Distribution Future Energy Scenarios 2023

Results and assumptions report

East Midlands licence area

Electricity Distribution

nationalgrid

Foreword by National Grid DSO

April 2023 marked the start of the RIIO-ED2 price control period, throughout which planning and investment in the distribution network will be an important factor to enable our customers to reach their decarbonisation targets.

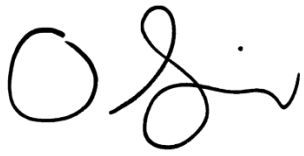
We have worked with Regen to help us understand what the changes that are forecast throughout the next decade and beyond might mean for our distribution network, and the investment that may be needed to meet customers' changing needs. These forecasts are the foundation of our strategic investment process, which is an ongoing analysis published biennially through the Network Development Plan (NDP). The NDP feeds into the Distribution Network Options Assessment process to determine the investment required to facilitate the UK's net zero ambitions, while promoting a smart and flexible network. The next NDP will be published in May 2024 and will include the forecasts from DFES.

This report summarises the 2023 Distribution Future Energy Scenarios (DFES) study for the East Midlands licence area. The network will see a large increase in distributed renewable generation and electricity storage connections. We predict high levels of low carbon technologies, such as electric vehicles and heat pumps and increasing household demand for electricity. The DFES study aims to understand where the growth of different technologies will be spatially distributed, which will materialise as load on our networks.

With our annual DFES cycle, we are able to incorporate and project new technologies in our analysis. In DFES 2023, we have added industrial heating to our projections and increased the granularity of our analysis down to Low Voltage (LV) level for several Low Carbon Technologies (LCT) to better inform reinforcement across our local networks. Additionally, we have continued to expand our engagement with Major Energy Users and industry representatives to better capture future changes in demand. As local authorities develop Local Area Energy Plans (LAEPs), we are continuing to proactively engage with them, ensuring that their ambitions are captured within our strategic investment process.

The scenario framework used in this study is heavily influenced by the UK and devolved government targets to reach net zero greenhouse gas emissions by 2050. Our projections provide a granular breakdown of the customers connected to the distribution network out to 2050, with three of the four scenarios being compliant with the UK 2050 net zero target.

This regional review is part of a wider suite of DFES documents hosted on our website alongside our interactive map. We welcome any feedback on the DFES process and outputs and will incorporate any suggestions into future forecasting activities.



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Electricity Distribution

Contents

Glossary

Short form	Definition	Short form	Definition
ACT	Advanced Conversion Technologies	GSP	Grid Supply Point
AD	Anaerobic Digestion	GW	Gigawatt
AONB	Area of Outstanding Natural Beauty	HGV	Heavy Goods Vehicle
ASHP	Air Source Heat Pump	HNDU	Heat Network Delivery Unit
CCGT	Combined-Cycle Gas Turbine	HNIP	Heat Network Investment Project
CCUS/CCS	Carbon Capture, (Utilisation) and Storage	HVO	Hydrotreated Vegetable Oil
CfD	Contract for Difference	IDNO	Independent Distribution Network Operator
CHP	Combined Heat and Power	kW	Kilowatts
DEFRA	Department for Environment, Food and Rural Affairs	LA	Local Authority
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
EfW	Energy from Waste	MCPD	Medium Combustion Plant Directive
EMR	Electricity Market Reform	MW (th, e)	Megawatts (thermal, electrical)
ENA	Energy Networks Association	NGED	National Grid Electricity Distribution
EPC	Energy Performance Certificate	OCGT	Open-Cycle Gas Turbine
ESA	Electricity Supply Area	ONS	Office for National Statistics
ESO	Electricity System Operator	OS	Ordnance Survey
EU	European Union	PHEV	Plug-in Hybrid Electric Vehicle
EV	Electric Vehicle	PV	(Solar) Photovoltaics
FES	National Grid ESO Future Energy Scenarios	REMA	Review of Electricity Market Arrangements
FiT	Feed-in Tariff	RHI	Renewable Heat Incentive
GB	Great Britain	SMR	Small Modular Reactor
GSHP	Ground Source Heat Pump	STOR	Short-Term Operating Reserve

Introduction to the National Grid Electricity Distribution DFES 2023

Background

The National Grid Electricity Distribution (NGED) Distribution Future Energy Scenarios (DFES) provides granular scenario projections for:

- Distributed electricity generation, such as solar PV, wind, hydro, fossil-fuelled generation, waste and bioenergy
- Distributed electricity demand, such as heat pumps, electric vehicle chargers, new housing developments, business space and hydrogen electrolysers
- Distributed electricity storage, including electricity storage and domestic thermal storage.

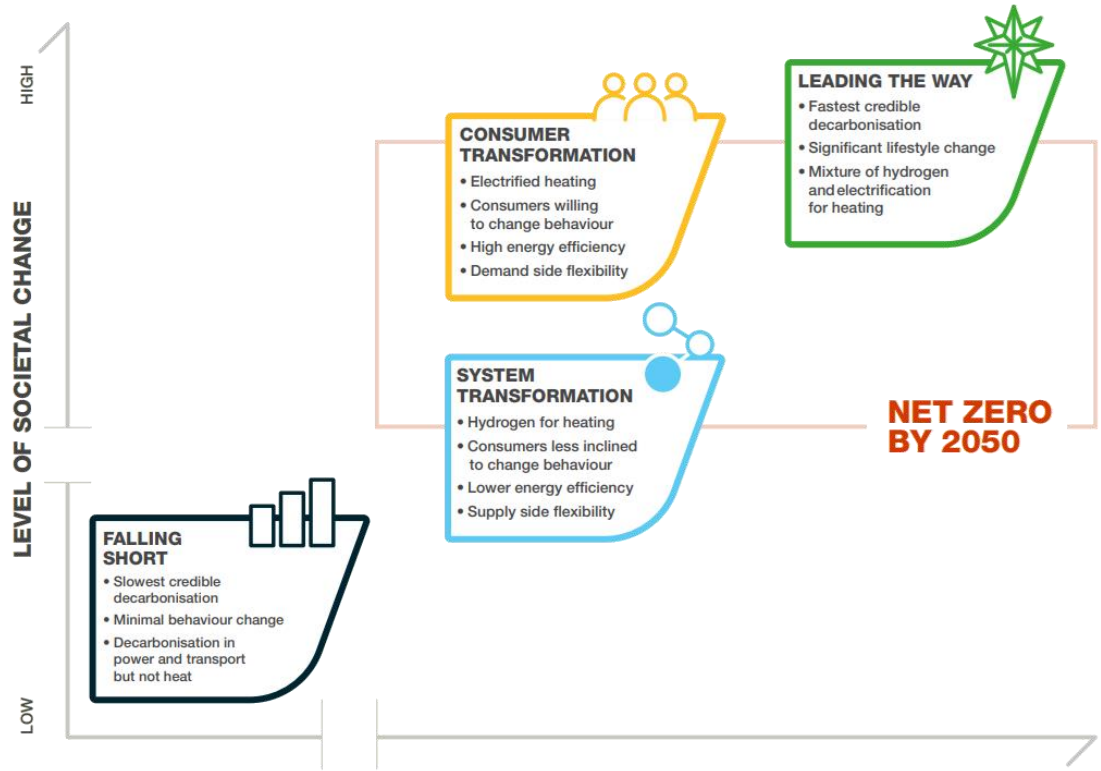
The DFES projections are directly informed by stakeholder engagement to reflect local and regional drivers, the ambitions of local authorities (including local area energy plans, where available) and national government targets and policies. The analysis is also influenced by the views of other sector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

For Distribution Network Operators (DNOs), 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.

Scenarios

The NGED DFES uses the National Grid ESO Future Energy Scenarios (FES) 2023 as a framework, adopting the same national-level societal, technological, and economic assumptions as the FES: **Consumer Transformation**, **Falling Short**, **Leading the Way**, and **System Transformation**. However, the DFES is a bottom-up analysis of a changing energy system at a more granular level, reflecting specific regional and local factors. The DFES seeks to recognise and reflect that distributed energy, demand and storage will develop in different ways, and at different paces, across the country.

Figure 1 – The National Grid ESO FES 2023 scenario framework



Scope

The NGED DFES 2023 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) Open Networks project.

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

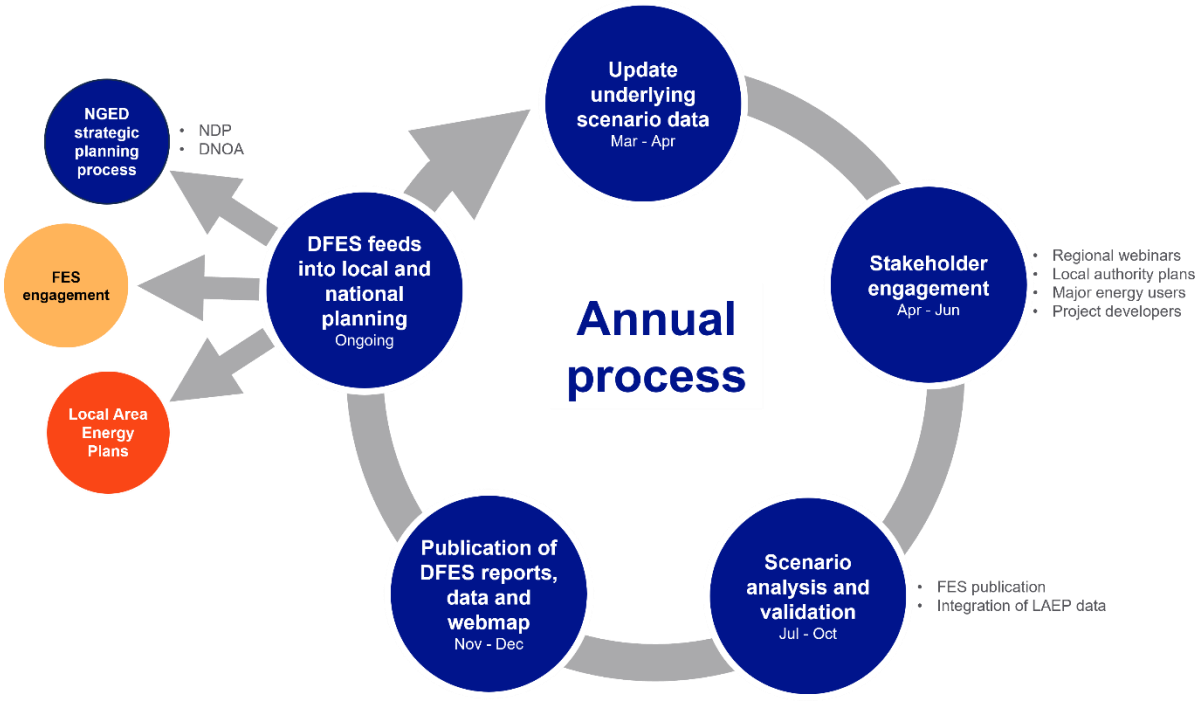
Annual cycle

The NGED DFES is produced annually, allowing scenario projections to be regularly updated to reflect the most up-to-date information available. The DFES is published towards the end of the calendar year, a few months after the release of National Grid ESO FES. This allows the DFES 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 scenario and licence area. This annual cycle also allows for data sharing between the NGED DFES and the National Grid ESO FES teams, facilitating continuous improvement of the data quality, processes and scenario modelling.

In addition to the interactions between FES and DFES, local area energy planning (LAEPs, produced by local authorities) also interacts with the DFES. This is both as a source of input data to feed into the DFES spatial analysis — reflecting specific local plans and ambitions — and with DFES data points being used to inform LAEPs when planning for future energy generation, demand and storage.

The annual DFES outputs also feed into wider NGED strategic planning processes, such as Network Development Plans and Distribution Network Options Assessments for each of the four licence areas.

Figure 2 – The NGED DFES annual process



Results

The NGED DFES 2023 analysis is produced to granular geographic areas known as Electricity Supply Areas (ESAs), of which there are four types:

- **Geographic ESA**: the geographic area as fed by a primary substation providing supplies at 11 kV or 6.6 kV.
- **Single customer ESA**: 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 connection agreement.
- **Low voltage ESA**: the geographic area as fed by a low voltage transformer, providing supplies at less than 11 kV. In the NGED DFES 2023, domestic-scale rooftop PV and batteries, electric heat and EV charger projections are produced at this highly granular level. The DFES 2023 is the first time this analysis has been carried out to low voltage granularity for the four NGED licence areas.

These ESAs are also split by local authority boundaries, allowing DFES data to be aggregated to local authority or primary substation level, allowing the data to 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 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. For previous DFES rounds, NGED has published the results of this process on their website.

The East Midlands licence area

The key features of the East Midlands licence area are detailed in the following table and depicted in Figure 3 and Figure 4:

Aspect	Characterisation
Geography	The NGED East Midlands licence area can be broadly divided into the western high-population corridor along the M1, through Leicester, Milton Keynes, Derby and Nottingham, and the more rural eastern side, characterised by high-grade agricultural land and a strip of North Sea coastline.
Distributed electricity generation	Distributed electricity generation in the area has increased significantly over the last five-to-six years. Over 50% of capacity has connected since 2015. Fossil gas-fired power and solar PV make up over two-thirds of the distributed electricity generation capacity, owing largely to Corby Power Station in Northamptonshire, with a connection capacity of over 400 MW.
Energy resources	Despite having lower solar irradiance than more southern areas of the UK, the East Midlands has been attractive to solar and battery storage developers. There are also a number of onshore wind farms in the east and south of the licence area.
Distributed electricity demand	Currently, less than 3% of East Midlands households have an electric vehicle, and less than 1% have an electric heat pump.
Policy and government	The East Midlands licence area contains over 50 local authorities, including city region councils like Nottingham City Council and Leicester City Council.

Figure 3 - The NGED East Midlands licence area, with the location of existing 'baseline' large-scale generation and storage sites

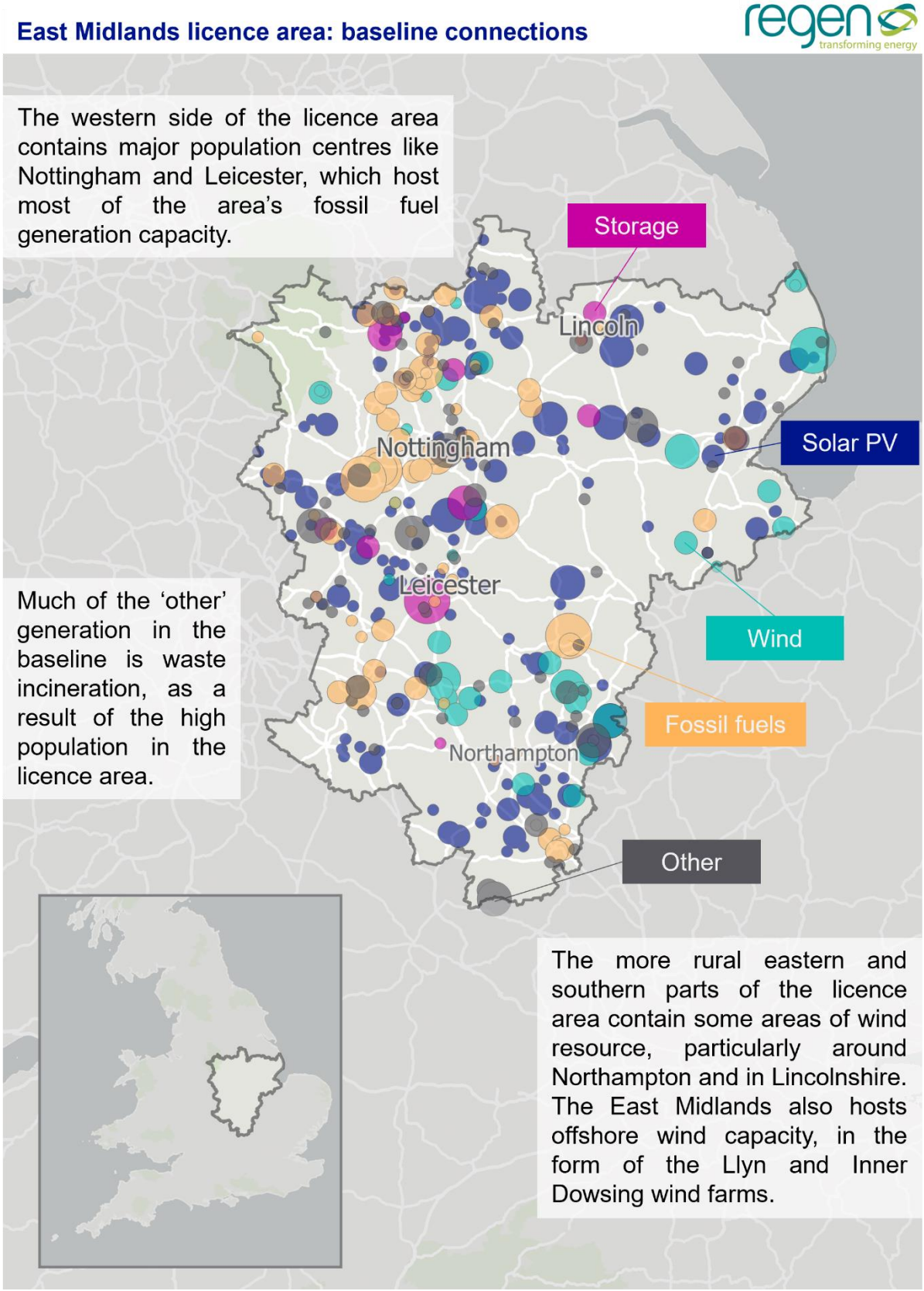
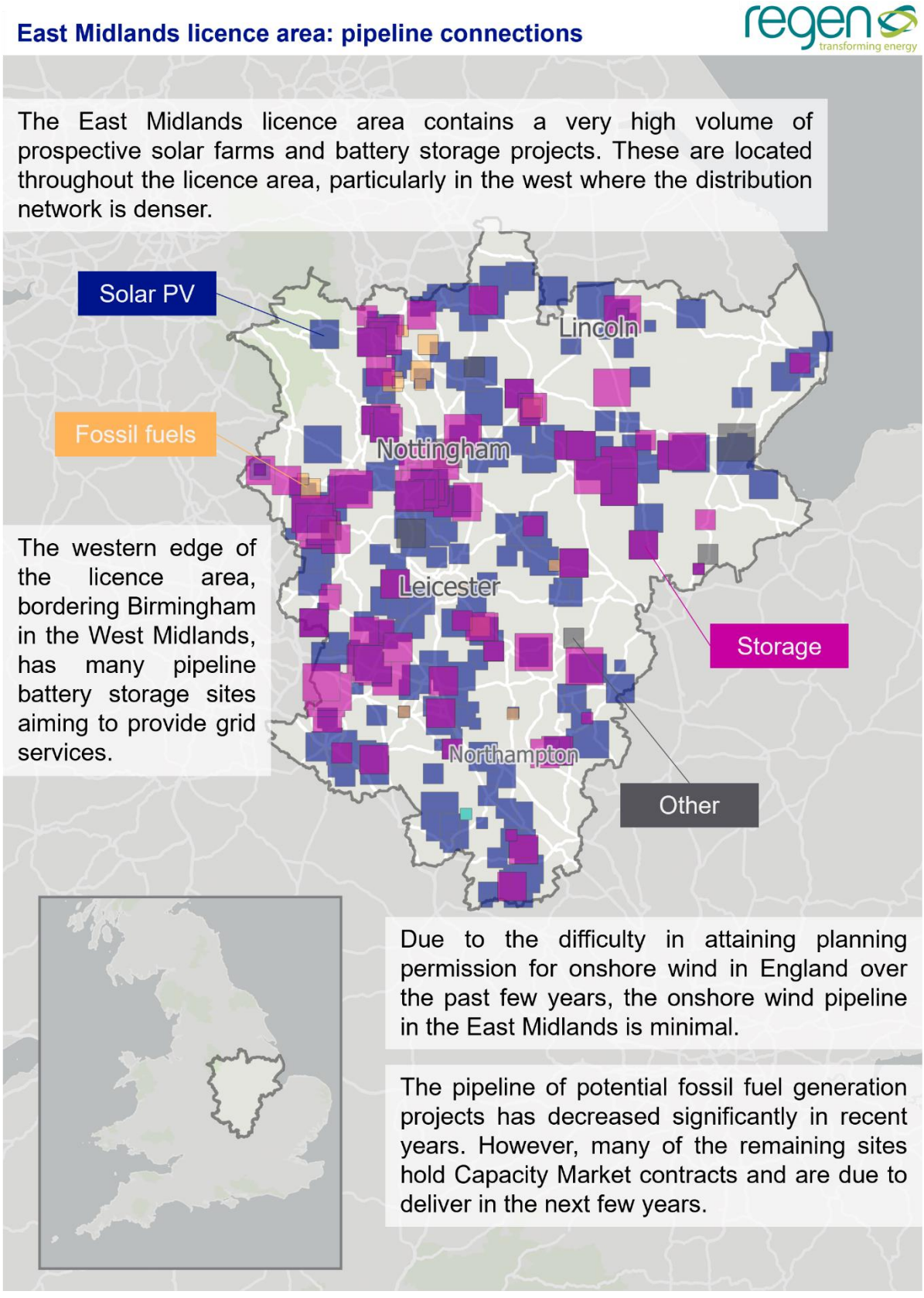


Figure 4 - The NGED East Midlands licence area, with the location of proposed 'pipeline' large-scale generation and storage sites



Methodology

This report details the analysis, assumptions and scenario outcomes for each individual technology in the 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 aspect	Characterisation
Baseline analysis	Existing generation, storage and demand connected to the distribution network are analysed to produce a baseline for the licence area. The 2023 baseline year represents the 2022/23 fiscal year, ending on 31 March 2023. This is based on NGED connection data, supplemented with project and energy subsidy programme registers, Department for Transport 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 planning approval, housing developments and proposed commercial development space in local authority planning documents.
Scenario projections	Key assumptions from the FES 2023 scenarios 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 engagement.

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 2023. These webinars aimed to allow a wide range of local stakeholders to communicate directly and 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 planning for new housing and commercial developments. In addition, where LAEP data was available, this was obtained and compared against the DFES scenarios to ensure the LAEP pathways are within the envelope of DFES scenario outcomes where applicable.
Developer engagement	Companies that are 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 electrolysis projects.
Major energy user engagement	A selection of large energy-consuming customers connected to NGED's network were contacted to seek views around decarbonisation plans, renewable energy deployment, flexibility technology uptake and electrification of heat and transport, if applicable.

Specific DFES aspects

While the scenario framework and high-level assumptions are driven by the FES 2023, a number of specific aspects of the current energy system have been considered in the DFES 2023 analysis:

Aspect	Impact on DFES
Reduced near-term projections under Falling Short	Analysis of previous FES and DFES iterations suggests that projections for some small-scale technologies fall below the least-ambitious scenario, **Falling Short**. As a result, the near-term projections for these technologies have been reduced in order for the **Falling Short** scenario to provide NGED with a clearer low-case scenario to inform network planning.
Retained capacity for decommissioning assets	Across the four DFES scenarios, assets that are incompatible with net zero targets, such as unabated fossil fuel power generation, decommission by 2050. 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, with a view to participating in network ancillary services such as reserve services or stability services, or for the potential future connection of an alternative generation or storage technology that is more compatible with net zero emission targets. 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	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 **Falling Short** 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.

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, such as the Review of Electricity Market Arrangements (REMA) and the British Energy Security Strategy.

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, heat pump uptake and electric vehicle sales.

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. As a result, the potential impacts of these energy policies and wider economic context are assumed to be captured in this envelope of potential futures rather than being explicitly modelled in the DFES 2023.

This immediate impact, however, is considered to be reflected in the detailed analysis of the known pipeline of potential connections and the range of results under the four-scenario framework rather than being a distinct element of the modelling.

Grid connections reform

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 given connection dates well into the 2030s.

As a result, grid connection processes are currently undergoing a number of reforms at both transmission and distribution levels. This could result in effective fast-tracking for projects that are 'shovel ready', requirements for holders of connection offers to demonstrate progression, and alternative forms of connection for assets such as battery storage, which would be generally expected to operate in a way that would alleviate constraints rather than add to them.

With regards to the DFES, the analysis is intentionally agnostic to constraints on the distribution network. This allows NGED to plan and upgrade the distribution network in areas where development is most suitable or targeted. However, the near-term projections are impacted by current network constraints, as these predominantly rely on the pipeline of accepted connections, which are naturally biased towards less constrained areas of the network where connection is more feasible in the near term.

Constraints on the transmission network, which are outside of NGED's control, are reflected under **Falling Short** only.

Technologies not currently in scope

There are a small number of technologies that are not currently within the scope of DFES, but may be in the future. This includes:

- Maritime electrification – including vessels and associated chargers
- Aviation electrification – including planes and associated chargers
- Off-highway vehicle and plant electrification, such as agricultural vehicles and extractive industry vehicles, and associated chargers
- Electrification of industrial processes

While these technologies are currently out of scope of the DFES, they remain of interest and feature within the stakeholder engagement and research undertaken as part of the DFES process.

Demand technologies

Results and assumptions

Domestic electric heat in the East Midlands licence area

Domestic dwellings where electricity is the primary fuel for space heating and hot water, delivered through a heat pump or resistive electric heater.

