connections register has not revealed any further baseline sites progressing to energisation.
- ▶ From 2027 onwards, the DFES is significantly higher than the FES projections for the licence area. While there is substantial uncertainty around the proportion of the battery storage project pipeline that is likely to connect over the coming decade, the DFES analysis has only modelled sites to connect that have high-levels of positive development evidence, such as fully consented planning permission. This subset of the pipeline represents over 2.2 GW of potential future capacity. Therefore, the DFES projections, even though substantially higher than the FES, reflect a credible range of outcomes for these projects based on site-by-site research and build-out timeframes, flexed by scenario.
- ▶ A relatively small amount of large-scale battery storage growth is projected in the DFES scenarios across the 2030s and 2040s. This is primarily based on battery storage co-located with large-scale solar PV and onshore wind sites. This is not reflected in the FES under any scenario, with large-scale battery storage capacity flatlining from the late 2030s in all scenarios.

Comparison to DFES 2023

- ▶ The modelling methods, business model assumptions and outcomes for large-scale battery storage are similar between DFES 2024 and DFES 2023.
- ▶ The assessment and assumptions around the future deployment of the pipeline have been more aggressive in DFES 2024, limiting uptake in all four scenarios to only sites with granted planning permission or positive Capacity Market activity.
- ▶ This results in a narrower range of 2050 scenario outcomes, ranging from 1.8-2.5 GW in DFES 2024 compared to 1.0-2.9 GW in DFES 2023. This aims to reflect greater certainty around the role of

battery storage in the energy system and an acknowledgement of the proposed reforms to connection policy and regional technology allocations proposed by NESO.

Endnotes

- ¹ <https://www.gov.uk/government/consultations/the-future-homes-and-buildings-standards-2023-consultation/the-future-homes-and-buildings-standards-2023-consultation>
- ² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1115622/evidence_update_of_low_carbon_heating_and_cooling_in_non-domestic_buildings.pdf
- ³ <https://epc.opendatacommunities.org/>
- ⁴ <https://www.gov.uk/government/news/pathway-for-zero-emission-vehicle-transition-by-2035-becomes-law>
- ⁵ <https://labour.org.uk/change/kickstart-economic-growth/#transport>
- ⁶ <https://assets.publishing.service.gov.uk/media/65841578ed3c3400133bfcf7/hydrogen-strategy-update-to-market-december-2023.pdf>
- ⁷ <https://www.nationalgas.com/future-energy/hydrogen/project-union>
- ⁸ <https://hynet.co.uk/>
- ⁹ <https://www.wvutilities.co.uk/media/5323/www-hyline-public-report.pdf>
- ¹⁰ <https://www.westmidlandsinterchange.co.uk/>
- ¹¹ <https://harworthgroup.com/projects/chatterley-valley/>
- ¹² <https://www.iba.aero/>
- ¹³ <https://hydrogenindustryleaders.com/gloucestershire-airport-to-trial-green-hydrogen-refuelling/>
- ¹⁴ <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf>
- ¹⁵ <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Shipping.pdf>
- ¹⁶ <https://www.europarl.europa.eu/news/en/press-room/20230320IPR77909/fit-for-55-deal-on-new-eu-rules-for-cleaner-maritime-fuels>
- ¹⁷ <https://assets.publishing.service.gov.uk/media/5d24a96fe5274a2f9d175693/clean-maritime-plan.pdf>
- ¹⁸ <https://www.ukri.org/who-we-are/how-we-are-doing/research-outcomes-and-impact/innovate-uk/demonstrating-shore-power-for-ferries-and-cruise-ships/>
- ¹⁹ <https://www.gov.uk/government/consultations/uk-ets-scope-expansion-maritime-sector>
- ²⁰ <https://www.forthports.co.uk/media-releases/innovative-green-hydrogen-shore-power-trial-launched-at-the-port-of-leith/>
- ²¹ <https://www.portofgothenburg.com/about/projects-at-the-port/onshore-power-supply-for-tankers/>
- ²² <https://www.britishports.org.uk/content/uploads/2023/06/BPA-Shore-Power-Paper-May-2020.pdf>
- ²³ <https://sustainableworldports.org/wp-content/uploads/ABB-Master-thesis-shore-side-power-supply-2008.pdf>
- ²⁴ <https://www.sciencedirect.com/science/article/abs/pii/S1361920924003894>
- ²⁵ <https://www.sciencedirect.com/science/article/abs/pii/S1361920917309124>
- ²⁶ <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Shipping.pdf>
- ²⁷ <https://assets.publishing.service.gov.uk/media/610d63ffe90e0706d92fa282/decarbonising-transport-a-better-greener-britain.pdf>
- ²⁸ <https://www.theccc.org.uk/publication/sixth-carbon-budget/>
- ²⁹ <https://www.gov.uk/government/collections/energy-consumption-in-the-uk>
- ³⁰ <https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june>
- ³¹ <https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level>
- ³² <https://www.gov.uk/government/statistical-data-sets/structure-of-the-agricultural-industry-in-england-and-the-uk-at-june>
- ³³ <https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level>
- ³⁴ <https://www.neso.energy/document/346651/download>
- ³⁵ <https://www.gov.uk/government/publications/policy-statement-on-onshore-wind/policy-statement-on-onshore-wind>
- ³⁶ <https://www.waterpowermagazine.com/news/ea-price-hike-could-be-final-nail-in-coffin-for-small-hydro-in-england-says-bha-9547334/>
- ³⁷ https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2012/RE_Technologies_Cost_Analysis-HYDROPOWER.pdf
- ³⁸ <https://assets.publishing.service.gov.uk/media/5a7c77ade5274a559005a113/pb14130-energy-waste-201402.pdf>
- ³⁹ https://api.solarpowereurope.org/uploads/1424_SPE_BEES_report_12_mr_84bdb6c5ae.pdf

