Distribution Future Energy Scenarios 2023

Results and assumptions report

South West 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.

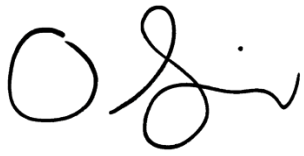
We have worked with Regen to help us understand what the changes that are forecast throughout the next decade and beyond might mean for our distribution network, and the investment that may be needed to meet customers' changing needs. These forecasts are the foundation of our strategic investment process, 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 South West 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 (LCTs) 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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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	HVAC	Heating, ventilation and air conditioning
CfD	Contract for Difference	HVO	Hydrotreated Vegetable Oil
CHP	Combined Heat and Power	IDNO	Independent Distribution Network Operator
DEC	Display Energy Certificate	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
DNOA	Distribution Network Options Assessment	MCPD	Medium Combustion Plant Directive
EfW	Energy from Waste	MW (th, e)	Megawatts (thermal, electrical)
EMR	Electricity Market Reform	NDP	Network Development Plan
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.

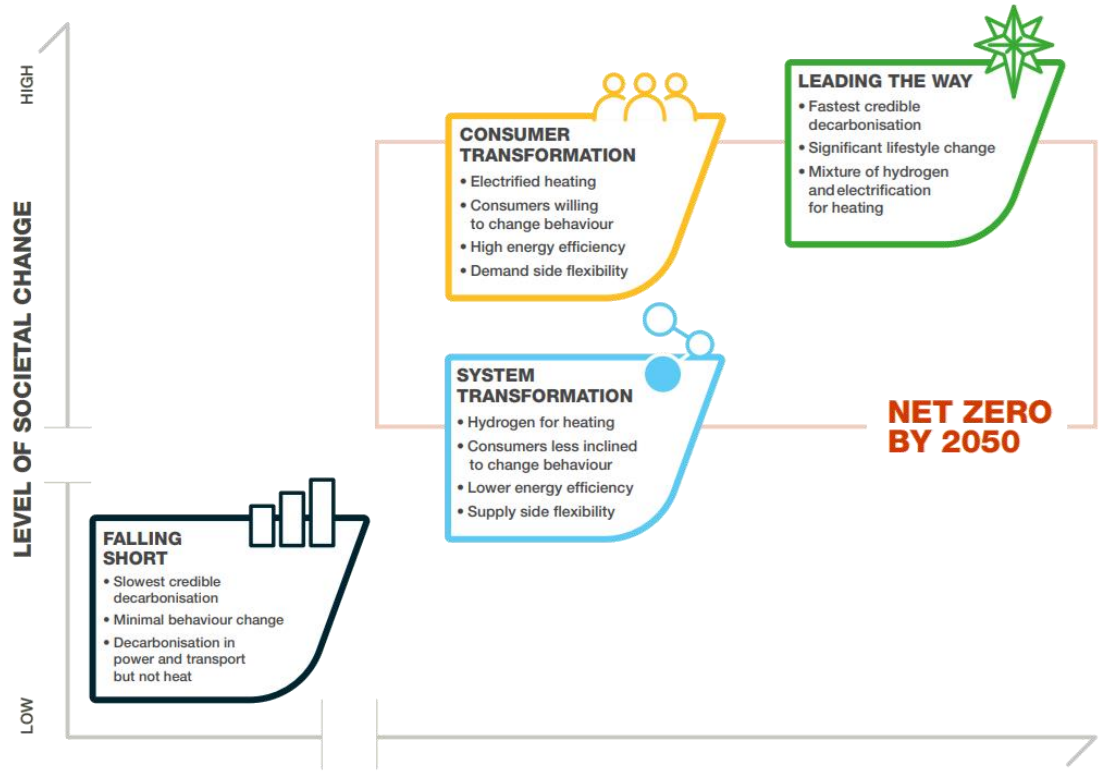
The DFES projections are directly informed by stakeholder engagement to reflect local and regional drivers, the ambitions of local authorities (including local area energy plans, where available) and national government targets and policies. The analysis is also influenced by the views of other sector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