Data summary for domestic electric heat in the East Midlands licence area:

Number of homes (thousands)		Baseline	2028	2035	2050
Non-hybrid heat pumps* (without thermal storage)	Falling Short	25	68	205	787
	System Transformation		75	151	479
	Consumer Transformation		205	768	1,592
	Leading the Way		228	814	1,234
Non-hybrid heat pumps* with thermal storage	Falling Short	0	32	99	449
	System Transformation		18	44	178
	Consumer Transformation		87	319	822
	Leading the Way		104	382	731
Hybrid heat pumps	Falling Short	0	1	6	21
	System Transformation		3	18	757
	Consumer Transformation		3	13	42
	Leading the Way		4	77	286
Connections to heat pump-driven district heat networks	Falling Short	0	11	44	202
	System Transformation		8	39	282
	Consumer Transformation		9	72	351
	Leading the Way		9	74	299
Resistive electric heating	Falling Short	197	196	186	160
	System Transformation		190	167	78
	Consumer Transformation		194	178	142
	Leading the Way		198	178	152

***** Note the heat pump figures shown are both Air Source Heat Pump (ASHP) and Ground Source Heat Pump (GSHP) projections combined. A full breakdown of heat technologies is included towards the end of the domestic heat chapter.

Summary:

- The East Midlands licence area has a broad range of housing, from dense areas of on-gas houses and flats in built-up urban areas such as Leicester, Nottingham and Milton Keynes, to more rural, off-gas areas along the east coast. Overall, the building stock in the licence area is representative of the GB average in terms of current heating technology use, housing types and tenure.
- Under **Consumer Transformation** and **Leading the Way**, heat is primarily decarbonised via heat pumps in both the East Midlands licence area and at a national level. Initial uptake is mostly modelled to occur in off-gas houses and well-insulated houses, before a wider-scale rollout of heat pumps across the majority of the housing stock is modelled out to 2050. For the East Midlands licence area, this results in c. 2.8 million homes operating a form of heat pump by 2050 under **Consumer Transformation**.

- Under **System Transformation**, decarbonisation of heat is driven primarily by low carbon hydrogen, either through standalone hydrogen boilers or hybrid heat pumps. With a high proportion of on-gas homes, this results in the vast majority of homes in the East Midlands licence area converting to hydrogen boilers or hydrogen hybrid heat pumps by 2050.
- Under **Falling Short**, progress towards heat decarbonisation is slow, and despite some uptake of heat pumps in the late 2030s and the 2040s, many homes remain heated by fossil gas boilers in 2050, as the UK fails to meet its carbon emissions reduction targets.
- The pipeline of planned heat-pump-driven heat networks sees build-out in the near term in all scenarios. Heat networks are modelled to increase across dense population centres in the licence area, such as Nottingham, Northampton and Derby, under the three net zero scenarios.
- The number of households on resistive electric heating decreases in all scenarios, replaced by 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.

Figure 5 – Summary of domestic electric heating technologies by scenario, East Midlands licence area

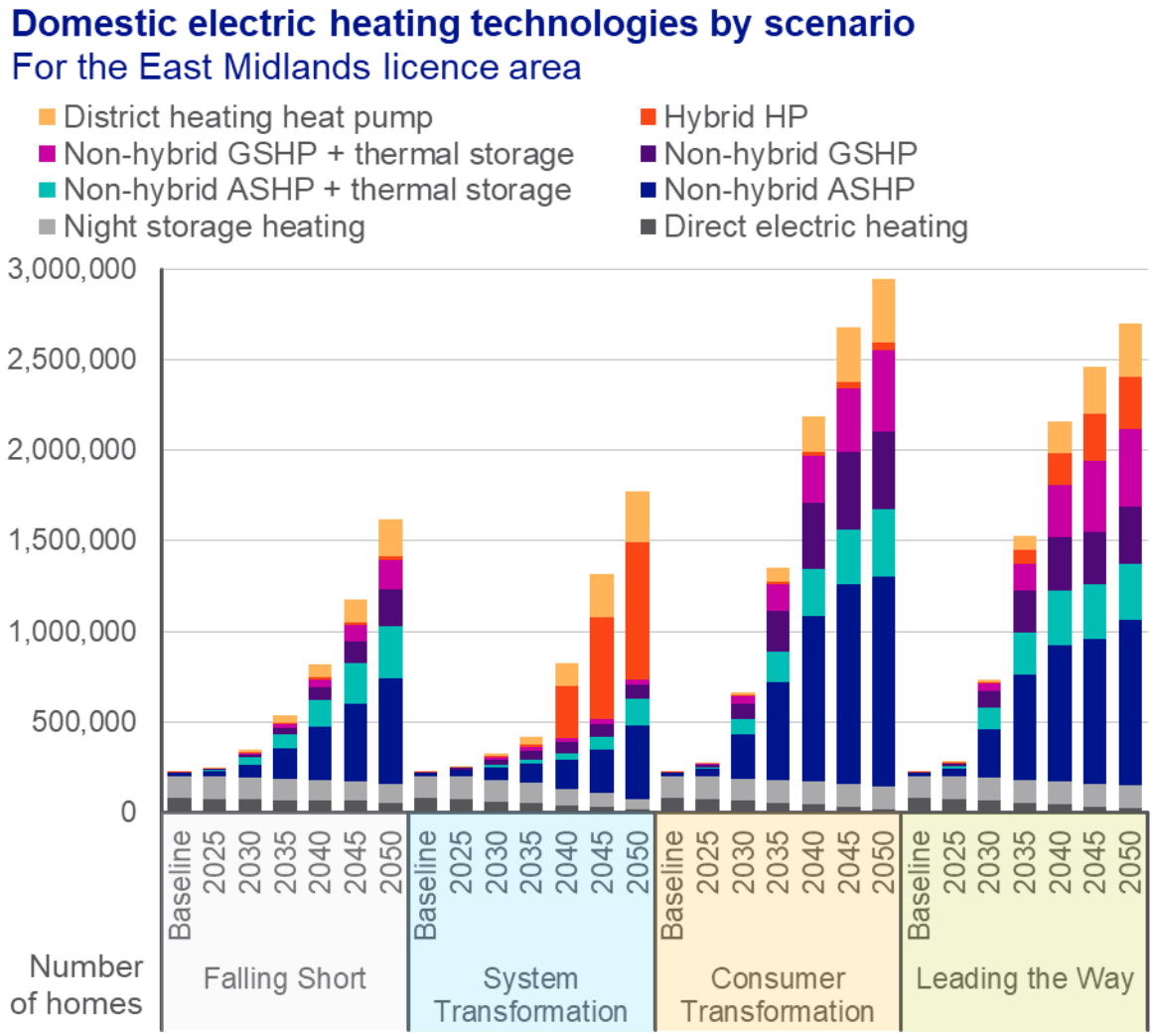
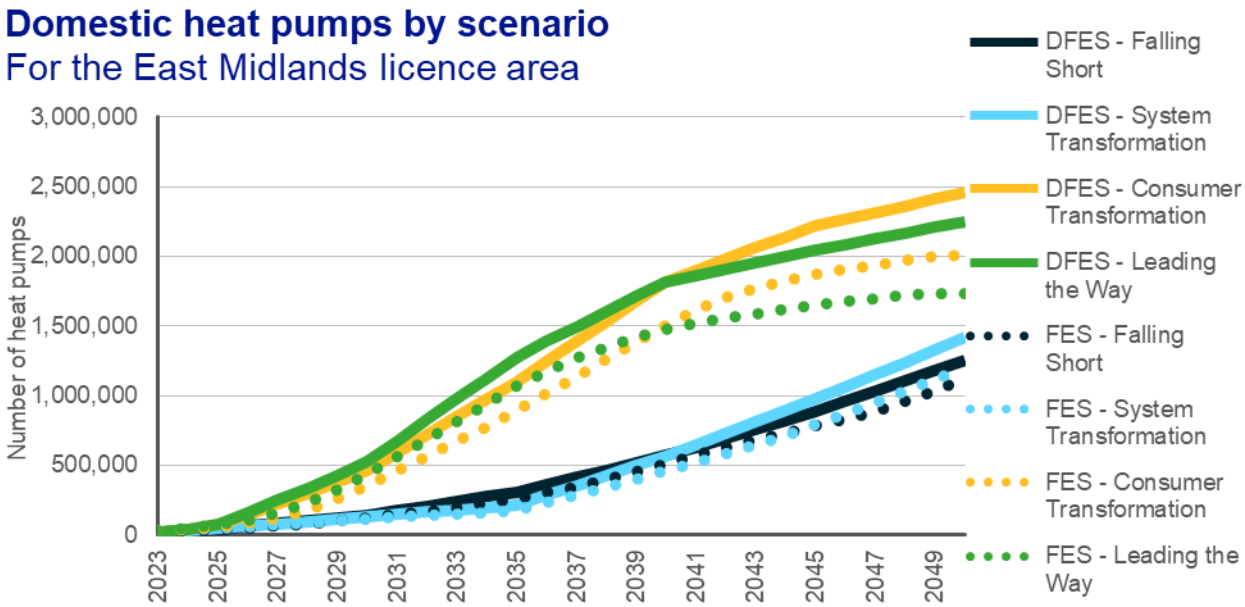


Figure 6 – Number of domestic heat pumps (hybrids and non-hybrid) by scenario, East Midlands licence area



Modelling assumptions and results

Baseline

Heat pumps

Most heat pumps in existing homes 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.

The 1.0% of existing homes with a heat pump in the licence area is very slightly ahead of the national average. This reflects the breakdown of current heating systems of homes in the East Midlands, which is similar to GB as a whole.

Sub-technology	Number of homes	Proportion of homes
Non-hybrid ASHP	22,132	0.9%
Non-hybrid GSHP	2,865	0.1%
Hybrid heat pump	97	0.0%
Heat pump-driven district heat network	0	0.0%

Due to a lack of evidence, the modelling assumes no thermal storage (such as a hot water cylinder) as a 'worst case' for existing heat pumps.

Resistive electric heating

Resistive electric heating is common in the East Midlands, broadly in line with the GB average at around 8% of homes. The majority of these homes have night storage heaters rather than direct electric heating.

The resistive electric heating baseline has been revised down since DFES 2022 as a result of Census 2021 data being released, enabling more accurate baselining.

Sub-technology	Number of homes	Proportion of homes
Night storage heaters	118,171	4.7%
Direct electric heaters	78,863	3.2%

Near-term projections (April 2023 to March 2028)

The estimated uptake of different types of electric heating is modelled based on a number of key factors assessed for the licence area, including housing types, current heating systems and sociodemographic factors. Across the net zero scenarios, the uptake of heat pumps is projected to increase significantly by 2026, particularly in off-gas homes heated by oil and LPG etc., while the number of homes heated by resistive electric heating is projected to slowly decrease under every scenario in the near term.

Near-term connections to heat pump-driven heat networks are based on the existing pipeline of planned heat networks. Heat networks that are well advanced in planning, such as the Island Quarter Phase 2 student accommodation in Nottingham, are modelled to connect in the near term under every scenario.

Heat pumps

Scenario	Description	% homes with a heat pump in 2028	
		East Midlands	GB (FES)
Leading the Way	The uptake of ASHP and GSHP heat pumps is highest in these scenarios, as GB progresses towards its 2028 goal of 600,000 installations per year. Off-gas and well-insulated homes are modelled to have particularly high uptake, however, a small proportion of on-gas houses and flats also convert to a heat pump, supported by the Boiler Upgrade Scheme. As a result, the East Midlands licence area sees near-term uptake of heat pumps in line with the overall GB average. Under **Leading the Way**, many of these heat pumps are equipped with thermal storage, either via a conventional hot water tank or a more modern heat battery.	13%	11%
Consumer Transformation		12%	10%
System Transformation	Near-term decarbonisation of heat is low under these scenarios, with heat pump uptake restricted to off-gas housing, replacing oil, LPG and resistive electric heating, and well-insulated homes in which a heat pump installation is likely to be easiest. This is linked to a longer-term strategy to introduce low carbon hydrogen supply and hydrogen boilers under **System Transformation**.	4%	6%
Falling Short		4%	6%

Resistive electric heating

Scenario	Description	% homes with resistive heating in 2028	
		East Midlands	GB (FES)
Leading the Way	Under these two scenarios, around 5% of houses and flats heated by resistive electric heating convert to a heat pump by 2026.	8%	8%
Consumer Transformation	A similar proportion of direct electric heated homes convert to night storage heaters in order to reduce heating costs.	7%	7%

System Transformation	A very small proportion of resistive electric heated homes convert to a heat pump under these scenarios in the near term. However, a greater proportion move onto the mains gas network in order to reduce heating costs. Similarly to the other two scenarios, a small proportion of direct electric heated homes convert to night storage heaters.	7%	7%
Falling Short		8%	7%

Medium and long-term projections (April 2028 to March 2050)

Heat decarbonisation accelerates in the medium and long term across GB, especially under the three net zero scenarios, as the country aims to meet its decarbonisation targets.

Under two of the scenarios, **Consumer Transformation** and **Leading the Way**, heat pumps are the main means of decarbonising heating in on-gas and off-gas properties, alongside district heat networks, driven by heat pumps or waste heat in dense urban areas or areas near a waste heat source, such as thermal or heavy industry.

Under **System Transformation** and **Falling Short**, heat pump uptake is more limited. Under **System Transformation** specifically, this is due to hydrogen boilers becoming the preferred heating technology for on-gas homes. Under **Falling Short**, decarbonisation of heat is slower across the country, and heat pump uptake is mainly limited to off-gas homes in the medium term.

New build homes are modelled to increasingly include low carbon heating appliances, mainly in the form of heat pumps or connections to a district heat network, under every scenario. A strong increase in heat pump uptake is modelled in new build homes from 2025, following a successful implementation of the Future Homes Standard.

Heat pumps

Scenario	Description	% homes with a heat pump in 2050	
		East Midlands	GB (FES)
Leading the Way	Under these scenarios, many on-gas homes have converted to a heat pump by 2035, driven by a national shift in heating technologies. Under both scenarios, heat pumps with thermal storage increase in popularity in the late 2020s and 2030s, enabling shifting of domestic demand to lower cost periods of the day. By 2050, almost all domestic properties are heated by heat pumps, district heating or resistive electric heating. A small number of homes are heated by hydrogen boilers or hydrogen hybrid heat pumps under **Leading the Way** only.	80%	80%
Consumer Transformation		90%	92%
System Transformation	Heat pump uptake in on-gas homes is minimal in the medium term under this scenario, except for a small proportion of homes that install a hybrid hydrogen heat pump. This is a result of low carbon hydrogen being anticipated to replace the fossil gas network in the 2030s and 2040s under this scenario. Otherwise, the majority of heat pump uptake is limited to off-gas houses and new build homes. Uptake of heat pumps increases substantially in the 2040s, particularly hydrogen hybrid heat pumps,	55%	60%

	which represent around one-third of all heat pumps in this scenario. The remainder of homes are heated by hydrogen boilers under this scenario.		
Falling Short	Heat pump uptake in on-gas homes is minimal, as fossil gas heating remains the most common form of heating under this scenario. Otherwise, the majority of heat pump uptake is in off-gas houses in the medium term. Long-term progress towards net zero is slow, and by 2050 many homes are still heated by fossil gas, despite a substantial heat pump uptake in the 2040s.	48%	53%
Resistive electric heating			
Scenario	**Description**	**% homes with resistive heating in 2050**	
		East Midlands	**GB (FES)**
Leading the Way	The overall number of resistive heated homes continues to decrease over time, replaced by district heating in denser urban areas and flats, and standalone heat pumps elsewhere. Direct electric heated homes that cannot convert to these technologies generally shift to night storage heating, enabling shifting of demand to lower cost periods of the day.	5%	5%
Consumer Transformation		5%	5%
System Transformation	The overall number of resistive heated homes decreases over time, replaced by connections to the fossil gas or hydrogen network. Direct electric heated homes that cannot convert to these technologies generally shift to night storage heating, enabling shifting of demand to lower cost periods of the day.	2%	2%
Falling Short		5%	5%

Reconciliation with National Grid FES 2023

- The DFES outcomes for total heat pumps under each scenario are broadly aligned with the FES 2023 data, albeit with slightly higher overall outcomes under every scenario by 2050. This could be due to differences in the total housing stock modelled in the FES and DFES.
- The property archetype-based heat analysis in the DFES models heat pump uptake based on existing heating technologies, building types, building efficiency, tenure and district heating potential. In these aspects, the East Midlands is very similar to the overall GB average.
- New build homes are modelled separately and are modelled to increasingly be built with heat pumps installed under each scenario. As the East Midlands has a strong pipeline of planned housing developments and a projected continued population growth; this potentially accounts for the higher uptake of heat pumps in the long term under every DFES scenario.

Factors that will affect deployment at a local level

Factor	Source
Current heating technology, categorised into on-gas, resistive electric heating, and off-gas (predominantly heating oil)	EPC data, ONS Census
Building type, categorised into semi-detached and detached	EPC data, ONS Census

houses, terraced houses, and flats	
Tenure, categorised into owner-occupied, private rented and socially rented	EPC data, ONS Census
Construction age band, categorised into pre-1930 and post-1930 construction. This aligns with the NGED DEFENDER project.	EPC data
Areas with potential for district heat networks, or an existing heat network pipeline project	Heat network pipeline data[i], and Opportunity Areas for District Heat Networks in the UK[ii] - BEIS

Large-scale heat pumps for district heating

As discussed in this section, domestic properties connecting to heat-pump-driven district heat networks have been modelled under the four DFES scenarios. Similarly, floorspace of non-domestic properties connecting to a heat network has also been modelled.

Informed by analysis of heat network project and procurement pipelines[iii], National Grid ESO FES data and assumptions, and best practice guides from e.g. CIBSE[iv] and BSRIA[v], the electrical capacity of the large-scale heat pumps driving future district heat networks has been projected under the four DFES scenarios, based on the domestic and non-domestic connections in each scenario.

It should be noted that heat network design is complex and effectively unique to each heat network, based on the geography and topology of each area, the anchor loads and secondary loads of the network and its subsections, and supplementary sources of heat, such as waste heat from industrial processes.

Several assumptions have been made in the calculation of large-scale heat pump capacity:

- In alignment with the National Grid ESO FES, future district heat networks are assumed to be predominately driven by a heat pump, coupled with thermal storage, but supported by a secondary gas, biomethane or hydrogen-fuelled boiler to provide additional heat during periods of peak demand. As a result, this reduces the diversified demand on the heat pump element of the heat network to approximately 1 kW per domestic connection, and just under 10 W per sqm of non-domestic floorspace.
- Heat network connections and the location of large-scale heat pumps to drive these networks have been located based on DESNZ's Opportunity Areas for District Heating. Networks in the UK[ii]. This National Comprehensive Assessment accounts for the heating and cooling demand on prospective district heating networks, alongside sources of heat such as waste-to-energy plants, waste heat and air, ground and water-source heat pumps.
- The heat networks are assumed to be planned ahead of need in each scenario, rather than directly matching demand in each year of the analysis. In the modelling, large-scale heat pumps are based on the demand three years ahead of the installation date, and in stages of 50 kWe.

As a result of this modelling, capacity of large-scale heat pumps for district heating ranges in the East Midlands in 2050 ranges from 247 MW under **Falling Short** to 459 MW under **Consumer Transformation**.

Non-domestic electric heat in the East Midlands licence area

Non-domestic premises where electricity is the primary fuel for space heating and hot water, delivered through a heat pump or resistive electric heater.

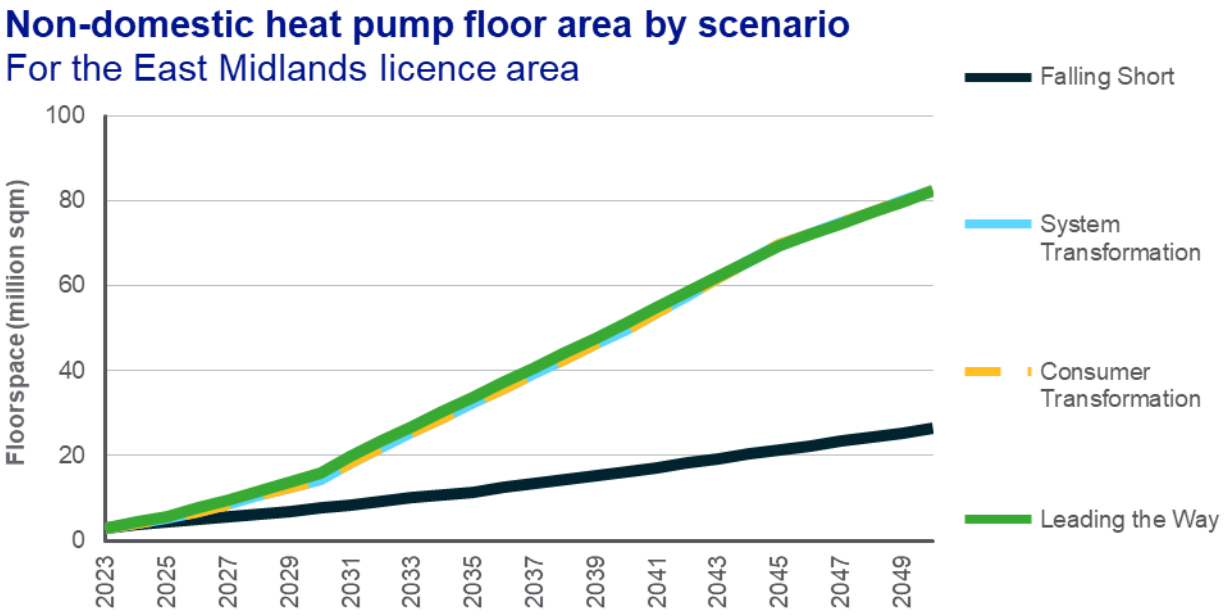
Data summary for non-domestic electric heat in the East Midlands licence area:

Total floorspace (million sqm)		Baseline	2028	2035	2050
Heat pumps	Falling Short	3	6	11	26
	System Transformation		11	32	82
	Consumer Transformation		11	32	82
	Leading the Way		12	34	82
Resistive electric heating	Falling Short	15	17	17	16
	System Transformation		16	12	8
	Consumer Transformation		16	12	8
	Leading the Way		15	11	8

Summary:

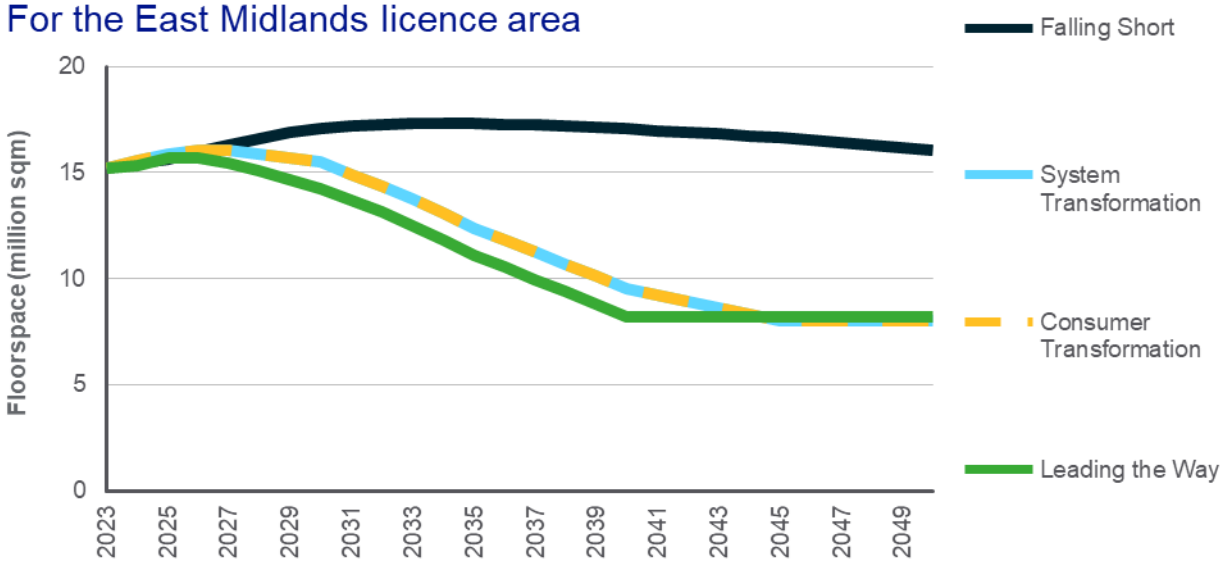
- Heating in non-domestic buildings is currently dominated by gas-fired central heating, resistive electric heating and air conditioning.
- A DESNZ evidence update of low carbon heating and cooling in non-domestic buildings[vi] found that non-domestic building decarbonisation pathways are strongly influenced by the existing heating system and HVAC environment.
- In the three net zero scenarios, this results in buildings currently heated by gas, oil or LPG moving to an air-source or ground-source heat pump, or connecting to a district heat network, while most buildings with resistive electric heating moving to more efficient air-to-air heat pumps, operating similarly to air conditioners.
- Under **Falling Short**, similarly to domestic heat, progress towards decarbonisation of buildings is slow for all types of non-domestic buildings.

Figure 7 – Non-domestic floorspace heated by heat pumps by scenario



Non-domestic resistive electric heating by scenario

For the East Midlands licence area



Modelling assumptions and results

Baseline		
Analysis of EPC and DEC data suggested that 15 million square meters of floorspace is heated by resistive electric heating. This does not include buildings with air conditioning that are recorded as predominantly providing cooling. EPC and DEC data do not record whether a building is heated by a heat pump. As a result, the heat pump baseline is informed by MCS installation data.	**Technology**	**Total floorspace (million sqm) and proportion***
	Heat pumps	3 (2%)
	Resistive electric heating	15 (9%)

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

Near-term projections (April 2023 to March 2028)			
Scenario	**Description**	**Total heated floorspace (million sqm) and proportion by 2028**	
		Heat pumps	**Resistive electric**
Leading the Way	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. By 2030, around 20% of these buildings are heated by a heat pump under the three net zero scenarios. Towards the end of the 2020s, the pipeline of new heat networks is built out and a number of non-domestic buildings begin to connect. For new build non-domestic properties, electric	12 (7%)	15 (9%)
Consumer Transformation		11 (6%)	16 (9%)
System Transformation		11 (6%)	16 (9%)

	heating quickly becomes the dominant technology. This follows a trend which has seen new build electric heating in new build non-domestic properties growing from under 40% of floorspace in 2018 to 70% of floorspace in 2023.		
Falling Short	Progress towards heat decarbonisation is slow, with small, incremental uptake of heat pumps in off-gas and direct electric heated buildings.	6 (4%)	17 (10%)

Medium and long-term projections (April 2028 to March 2050)			
Scenario	**Description**	**Total heated floorspace (million sqm) and proportion by 2050**	
		Heat pumps	**Resistive electric**
Leading the Way	Non-domestic heat decarbonisation accelerates in the 2030s, with a high proportion of buildings shifting to electrified heat by 2040.	82 (41%)	8 (4%)
Consumer Transformation	In currently gas-heated premises, air-source and ground-source heat pumps are preferred where a district heating connection is not available.	82 (41%)	8 (4%)
System Transformation	In premises with direct electric heating, moving to an air-to-air heat pump is more suitable.	82 (41%)	8 (4%)
Falling Short	Progress towards heat decarbonisation remains slow, with many properties remaining heated by natural gas by 2050. Much of the heat pump uptake that is achieved is in the form of direct electric heating shifting to air-to-air heat pumps.	26 (13%)	1 (8%)

Reconciliation with National Grid FES 2023

- As the FES non-domestic heat outputs are reported in numbers of installations rather than heated floorspace. The modelling aims to mirror the high-level outcomes from non-domestic heating in each of the four FES scenarios.

Factors that will affect deployment at a local level

Factor	**Source**
Current heating technology of each non-domestic building	Non-domestic EPC and Display Energy Certificate data
Building environment of each non-domestic building, including heating demand, cooling demand and HVAC system.	Non-domestic EPC and Display Energy Certificate data
Existing baseline of non-domestic heat pump installations	MCS installation data
Areas with potential for district heat networks, or an existing heat network pipeline project	Heat network pipeline data[vii], and Opportunity Areas for District Heat Networks in the UK[viii] - BEIS

Electric vehicles and EV chargers in the East Midlands licence area

Pure electric and plug-in hybrid electric vehicles, and associated domestic and non-domestic electric vehicle chargers required to charge them.

Data summary for electric vehicles in the East Midlands licence area:

Number of vehicles (thousands)		Baseline	2028	2035	2050
Battery electric cars, LGVs and motorbikes	Falling Short	77	301	1,236	3,999
	System Transformation		368	1,873	3,711
	Consumer Transformation		700	2,926	3,700
	Leading the Way		634	3,105	2,985
Plug-in hybrid electric cars, LGVs and motorbikes	Falling Short	45	117	251	100
	System Transformation		110	208	16
	Consumer Transformation		95	131	11
	Leading the Way		113	111	14
Battery electric HGVs, buses and coaches	Falling Short	0	1	5	86
	System Transformation		2	17	57
	Consumer Transformation		2	23	98
	Leading the Way		2	23	95

Data summary for EV chargers in the East Midlands licence area:

Capacity of chargers (MW)		Baseline	2028	2035	2050
Domestic chargers	Falling Short	360	1,184	3,865	9,679
	System Transformation		1,474	5,516	9,269
	Consumer Transformation		2,741	10,411	13,597
	Leading the Way		2,497	11,139	15,269
Non-domestic chargers	Falling Short	142	323	746	2,658
	System Transformation		388	1,307	2,522
	Consumer Transformation		503	1,557	2,216
	Leading the Way		493	1,644	2,275

Summary:

- 3% of vehicles in the East 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.
- Under **Consumer Transformation** and **Leading the Way**, passenger vehicles such as cars and LGVs are rapidly electrified over the 2020s and 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 in these scenarios. In these scenarios, EVs become the default

new car choice regardless of any ban on petrol and diesel vehicle sales in the 2030s.

- Under **System Transformation**, the electrification of vehicles is slightly slower. Additionally, a higher availability of low carbon hydrogen in this scenario results in a small number of passenger and non-passenger vehicles being fuelled by hydrogen.
- The electrification of transport is slowest under **Falling Short**. While by 2050 the vast majority of vehicles are still electrified, a high proportion of this electrification occurs in the 2040s.
- Regen's EV charger model determines the charger capacity required to charge the number of vehicles projected under each of the four DFES scenarios, split across a number of different domestic and non-domestic charger types such as rapid en-route chargers and slow and fast chargers in public car parks. In addition, eHGV chargers have been modelled as their own category, with deployment centred on HGV service stations along the strategic road network.
- By 2050, EV charger capacity in the East Midlands ranges between 12 GW and 17 GW.

Figure 8 – Number of plug-in (battery electric and hybrid) cars, LGVs and motorcycles by scenario, East Midlands licence area

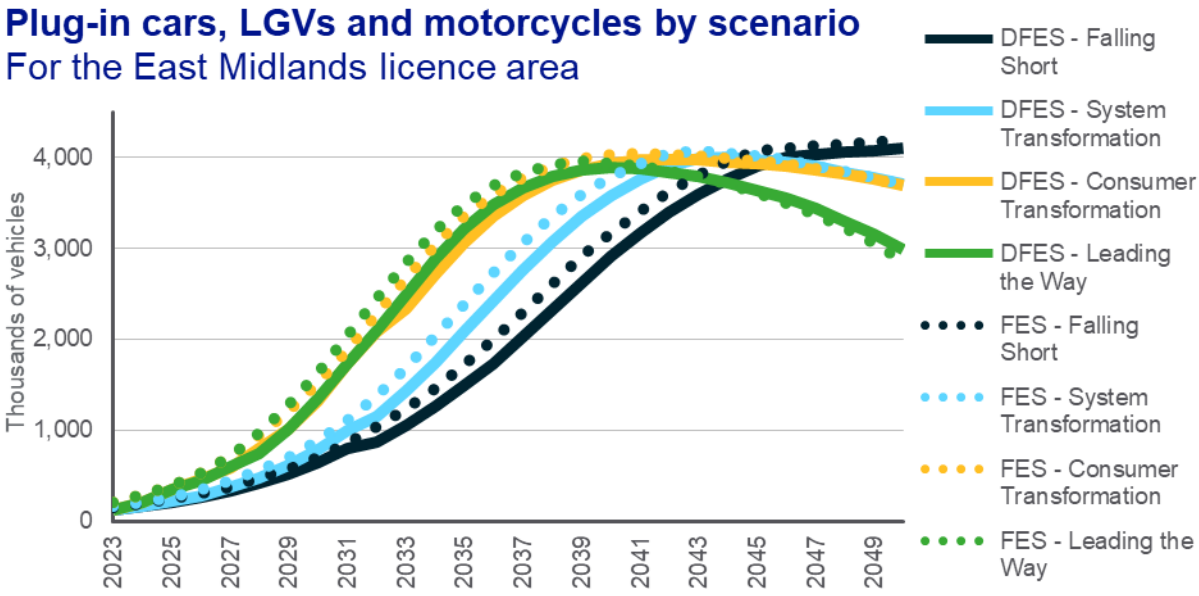
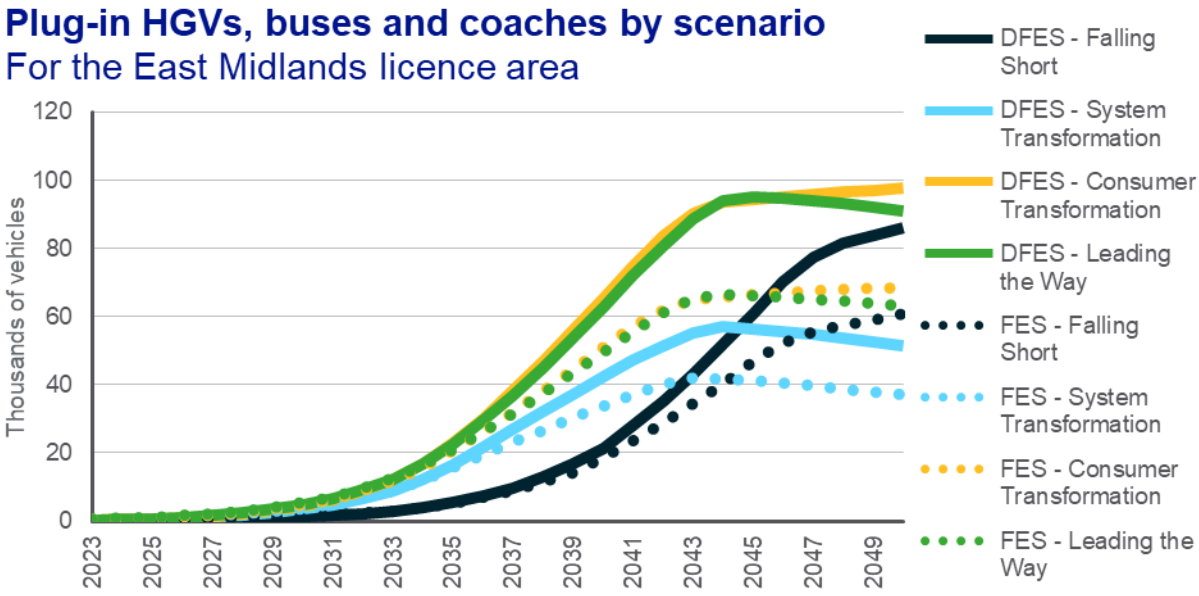


Figure 9 – Number of plug-in (battery electric and hybrid) HGVs, buses and coaches by scenario, East Midlands licence area



Baseline

Electric vehicles

The electric vehicle baseline represents 3.0% of vehicles registered in the East Midlands licence area.

Uptake of electric vehicles across the UK has been steadily accelerating. This has been due to a number of factors, including favourable tax benefits and grant support, increasing consumer confidence and electrification of commercial vehicle fleets.

While the vast majority of electric vehicle 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.

Vehicle type	Thousands of vehicles
Pure electric car	67
Plug-in hybrid car	45
Pure electric LGV	9
Other electric vehicles	1

EV chargers

As the number of electric vehicles has increased, the number and capacity of EV chargers has similarly increased. In addition to most domestic EV owners having a home charger, non-domestic chargers in the form of car park chargers, workplace charging and rapid en-route chargers on forecourts have seen an increasing rollout in recent years.

Charger type	Capacity (MW)
Domestic	360
Non-domestic	142

Near-term projections (April 2023 to March 2028)

The acceleration in EV uptake seen over the past few years is anticipated to continue under every scenario, however the extent of this varies under the four future scenarios.

Charger uptake is tied to EV uptake, with domestic and non-domestic chargers continuing to be installed in order to meet demand. This is augmented by the known pipeline of accepted connection offers for major EV charger installations connecting to the NGED distribution network, predominantly in the form of en-route charging hubs at service stations on major M and A roads such as the M1 and A1.

Scenario	Description	Total plug-in vehicles by 2028 (000s)	EV charger capacity by 2028 (MW)
Leading the Way	Uptake of electric vehicles and EV chargers rapidly increases under these scenarios, driven by favourable financial conditions for EVs and increasing consumer confidence.	749	2,956
Consumer Transformation	The majority of EV charger capacity is domestic chargers in this period. However, uptake of rapid en-route and on-street chargers increases substantially.	797	3,211
System Transformation	Uptake of electric vehicles increases substantially, but less rapidly than the other two scenarios due to lower levels of consumer engagement. However, over 5% of cars are electrified by 2025 under both scenarios.	480	1,829
Falling Short	The majority of EV charger capacity is domestic chargers in this period. However, uptake of rapid en-route and on-street chargers increases substantially.	419	1,474

Medium and long-term projections (April 2028 to March 2050)

The uptake of electric vehicles and EV chargers is modelled to continue accelerating between 2025 and 2035 across all scenarios. Between 2030 and 2035, major reductions in the sale of petrol and diesel cars and vans result in electric vehicles representing the vast majority of new vehicles in this period. Recent policy uncertainty around the end of sales of petrol and diesel vehicles is reflected in the three net zero scenarios.

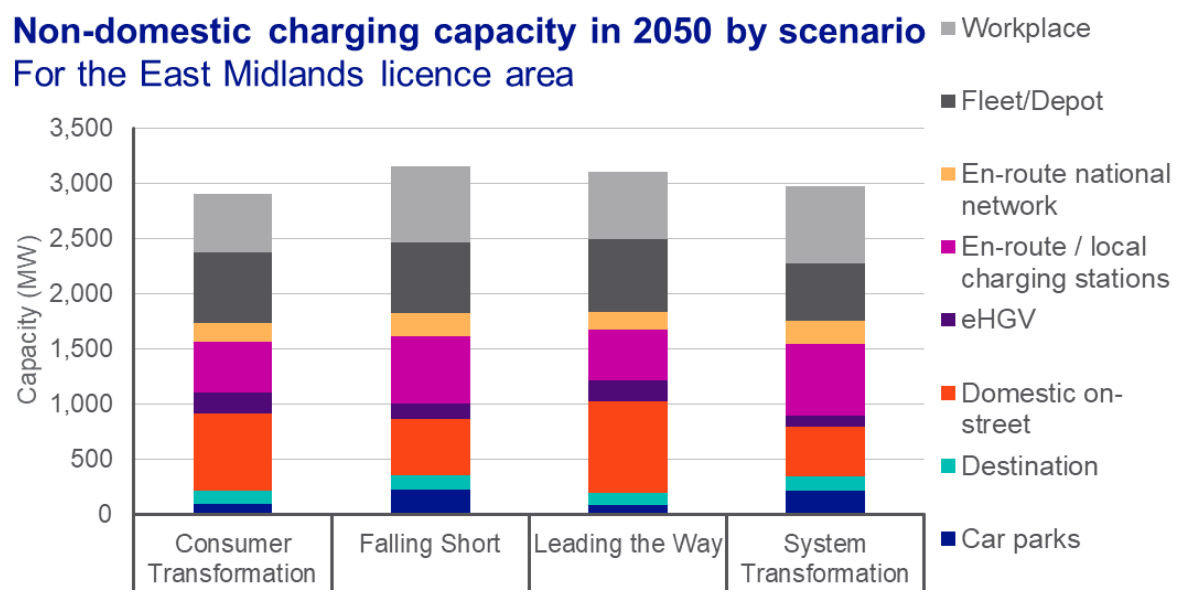
By 2035, the installation rate of EV chargers slows. Homes with multiple EVs are assumed not to purchase a second charger at the same rate as their first, and the demand for additional public charging reduces as the majority of vehicles are electrified under net zero scenarios by this point.

In the longer term under the three net zero scenarios, EV adoption approaches saturation and new EV uptake slows in most areas. Harder-to-electrify vehicles that saw lower uptake in the near term, such as HGVs, 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. It is assumed that while EV numbers may reduce in the 2040s under some scenarios, installed EV chargers will remain in place, but see lower utilisation as the overall number of vehicles on the road decreases.

Scenario	Description	Total plug-in vehicles by 2050 (000s)	EV charger capacity by 2050 (MW)
Leading the Way	EVs dominate new car and LGV sales from the late 2020s under these scenarios, and from 2030 almost all new cars and LGVs are electric. Harder-to-electrify vehicles such as buses and HGVs also see accelerated uptake in the medium-term, with the majority of road vehicles electrified by 2035. With such a rapid shift toward battery electric vehicles, plug-in hybrid vehicles see relatively little uptake, and begin to decline in the 2030s. EV uptake is facilitated by a widespread rollout of domestic and non-domestic charging. This includes a specific eHGV charger category, with 350 kW and 1 MW chargers at major service stations. Under **Leading the Way**, in addition to the above, overall vehicle ownership falls as car sharing via autonomous vehicles, active travel and greater use of public transport reduce the need for private vehicle ownership under this scenario.	3,093	17,503
Consumer Transformation		3,808	15,772
System Transformation	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 vehicles. Plug-in hybrid vehicles see moderate uptake, with battery electric vehicles being the dominant EV technology across all vehicle classes. While domestic charging is most common, rapid en-route charging also sees high uptake under this scenario.	3,784	11,750

Falling Short	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 are the dominant EV technology across all vehicle classes.	4,184	12,296

Breakdown of non-domestic EV charging capacity in 2050 by scenario



Reconciliation with National Grid FES 2023

- As the EV market and provision of EV charging infrastructure are heavily driven by national factors, the DFES projections for EVs and EV chargers in the licence area strongly mirror the national FES outcomes.
- Uptake of electric HGVs, buses and coaches is significantly lower in the FES analysis compared to the DFES. The reason for this variance is unclear, but is likely to be due to differences in modelled 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 future electric vehicles out to 2050.
- The different EV charger subtechnologies are not broken down in the FES 2023 data at a GSP, licence area or national level. As such, a reconciliation is not possible. For vehicle efficiencies, mileage and vehicle numbers, FES projections and assumptions were used to inform the DFES analysis, where available.

Factors that will affect deployment at a local level

Factor	Source
The baseline of existing electric vehicles and petrol/diesel vehicles strongly informs the uptake of future electric vehicles	DfT statistics
The baseline of existing EV chargers is used as an indicator for the location of projected EV chargers	DfT data, NGED data, National Chargepoint Registry, Open Charge Map
Access to off-street and on-street parking, affluence and rurality are considered in the near-term uptake of electric vehicles and the associated off-street and on-street domestic EV chargers	ONS Census
The location of petrol/diesel fuelling stations is used to indicate the location for projected en-route EV chargers	OS Addressbase
The location of car parks, workplaces and fleets/depots are used to indicate the location of projected car park, workplace and fleet/depot EV chargers.	OS Addressbase

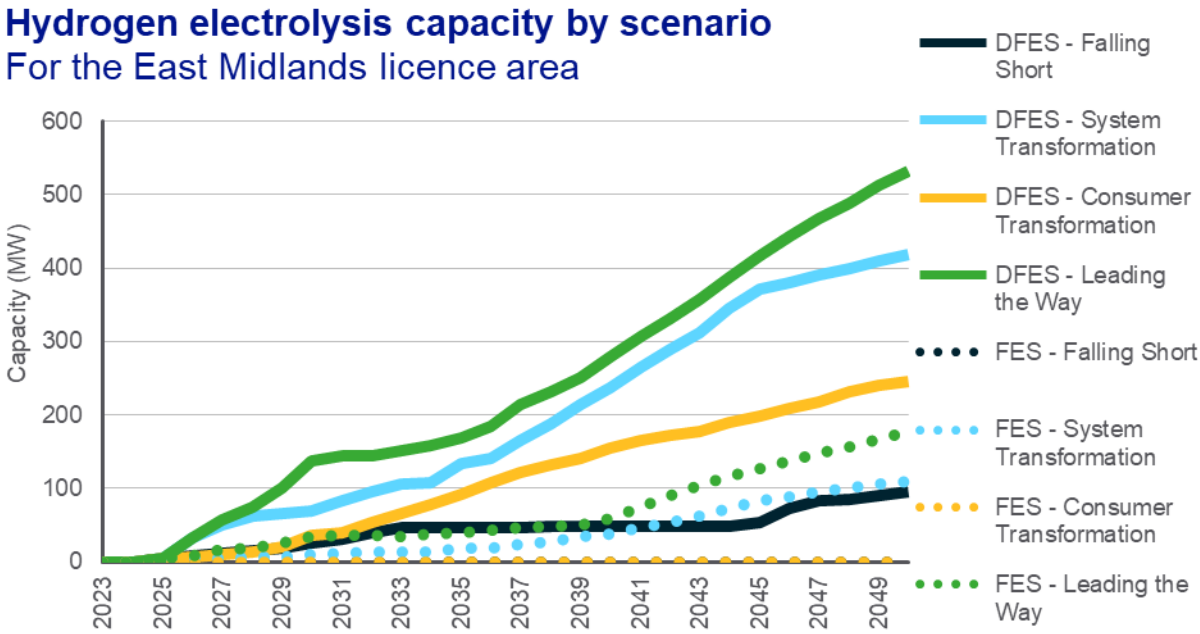
Hydrogen electrolysis in the East Midlands licence area

Capacity of distribution network connected hydrogen electrolysers. This does not include CCUS-enabled hydrogen produced via the reformation of fossil gas.

Data summary for hydrogen electrolysis uptake in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	0	15	47	96
System Transformation		62	133	418
Consumer Transformation		14	93	246
Leading the Way		75	168	533

Figure 10 – Installed capacity of hydrogen electrolysis by scenario, East Midlands licence area



Summary:

- Hydrogen is currently produced at scale via reformation of fossil gas with carbon dioxide released directly into the atmosphere. In the future, hydrogen will be produced either via electrolysis, where water is split into component molecules of hydrogen and oxygen using electricity, or via reformation of fossil gas with carbon capture and storage.
- Hydrogen electrolysis is not a new technology but is yet to be commercially deployed at scale. There is still significant uncertainty around hydrogen's role in decarbonising the economy. The deployment of hydrogen electrolysis is a potentially disruptive source of electricity demand on the electricity distribution network, with uncertainty around where and when electrolyser developers might connect to the distribution network in the future.
- The UK Government has set a target of 10 GW of low carbon hydrogen production capacity by 2030, with 5 GW to come from hydrogen electrolysis. Based on analysis of planning applications, Regen estimates there is currently less than 100 MW of electrolyser capacity connected across Great Britain.

- Under the FES 2023 framework, **Leading the Way** and **System Transformation** see significant deployment of hydrogen as an energy vector and gas networks are assumed to be developed to enable nationwide hydrogen distribution. In **Consumer Transformation** and **Falling Short**, hydrogen demand is significantly lower and hydrogen distribution networks are not developed.
- While there is currently no electrolyser capacity connected to the distribution network in the East Midlands licence area, there are six projects with evidence of progression through the planning system, estimated to total around 15 MW.
- In the medium and long term, projections for electrolyser capacity have been modelled based on an analysis of potential supply and demand drivers for hydrogen in each licence area under each of the four future scenarios.
- The East Midlands has a higher level of industrial energy usage and HGV transport compared to other licence areas, both of which drive hydrogen demand and thus electrolysis deployment in the near and medium term.
- In addition to these factors, National Gas' proposed future hydrogen backbone transmission network (Project Union[1]) could include various parts of the East Midlands. In addition to this, significant amounts of existing gas network infrastructure and gas-fuelled electricity generation capacity are key locational factors that drive the projections for electrolysis capacity in the East Midlands.
- By 2050, electrolysis capacity reaches 532 MW in the licence area under **Leading the Way**.

Modelling assumptions and results

Baseline

There are no hydrogen electrolysis plants currently connected to the distribution network in the East Midlands licence area. A small demonstrator electrolyser previously operating at West Beacon Farm in Nottingham has been decommissioned.

Near-term (April 2023 to March 2028)

There are six proposed electrolysis projects that have entered the planning system in the East Midlands licence area, some of which are not proposing to connect to the distribution network:

- High Marnham Power Station, Nottinghamshire (8 MW, transmission-connected)
- Toyota HRS in Burnaston, Derbyshire (capacity unknown)
- Redfield Road Hydrogen Energy Project, Nottinghamshire (4 MW)
- Featherstone House Farm, Nottinghamshire (1.25 MW, not grid connected)
- MIRA Technology Park, Leicestershire (1 MW)
- Derby HRS, Derbyshire (1 MW)

The East Midlands hosts some of the UK's key road transport infrastructure and the development of several Hydrogen Refuelling Stations (HRS) reflects this. There are also projects in development without connection offers or planning system progress that do not influence the projections:

- East Midlands Hydrogen, an industry-group supported by Cadent (the region's gas distribution network), is seeking to develop a hydrogen demand cluster in the area. Members include the East Midlands airport, which has ambitions to operate hydrogen-fuelled planes and has committed to net zero operation by 2038.
- H2GVMids carried out a government-funded feasibility study in the region in 2021, creating a plan for potential refuelling station locations and capacities.

The projections for distribution network connected electrolyser capacity between 2022 and 2025 are based on these projects progressing through the planning system.

[1] See https://www.nationalgas.com/document/139641/download

Pipeline project details	Scenario	Connection date	
Sites with planning approval	**Falling Short**	1.5 years	From approval
	System Transformation	1.5 years	
	Consumer Transformation	1 year	
	Leading the Way	1 year	
Sites with planning submitted	**Falling Short**	2 years	From submission
	System Transformation	2 years	
	Consumer Transformation	1.5 years	
	Leading the Way	1.5 years	
Sites with some pre-planning evidence	**Falling Short**	2027	
	System Transformation	2026	
	Consumer Transformation	2026	
	Leading the Way	2026	

Medium and long-term (April 2028 to March 2050)

The projections for distribution network connected electrolyser capacity from 2028 to 2050 are based on the national projections from FES 2023. The proportion of these national capacity projections that are located within the licence area is based on a regional analysis of hydrogen supply and demand factors, which are weighted based on the overall level of distributed hydrogen assumed under the four scenarios.

An assessment of hydrogen supply and demand factors for all GB licence areas was completed, enabling the presence of these factors in the East Midlands (compared to the rest of GB) to be determined. These factors were used to inform the level of electrolytic hydrogen production and thus the projected capacity of hydrogen electrolysis by scenario.