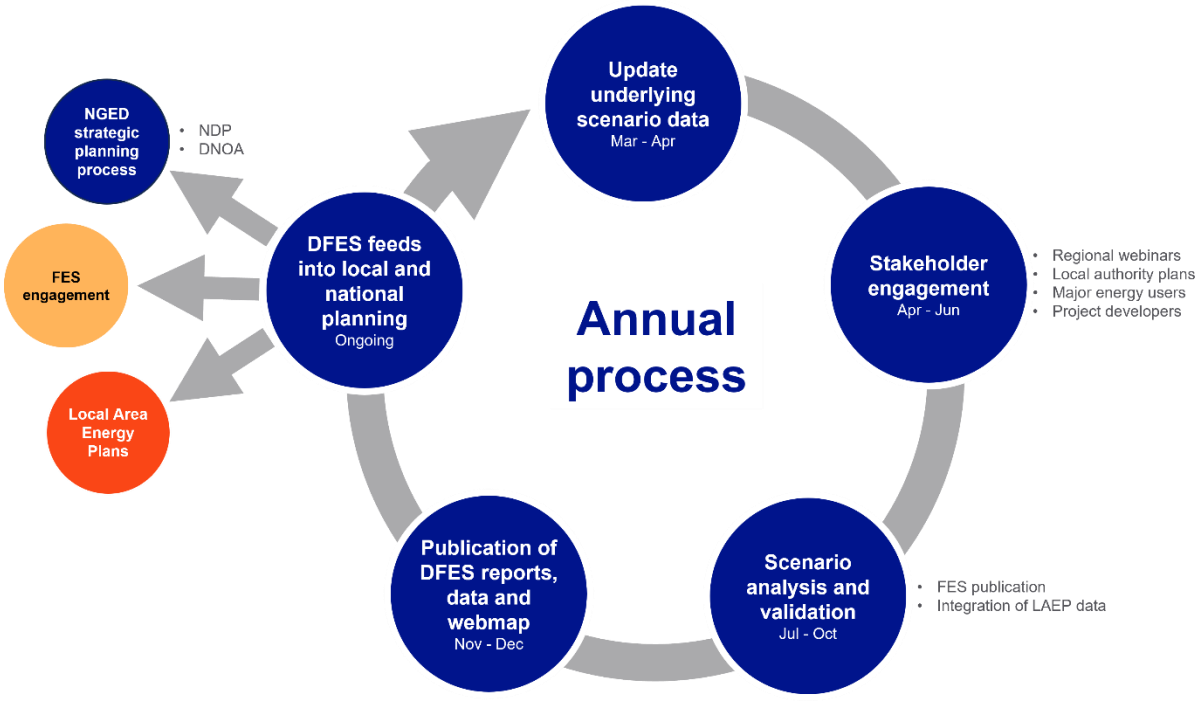
Annual cycle

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 South West licence area

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

Aspect	Characterisation
Geography	The NGED South West licence area contains a mixture of more populated areas, including Bristol, Exeter and Plymouth, alongside more sparsely populated rural areas, two national parks and hundreds of miles of coastline.
Distributed electricity generation	Distributed electricity generation in the area has increased significantly in recent years. Over 50% of generation capacity connected to the distribution network has connected since 2014.
Energy resources	The South West licence area has some of the highest levels of solar irradiance in the UK, and several areas of significant wind resource along the north coast of Devon and Cornwall. The licence area also has potential for other renewable technologies such as floating offshore wind, bioenergy and geothermal energy.
Distributed electricity demand	Under 3% of South West homes currently have a heat pump, and a similar proportion have an electric vehicle.
Policy and government	The South West licence area currently contains 18 local authorities.

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

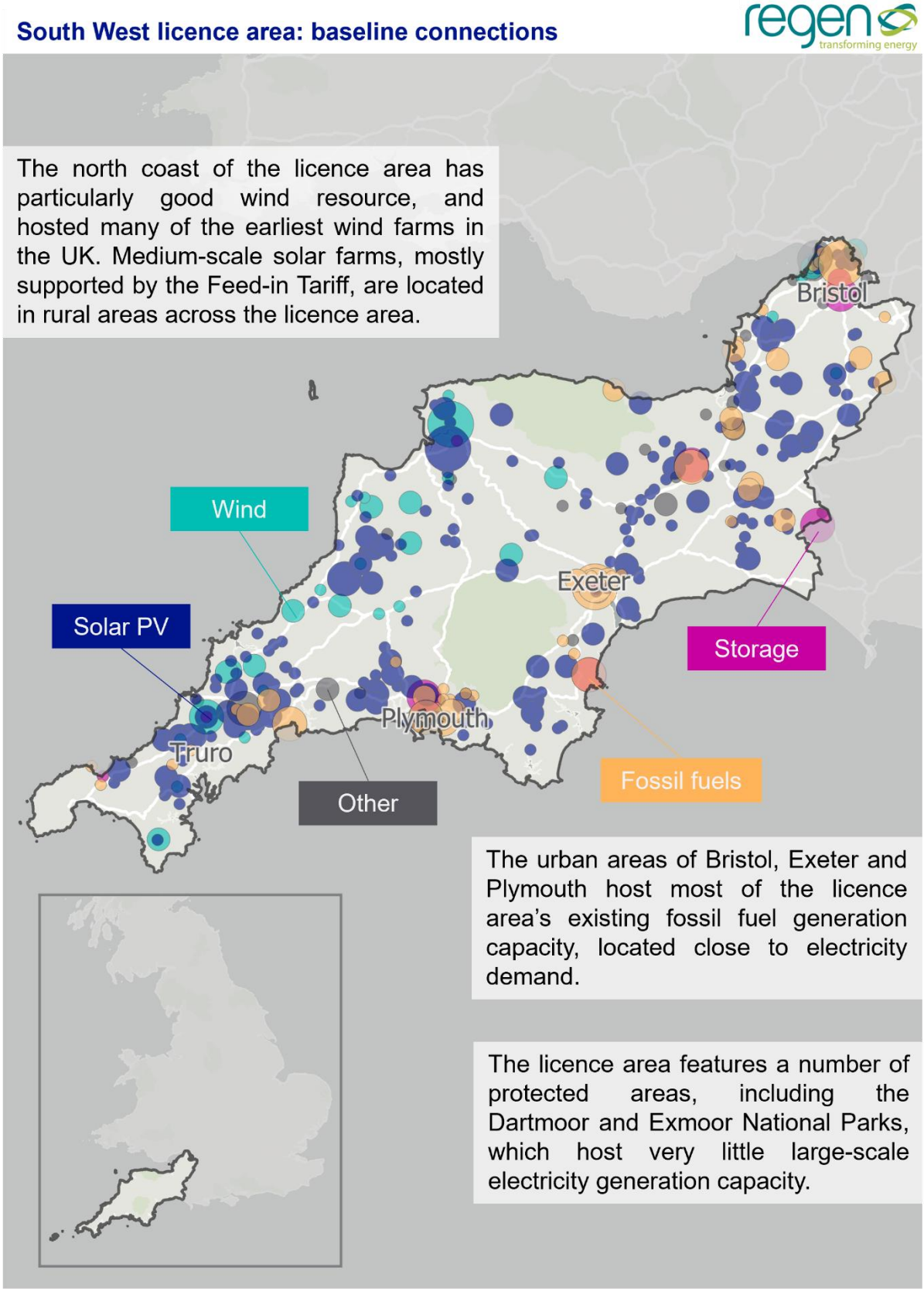
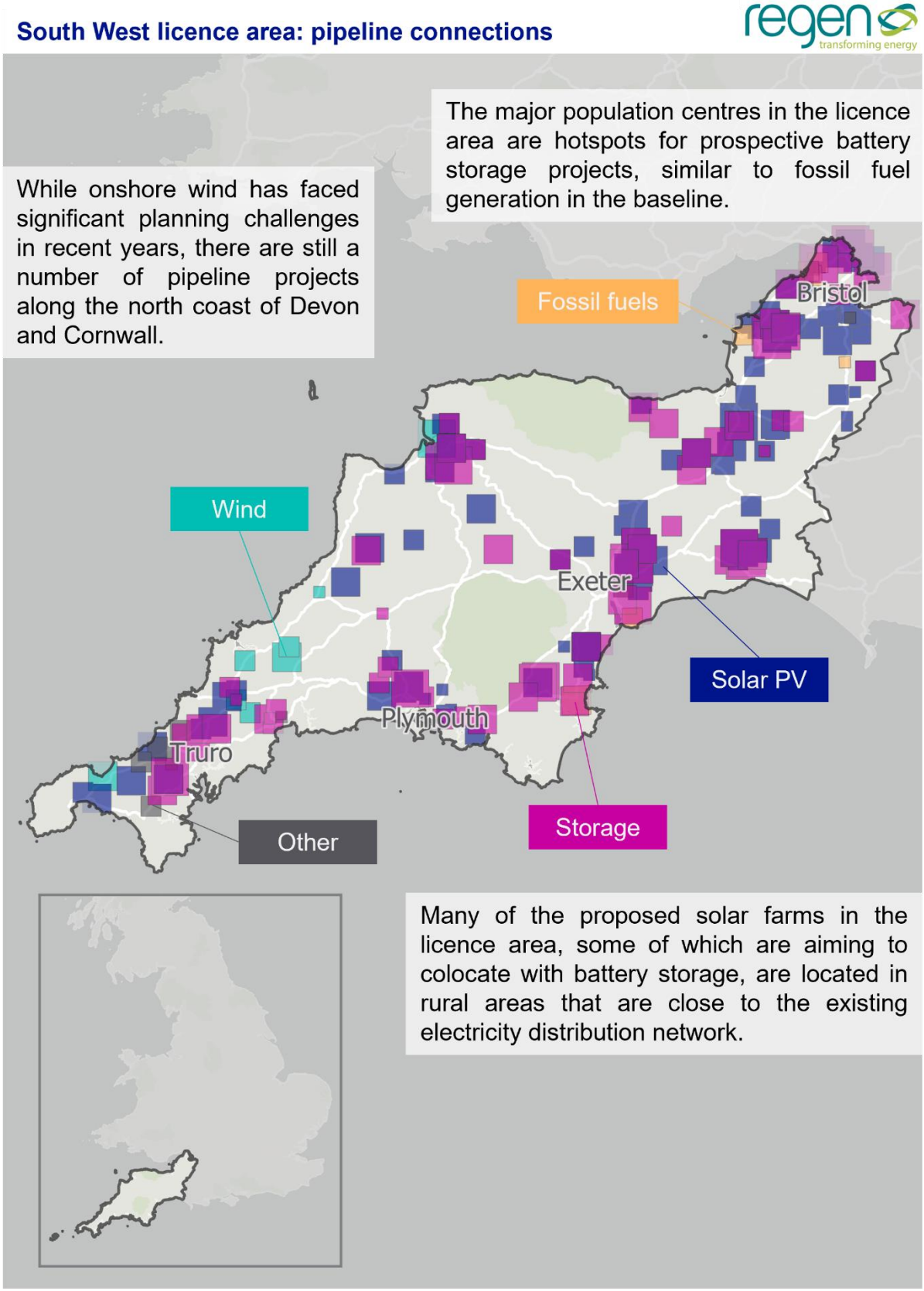