For example, one factor used was future hydrogen transmission network coverage. This was determined using the proportion of the length of proposed hydrogen transmission pipelines in each licence area, using National Gas's published plans under Project Union.

The weightings applied to these factors were derived from assumptions in the FES scenario framework and the volume of hydrogen demand projected in each sector in each scenario.

As a result of this analysis, hydrogen electrolysis capacity reaches over 0.5 GW by 2050 under **Leading the Way**.

Scenario	Capacity by 2050 (MW)
Falling Short	96
System Transformation	418
Consumer Transformation	246
Leading the Way	533

Scenario	Regional supply considerations	Regional demand considerations
Falling Short	Hydrogen distribution networks are not developed under this scenario, so hydrogen production and demand are matched at a local level.	In the medium and long-term, hydrogen demand is primarily driven by the industrial sector, with road transport accounting for less than 10% of overall demand in the licence area.

	Electrolyser projects are therefore limited overall in the medium and long term and located close to hydrogen demand.	In the long term, power generation grows to provide approximately 20% of demand.
System Transformation	**Medium-term:** These scenarios see high levels of hydrogen blended into the existing methane supplied through the gas network. This means the coverage of the existing gas network infrastructure is an important regional supply consideration in this scenario. **Long-term:** The development of a hydrogen distribution pipeline network is a defining characteristic of electrolysis development under these scenarios. This reduces the need for demand and production to be as locally tethered and allows hydrogen production sites to be developed in areas that are most appropriate. This results in a balance between the proximity to the hydrogen gas transmission system, renewable energy projects (including for co-location) and sources of low carbon hydrogen demand.	**Medium-term:** demand for hydrogen is driven mainly by blending into gas distribution networks for end-use in I&C, residential and power generation applications. **Long-term:** residential heat becomes the greatest demand for hydrogen out to 2050. Hydrogen is used across all sectors (by order of demand share): • Residential heating • Industrial & commercial • Shipping • Road transport • Power generation • Aviation • Rail
Leading the Way		**Medium-term:** demand is driven mainly by blending into the gas distribution networks for end-use in I&C, residential and power generation applications. **Long-term:** blending is replaced with direct use in the same three sectors. Shipping demand grows to become the largest demand sector. Demand for hydrogen for aviation grows but remains small.
Consumer Transformation	Hydrogen production and demand are matched at a regional level because hydrogen distribution networks are not developed. Electrolyser projects are therefore limited and located close to hydrogen demand.	**Medium-term:** shipping, power generation and industrial activity are all significant demand sectors. **Long-term:** shipping demand grows to become the largest sector, and a small amount of demand comes from aviation in addition to power generation and industry.

Hydrogen distribution factors					
Factor	Scenario weighting				Level in the East Midlands
	Leading the Way	Consumer Transformation	System Transformation	Falling Short	
Industrial energy demand	High	High	High	High	Medium
Heavy transport demand	Low	Medium	Medium	High	Medium
H2 transmission network coverage	Medium	Low	Medium	Low	High
Location of maritime activity	Medium	High	High	Low	Low
Gas distribution network coverage	High	Low	High	Low	High
Gas-powered electricity generation	Medium	High	Medium	Medium	High
Hydrogen innovation projects	High	High	High	High	Medium
Location of aviation activity	Low	Low	Low	Low	Medium
Existing grey hydrogen demand sites	Medium	Low	Low	High	Low
Renewable electricity generation	Medium	Low	Low	Low	Low

Reconciliation with National Grid FES 2023

- In all scenarios, the DFES 2023 projections are higher across the projection timeline to 2050 than the FES 2023 projections in the East Midlands. This reflects the hydrogen distribution factors details in the table above, in which the level in the East Midlands is the highest of the four NGED licence areas, with particularly high network coverage, industrial demand and heavy transport demand due to the East Midlands being a logistics hub for the UK.
- In **Leading the Way** and **System Transformation**, the FES 2023 allocates electrolyser capacity in proportion to renewable generation capacity, so in those scenarios, the East Midlands' relatively low potential for renewable generation may contribute to lower projections compared to the DFES, which takes into account a wider number of factors.

Factors that will affect deployment at a local level

Factor	Source
Location of key development zones for hydrogen production and demand, such as airports and potential hydrogen storage.	Regen analysis
Location of heavy industry energy users.	National Atmospheric Emissions Inventory
Location of heavy transport and fuelling hubs, using road traffic counts for light commercial vehicles, heavy goods vehicles and buses and coaches.	Department for Transport

New developments in the East Midlands licence area

New-build property developments, including new housing and new non-domestic sites.

Data summary for new domestic developments in the East Midlands licence area:

Houses (thousands)	Baseline	2028	2035	2050
Falling Short	-*	135	374	704
System Transformation		174	442	753
Consumer Transformation		174	442	753
Leading the Way		220	488	817

* there are currently around 2.3 million domestic customers in the East Midlands licence area.

Data summary for new non-domestic developments in the East Midlands licence area:

Floorspace (sqm, 100,000s)	Baseline	2028	2035	2050
Falling Short	-*	67	149	195
System Transformation		87	180	193
Consumer Transformation		87	180	193
Leading the Way		96	183	193

* there are currently around 190 thousand non-domestic customers in the East Midlands licence area. Floorspace recorded in EPC and DEC data totals 161 million sqm.

Summary:

- The development of new housing and non-domestic sites represents future hotspots of conventional electricity demand, as these new developments are constructed and occupied over the scenario timeframe.
- The modelling of new developments is based on direct engagement with local authorities' planning departments and analysis of local planning documents submitted to Regen. These detail the planning stages of each new development, i.e., 'under construction', 'full planning permission', or allocated land space for future use.
- The local planning documents provide data out to 2042, so new long-term housing developments were modelled based on an analysis of ONS household projections.
- By 2050, this modelling results in between 704,000 and 817,000 new homes in the East Midlands licence area across the scenarios, representing a 25-30% increase in the number of domestic houses between 2023 and 2050.
- An additional 19.5 million square meters of non-domestic floorspace is also modelled in the licence area under each DFES scenario.

Figure 11 – Cumulative planned and total new housing developments by scenario, East Midlands licence area

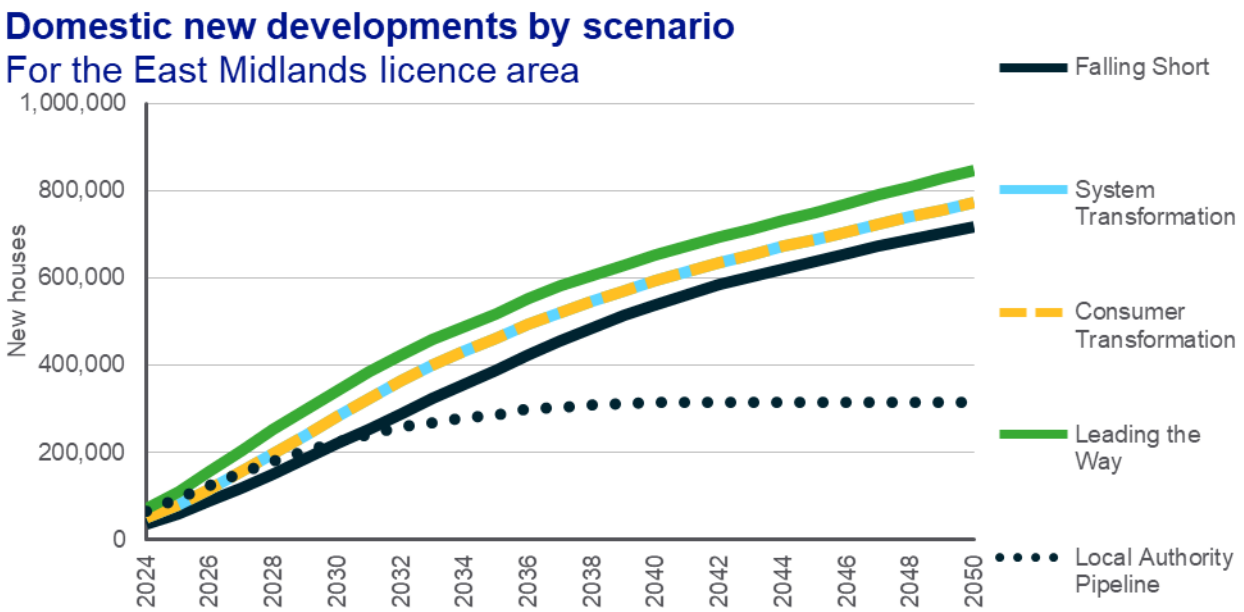
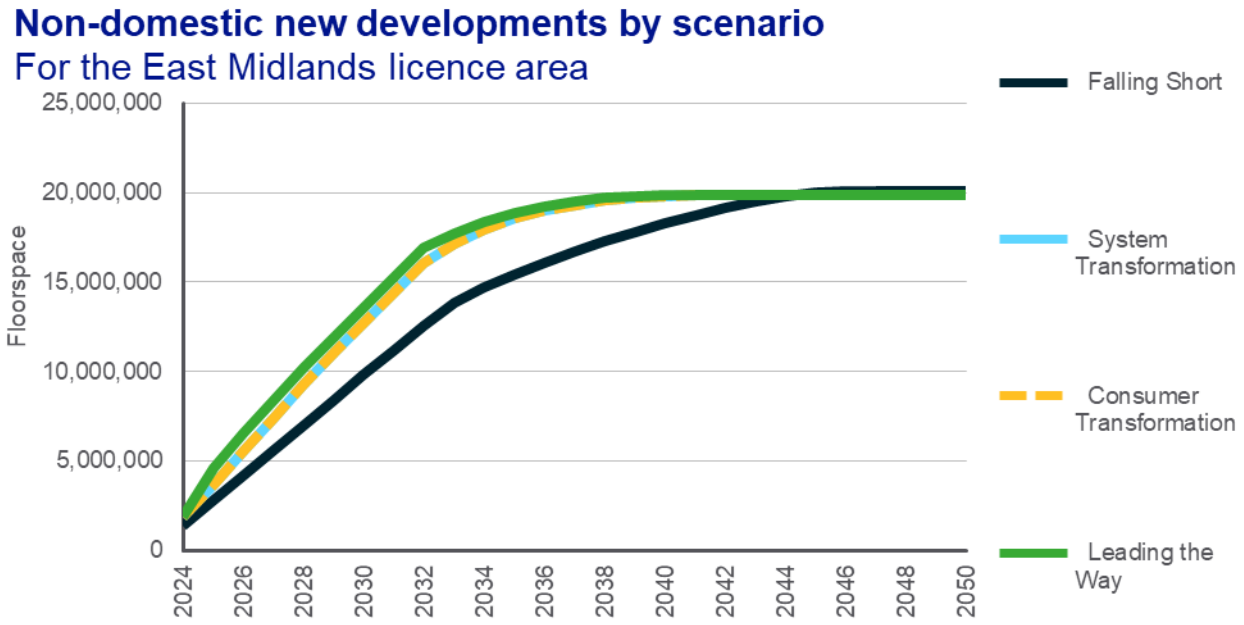


Figure 12 – Cumulative planned non-domestic developments by scenario, East Midlands licence area



Modelling assumptions

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.

Planned developments (April 2023 to March 2050)	
Methodology	
Data exchange with all LAs in the licence area	Planning departments in all local authorities in the NGED licence areas are contacted to review a data register of existing new developments, sourced from the previous DFES analysis. The local authorities then provide updates to existing sites and add additional sites where appropriate to this register. This process aims to capture housing developments of 20 homes or more.
Database update	This LA-provided data is checked and supplemented where necessary from other online data sources. Where new data was not provided, the data is gathered through publicly available planning documents such as 5-year housing land supplies and local plans, as necessary.
ESA assignment	Sites are spatially mapped to NGED's network infrastructure based on their location. Where locational data is not provided, new sites were located using address information, automated geolocation or manual searches.
Scenario projections	The build-out profile of the new developments is adjusted to produce a range of scenario projections based on historic housebuilding data and construction of new non-domestic premises.

Domestic

Total number of planned homes	**Number of development sites identified**
313,892	1,407

The local authorities with the highest number of planned homes are detailed below:

Local Authority	**Number of homes**	**Number of sites**	**Largest development site**
West Northamptonshire	30,143	89	Daventry North East (3,535 homes)
North Northamptonshire	26,979	94	West Corby (4,500 homes)
Milton Keynes	22,930	54	Western Expansion Area (5,472 homes)

Commentary on specific development sites:

West Northamptonshire has 89 housing sites planned, averaging 388 homes per site. In addition to the Daventry North East development, there are nine other large sites of 1,000 homes or greater planned in the area.

- Five of these sites, totalling over 10,000 homes, do not yet have planning permission.
- There are currently 16 sites, totalling almost 4,000 homes, that are under construction and scheduled to complete in the late 2020s.

There are 94 sites planned in North Northamptonshire, with an average of 383 homes per site.

- Ten sites are 1,000 homes or greater, of which nine have planning permission.
- There are seven sites currently under construction, five of which are larger than 1,000 homes scheduled to be completed by the early 2030s.

Milton Keynes has 54 sites, averaging over 500 homes per site.

- There are seven sites of at least 1,000 homes, including the Western Expansion Area of 5,472 homes.
- The second largest site is the East of M1 strategic growth area (5,000 homes), which is currently in planning.

Outside of these three LAs, the East Midlands licence area has 51 other planned housing sites greater than 1,000 homes, accounting for just over 108,000 homes.

- The largest site in planning is a part of the Central Development Area in Leicester, totalling 6,286 homes. This site is currently in the Proposed Allocated Draft Plan and not modelled to begin construction until the mid-2030s.
- 24 large-scale sites are currently under construction, including a 4,000 homes site in Charnwood.
- 19 large-scale sites have planning permission and are modelled to begin construction in the late 2020s.

Non-domestic

Regen category	Non-domestic sites		Total non-domestic floorspace (sqm)	
	Number	Proportion	Total per category	Proportion of total
Factory and warehouse	357	37.1%	12,110,924	56.4%
Office	255	26.5%	4,880,255	22.7%
Retail	66	6.9%	380,936	1.8%
School and college	105	10.9%	407,482	2.5%
Other (e.g. medical, hotel, sport & leisure)	179	18.6%	3,569,516	16.6%

The majority (79%) of East Midlands non-domestic planned floorspace is designated as 'employment land', split into factory and warehouse or office space.

The licence area has 91 unique developments with a floorspace of 50,000 sqm or greater. Some notable large sites are the 219-hectare (.47 million sqm) Northampton Gateway Rail Freight Interchange in **West Northamptonshire** and Apleyhead Junction (1.18 million sqm) in **Bassetlaw.**[ix]

Where possible, the planned development floorspace for each site cited in the local authority data has been used in the DFES modelling. Where planned floorspace was not available, overall planned site areas have been converted into floorspace based on benchmarking figures for specific development types (i.e. school, retail, office etc.).

Modelled developments (April 2023 to March 2050)

Domestic

There are two forms of new housing that are not captured through known/planned developments. These have been modelled to ensure the DFES scenarios capture a range of housebuilding trends between 2023 and 2050. These are **residual developments** and **post-planned developments**, described in more detail below:

Residual developments	These are small-scale developments of less than 20 homes, which are not included in the data collection with 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 was applied to the planned projections throughout the scenario timeframe, to account for these residual developments.

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. As planned developments tail off in the 2020s and 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[x].
Non-domestic	
The non-domestic scenario projections are based on planned developments only.	

Reconciliation with National Grid FES 2023

- 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; this aids distribution network planning, as new domestic customers can represent key bulk loads of conventional demand on the network.
- Non-domestic floorspace is not detailed in the FES data and is unable to be compared.
- As a result of these factors, the new developments outputs have not been reconciled against the National Grid FES data.

Factors that will affect deployment at a local level

Factor	Source
Planned sites are located based on their address or the description of their location, and directly assigned to the ESA that they fall within.	Local authority engagement
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, EPC records

Air conditioning (A/C) in the East Midlands licence area

Domestic A/C units, based on a typical portable or window-mounted air conditioner

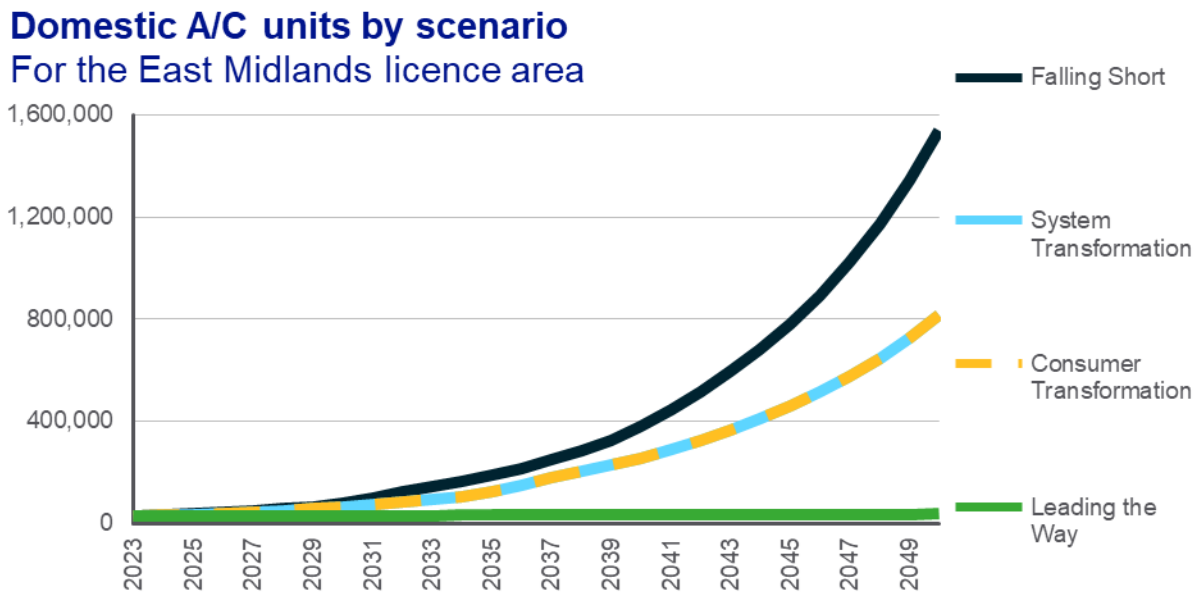
Data summary for A/C uptake in the East Midlands licence area:

A/C units (thousands)	Baseline	2028	2035	2050
Falling Short	28	57	188	1,537
System Transformation		50	122	816
Consumer Transformation		50	122	816
Leading the Way		29	31	36

Summary:

- Domestic air conditioning (A/C) is not currently common in the UK, with only c.1% of UK homes thought to have an A/C unit. However, this baseline is based on national estimates, as no register of domestic A/C uptake exists.
- In the East Midlands licence area, modelling suggests around 1.1% of homes currently have an A/C unit.
- Increased summer temperatures and extended heat waves could result in an increased uptake of A/C units over the coming decades. The UK building stock is not optimised around passive cooling, which could see A/C uptake increase under some scenarios.
- A/C uptake is modelled to occur across all types of homes but is focused in urban areas due to the 'heat island effect' under which urban areas are notably warmer than surrounding rural areas, causing increased temperatures in built-up areas such as Nottingham.
- Given the small baseline and high level of uncertainty around whether domestic cooling will be active or passive in the future, there is a broad range of scenario outcomes, from minimal further uptake under **Leading the Way** to A/C becoming commonplace under **Falling Short**.

Figure 13 – Number of domestic A/C units by scenario, East Midlands licence area



Modelling assumptions and results

Baseline		
There is limited baseline data on domestic A/C levels in the UK. The DFES modelling has aligned with the National Grid FES 2023 data, which has a national baseline of around 330,000 domestic A/C (which equates to c.1.1% of GB homes). To estimate the licence area baseline, this national figure has been distributed based on regional cooling demand and housing density.	Number of domestic units	Proportion of homes with an A/C unit
	c. 28,000	1.1%

Projections (April 2023 to March 2050)		
Scenario	**Description**	**2050 projection**
Falling Short	Increasing frequency of heat waves and a low uptake of passive cooling methods under this scenario leads to a high uptake of A/C as the 'easiest' route to comfortable internal temperatures.	c. 1,537,000 homes
System Transformation	Over time, A/C becomes common in all types of dwellings under these scenarios. The uptake of domestic A/C accelerates in urban areas due to heat island effects and the prevalence of smaller dwellings, such as flats.	c. 816,000 homes
Consumer Transformation		
Leading the Way	The uptake of domestic A/C is minimal under this scenario, with households opting for passive cooling methods such as shading, ventilation and increased levels of insulation.	c. 36,000 homes
New build homes		
UK government published statutory guidance in late 2021[xi], setting standards for overheating in new residential buildings in England. This 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, the uptake of A/C in new-build homes is minimal under every scenario.		

Reconciliation with National Grid FES 2023

- The FES 2023 does not directly detail the number of domestic A/C units by region, making a direct comparison to the DFES not possible.
- The East Midlands licence area sees uptake of A/C slightly above the national level seen in FES 2023, as the licence area is above the national average for cooling demand and similar to the national average in terms of population density.

Factors that will affect deployment at a local level

Factor	Source
Early uptake of domestic A/C is focused in denser urban areas such as Nottingham and Leicester. In scenarios where domestic A/C becomes more prevalent, uptake expands to less dense areas.	Census 2021
Affluence, based on net annual income after housing costs, impacts the near-term distribution of A/C due to the relatively high upfront and running costs of domestic A/C units.	ONS Income Estimates for Small Areas

Generation technologies

Results and assumptions

Large-scale solar in the East Midlands licence area

Solar generation sites of installed capacity of 1 MW and above

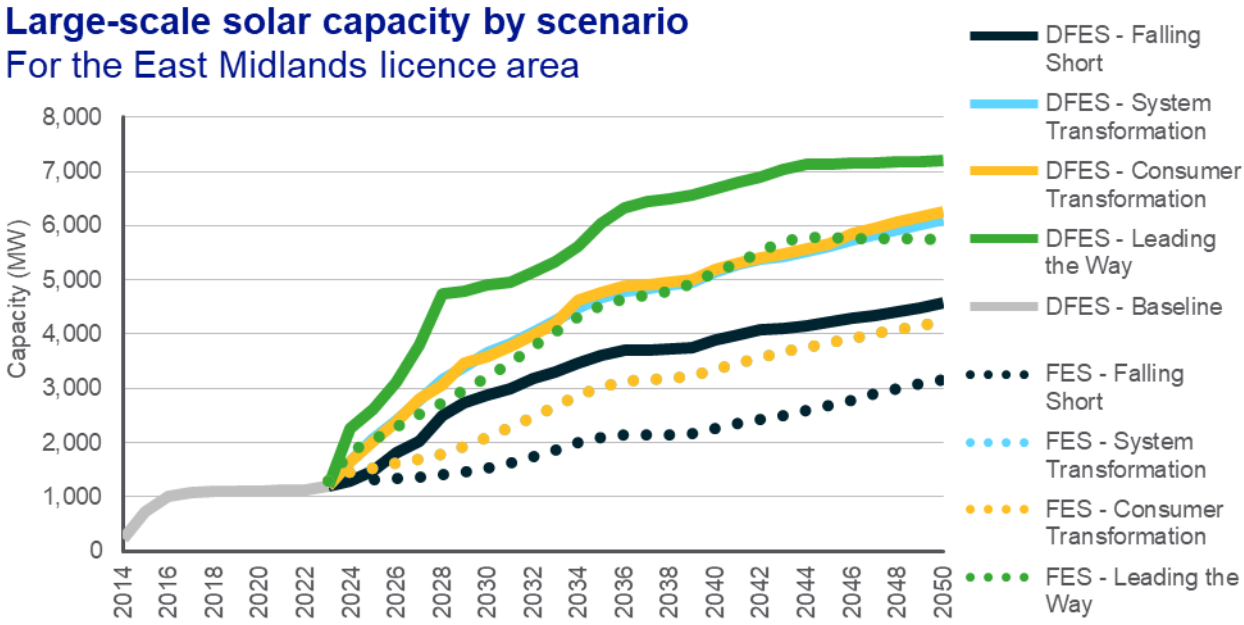
Data summary for large-scale solar power in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	1,192	2,498	3,597	4,564
System Transformation		3,161	4,671	6,129
Consumer Transformation		3,055	4,771	6,256
Leading the Way		4,740	6,046	7,206

Summary:

- The East Midlands licence area has historically seen a high level of large-scale solar PV deployment, with over 1 GW of capacity connected over the past decade.
- Deployment has slowed in recent years. However, a renewed developer interest in the region is reflected in the current volume of large-scale solar PV pipeline projects, with 260 sites totalling 7 GW in various stages of development.
- The capacity of large-scale solar in the licence area is expected to increase substantially in all scenarios out to 2050. In addition to the low cost of large-scale solar generation, the East Midlands hosts a significant amount of suitable land for solar farm development, moderately high solar irradiance and a history of planning friendliness by regional local authorities.
- Scenario outcomes by 2050 range from 4.6 GW under **Falling Short**, around four-times the current baseline, to 7.2 GW under **Leading the Way**, nearly six-times the baseline.