Figure 4 - The NGED South West licence area, with the location of proposed 'pipeline' large-scale generation and storage sites



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

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 South West 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 South West licence area:

Number of homes (thousands)		Baseline	2028	2035	2050
Non-hybrid heat pumps* (without thermal storage)	Falling Short	30	57	147	509
	System Transformation		73	143	359
	Consumer Transformation		135	454	915
	Leading the Way		155	489	742
Non-hybrid heat pumps* with thermal storage	Falling Short	0	18	60	259
	System Transformation		23	59	148
	Consumer Transformation		49	179	475
	Leading the Way		61	218	424
Hybrid heat pumps	Falling Short	0	1	8	31
	System Transformation		3	19	393
	Consumer Transformation		4	19	62
	Leading the Way		5	49	178
Connections to heat pump-driven district heat networks	Falling Short	0	8	23	100
	System Transformation		7	22	141
	Consumer Transformation		8	40	177
	Leading the Way		8	41	156
Resistive electric heating	Falling Short	233	223	198	143
	System Transformation		217	182	64
	Consumer Transformation		221	196	144
	Leading the Way		224	195	153

***** 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 below.

Summary:

- The South West licence area has a broad range of housing, from dense areas of on-gas houses and flats in built-up urban areas such as Bristol, to highly rural, off-gas areas in Devon and Cornwall. Overall, the licence area has a much higher proportion of off-gas homes than the GB average, resulting in an accelerated uptake of heat pumps in the near term.
- Under **Consumer Transformation** and **Leading the Way**, heat is primarily decarbonised via heat pumps in both the South West 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 South West licence area, this results in c. 1.4 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. However, the higher proportion of off-gas homes in the South West results in higher uptake of non-hybrid heat pumps, as the availability of hydrogen from domestic heating is assumed to be in line with the current fossil gas heating.
- 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.
- Bristol, the largest population centre in the South West licence area, sees roll-out of a number of planned heat-pump-driven heat networks under all scenarios, significantly influencing the uptake of district heat network heat pumps in the licence area in the near term. The adoption of district heat networks is expanded across Bristol and into other dense population centres in the licence area, such as Exeter and Plymouth, 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, South West licence area

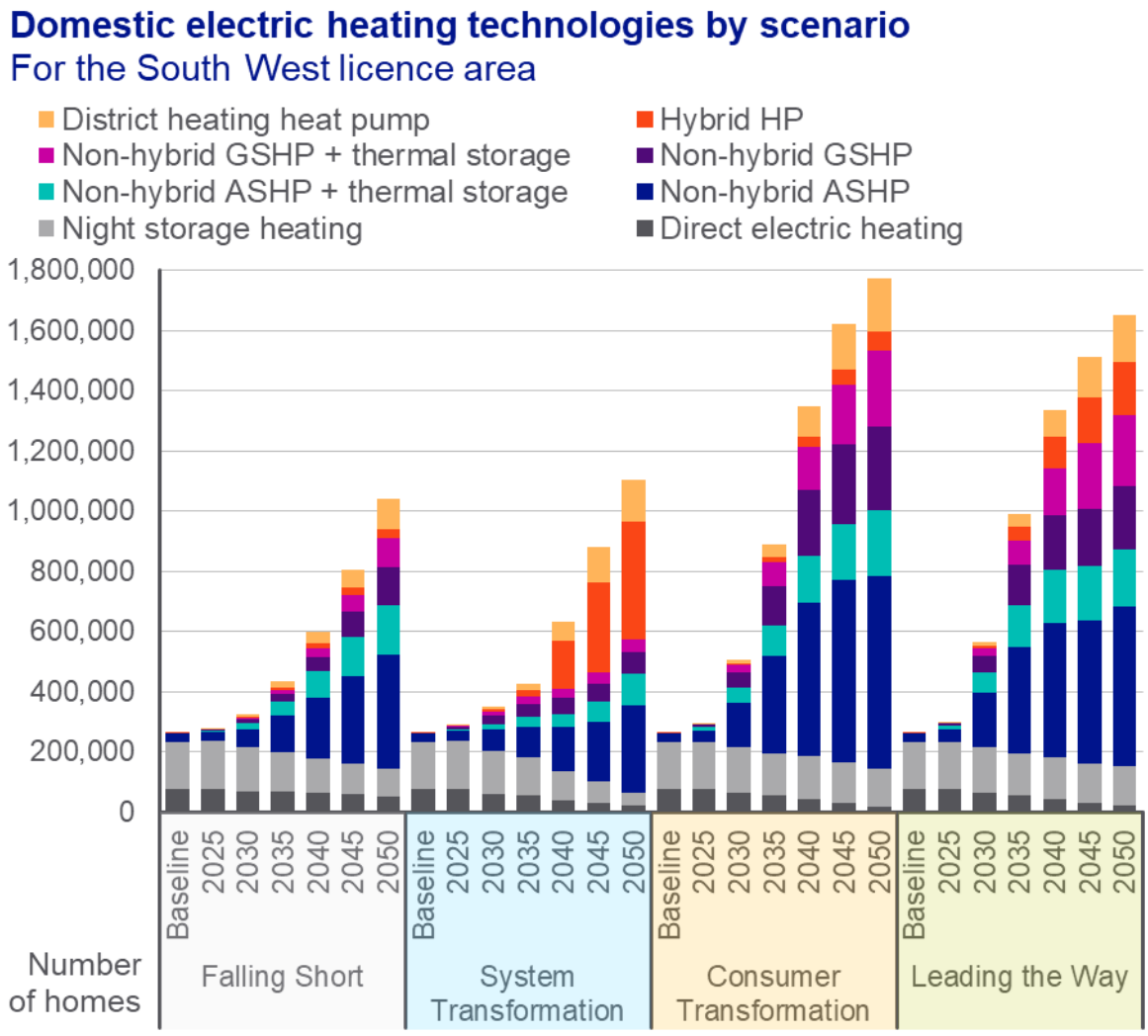
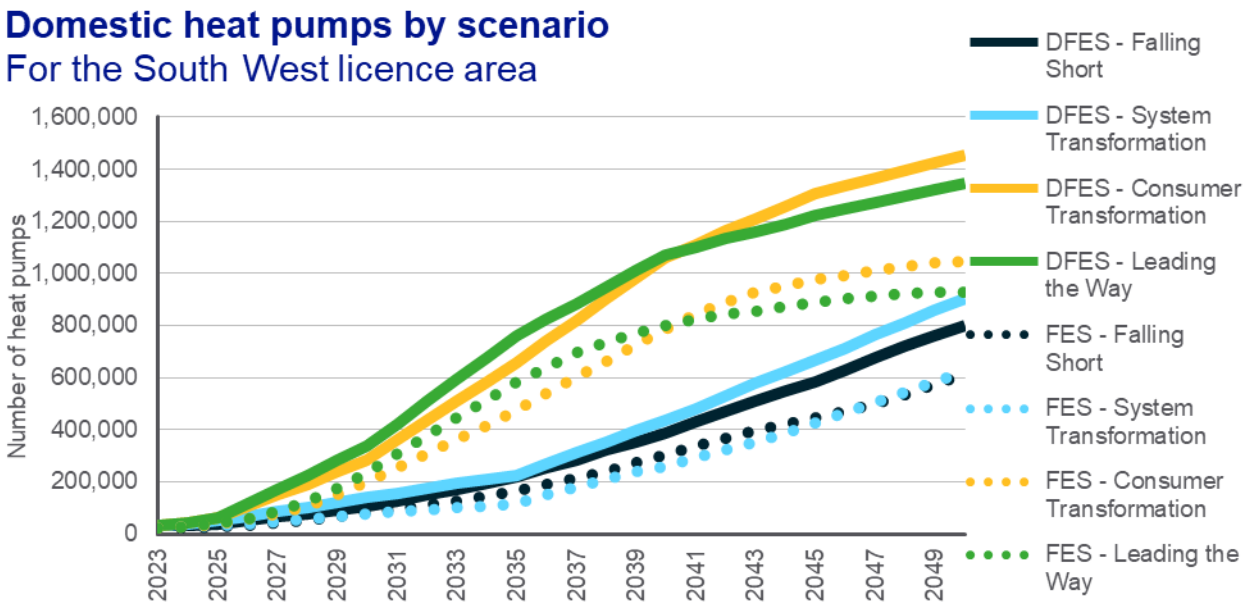


Figure 6 – Number of domestic heat pumps (hybrids and non-hybrid) by scenario, South West licence area



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 RHI was particularly popular in the South West, with around 15% of heat pumps accredited by the RHI being in the South West licence area. This has resulted in c. 2% of homes in the licence area now having a heat pump, slightly above the GB average.