Figure 14 – Electrical capacity of large-scale solar by scenario, East Midlands licence area



Modelling assumptions and results

Baseline		
The majority of current installed large-scale solar PV capacity was deployed between 2012 and 2015, when Feed-in Tariff (FiT) rates for solar PV were highest, with over 1 GW connecting during that time. This past year has seen the addition of 66 MW of new large-scale solar PV connecting in the East Midlands, including a 45.6 MW site in North Kesteven, now the largest site in the licence area, and an 11 MW site in Chesterfield.	**Number of sites**	**Total capacity (MW)**
	174	1,192

Pipeline (April 2023 to March 2028)		
The pipeline of projects with an accepted connection offer in the licence area now totals almost 8 GW, increasing by over 400 MW over the past year. This includes a 200 MW site located in East Staffordshire and three other sites of 100 MW. The average capacity of pipeline sites in the East Midlands is around 30 MW, substantially greater than the baseline average. With such a large pipeline of bigger individual projects, engagement with stakeholders and developers in the region was used to help understand the likelihood and timeline of some key sites coming online.	**Number of sites**	**Total capacity (MW)**
	260	7,795

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Operational	A 3.7 MW site in Buckinghamshire became operational in 2023.	1	3.7
Under Construction	Four sites in the East Midlands licence area are currently under construction and are modelled to connect in all four scenarios. All of these sites have capacity of at least 15 MW and total 127 MW. The two largest sites, in Bassetlaw (49.9 MW) and East Lindsey (43.5 MW), are modelled to connect 2024 and 2026 respectively, based on developer engagement and individual site research.	4	127
Planning Permission Granted	The number of sites with planning granted has increased over the past 12 months, with the addition of 14 new granted sites (263 MW) compared to DFES 2022. This includes 32 sites that are individually 20 MW or greater, the largest being the 70 MW Vicarage Drove Energy Centre development in Boston.	53	1,297
Planning Application Submitted	Nine sites with scales larger than 40 MW were modelled to connect under **Leading the Way**. Under **Consumer Transformation**, ten sites with installed capacity less than 40 MW were modelled to connect. Fifteen submitted sites under **System Transformation** were modelled based on an analysis of the level of local ambition and historic planning permission success rates.	21	720

	Under **Falling Short**, only sites with high levels of historic planning success for large-scale solar PV are modelled to connect.		
Pre-planning	Pre-planning includes sites with evidence of development beyond an accepted connection offer, such as a screening opinion for the need for environmental impact assessments (EIA) or early-stage community engagement. Currently there are just over 1.3 GW of sites that fall into this category in the East Midlands. Sites in pre-planning stages were only modelled to connect under the three net zero scenarios. Under **System Transformation** and **Consumer Transformation**, 25% of sites were modelled to connect based on local ambition and historic planning permission success rates. Under **Leading the Way**, this was increased to 50%.	37	1,319
No information	Due to the size of the large-scale PV pipeline, sites with no evidence of development are only modelled to connect under the **Leading the Way** scenario.	131	3,632
Rejected or Withdrawn	Sites that were rejected in planning, withdrew their application or have abandoned development were not modelled to connect under any scenario.	13	489
Contract for Difference Allocation Round 5	Five sites were identified as having been awarded a contract for difference in allocation round 5: **Newark and Sherwood:** Halloughton Solar Farm (59.9 MW) **South Kesteven:** Gonerby Moor (49.9 MW) **Buckinghamshire:** East Wood End PV (40 MW) **Rugby:** Canal Solar Farm (35.5 MW) **Charnwood:** Mill Farm (22 MW) All sites were modelled to connect under all four scenarios by the delivery year of 2028. The only exception was the **Buckinghamshire** site, where pipeline analysis was able to conclude that the site had planning permission refused.	5	207

Medium and long-term (April 2028 to March 2050)

Beyond the pipeline of projects currently in development, future projections are based predominantly on Regen's in-house solar resource assessment, which accounts for land availability, grid proximity, protected areas, solar irradiance and buildings.

In addition to new sites connecting, the repowering of baseline sites will also contribute to an increase in overall installed capacity in the region. As solar panel technology continues to improve, sites installed in the FiT era will be able to replace their current modules, typically rated around 250 W, with modules with a power density at least twice as high at the end of their operational life.

Scenario	Description	Capacity by 2050 (MW)
Falling Short	Whilst the least ambitious of the four scenarios for renewable energy development, the DFES still models a capacity increase of nearly quadruple the baseline by 2050. Pipeline sites connecting	4,564

	with delayed timelines drives medium-term growth before the late 2030s, where growth levels off, reaching 4.6 GW by 2050. Repowering is assumed to have minimal impact under this scenario, with most site owners choosing to extend the life of their existing panels rather than increase capacity.	
System Transformation	Solar PV deployment increases steadily under this scenario, reaching c.6 GW by 2050. Repowering of baseline sites at the end of their operational life is modelled to increase capacity by 25%.	6,129
Consumer Transformation	Solar PV deployment increases substantially under his scenario, driven by high levels of local ambition, reaching over 6 GW by 2050. Repowering of baseline sites at the end of their operational life is modelled to increase capacity by 25%.	6,256
Leading the Way	Solar PV deployment increases substantially, driven by a high proportion of the known pipeline being modelled to connect, including some sites with only limited development evidence. Repowering of baseline sites at the end of their operational life is modelled to increase capacity by 50%. Solar capacity resultantly reaches over 7 GW by 2050 in the licence area.	7,206

Reconciliation with National Grid FES 2023

- The FES 2023 baseline is around 100 MW higher than the DFES 2023 baseline for the East Midlands licence area. This could be due to the method that the FES uses to assign solar farms to GSPs on the edge of the licence area.
- The DFES 2023 near-term uptake reflects the very large pipeline of projects at various stages of development, augmented by direct engagement with developers on target connection years. This results in the DFES projections for the East Midlands being significantly higher than the FES in every scenario, as a significant proportion of the large pipeline capacity has been found to have strong evidence for near-term deployment, such as full planning permission or being awarded Contracts for Difference.
- In the medium and longer term, the year-on-year capacity growth for large-scale solar PV in the FES and DFES projections is closely aligned under each scenario. Due to the significant variation in the near-term (due to the enhanced DFES pipeline analysis), the total cumulative projections by 2050 remain significantly higher in the DFES than the FES by 2050.

Factors that will affect deployment at a local level

Factor	Source
Regen in-house resource assessment, taking into consideration solar resource land availability and planning constraints in the licence area.	Solar irradiance data, Natural England, OS Addressbase
Local ambition reflecting the local authority policy landscape and proclivity to renewable energy and net zero goals.	Climate Score Cards[xii]
Proportion of solar sites that are successful with a planning application in the local planning authority.	Renewable Energy Planning Database

Small-scale solar in the East Midlands licence area

Solar PV generation sites with installed capacity of less than 1 MW. This includes domestic-scale rooftop PV of under 10 kW, and small-scale commercial PV of 10 kW–1 MW capacity.

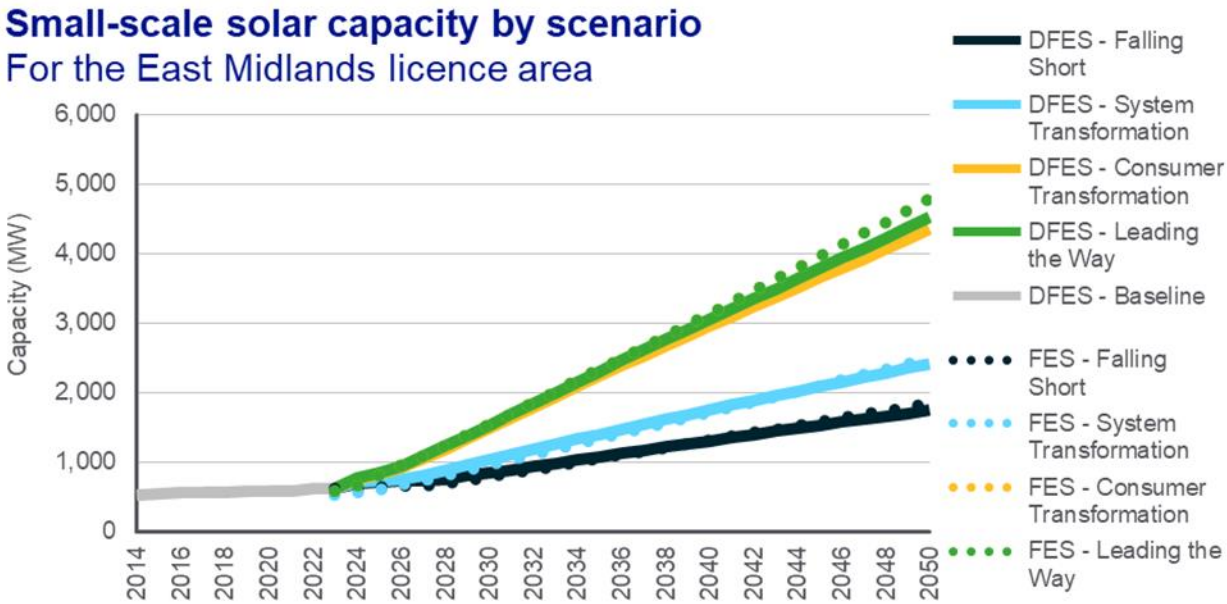
Data summary for small-scale solar generation in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	632	761	1,066	1,728
System Transformation		887	1,392	2,399
Consumer Transformation		1,195	2,232	4,323
Leading the Way		1,235	2,294	4,494

Summary:

- The recent increase in energy prices has resulted in an increase in solar PV deployment, with 120 MW of small-scale solar installed within the last year. The East Midlands baseline now totals 631 MW, with over 400 MW of this installed on domestic rooftops.
- Growth in the deployment of rooftop solar capacity in the UK has reached its highest level since the early FiT era. Across GB, installations in the first quarter of 2023 doubled compared to the previous year[xiii].
- High electrification of transportation and heating drives the uptake of small-scale solar in homes and businesses under both **Consumer Transformation** and **Leading the Way**. Both of these scenarios see seven times the current level of installed capacity, each reaching c. 4.3-4.5 GW by 2050.
- **System Transformation** and **Falling Short** reflect lower levels of electrification, but both scenarios still show significant growth in small-scale solar, with over four times and three times the current capacity by 2050, respectively.

Figure 15 – Capacity of small-scale solar generation by scenario, East Midlands licence area



Baseline			
The majority of small-scale solar was deployed in the FiT era in the 2010s, with over 420 MW connecting during that period. The East Midlands is currently seeing a resurgence of small-scale solar deployment, with 125 MW of new connected capacity in the licence area, compared to DFES 2022. This growth is driven by a number of factors, including high electricity and gas prices.			
Scale	**Number of sites**	**Total capacity (MW)**	**Notes**
Domestic (<10 kW)	99,172	420	Equivalent to 4% of homes
Commercial (10 kW-1 MW)	3,842	211	Average array size: 55 kW

Pipeline (April 2023 to March 2024)		
There are 398 small-scale solar sites in the pipeline, representing over 71 MW of potential additional capacity in the licence area. The majority of sites are categorized as commercial scale between 10 kW and 1 MW. This isn't reflective of the baseline due to domestic solar sites often commissioning quickly and not holding an accepted connection offer for long before being installed. This could mean that additional domestic-scale solar capacity could be deployed in the very near term, but this isn't represented by known connection applications data.		
Scale	**Number of sites**	**Total capacity (MW)**
Domestic (<10 kW)	99	0.5
Commercial (10 kW-1 MW)	299	71
Pipeline analysis		
All pipeline sites are modelled to connect in 2024 under all scenarios, with the exception of three sites with connection offers prior to 2020; these have been removed from modelling as they appear to have been abandoned.		

Medium and long-term projections (April 2024 to March 2050)		
The impacts of government policy have been considered in the modelling for every scenario to a varying degree. An example being changes to Building Regulations (Part L)[xiv] that relate to the reduction in carbon emissions for new-build homes. On existing domestic and commercial rooftops, small-scale solar uptake accelerates due to the falling installation costs of both solar modules and domestic batteries and the increased use of solar to power electrified heat and transport. By 2050 a significant range is seen across the scenarios for small-scale solar in the licence area, ranging from 1.7 GW under **Falling Short** to 4.5 GW under **Leading the Way**.		
Scenario	**Description**	**Capacity by 2050 (MW)**
Falling Short	Reflecting a lower uptake of low carbon technologies, smart tariffs and less engaged customers, this scenario results in lower demand for small-scale solar. The rate of new builds with solar module installation remains at its current level of c. 10% until 2050.	1,728

System Transformation	With the need to decarbonise electricity demand quickly to meet carbon reduction targets, solar PV uptake is also high under this scenario, reaching nearly 2.4 GW by 2050. The rate of new builds with solar module installation is modelled to increase to 25% by 2030 and 40% by 2050.	2,399
Consumer Transformation	High levels of consumers engaging with smart electricity usage, dynamic electricity tariffs and high green ambition help boost small-scale deployment under these scenarios. In addition, the rate of new builds with solar module installation is modelled to increase to 50% by 2030 and 70% by 2050. This results c.4.5 GW of small-scale solar by 2050.	4,323
Leading the Way		4,494

Reconciliation with National Grid FES 2023

- The FES and DFES outputs for small-scale solar PV in the licence area are closely aligned in the baseline, near-term and throughout the projection timeline to 2050.
- There is a small divergence between the DFES **Consumer Transformation** and **Leading the Way** scenarios, which is not seen in the FES projections. This is due to the DFES new-build housing assumptions moderately differentiating between these two scenarios, whereas the FES modelling exhibits a single housebuilding projection for all four scenarios.

Factors that will affect deployment at a local level

Factor	Source
The factors detailed in the modelling assumptions above, such as building type, tenure and affluence, are used to model deployment at a local level.	OS Addressbase, ONS Census
New-build housing is modelled to include rooftop solar PV. As such, the outputs of the DFES new housing projections directly influence the location of small-scale solar PV in the projections.	DFES new developments projections

Onshore wind in the East Midlands licence area

Onshore wind electricity generation

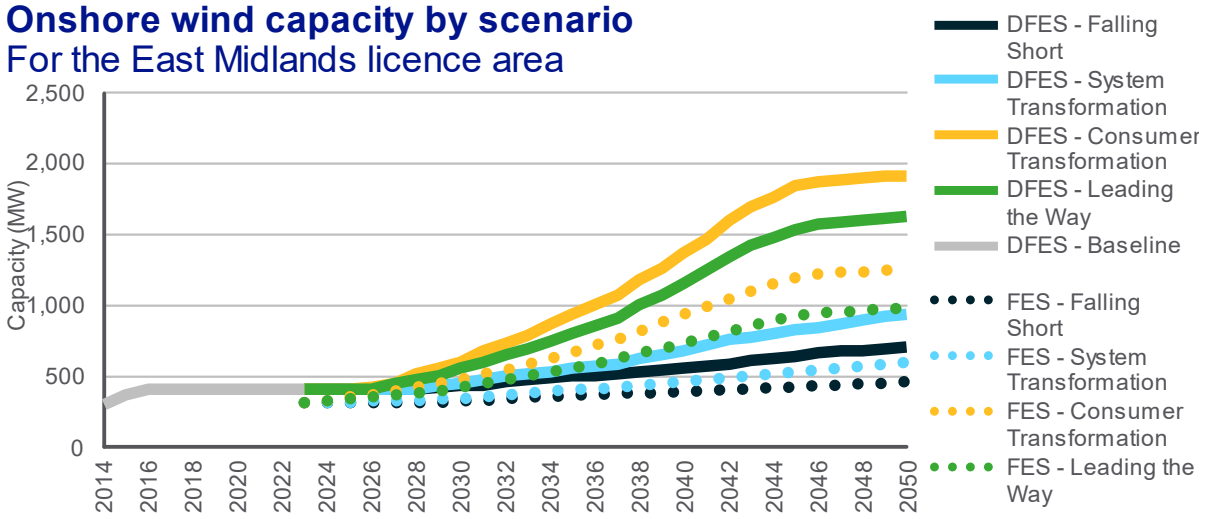
Data summary for onshore wind power in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	410	410	495	702
System Transformation		410	550	939
Consumer Transformation		509	930	1,913
Leading the Way		477	805	1,621

Summary:

- The East Midlands has a significant baseline of onshore wind projects (410 MW), hosting some of the UK's first commercial wind farms. The majority of this baseline was deployed during the FiT era across the 2010s.
- There is substantial onshore wind resource in the East Midlands, with areas of high wind speeds and suitable land. However, recent deployment has been heavily limited by the planning regime in England. This planning obstacle is modelled to continue under **Falling Short**, resulting in only 703 MW by 2050.
- The Contract for Difference allocation round 5 was favourable for onshore wind, allocating nearly 1.5 GW on capacity across 24 sites. However, all sites except one, a 34 MW located in Wales, are in Scotland.
- The **Consumer Transformation** and **Leading the Way** scenarios see the renewed deployment of onshore wind projects, reflecting local and national ambitions to reach net zero targets, nearly doubling between 2023 and 2035. This scale of deployment continues in the 2040s, augmented by existing windfarms repowering at increased capacities at the end of their operational life. As a result, capacity reaches between 1.6-1.9 GW by 2050 under these scenarios.
- There is comparatively less deployment of onshore wind under the **System Transformation** and **Falling Short** scenarios, as there is greater focus on large-scale, transmission-connected power generation in these scenarios.

Figure 16 – Electrical capacity of onshore wind by scenario, East Midlands licence area



Baseline			
Over 90% of onshore wind capacity in the East Midlands comes from 39 sites of at least 1 MW. Northamptonshire hosts one-third of the large-scale onshore wind capacity in the licence area, including the largest wind farm, the 32 MW Chelveston Renewable Energy Park, which has been in operation since 2013. Changes in the planning regime in England have meant that no onshore sites have commissioned since 2017.	**Scale**	**Number of sites**	**Total capacity (MW)**
	Small-scale (<1 MW)	307	42
	Large-scale (>=1 MW)	39	368

Pipeline (April 2023 to March 2028)		
There is only a limited pipeline of four new onshore wind sites, all of which are under 5 MW. This reflects the negative planning policy environment for onshore wind in England. None of these pipeline sites have evidence of development. As a result, just two of the sites are modelled to connect, located in local authorities with high success rates for onshore wind sites in planning, and only under the **Consumer Transformation** scenario.	**Number of sites**	**Total capacity (MW)**
	4	10

Medium and long-term (April 2028 to March 2050)		
Scenario	**Description**	**Capacity by 2050 (MW)**
Falling Short	This scenario reflects the current planning regime for onshore wind in England, resulting in limited deployment. While a small number of new sites are connected, the majority of capacity growth comes from repowering of existing sites. Baseline sites with a capacity higher than 5 MW are modelled to repower with +25% capacity[xv].	702
System Transformation	This scenario sees more focus on transmission network connected generation to achieve net zero targets, resulting in limited onshore wind deployment on the distribution network. Repowering of baseline sites with +25% capacity results in an increased rate of capacity growth in the 2030s and 2040s.	939
Consumer Transformation	This scenario sees the largest growth, reaching just under 2 GW by 2050 – almost five times the current baseline. As distributed onshore wind is key to reducing carbon emissions in this scenario, the modelling assumes continued deployment of new onshore wind sites in the licence area throughout the 2030s and early 2040s. In addition, baseline sites larger than 5 MW are modelled to repower with an additional 50% capacity due to more efficient and larger turbines.	1,913
Leading the Way	This scenario is similar to **Consumer Transformation**, with marginally lower levels of deployment due to the wider energy system being less heavily electrified under **Leading the Way**.	1,621

Reconciliation with National Grid FES 2023

- The FES 2023 baseline of 309 MW is substantially lower than the DFES baseline of 410 MW, which is more comparable to both the FES 2022 (416 MW) and DFES 2022 (412 MW). The reason for this variance is unclear.
- While the baseline between the FES 2023 and DFES 2023 are misaligned, near-term capacity growth is comparable. In the longer term, the FES projections are below the DFES in every scenario – this is likely the result of extrapolation from a lower baseline. The DFES 2023 projections, however, are in line with previously modelled scenarios for this licence area and aim to reflect the onshore wind resource available in the licence area alongside historic deployment.
- The deviation from FES 2023 reflects a potential difference in the method of modelling the repowering of onshore wind sites than the FES. The DFES models increased capacity for repowering of existing sites larger than 5 MW. With most baseline sites set to reach the end of their operational life in the 2030s and 2040s, this plays a significant role in the East Midlands projections.

Factors that will affect deployment at a local level

Factor	Source
Regen in-house resource assessment, taking into consideration wind resource land availability and planning constraints in the licence area.	NOABL wind speed data, Natural England, OS addressbase
Local ambition, reflecting the local authority policy landscape and commitment to renewable energy and net zero goals.	Climate Score Cards
Proportion of wind sites that are successful with a planning application in the local planning authority.	Renewable Energy Planning Database

Offshore wind in the East Midlands licence area

Offshore wind electricity generation, including fixed and floating foundations

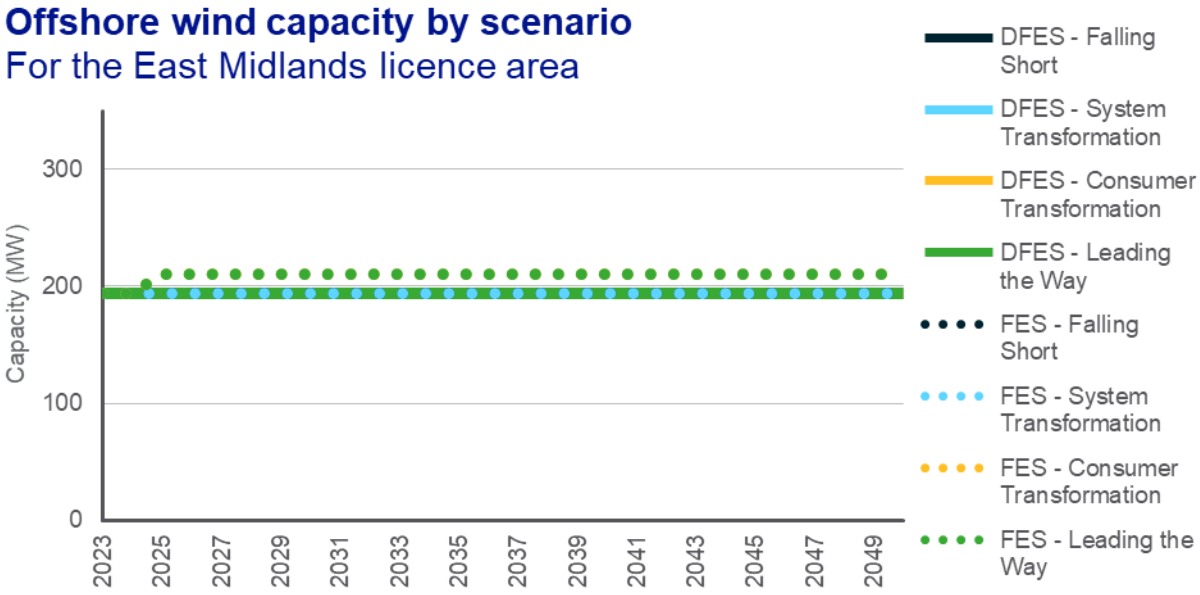
Data summary for offshore wind and marine in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
All scenarios	194	194	194	194

Summary:

- Two offshore wind farms are currently connected to the distribution network in the East Midlands licence area, totalling 194 MW.
- Fixed-foundation offshore wind on the east coast of GB has now scaled up to connect to the transmission network. Therefore, any future offshore wind capacity in the East Midlands is anticipated to connect to the transmission network in all scenarios.

Figure 17 – Capacity of offshore wind generation by scenario, East Midlands licence area



Modelling assumptions and results

Baseline
The baseline consists of the adjacent Lynn and Inner Dowsing offshore wind sites of 97.2 MW capacity each, located off the coast of Skegness, Lincolnshire. These sites, developed in the Crown Estate Offshore Wind Leasing Round 1, connected in 2008 and fully commissioned in 2009. A further 20 MW of capacity was added within the wind farm boundary in 2013, but this capacity was connected to the nearby transmission network-connected Lincs Wind Farm.

Reconciliation with National Grid FES 2023

- The DFES 2023 and FES 2023 baseline are identical, at 194 MW.
- The FES 2023 data contains a 17 MW increase in capacity in the mid-2020s under **Consumer Transformation** and **Leading the Way**. This increase in capacity is not reflected in the DFES projections, as no evidence for further connection of offshore wind capacity to the East Midlands distribution network has been found.

Hydro in the East Midlands licence area

Hydropower electricity generation

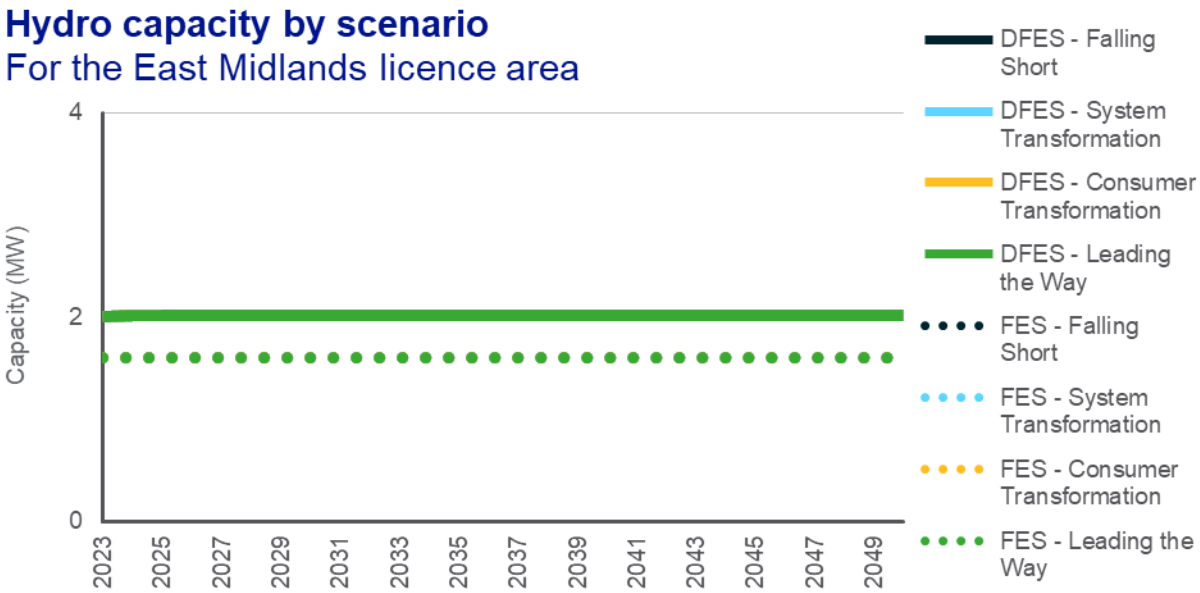
Data summary for hydropower in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
All scenarios	2	2	2	2

Summary:

- The East Midlands has limited hydropower resource, with a baseline totalling 2 MW.
- Due to lack of suitable hydropower sites, combined with a lack of subsidy support and increased abstraction licencing costs, no further hydropower deployment is modelled under any scenario out to 2050.

Figure 18 – Electrical capacity of hydropower by scenario, East Midlands licence area



Modelling assumptions and results

Baseline
There are 45 small-scale hydropower sites currently operational in the East Midlands, totalling 2 MW. Most of this capacity is located in the Derbyshire Dales and Amber Valley, bordering the Peak District, and was deployed between 2011 and 2016 with support from the FiT scheme.

Projections (April 2023 to March 2050)
There is a single micro-scale (14 kW) hydropower site with an accepted connection offer in the licence area. This is modelled to go ahead in the near term under every scenario. Hydropower resource in the East Midlands is limited to very small and micro-scale hydropower. High abstraction licence costs[xvi] in England and a lack of subsidy support results in no further deployment of hydropower in the East Midlands under any scenario.

Reconciliation with National Grid FES 2023

- The DFES and FES projections for hydropower in the East Midlands are closely aligned.

Biomass in the East Midlands licence area

Biomass-fuelled power generation, including standalone and CHP generation

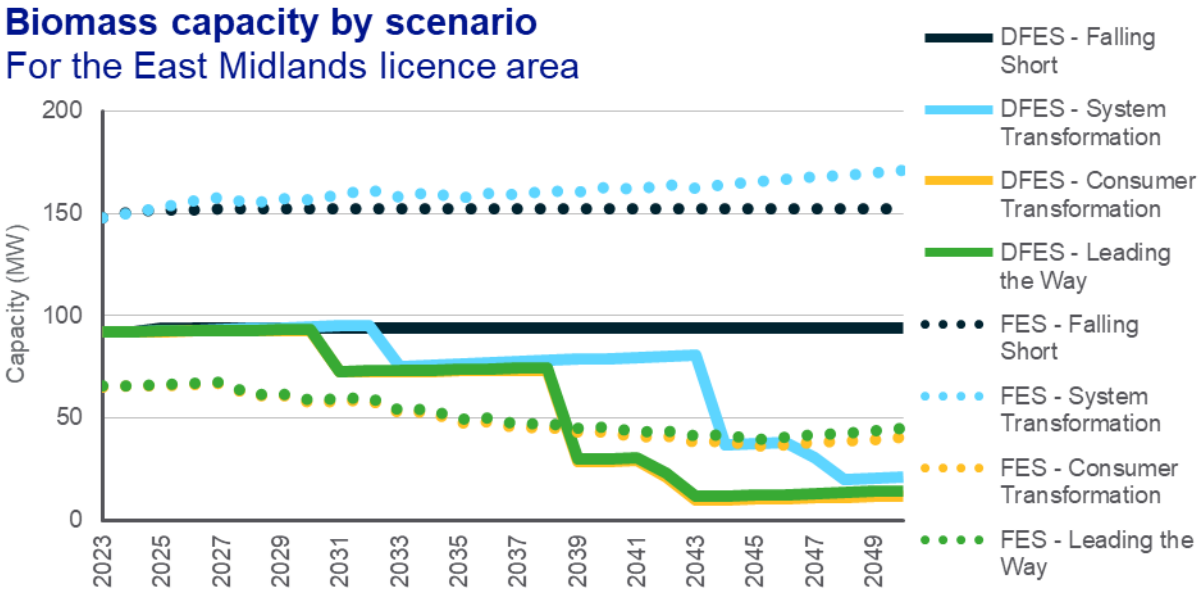
Data summary for biomass power in the East Midlands licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	92	94	94	94
System Transformation		94	76	21
Consumer Transformation		93	73	12
Leading the Way		93	74	14

Summary:

- The future of biomass power generation on the distribution network is impacted by competing demands for bioenergy in sectors such as heat, industry, aviation, and shipping. Despite being a low carbon, flexible generation technology, biomass sees a decrease over time under the three net zero scenarios as the use of biomass for power is prioritised for transmission-scale BECCS generation.
- Standalone biomass power generation is progressively decommissioned in the three net zero scenarios as bioenergy resources are used elsewhere, resulting in the vast majority of biomass capacity in the East Midlands decommissioning in the 2030s and 2040s.
- There is, however, some growth in the capacity of small-scale biomass CHP in the licence area as a means of decarbonising heat, particularly under **System Transformation**.
- Under **Falling Short**, biomass capacity remains stable as alternative uses of bioenergy in harder-to-decarbonise sectors are not progressed under this scenario.

Figure 19 – Electrical capacity of biomass by scenario, East Midlands licence area



Modelling assumptions and results

Baseline			
The East Midlands baseline almost entirely comprises four large-scale biomass power generation sites. This includes the 45 MWe straw-fuelled Sleaford Renewable Energy Park, which began operating in 2014, and the 21 MWe waste-wood-fuelled Goosey Lodge Power Plant in Bedford. Eleven smaller-scale sites, appearing to use biomass for CHP, were commissioned between 2012 and 2020.	**Scale**	**Number of sites**	**Total capacity (MW)**
	Under 5 MW	11	7
	Over 5 MW	4	85

Pipeline (April 2023 to March 2028)
There is one pipeline biomass site in the East Midlands licence area, with a capacity of 1.5 MWe. The site previously held planning permission, but this has since expired. As a result, the site is only projected to go ahead under **Falling Short**.

Medium and long-term projections (April 2028 to March 2050)			
Beyond the pipeline, the prospects for biomass generation on the distribution network are strongly dependent on the demand for biomass from non-power sectors under each scenario and whether the biomass is fuelling standalone electricity generation or combined heat and power.			
Scenario	**Standalone generation**	**CHP generation**	**Capacity by 2050 (MWe)**
Leading the Way	Biomass is prioritised for transmission-scale BECCS and other hard-to-decarbonise sectors. As a result, standalone biomass is decommissioned after 25 years of operational life.	Greater electrification of heat results in less demand for biomass CHP. There is minor growth in CHP capacity for heating business parks and industrial sites.	14
Consumer Transformation			12
System Transformation	Biomass is prioritised for hydrogen production and BECCS. As a result, standalone biomass is decommissioned after 25 years of operational life.	While heat in this scenario is dominated by hydrogen, biomass CHP sees uptake in the areas not connected to the hydrogen network.	21
Falling Short	Standalone biomass generation remains connected in 2050, as other sectors' decarbonisation progress is slow.	Biomass CHP sees no further growth under this scenario, as decarbonisation progress is slow.	94

Reconciliation with National Grid FES 2023

- There is a major difference between the DFES baseline, the FES data for 2023, and the FES data for the baseline year of 2022. There are no projects in the DFES baseline or pipeline data that could explain this variation.
- In the longer term, the DFES aligns with the overall trend for distribution-connected biomass seen in the national FES 2023, with standalone biomass generation capacity reducing over time under the three net zero scenarios. This outcome does not, however, appear to be reflected in the FES GSP-level results for the East Midlands.

Factors that will affect deployment at a local level

Factor	Source
Sites already in the NGED connections baseline and pipeline	NGED

Renewable engines in the East Midlands licence area

Electricity generation from sewage gas, landfill gas and anaerobic digestion

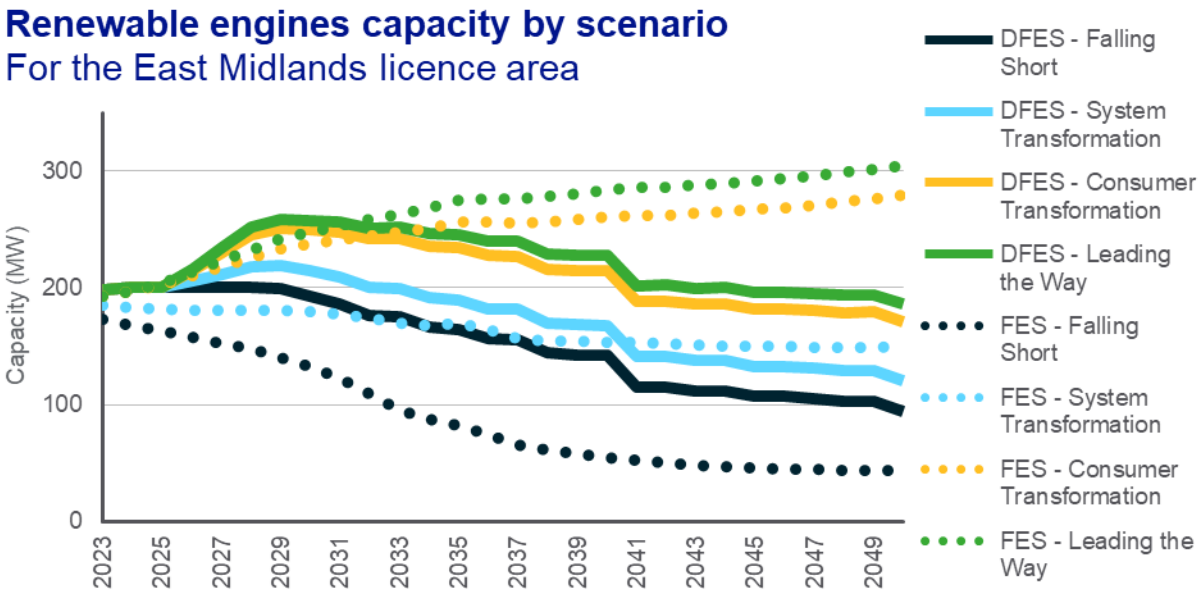
Data summary for renewable engines in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	198	201	164	94
System Transformation		218	189	120
Consumer Transformation		245	234	170
Leading the Way		252	246	186

Summary:

- Renewable engines are divided into three types of sites: landfill gas, anaerobic digestion at farms and food waste collection centres, and sewage gas at sewage treatment plants.
- Landfill gas, which makes up over half of the baseline in the East Midlands, is modelled to decommission over time in every scenario, as Wales and the rest of the UK move towards more sustainable waste treatment and an overall reduction in waste production.
- Anaerobic digestion, accounting for around one-third of the renewable engines baseline capacity, is projected to increase in capacity under the three net zero scenarios, particularly under **Consumer Transformation** and **Leading the Way**. However, in all net zero scenarios, bioenergy resource is prioritised where possible for harder-to-decarbonise sectors such as industry, thereby limiting its role in electricity generation.
- Sewage gas, which makes up around one-tenth of the baseline, 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.

Figure 20 – Electrical capacity of renewable engines by scenario, East Midlands licence area



Baseline

Renewable engines are divided into three types of sites: landfill gas, anaerobic digestion at farms and food waste collection centres, and sewage gas at sewage treatment plants.

The majority of anaerobic digestion baseline capacity is at sites of less than 2 MW capacity at farms in rural areas in the eastern half of the East Midlands licence area.

The landfill gas baseline consists of sites near urban areas. Landfill gas generation capacity has been regularly deployed in the licence area since the late 1990s. This includes the 18 MW Calvert Landfill site in Buckinghamshire, connected in 2010.

The sewage gas baseline consists of generation at Severn Trent and Anglian Water treatment works. All of these sites are relatively small-scale, with a maximum capacity of 3.2 MW, and connected between 1997 and 2015.

Type	Number of sites	Total capacity (MW)
Anaerobic digestion	57	65
Sewage gas	20	23
Landfill gas	49	110

Pipeline (April 2023 to March 2028)

There are just four projects in the pipeline, totalling 2.7 MW. All of these sites are under 1 MW.

Three of these sites are small-scale anaerobic digestion projects and are modelled to go forward in the near term under all four scenarios.

The remaining site, a 0.5 MW landfill gas project, previously had planning permission in 2009 but has had no development at the site since. This site only goes ahead under **Falling Short**.

Medium and long-term projections (April 2028 to March 2050)

Type of site	Scenario outcomes
Anaerobic digestion	The East Midlands has high potential for anaerobic digestion deployment due to the amount of farmland, particularly in the more rural eastern side of the licence area. Under **Consumer Transformation** and **Leading the Way**, deployment peaks in the late 2020s and early 2030s, as the electricity system is rapidly decarbonised and small-scale, established renewables such as anaerobic digestion play a larger role. In the longer term, deployment of anaerobic digestion for electricity generation slows as biogas is prioritised for hard-to-decarbonise sectors such as industry, aviation and shipping.
Sewage gas	Sewage gas baseline and pipeline sites 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 of sewage gas capacity.
Landfill gas	Landfill gas baseline and pipeline sites are modelled to have a lifespan of 30 years under every scenario, after which point the connection is decommissioned. The lack of projects being developed indicates there is low potential for growth of landfill gas capacity.

Reconciliation with National Grid FES 2023

- The FES and DFES baselines in the East Midlands are closely aligned.
- Under **Consumer Transformation** and **Leading the Way**, the near-term projections are similar in the FES and DFES data, driven in the DFES by pipeline projects and uptake of anaerobic digestion.
- The near-term decrease in capacity under **System Transformation** and **Falling Short** is not reflected in the DFES modelling, as there are no baseline sites known to be intending to decommission in the next few years.
- In the longer term, the **Consumer Transformation** and **Leading the Way** DFES projections fall below the FES despite continued uptake of anaerobic digestion, as landfill gas sites are modelled to come offline at the end of their operational life.
- Under **System Transformation** and **Falling Short**, the DFES remains above the FES despite landfill gas coming offline, as the modelling assumes that anaerobic digestion and sewage gas continue to operate at similar capacities throughout the projection timeframe.

Factors that will affect deployment at a local level

Factor	Source
Sites already in the NGED connections baseline and pipeline	NGED
Regen's anaerobic digestion resource assessment, taking into account agricultural production, animal slurry and local authority food waste collection	Regen local authority engagement, Natural England, DEFRA

Diesel generation in the East Midlands licence area

Diesel-fuelled electricity generation, including standalone commercial diesel plants and behind-the-meter diesel backup generators.

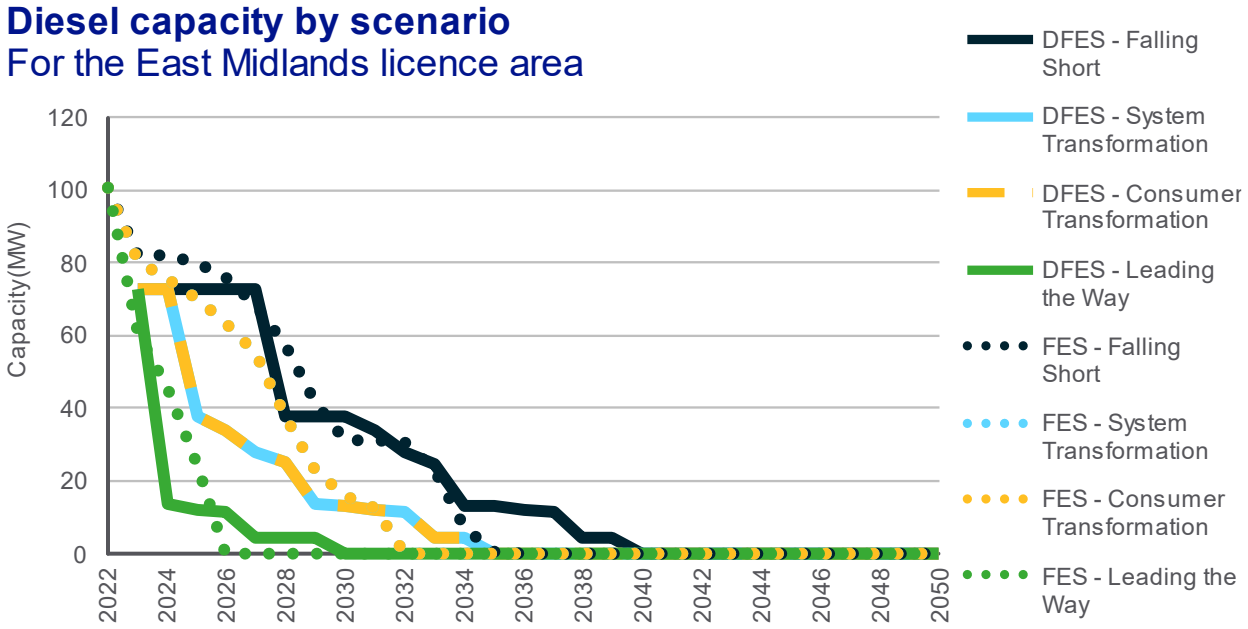
Data summary for diesel generation uptake in the East Midlands licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	73	38	13	0
System Transformation		25	0	0
Consumer Transformation		25	0	0
Leading the Way		4	0	0

Summary:

- Diesel electricity generation is being phased out as generators respond to policies designed to minimise air pollution in the short term and meet carbon targets in the longer term.
- There is already evidence of this response in the East Midlands licence area, with no new diesel generators looking to connect. Across the wider NGED distribution network, a number of diesel generators have disconnected since last year's DFES, showing very short lifetimes of around ten years.
- The operation of unabated diesel generation is at odds with net zero emissions targets and is restricted by the UK implementation of the EU Medium Combustive Plant Directive (MCPD), which requires diesel generation plants with a capacity over 5 MWth (c. 2 MWe) to adhere to stringent air quality limits through environmental permitting unless they operate for 500 hours or less per year.
- Backup diesel generators are expected to remain connected to the network for longer under all scenarios, as they are operating for standby purposes only under the MCPD. Engagement with major energy users revealed that some organisations with backup diesel plants plan to switch to biofuels such as HVO as an interim solution to reduce reportable carbon emissions.

Figure 21 – Installed capacity of diesel generation by scenario, East Midlands licence area



Baseline

The 94 MW of existing operational sites in the licence area have been classified as either standalone commercial diesel generators or behind-the-meter backup generators. Larger diesel plants have historically targeted commercial electricity network reserve services (such as Short Term Operating Reserve (STOR) or the Capacity Market).

Type	Number of sites	Total capacity (MW)
Backup	24	37
Commercial	3	35

Medium Combustive Plant Directive

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 less than 500 hours per year.

Unabated commercial diesel generation falls within this regulation and, therefore, will no longer be able to operate from 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.

Backup diesel generators are exempt from similar environmental permit requirements, due to their limited operational hours. Additionally, backup generators are also allowed to extend their annual operating hours to 1,000 hours if needed in an emergency.

Biofuels

It is possible to substitute fossil diesel oil with biofuels that have similar properties for combustion in diesel generators. Vegetable oils can be esterified to produce **Biodiesel** or hydrotreated to produce **Hydrotreated Vegetable Oil** (HVO, sometimes referred to as green diesel).

Two organisations that operate backup generators responded to a survey sent to Major Energy Users to say their decarbonisation strategy for back-up power involved HVO in the short term.

In some circumstances, substituting diesel with biofuels for power generation can reduce CO_2 emissions but to achieve net zero the use of biofuels will have to be prioritised for other applications such as transport modes that require energy-dense liquid fuels (such as aviation and maritime) and power generation with CCS (carbon capture and storage). Therefore, it is assumed that the use of biofuels extends diesel generator lifetimes only in the Falling Short scenario.

Projections (April 2023 to March 2050)

Scenario	Description	Backstop year for decommissioning
Falling Short	Biofuels could still play a role for backup generators, so diesel plants are modelled to run until the end of their operational life (up to 2035 for commercial generation and 2040 for backup generation).	Backup: 2040 Commercial: 2035
System Transformation **Consumer Transformation**	Standalone sources of flexible generation are assumed to move to lower carbon alternatives, such as electricity storage/biofuels. Some backup diesel generators continue to operate out to 2035, but only in mains failure situations, for a handful of hours per year.	Backup: 2035 Commercial: 2030
Leading the Way	Commercial diesel generators over 2 MWe are modelled to decommission by 2025, with a handful of backup generators and small commercial plant (13 MW) continuing to operate until 2030.	Backup: 2030 Commercial under 2 MWe: 2030 Commercial over 2 MWe: 2025

Reconciliation with National Grid FES 2023

- DFES 2023 and FES 2023 projections are closely aligned for the East Midlands licence area.
- In the DFES, small commercial and backup generators are assumed to decommission later than large commercial plant than in FES, reaching 0 MW capacity later in all scenarios.

Factors that will affect deployment at a local level

Factor	Source
Location of baseline and pipeline diesel generation sites	National Grid

Fossil gas-fired generation in the East Midlands licence area

Fossil gas-fired power generation connected to the distribution network, covering close cycle gas turbines (CCGT), open cycle gas turbines (OCGT), gas reciprocating engines and gas combined heat and power (gas CHP) plants.

Data summary for fossil gas-fired power generation in the East Midlands licence area:

Capacity (MWe)		Baseline	2028	2035	2050
CCGT	Falling Short	407	0	0	0
	System Transformation		0	0	0
	Consumer Transformation		0	0	0
	Leading the Way		0	0	0
OCGT (non-CHP)	Falling Short	272	592	592	592
	System Transformation		592	592	0
	Consumer Transformation		592	592	0
	Leading the Way		592	0	0
Reciprocating engines (non-CHP)	Falling Short	290	358	359	350
	System Transformation		333	302	0
	Consumer Transformation		333	302	0
	Leading the Way		292	0	0
Gas CHP	Falling Short	298	301	301	196
	System Transformation		190	142	0
	Consumer Transformation		190	142	0
	Leading the Way		160	0	0

Summary:

- There is a significant baseline (c. 1.3 GW) of operational fossil gas-fired generation connected to the distribution network in the East Midlands licence area. This includes large CCGT and OCGT sites as well as smaller-scale CHP and reciprocating engine plant.
- There is a pipeline of 24 sites in development with accepted connection offers with NGED in the licence area, comprising 19 applications for reciprocating engines and 5 CHPs, totalling 95 MW. In addition, the CCGT at Corby Power Station is anticipated to repower as a 320 MW OCGT.
- The current primary role of distribution-scale fossil gas-fired generation is to provide flexibility and backup services. The operation of all types of fossil gas generation significantly reduces in the three net zero scenarios out to 2050 as the use of unabated fossil gas-fired electricity generation is at odds with the UK's net zero targets.
- The DESNZ and Ofgem Smart Systems and Flexibility Plan, updated in July 2021, outlines projections for 30 GW of low carbon flexible assets by 2030 and 60 GW by 2050. The government's Review of Electricity Market Arrangements could lead to significant changes to the business model for fossil fuel projects.

- The Climate Change Committee's Sixth Carbon Budget also advised government to "produce a comprehensive long-term plan for weaning Great Britain off unabated gas power by 2035".
- Under **Falling Short**, the installed capacity of gas reciprocating engines and gas CHPs increases in the near term as gas generators play an increasingly important role as flexible generation in the absence of strong growth in low carbon forms of flexibility.
- **Leading the Way** sees the most rapid decommissioning of existing fossil gas-fired generation, as this scenario models the quickest route to decarbonisation. This scenario also reflects a shift to lower carbon forms of flexibility.
- At a national level, after 2030, hydrogen-fuelled generation becomes a potentially economical source of supply-side flexibility in some scenarios. This results in some existing fossil gas generation site locations 'repowering' with hydrogen-fuelled electricity generation assets between 2030 and 2050. The hydrogen-fuelled generation scenario analysis and results are outlined separately in the next section'.