Sub-technology	Number of homes	Proportion of homes
Non-hybrid ASHP	26,442	1.8%
Non-hybrid GSHP	3,254	0.2%
Hybrid heat pump	58	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 much more common in the South West compared to the national average, heating over 15% of homes compared to around 8% nationally.

This is due to a combination of rural areas not connected to the fossil gas network and dense urban areas such as Bristol, which features many blocks of flats with electric heating.

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

Sub-technology	Number of homes	Proportion of homes
Night storage heaters	154,927	10.3%
Direct electric heaters	78,379	5.2%

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, including several in Bristol, are modelled to connect in the near term under every scenario.

Heat pumps

Scenario	Description	% of homes with a heat pump in 2028	
		South West	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 South West licence area sees high near-term uptake of heat pumps relative to GB overall. 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.	14%	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**.	7%	6%
Falling Short		5%	6%

Resistive electric heating

Scenario	Description	% homes with resistive heating in 2028	
		South West	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. A similar proportion of direct electric heated homes convert to night storage heaters in order to reduce heating costs.	14%	8%
Consumer Transformation	As the South West has a much higher baseline proportion of homes heated by resistive electric heating, this proportion is still much higher than the GB average in 2026.	14%	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.	14%	7%
Falling Short		14%	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	
		South West	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.	79%	80%
Consumer Transformation		89%	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	57%	60%

	pumps, 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.	50%	53%
Resistive electric heating			
Scenario	**Description**	**% homes with resistive heating in 2050**	
		South West	**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.	8%	5%
Consumer Transformation		8%	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.	3%	2%
Falling Short		8%	5%

Reconciliation with National Grid FES 2023

- The DFES trajectories for total heat pumps under each scenario are broadly aligned with the FES 2023.
- In the near term, uptake of heat pumps in the South West is higher in the DFES. The property archetype-based heat analysis models near-term heat pump uptake mostly in off-gas dwellings, new build homes, and owner-occupied homes, driven by direct stakeholder engagement in all four NGED licence areas. In these metrics, the South West licence area is above the national average, resulting in faster near-term uptake of heat pumps.
- In the long term, heat pump uptake is higher under every scenario in the DFES. While this is impacted by the high proportion of off-gas housing and lower proportion of homes with the potential for hydrogen heating, it is also likely that there is a discrepancy between the number of households in the licence area between the FES and DFES. The DFES heat modelling is based on the number of domestic customer connections in NGED's customer data.

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 houses, terraced houses, and flats	EPC data, ONS Census
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 at least one year 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 South West in 2050 ranges from 126 MW under **Falling Short** to 225 MW under **Consumer Transformation**.

Non-domestic electric heat in the South West 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.

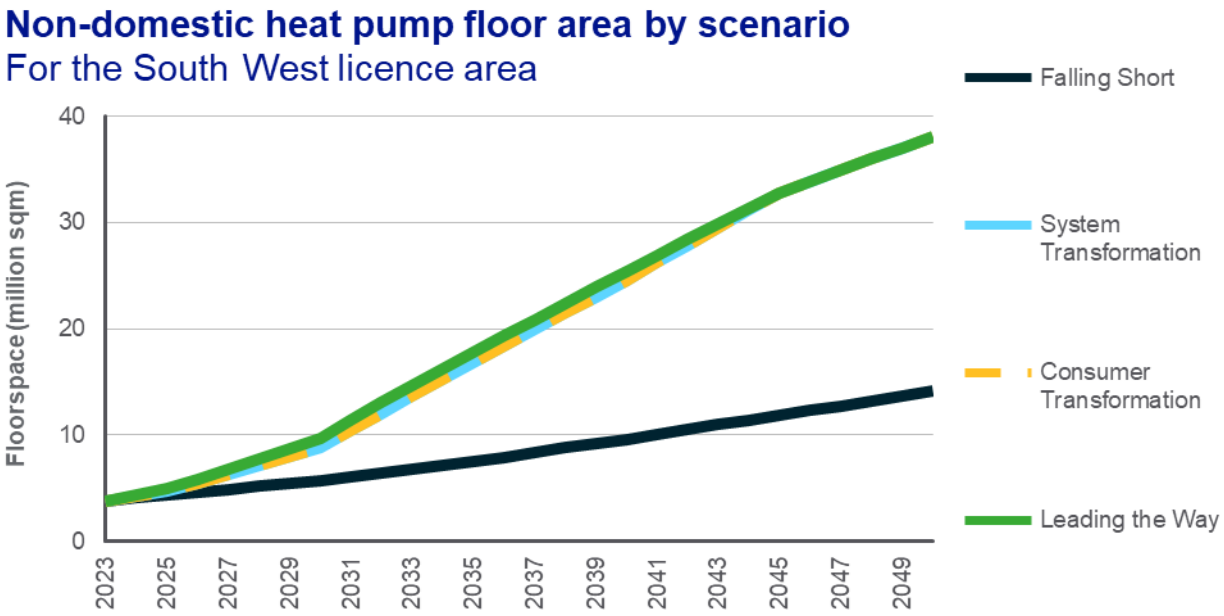
Data summary for non-domestic electric heat in the South West licence area:

Total floorspace (million sqm)		Baseline	2028	2035	2050
Heat pumps	Falling Short	4	5	7	14
	System Transformation		7	17	38
	Consumer Transformation		7	17	38
	Leading the Way		8	18	38
Resistive electric heating	Falling Short	9	9	9	8
	System Transformation		8	6	4
	Consumer Transformation		8	6	4
	Leading the Way		8	5	4