Figure 22 – Electrical capacity of CCGTs by scenario, East Midlands licence area

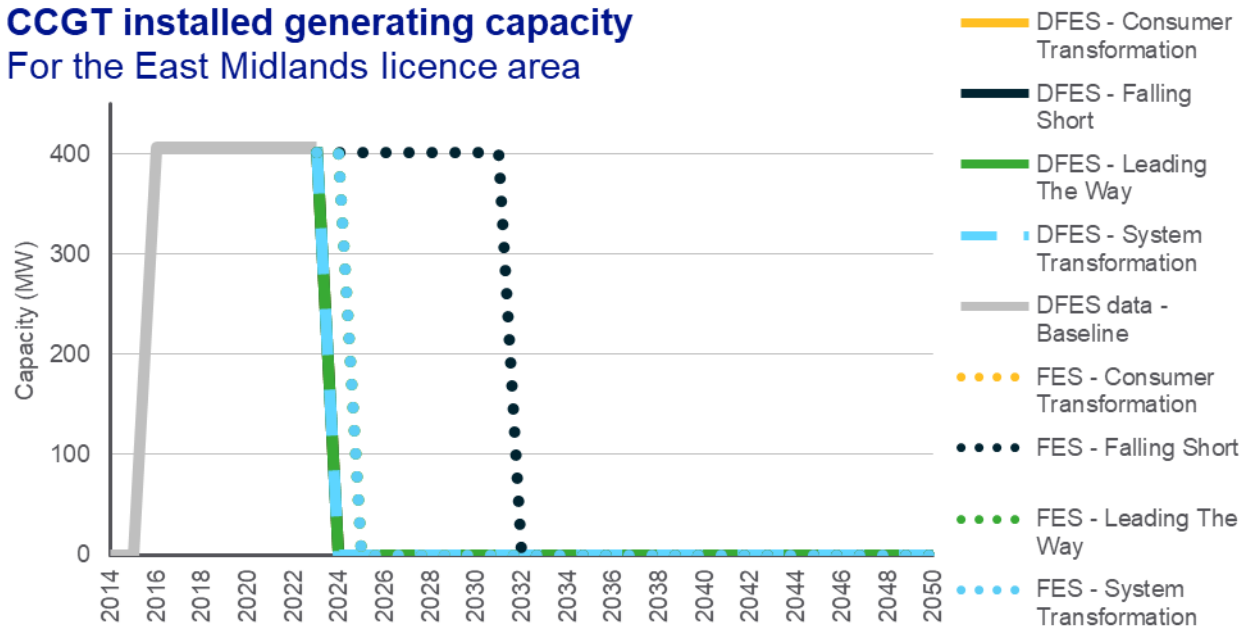


Figure 23 – Electrical capacity of OCGTs by scenario, East Midlands licence area

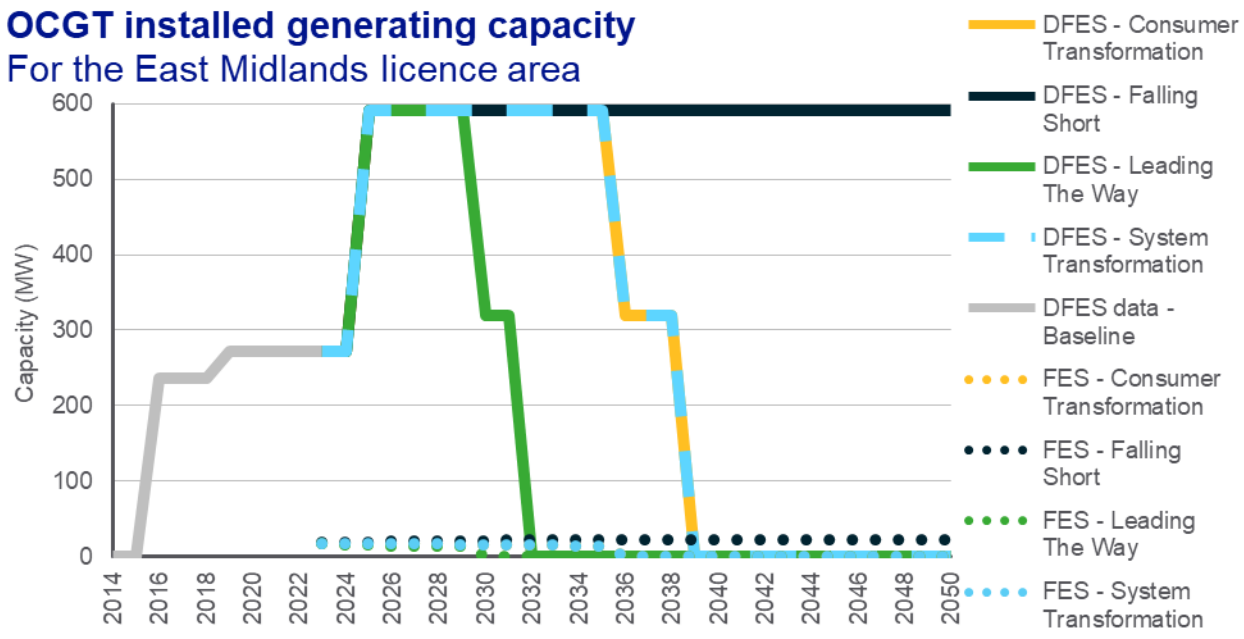


Figure 24 – Electrical capacity of fossil gas reciprocating engines by scenario, East Midlands licence area

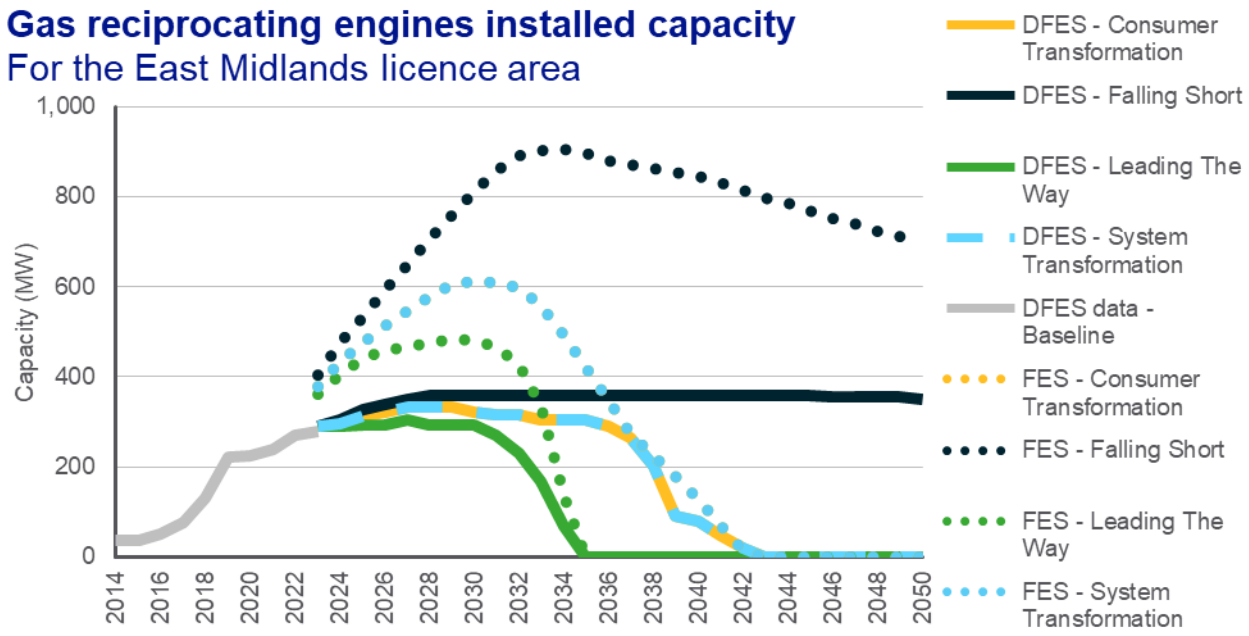
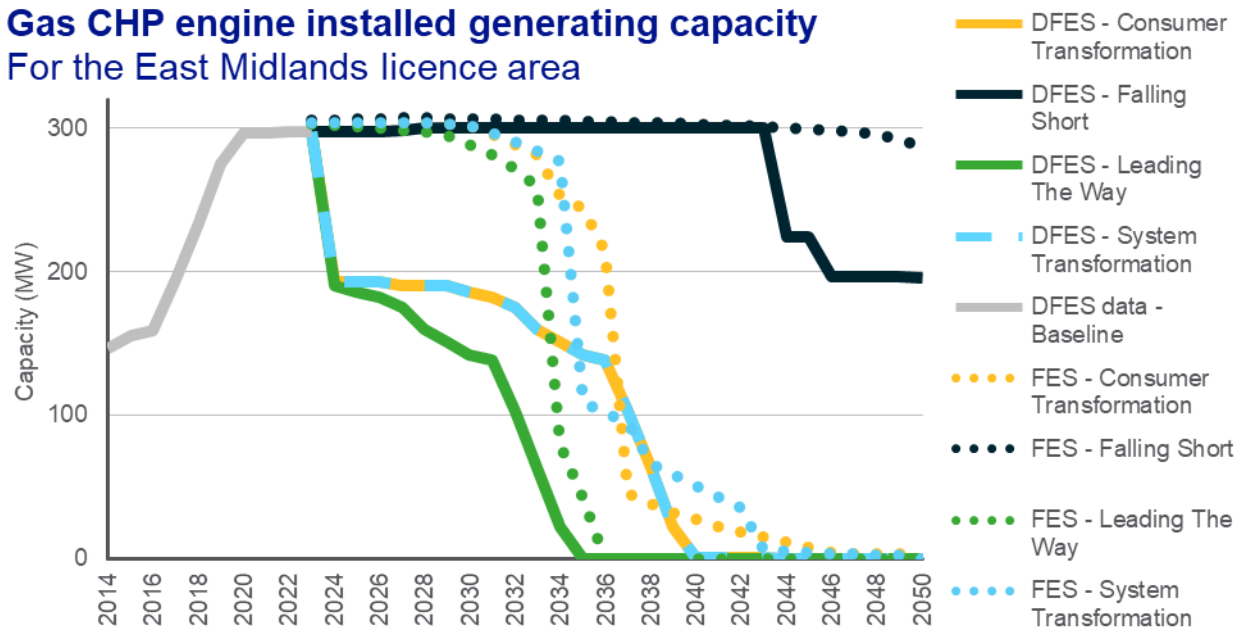


Figure 25 – Electrical capacity of fossil gas CHPs by scenario, East Midlands licence area



Modelling assumptions and results

Baseline			
There are 120 fossil-gas generation sites connected in the East Midlands licence area, totalling 1267 MW. The largest site in the East Midlands licence area is Corby Power Station, a 407 MW CCGT which was commissioned in 1994 and is operated by ESB. Under the EU's Industrial Emissions Directive (which has been	**Type**	**Number of sites**	**Total capacity (MW)**
	CCGT	1	407

integrated into UK law), plants not meeting pollution standards would have to perform upgrades or opt-out and retire by 2023. ESB is replacing the existing CCGT with a 320 MW OCGT[xvii], which is compliant with the updated regulations. This site has prequalified in the T-4 Capacity Market for 2023 and has also received planning permission for the conversion of the site. In October 2022, ESB submitted photos of construction progress to the local authority. Therefore, it is modelled to repower as an OCGT in 2024 under all scenarios.	OCGT	3	272
	Reciprocating engines	51	290
	Gas CHP	65	298

Pipeline (April 2023 to March 2028)

There are 25 fossil-gas generation sites with an accepted connection offer in the East Midlands licence area, totalling 415 MW (including the Corby CCGT repowering as a 320 MW OCGT). This is broken down into the following fossil gas technologies:

Type	Number of sites	Total capacity (MW)
OCGT	1	320
Reciprocating engines	19	87
Gas CHP	5	8

Pipeline analysis

Status	Scenario outcomes	Number of sites	Total capacity (MW)
Planning Permission Granted	There are 12 sites, totalling 375 MW, with an accepted connection offer from NGED that have also received planning permission. 10 of these sites are reciprocating engines with capacities ranging from 2 MW to 8 MW. Included in this group is the 320 MW OCGT at Corby Power Station.	12	375
Planning Application Submitted	There is one site, a small CHP, with a pending planning application.	1	0
No information	There are 12 sites, totalling 40 MW, with an accepted connection offer from NGED that have no evidence of progress through the planning system.	12	40

Medium and long-term projections (April 2028 to March 2050)

The operation of all types of unabated fossil gas generation significantly reduces in the three net zero scenarios out to 2050 as the use of fossil gas for electricity generation is at odds with the UK's net zero targets.

Sub technology	Scenario	Description	Decommissioning timescale
CCGT	**Leading the Way**	Corby Power Station (407 MW) is modelled to decommission under all scenarios at the end of 2023, as it no	2023
	Consumer Transformation		

	System Transformation	longer meets the emissions limits specified under the EU's Industrial Emissions Directive.	
	Falling Short		
OCGT (non-CHP)	Leading the Way	OCGT capacity increases initially in all scenarios due to the Corby CCGT repowering as a 320 MW OCGT. The three OCGTs currently operating in the East Midlands were all installed between 2016 and 2018, and so capacity drops dramatically as these sites reach end of life in the net zero compliant scenarios. In Falling Short, capacity remains beyond 2050.	2023 – 2030
	Consumer Transformation		2023 – 2036
	System Transformation		2023 – 2036
	Falling Short		Post-2050
Reciprocating engines (non-CHP)	Leading the Way	Gas reciprocating engine capacity is modelled to steadily reduce across the medium term. This reflects a rapid switch to alternative low carbon sources of flexibility such as electricity storage, bioenergy and hydrogen.	2023 – 2035
	Consumer Transformation	A moderate amount of reciprocating engine capacity continues to connect to the distribution network in the early 2030s, reflecting a slightly slower transition to lower carbon flexibility. Sites then steadily decommission so that no capacity is operating on the network by 2050.	2023 – 2043
	System Transformation		2023 - 2043
	Falling Short	Notable additional reciprocating engine capacity continues to connect to the distribution network in the medium term, reflecting this rapid-response technology continuing to win response and reserve flexibility contracts. After peaking, some capacity is modelled to decommission, reflecting the transition away from fossil-fuel-driven flexibility.	2023 – post-2050
Gas CHP	Leading the Way	The majority of gas CHP sites in the licence area are small-to-medium engines located onsite at commercial buildings such as factories, universities, hospitals or industrial sites. Under the three net zero scenarios, no additional increase in gas CHP capacity is modelled beyond the mid-2020s, and all gas CHP capacity is modelled to decommission by 2050 at the latest.	2024 - 2035
	Consumer Transformation		2024 – 2045
	System Transformation		2024 - 2045
	Falling Short	Under Falling Short, the gas CHP baseline continues to operate in the medium term, and only a small number of these CHPs decommission by 2050.	2049 – post-2050

Reconciliation with National Grid FES 2023

- For all fossil gas sub-technologies included, the DFES has sought to classify each of the baseline and pipeline sites based on connection data held by National Grid and through site-by-site reconciliation with Capacity Market registers published by the EMR Delivery Body.
- Each pipeline site with an accepted connection offer was also individually assessed for evidence of development by reviewing online planning portals for planning activity and Capacity Market registers for capacity auction activity.
- These analyses have led to some variances between the FES and the DFES in the 2023 baseline and in the near-to-medium term projections.
    - CCGT: The DFES and FES baselines are well aligned. The DFES models the 407 MW CCGT at Corby Power Station to decommission at the end of 2023 in all scenarios in line with published plans, whilst the FES envisages operation will continue as late as the early 2030s in **Falling Short**.
    - OCGT: The DFES baseline is significantly higher than the FES for OCGT installed capacity. The DFES also models OCGTs to decommission slightly later than the FES in all net zero compliant scenarios.
    - Reciprocating engines: The DFES and FES baselines are reasonably well aligned. The DFES has lower near-term growth in all scenarios than the FES because the pipeline of 87 MW of projects does not indicate the scale of growth seen in the FES.
    - Gas CHP: The baselines are well aligned, but near-term projections diverge quickly with much more rapid decommissioning in the DFES under the net zero compliant scenarios due to a large proportion of installed capacity reaching end of life in the near-term. In the longer term, the projections are more aligned with decommissioning of last-standing capacity occurring within similar timeframes.

Factors that will affect deployment at a local level

Factor	Source
The location of the known baseline and pipeline sites	National Grid

Hydrogen-fuelled generation in the East Midlands licence area

Hydrogen-fuelled electricity generation, which has been modelled to connect to the distribution network in areas where there is the potential for hydrogen supply.

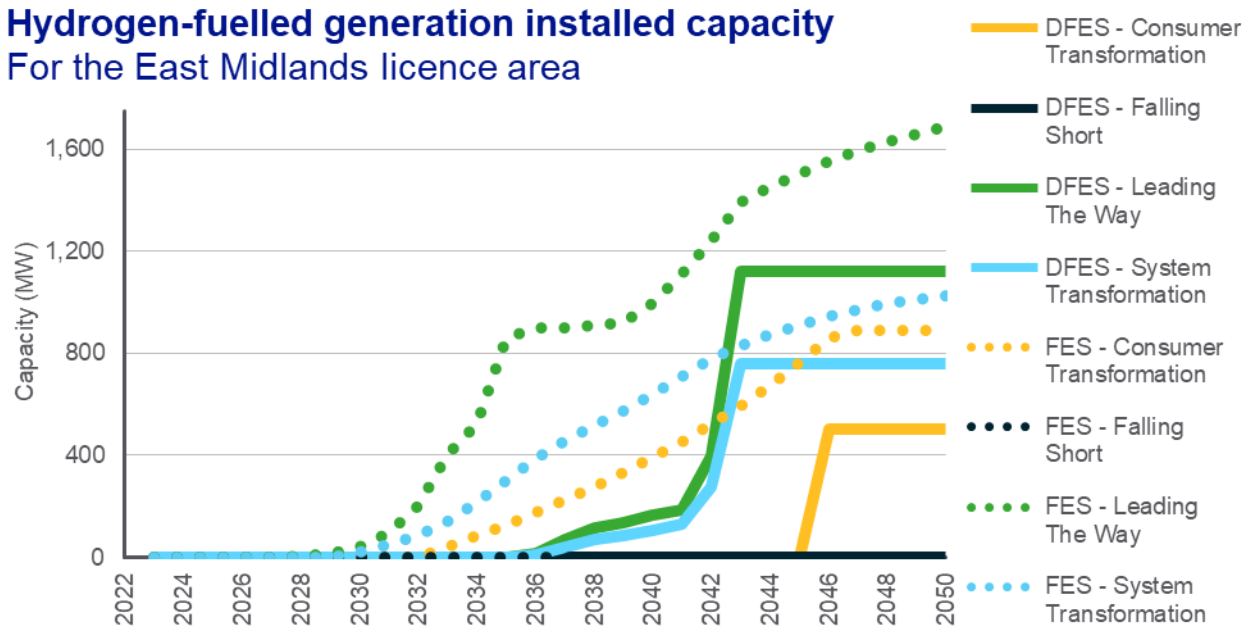
Data summary for hydrogen-fuelled generation in the East Midlands licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	0	0	0	0
System Transformation		0	0	770
Consumer Transformation		0	0	501
Leading the Way		0	0	1,135

Summary:

- Engagement with National Grid ESO highlighted that they expect most of the UK's dedicated hydrogen generation to be new-build (albeit located at existing sites) and optimised for peak running. The DFES has, therefore, modelled the potential for existing and pipeline commercial gas generation sites to convert to run hydrogen generation instead of fossil gas.
- Regen's 'A day in the life 2035'[xviii] analysis with National Grid ESO highlighted the potential role of hydrogen-fuelled generation in a net zero electricity system as a form of low carbon dispatchable generation. The analysis suggests a cold, calm and cloudy winter day might require between 10-15 GW of hydrogen-fuelled generation.
- Under **Leading the Way** and **System Transformation**, conversion to hydrogen generation in the DFES has been modelled to occur initially at sites in proximity to industrial clusters and the core hydrogen network proposed by National Gas.
- The East Midlands hosts a significant length of the gas National Transmission System, which under National Gas' Project Union plan would be converted to transport 100% hydrogen. 17 sites, with a combined capacity of almost 450 MW, are operating within 10 km of the planned route.
- In the long term, under **Leading the Way** and **System Transformation**, a national hydrogen network is assumed to be developed which enables more of the licence area to have access to hydrogen and more opportunity for hydrogen generation sites to be developed.
- The East Midlands licence area has a significant amount of existing gas generating capacity (c. 1,300 MW) along with a further pipeline of 95 MW. Therefore, in high hydrogen scenarios, the East Midlands licence area is likely to be a key region for hydrogen-fuelled generation in the future under some scenarios.
- As a general consideration, the business case for hydrogen-fuelled electricity generation is likely to be challenging and may require new markets to incentivise uptake. Hydrogen is likely to be an expensive fuel, with production at scale unlikely to be developed until the 2030s at the earliest.
- However, there is strong support for the role of low carbon hydrogen in providing flexible power generation, as stated in the UK Hydrogen Strategy. In October 2023, the UK government published its response to the consultation on The Hydrogen Production Business Model (HPBM), which intends to incentivise the production and use of low carbon hydrogen.

Figure 26 – Electrical capacity of hydrogen-fuelled generation by scenario, East Midlands licence area



Modelling assumptions and results

Baseline

Hydrogen-fuelled generation is not yet being trialled due largely to a lack of hydrogen supply across the UK. There is currently no hydrogen-fuelled generation connected to the distribution network in the East Midlands licence area or nationally.

Pipeline (April 2023 to March 2028)

There is unlikely to be any development in grid-connected hydrogen-fuelled generation in the near term as fossil gas powered generation is still providing energy and flexibility to the system.

Developers contacted as part of the project research suggested that they were actively evaluating future plans but were unwilling to make final decisions before the government announces new policy in this space. A government consultation on market interventions required to incentivise the shift away from unabated gas towards hydrogen-fuelled generation is expected soon.

Medium and long-term projections (April 2028 to March 2050)

With hydrogen-powered turbine and engine technology coming to market already, the critical enabler of hydrogen-fuelled generation will be access to hydrogen supply. Hydrogen is likely to be available first at industrial cluster sites as early as 2030 and then in proximity to hydrogen pipeline networks as they develop from 2035.

In the East Midlands, it is likely that conversion to hydrogen will occur when hydrogen networks are developed due to a lack of industrial clusters. The planned Humberside industrial cluster is located outside the licence area, more than 50 km from the nearest existing gas sites.

The core hydrogen network proposed by National Gas runs down the east coast to near Peterborough, then across past Leamington-Spa to Wales, with many opportunities in the East Midlands licence area for local offtake. 17 sites, with a combined capacity of almost 450 MW, are operating within 10 km of the planned route.

The medium and long-term projections are modelled according to the framework described below.

Scenario	Description	Capacity by 2050 (MW)
Falling Short	No hydrogen-fuelled generation capacity is projected as hydrogen networks are undeveloped and fossil gas-fuelled generation continues to provide flexibility in the absence of alternatives, such as battery storage and demand side response, until 2050.	0
System Transformation	This scenario sees high levels of policy support for hydrogen and a national hydrogen transportation network is developed. Sites are assumed to convert to hydrogen in the following order: • Existing and pipeline fossil gas sites in proximity to industrial cluster zones are modelled to convert to hydrogen from 2030 • Sites in proximity to the hydrogen core network (as proposed by National Gas) are modelled to convert from 2035 • Remaining sites are assumed to convert from 2040, by which point hydrogen is assumed to be widely available through a national hydrogen network	770
Consumer Transformation	Hydrogen networks are assumed to be less developed in this scenario, and hydrogen is produced near to demand in industrial clusters. Sites in proximity to industrial clusters are repowered after 2030 and sites in proximity to a core hydrogen network (as proposed by National Gas) are repowered after 2045.	501
Leading the Way	This scenario sees moderate to high levels of policy support for hydrogen and the development of a national hydrogen transportation network. Hydrogen-fuelled generation is assumed to dominate the low running hours segment of the flexibility market; to reflect the lower capacity factors, sites are assumed to convert to hydrogen at 50% greater capacity in the following order: • Existing and pipeline fossil gas sites in proximity to industrial cluster zones are modelled to convert to hydrogen from 2030 • Sites in proximity to the hydrogen core network (as proposed by National Gas) are modelled to convert from 2035 • Remaining sites are assumed to convert from 2040, by which point hydrogen is assumed to be widely available through a national hydrogen network	1,135

Reconciliation with National Grid FES 2023

- Neither FES nor DFES project any conversion to hydrogen in **Falling Short**.
- In both **System Transformation** and **Leading the Way** conversion begins after 2035 in the DFES as the East Midlands does not host industrial clusters that may provide a source of hydrogen from as early as 2030. In the long-term, in these scenarios, the DFES projections are lower than the FES but at a similar level to existing gas-fired generation capacity today.
- Uptake in **Consumer Transformation** is lower and later in the DFES projections compared to the FES. In this scenario, hydrogen networks are assumed to be less developed and the lack of a core hydrogen network until 2045 delays conversion to hydrogen. The Humberside cluster is too far outside the licence area to enable earlier conversion.

Factors that will affect deployment at a local level

Factor	Source
Location of existing and known commercial gas sites in the East Midlands licence area.	National Grid
Spatial analysis of industrial cluster locations and National Gas plans for a core hydrogen network.	Regen analysis

Energy from waste in the East Midlands licence area

Energy from Waste (EfW) sites, including incineration and Advanced Conversion Technologies (ACT).