Summary:

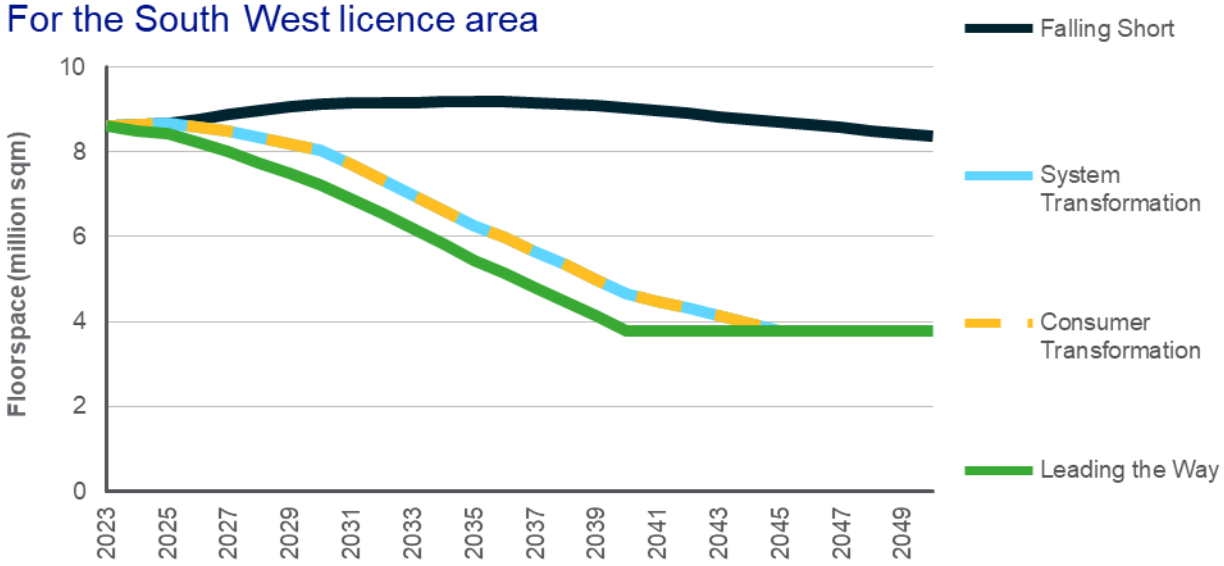
- Heating in non-domestic buildings is currently dominated by gas-fired central heating, resistive electric heating and air conditioning.
- A DESNZ evidence update of low carbon heating and cooling in non-domestic buildings[vi] found that non-domestic building decarbonisation pathways are strongly influenced 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 South West licence area



Modelling assumptions and results

Baseline		
Analysis of EPC and DEC data suggested that 9 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	4 (5%)
	Resistive electric heating	9 (12%)

* 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	8 (10%)	8 (8%)
Consumer Transformation		7 (9%)	8 (8%)
System Transformation		7 (9%)	8 (8%)

	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.	5 (7%)	9 (9%)

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. In currently gas-heated premises, air-source and ground-source heat pumps are preferred where a district heating connection is not available. In premises with direct electric heating, moving to an air-to-air heat pump is more suitable.	38 (43%)	4 (4%)
Consumer Transformation		38 (43%)	4 (4%)
System Transformation		38 (43%)	4 (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.	14 (16%)	8 (9%)

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 for 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 South West 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 South West licence area:

Number of vehicles (thousands)		Baseline	2028	2035	2050
Battery electric cars, LGVs and motorbikes	Falling Short	36	158	675	2,205
	System Transformation		196	1,032	2,060
	Consumer Transformation		375	1,611	2,062
	Leading the Way		340	1,709	1,679
Plug-in hybrid electric cars, LGVs and motorbikes	Falling Short	17	55	134	53
	System Transformation		52	111	10
	Consumer Transformation		44	70	6
	Leading the Way		54	60	8
Battery electric HGVs, buses and coaches	Falling Short	0	0	2	30
	System Transformation		1	7	22
	Consumer Transformation		1	9	35
	Leading the Way		1	10	34

Data summary for EV chargers in the South West licence area:

Capacity of chargers (MW)		Baseline	2028	2035	2050
Domestic chargers	Falling Short	166	676	2,331	5,604
	System Transformation		808	3,289	5,434
	Consumer Transformation		1,649	6,354	7,976
	Leading the Way		1,491	6,784	9,012
Non-domestic chargers	Falling Short	77	199	464	1,508
	System Transformation		244	792	1,482
	Consumer Transformation		313	912	1,224
	Leading the Way		304	982	1,276

Summary:

- Over 2% of vehicles in the South West 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, total EV charger capacity in the South West ranges between 7.1 GW and 10.2 GW.