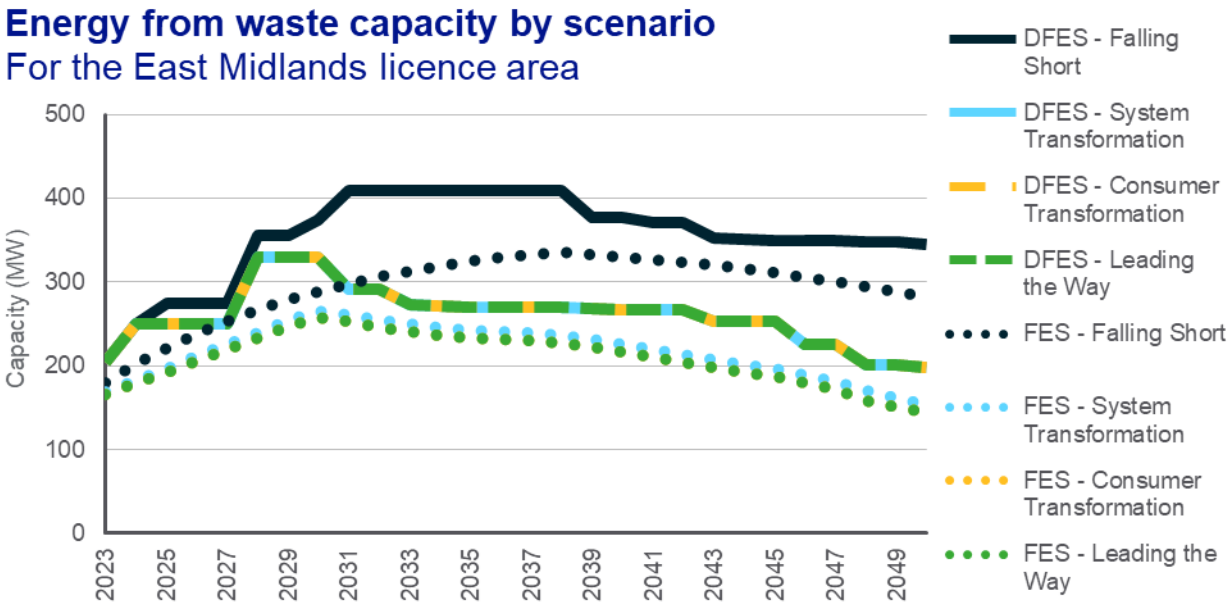
Data summary for energy from waste in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	204	355	409	345
System Transformation		330	270	198
Consumer Transformation		330	270	198
Leading the Way		330	270	198

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. As a result, there is a substantial 204 MW baseline of projects currently operating in the East Midlands licence area, alongside a pipeline of projects currently in development totalling 230 MW.
- In the near-term to the late 2020s, energy from waste capacity increases in all scenarios. Pipeline sites with lesser levels of development evidence are only modelled to connect under **Falling Short**.
- Waste incineration is highly carbon intensive and, therefore, sees reduced capacity under the three net zero scenarios out to 2050, as more environmentally friendly approaches to waste management become commonplace.
- More efficient energy from waste plants, such as ACT gasification plants, operate beyond 2050 under all four scenarios.
- Only a handful of very old waste incineration plants are modelled to decommission under **Falling Short**, which almost the same level of capacity operating by 2050 as the baseline.

Figure 27 – Energy from waste capacity by scenario, East Midlands licence area



Baseline			
The baseline of energy from waste capacity in the East Midlands ranges from very old sites built in the mid-1990s to very new sites commissioned in 2022. The largest site is also the most recent, the 49 MW Newhurst Energy Recovery Facility in Charnwood, commissioned in mid-2022. The majority of existing sites are located around population centres such as Nottingham and Derby.	**Type**	**Number of sites**	**Total capacity (MW)**
	Incineration	17	132
	ACT	2	72

Pipeline (April 2023 to March 2028)			
The total capacity of energy from waste projects with accepted connections with NGED in the East Midlands exceeds the current baseline. This significant development pipeline of new sites goes against the trend seen in the other three NGED licence areas, where energy from waste deployment appears to be slowing. The East Midlands pipeline includes a prospective new 80 MW Advanced Thermal Conversion site in Boston, which was granted an environmental permit in July 2023. The following table provides a summary of the modelling assumptions applied to prospective energy from waste sites in the planning system. The timescales applied are based on an analysis of the build-out timescales of existing projects.		**Number of sites**	**Total capacity (MW)**
		7	220
Project status	**Outcome**	**Number of sites**	**Total capacity (MW)**
Abandoned	Do not go ahead under any scenario	1	10
Planning permission expired	Only go ahead under **Falling Short** in the late 2020s.	2	34
Planning application submitted	Only go ahead under **Falling Short**, six years after planning submission.	2	45
Planning permission granted	Goes ahead in all scenarios, five years after planning permission granted date.	1	80
Under construction	This site commenced full operations in 2023 and, therefore, is modelled to connect immediately under all four scenarios.	1	46

Medium and long-term projections (April 2028 to March 2050)		
Beyond the pipeline of projects with accepted connection offers, the projections of future energy from waste capacity are predominantly modelled based on the anticipated decommissioning dates of existing baseline sites. These dates are based on the expected operational life of energy from waste sites, which varies under each scenario.		
Scenario	**Description**	**Capacity in 2050 (MW)**
Leading the Way	Under the net zero scenarios, conventional waste incineration sites are projected to decommission after thirty years of operational life, reflecting a reduced volume of waste in these	198

Consumer Transformation	scenarios and the drive to reduce carbon emissions. More efficient sites using ACT technology or 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. Due to the large pipeline, there is still almost 200 MW of operational energy from waste capacity remaining in the East Midlands in 2050 under these scenarios.	198
System Transformation		198
Falling Short	Under **Falling Short**, lower levels of societal change and limited progress towards carbon emission reduction mean that waste incineration sites continue to operate up to forty years after their commissioning date. This results in a much higher capacity remaining online in 2050. Similarly to the net zero scenarios, more efficient ACT and ERF sites are assumed to continue operation beyond 2050.	345

Reconciliation with National Grid FES 2023

- The DFES and FES baselines broadly align, although the FES baseline is slightly lower by around 40 MW.
- The DFES energy from waste projections for the East Midlands exceed the FES projections in each scenario across the 2020s. This is driven by the large pipeline of contracted energy from waste sites, some of which are under construction or have achieved full planning permission and are, therefore, likely to commission in the next few years.
- In the longer term, though the DFES remains above the FES due to the aforementioned pipeline, the DFES and FES trends align as older sites decommission and energy from waste capacity decreases overall by 2050.

Factors that will affect deployment at a local level

Factor	Source
Location of waste to energy baseline and pipeline sites.	National Grid

Other generation and nuclear SMR in the East Midlands licence area

Sites in NGED connections data where the technology could not be identified, and how nuclear Small Modular Reactors (SMR) are treated in the analysis.

Data summary for other generation in the East Midlands licence area:

Capacity (MW)	Baseline	2028	2035	2050
All scenarios	2	8	8	8

Summary:

- There are six connected sites in the licence area that have not been categorised as a particular technology, totalling 2.0 MW. These are likely to be small-scale fossil-fuelled sites, but they could not be specifically identified as such in the NGED connections data.
- There are 38 additional other generation sites with an accepted connection offer, totalling 6.1 MW. As with the baseline sites, these small-scale sites could not be positively identified as a specific technology. These pipeline sites have, therefore, been modelled to connect in 2023 under every scenario.
- There are no projections for other generation beyond this pipeline of accepted connections.

Nuclear Small Modular Reactors (SMR)

Nuclear SMR has been included in the scope of this year's DFES analysis. The UK government is targeting 24 GW of nuclear power capacity by 2050, delivered through a mixture of conventional nuclear power stations and SMR solutions.

Through desktop analysis, it has been assumed in the DFES that individual nuclear SMR sites will be large-scale and therefore exclusively connect to the transmission network.; This assumption is echoed in the National Grid ESO FES. The most advanced SMR technology currently in development in the UK is the Rolls-Royce SMR, which has a design capacity of 470 MW. This would require a transmission-level grid connection. This is the only SMR design which has progressed to Step 2 of the Generic Design Assessment process[xix].

The Holtec-160 SMR, a 160 MW design, was set to enter the Generic Design Assessment process as of late 2022[xx]. At this scale, a connection to NGED's distribution network (likely at the 132 kV level) could be feasibly possible. However, the three potential sites identified by Holtec — Trawsfynydd in North Wales, Heysham in Lancashire and Oldbury in South Gloucestershire — are all located at existing nuclear power stations with transmission network connections.

As a result, there is no projected nuclear SMR capacity in the licence area under any of the four scenarios out to 2050.

While there are not yet any indications that distribution network-connected SMR is likely, the technology will remain in the scope of the DFES analysis and research.

Storage technologies

Results and assumptions

Battery storage in the East Midlands licence area

Battery storage, comprising four business models:

- **Standalone network services** – typically multiple megawatt-scale projects that provide balancing, flexibility and support services to the electricity network
- **Generation co-location** – typically multiple megawatt-scale projects, sited alongside renewable energy (or occasionally fossil fuel) generation projects.
- **Behind-the-meter high-energy user** – typically single megawatt or smaller scale projects, sited at large energy-user operational sites to support on-site energy management or to avoid high electricity cost periods.

  These three business models combine to form 'large-scale' battery storage, which aligns with the FES building blocks.
- **Domestic-scale batteries** – typically 5-20 kW scale batteries that households buy to operate alongside rooftop PV or to provide backup services to the home. Includes domestic-scale batteries installed by small businesses.

Data summary for battery storage in the East Midlands licence area:

Capacity (MW)		Baseline	2028	2035	2050
Standalone network services	Falling Short	165	592	1,220	1,220
	System Transformation		916	1,242	1,242
	Consumer Transformation		1,144	2,081	2,081
	Leading the Way		1,334	2,097	2,097
	Storage Planning		1,354	5,508	5,508
Generation co-location	Falling Short	4	10	160	160
	System Transformation		85	301	301
	Consumer Transformation		78	241	241
	Leading the Way		271	892	892
	Storage Planning		279	900	900
Behind-the-meter high-energy user	Falling Short	2	29	29	50
	System Transformation		29	32	114
	Consumer Transformation		29	52	162
	Leading the Way		29	52	162
	Storage Planning		29	29	29
Domestic-scale batteries	Falling Short	7	17	28	191
	System Transformation		37	80	327
	Consumer Transformation		80	279	1,000
	Leading the Way		98	365	1,310

Summary:

- Low-carbon dispatchable power is required in a net zero electricity system 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. Regen's analysis,[2] in partnership with ESO, suggested that across GB 80-100 GW of flexibility capacity will be needed by 2035, with 20-25 GW provided by electricity storage.
- The East Midlands licence area currently has 121 operational large-scale battery storage sites, totalling 172 MW and a pipeline of 7.3 GW.
- The battery storage pipeline across the four NGED licence areas is now 19 GW, up from 13.5 GW in 2022 and just 2 GW in 2021. In context, NGED currently manages connections of c. 11 GW of operational generation assets.
- Based on analysis of projects in this licence area, 1.23 GW of the storage pipeline has either received or submitted planning permission. A further 1.28 GW of projects have some pre-planning application evidence such as environmental impacting assessment screening.
- Upstream constraints on the transmission network can impact the deployment timescale of projects in the pipeline connecting at distribution level. These constraints have been directly reflected under the **Falling Short** scenario, but not in the three net zero scenarios. This allows the scenarios to represent a realistic range of potential future connections.
- Due to the unprecedented pipeline of large-scale battery storage projects across National Grid's licence areas, the DFES 2023 includes an additional scenario, **Storage Planning**, which is based solely on the significant pipeline of projects with connection offers with National Grid Electricity Distribution. This is outside of the envelope of the four National Grid ESO FES scenarios, which aim to represent a balanced energy system at a national level and to which the four main DFES scenarios broadly align, due to the scale of the battery storage pipeline.
- The East Midlands licence area has a strong potential for long-term growth in battery storage capacity. This is due to significant 33 kV and 132 kV network infrastructure across the licence area, high potential for solar and wind deployment which may be co-located with storage, high numbers of non-domestic properties with the potential for behind-the-meter batteries, and significant potential for domestic rooftop solar, which is now commonly installed alongside a domestic battery.

[2] Bridging the gap to Net Zero – a Day in the Life 2035 report, carried out by Regen and ESO

Figure 28 – Electrical capacity of large-scale battery storage by scenario (including the Storage Planning scenario), East Midlands licence area

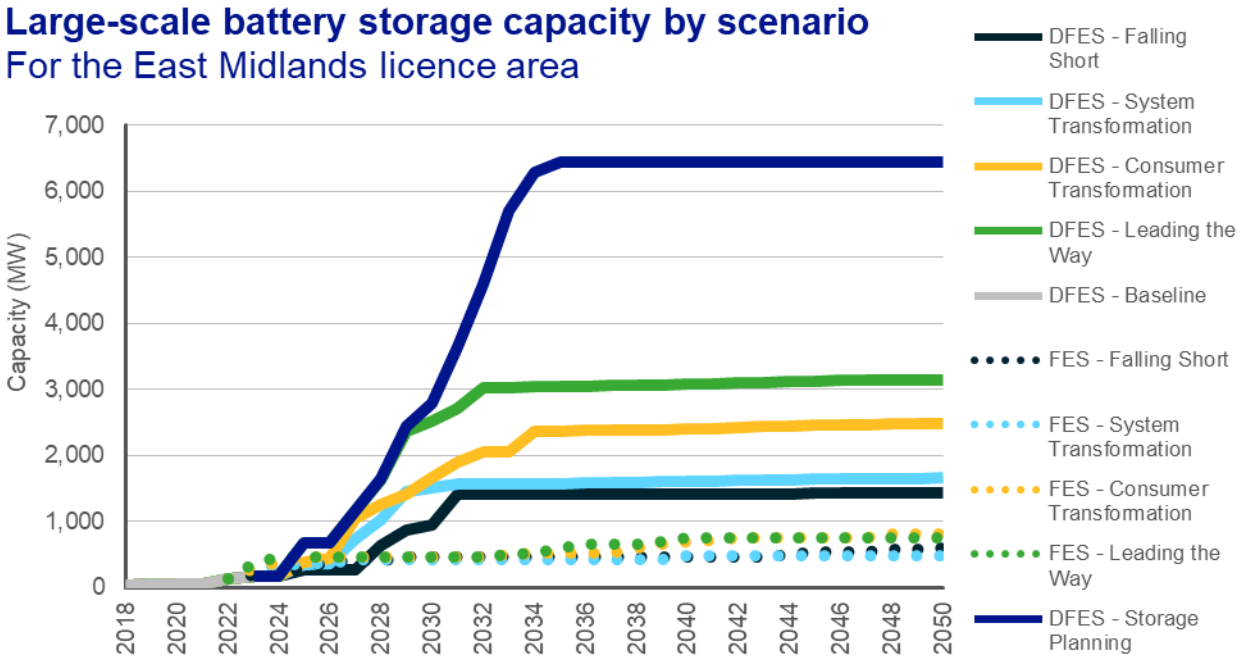
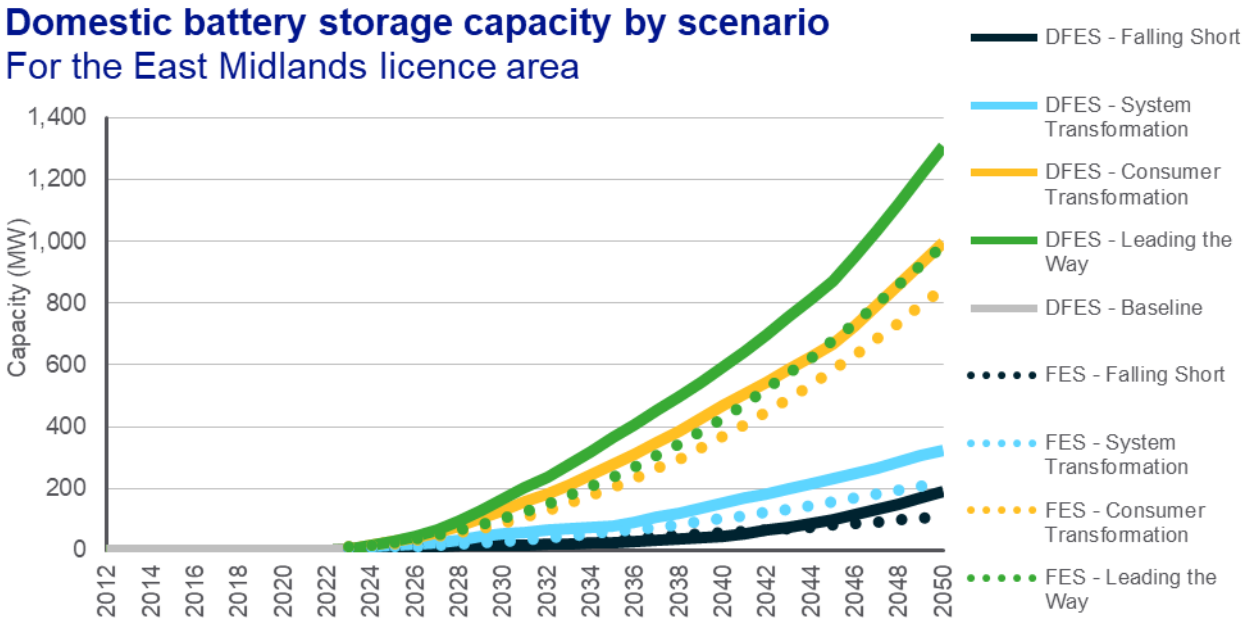


Figure 29 – Electrical capacity of domestic battery storage by scenario, East Midlands licence area



Modelling assumptions and results

Baseline

There are 121 large-scale battery storage projects in the baseline, totalling 172 MW. Most of this capacity is made up of standalone battery sites providing network services, with a smaller capacity co-located with electricity generation or at premises with high energy demand like hospitals or schools.

There are almost 1,400 known domestic batteries in the East Midlands licence area, totalling 7 MW. Installation of domestic batteries and rooftop solar generation has increased rapidly over the past two years as consumers have sought to protect themselves from very high electricity prices. Unit prices for residential consumers reached around £0.32/kWh under the Energy Price Guarantee implemented by the UK Government at the peak of the energy price crisis, creating a strong financial incentive for installing domestic PV and battery storage.

Type	Number of sites	Total capacity (MW)
Standalone network services	10	165
Generation co-location	3	4
Behind-the-meter high-energy user	108	3
Domestic-scale batteries	c. 1,400*	7

* based on an average domestic-scale battery capacity of 5 kW

Pipeline (April 2023 to March 2028)

The pipeline of storage projects has surged across the country in the last couple of years. The East Midlands licence area has a pipeline of 164 large-scale projects totalling 7.33 GW.

As a key technology that can provide flexibility services to the network, battery storage is active in the National Grid ESO's ancillary service markets. In recent years, the ESO has evolved their suite of response and reserve services, including the new trio of frequency response markets: Dynamic Containment, Dynamic Regulation and Dynamic Moderation. In addition, the ESO has launched a new Slow Reserve service and continues to deliver its network options assessment pathfinders for stability, voltage and reactive power services. Under the Government's Review of Energy Market Arrangements (REMA), opportunities for flexibility services are likely to continue to evolve.

The battery storage pipeline across the four NGED licence areas is 19 GW, up from 13.5 GW in 2022 and just 2 GW in 2021. This interest in development is also reflected at a national level, with over 150 GW of battery storage projects seeking a transmission network connection.

Type	Number of sites	Total capacity (MW)
Standalone network services	93	5,343
Generation co-location	55	1,959

The length of the queue to secure a grid connection is a key challenge for the sector. There is over 400 GW of capacity waiting to connect to the transmission system, increasing by around 25 GW per month. ESO and the ENA have announced short-term changes to accelerate connections, particularly affecting flexible battery storage projects, and ESO is working on longer-term connections reform. Regen has been supporting the developer industry and working closely with ESO to accelerate connection timelines.	Behind-the-meter high-energy user	16	28

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Planning Permission Granted	In the East Midlands licence area, 15 projects in the pipeline have been granted planning permission, totalling 611 MW of capacity. Sites with planning permission are modelled to connect to the network in all scenarios. Where projects hold a Capacity Market (CM) contract, they are modelled to connect in the relevant delivery year.	15	611
Planning Application Submitted	In the East Midlands licence area, ten projects have submitted a planning application and are waiting for approval, totalling 616 MW of capacity. Two battery projects (22 MW and 90 MW) in Derbyshire have also won Capacity Market contracts. Sites with a planning application are modelled to connect to the network in **Leading the Way** and **Consumer Transformation**, but only **System Transformation** if they prequalified or won a CM contract and in **Falling Short** if they have been awarded a CM contract.	10	616
Pre-planning	16 projects have evidence of pre-planning progress, such as Environmental Impact Assessment screening, totalling 1280 MW of capacity. Sites with pre-planning evidence are modelled to connect to the network in **Leading the Way** and **Consumer Transformation**, but only **System Transformation** if they prequalified or won a CM contract and in **Falling Short** if they have been awarded a CM contract.	16	1,280
No information	Most sites in the pipeline do not have evidence of project development beyond an accepted grid connection offer. In the East Midlands licence area, 3.9 GW of capacity has no Capacity Market (CM) contracts or planning evidence. In the three net zero compliant scenarios, projects that have no planning evidence are not modelled to connect unless they have if they prequalified or won a CM contract. In **Falling Short** they are only modelled to connect if they	187	3,938

	have been awarded a CM contract.		
Rejected, Withdrawn or Abandoned	Three projects are known to have been abandoned, totalling 640 MW. An additional five projects have had their planning application refused. These sites are removed from projections in all scenarios (including **Storage Planning**).	8	640

Medium and long-term projections (April 2028 to March 2050)				
Business model	**Projection methodology**	**Scenario**	**Capacity by 2035 (MW)**	**Capacity by 2050 (MW)**
Standalone network services	Standalone storage continues to dominate the project pipeline and sees increased deployment across all scenarios by 2035. The growth in capacity stalls beyond the late 2030s out to 2050, reflecting market saturation following a rapid roll-out in the 2020s.	**Falling Short**	1,220	1,220
		System Transformation	1,242	1,242
		Consumer Transformation	2,081	2,081
		Leading the Way	2,097	2,097
		Storage Planning	5,508	5,508
Generation co-location	Generation co-location capacity also sees a strong uptake in the East Midlands licence area. This is in part due to a notable number of co-location sites with accepted connection offers and the licence area having the highest combined ground-mounted solar PV and onshore wind capacity projections by 2035 across NGED's network. Beyond 2035, the significant annual growth in new co-location capacity lessens as network capacity and flexibility markets saturate, and grid-scale battery projects co-locating with new solar and wind generation develop at a more moderate pace out to 2050. In the East Midlands, capacity is highest in **Consumer Transformation** due to the very strong renewable generation deployment in this scenario.	**Falling Short**	160	160
		System Transformation	301	301
		Consumer Transformation	241	241
		Leading the Way	892	892
		Storage Planning	900	900
Behind-the-meter high-energy user	The East Midlands licence area has the second highest number of non-domestic properties with the potential for a battery across NGED's network. Thus, the uptake of behind-the-meter storage projects in the licence area is also relatively strong across all scenarios by 2035. This reflects feedback from stakeholders that high-	**Falling Short**	29	50
		System Transformation	32	114

	energy users, such as industrial customers, could drive electricity storage deployment in the medium term. Annual capacity deployment under this business model begins to increase further in the longer term out to 2050 under **Consumer Transformation** and **Leading the Way**, as more businesses seek to manage their onsite energy use and costs through flexibility technologies.	**Consumer Transformation**	52	162
		Leading the Way	52	162
		Storage Planning	29	29
Domestic-scale batteries	Of all NGED licence areas, the East Midlands has the highest potential for domestic battery deployment in the medium and long term due to the overall number of homes and significant domestic-scale rooftop PV deployment projections. The projections for domestic batteries are directly tied to domestic solar PV uptake in all four scenarios.	**Falling Short**	28	191
		System Transformation	80	327
		Consumer Transformation	279	1,000
		Leading the Way	365	1,310

Reconciliation with National Grid FES 2023

- Large-scale battery storage:
    - The FES 2023 and DFES are reasonably well aligned on the baseline of connected battery capacity. The DFES found 172 MW of connected battery capacity in 2023, whereas the FES projected a range of 187-368 MW.
    - Reflecting the very large near-term pipeline, the DFES 2023 projections significantly exceed the FES 2023 near-term projections. This is based on a detailed assessment of planning status, Capacity Market auction activity and direct engagement with battery project developers.
- Domestic-scale batteries: the DFES 2023 projections for domestic batteries align well with FES 2023 across the analysis period and in all scenarios. The DFES projection for the **Leading the Way** scenario is notably higher than the FES in the long term. This is because the proportion of small-scale solar capacity with battery storage is assumed to increase more in the DFES than the FES as battery costs fall over time.

Factors that will affect deployment at a local level

Factor	Source
Standalone network services: Location of existing and known pipeline sites in the East Midlands licence area.	NGED
Generation co-location: Proximity to existing and future ground-mounted solar PV and onshore wind projects within the licence area.	Regen analysis
Behind-the-meter high-energy user: Proximity to industrial estates and commercial buildings that could be suitable for battery storage installations.	Addressbase, local authority data
Domestic batteries: Domestic dwellings with rooftop PV.	Regen analysis

Endnotes

[i] Heat network pipelines
[ii] Opportunity Areas for District Heat Networks in the UK, BEIS
[iii] Heat networks pipelines
[iv] Integrating heat pumps in heat networks, CIBSE
[v] Rules of thumb; Guidelines for building services, BSRIA
[vi] Evidence update of low carbon heating and cooling in non-domestic buildings
[vii] Heat network pipelines
[viii] Opportunity Areas for District Heat Networks in the UK, BEIS
[ix] Bassetlaw Local Plan Examination, 2022
[x] 2018-based household projections by local authority
[xi] Overheating: Approved Document O, DLUHC
[xii] Council Climate Plan Scorecards 2022
[xiii] Power Technology- Number of UK homes, 2023
[xiv] Building Regulation (Part L)
[xv] RWE completes German wind farm repowering, 2022
[xvi] British Hydropower Association - Environment Agency charges press release, 2022
[xvii] Corby Power Station Planning Application for repurposing CCGT as OCGT
[xviii] A day in the life of 2035
[xix] Rolls-Royce SMR design moves to next stage of regulatory assessment, 2023
[xx] Holtec Britain applies to join UK government process for Generic Design Assessment, 2022

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