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

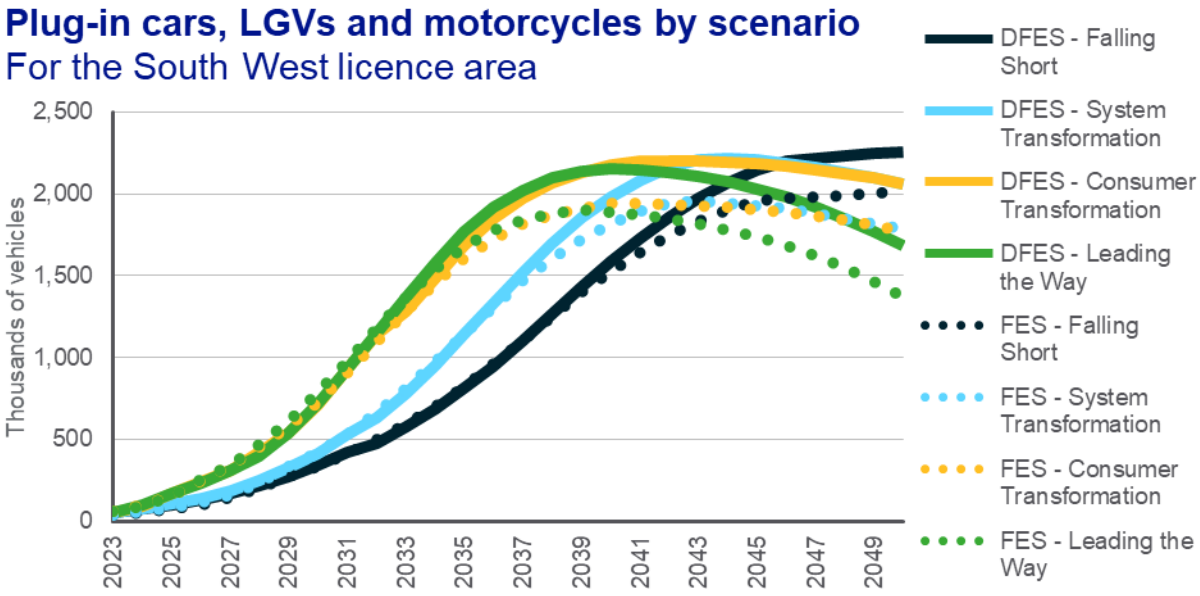
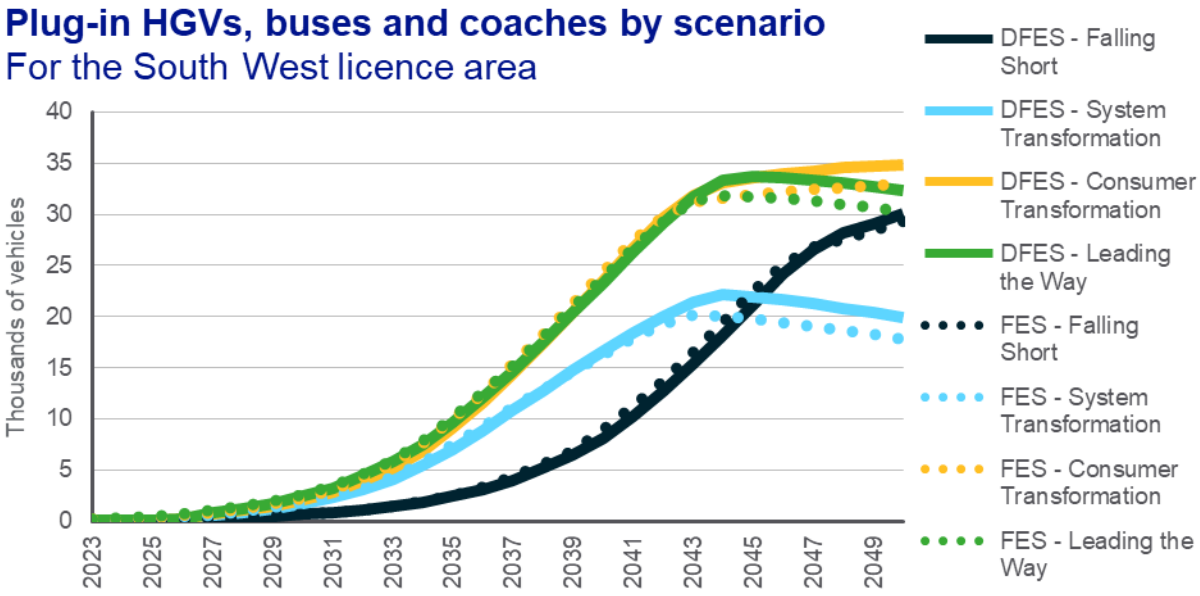


Figure 9 – Number of plug-in (battery electric and hybrid) HGVs, buses and coaches by scenario, South West licence area



Baseline

Electric vehicles

The electric vehicle baseline represents 2.3% of vehicles registered in the South West 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 also 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	33
Plug-in hybrid car	17
Pure electric LGV	2
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	166
Non-domestic	77

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 M5.

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.	394	1,795
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.	419	1,962
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.	248	1,052
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.	213	875

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.

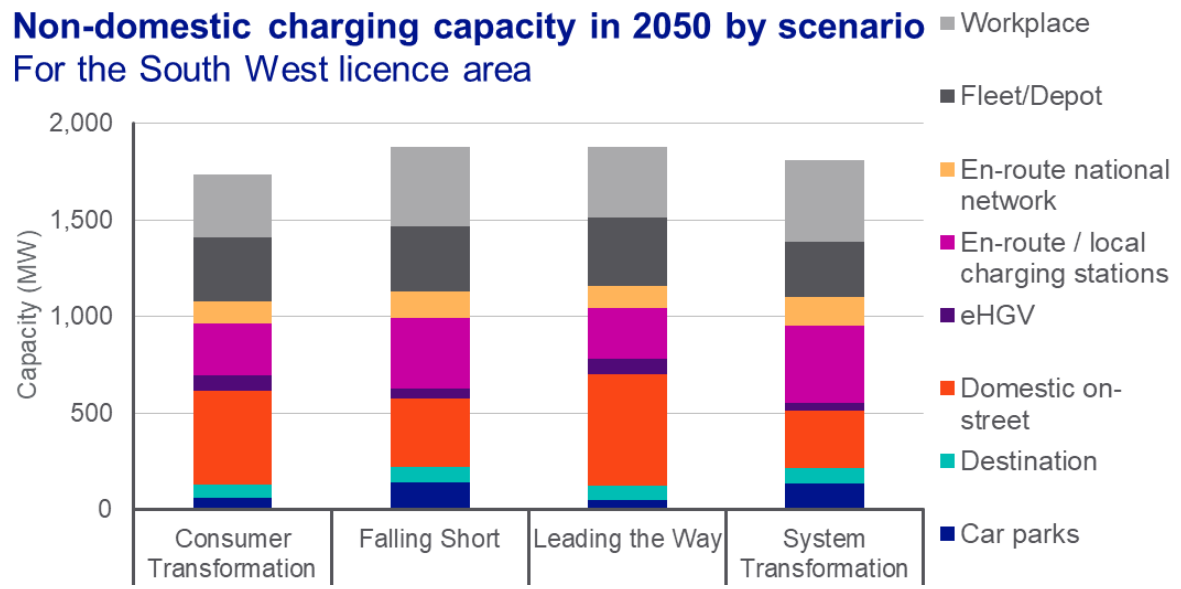
By 2035, the installation rate of EV chargers slows. Homes with multiple EVs are assumed not to purchase a second charger at the same rate as their first, and the demand for additional public charging reduces as the majority of vehicles are electrified under net zero scenarios by this point.

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.	1,721	10,288
Consumer Transformation	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.	2,103	9,200
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.	2,092	6,916

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.	2,288	7,112

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

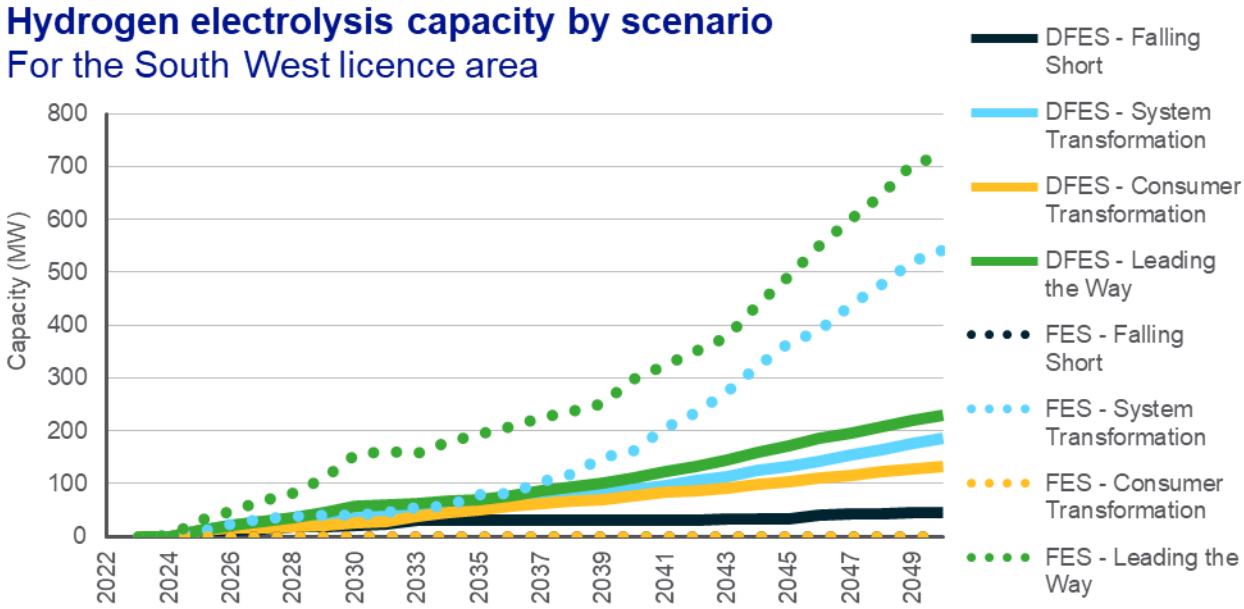
Hydrogen electrolysis in the South West licence area

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

Data summary for hydrogen electrolysis uptake in the South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	0	18	31	46
System Transformation		32	59	186
Consumer Transformation		18	51	132
Leading the Way		35	70	230

Figure 10 – Installed capacity of hydrogen electrolysis by scenario, South West 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 South West licence area, there is a pipeline of three projects with cumulative capacity of at least 10.5 MW with evidence of progress through the planning system.
- In the medium and long term, projections for electrolyser capacity are modelled based on expected supply and demand drivers for electrolytic hydrogen in each licence area under each of the four future scenarios.
- The projections for electrolysis capacity in the South West are relatively low compared to other regions due to the combination of several factors, including low current demand for hydrogen, relatively little existing gas-powered electricity generation capacity and the fact that National Gas' plans for a hydrogen transmission backbone do not include the region.
- Aviation activity is higher than average in the South West, which boosts demand in the long term, particularly in **System Transformation** and **Consumer Transformation**.
- By 2050, electrolysis capacity reaches 230 MW in the licence area under **Leading the Way**.

Modelling assumptions and results

Baseline

There is currently no electrolyser capacity connected to the distribution network in the South West licence area.

Near-term (April 2023 to March 2028)

The projections for distribution network connected electrolyser capacity until 2025 are based on evidence of progress through the planning system.

There is a small pipeline of electrolysis projects in the South West made up of three projects:

- 0.5 MW project in South Gloucestershire connecting imminently
- 10 MW project at Langage near Plymouth, South Hams
- Project in Cornwall (unknown capacity)

There are also projects in development without connection offers or planning system progress that do not influence the projections:

- Plans to configure Bristol Port to accept hydrogen or ammonia by ship and produce hydrogen on-site
- The second phase of Project Acorn which is exploring hydrogen-powered ground support equipment at Bristol Airport.
- HyHAUL, a project that will develop hydrogen refuelling services for HGVs along the M4 corridor, has recently won £30m of government funding.

After 2025, the projections are based on a combination of project evidence and long-term modelling as described in the **Medium and Long-term section** below.

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	**Falling Short**	2 years	From submission

submitted	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 South West (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 230 MW by 2050 under **Leading the Way**.

Scenario	Capacity by 2050 (MW)
Falling Short	46
System Transformation	186
Consumer Transformation	132
Leading the Way	230

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. Electrolyser projects are therefore limited overall in the medium and long term and located close to hydrogen demand.	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. 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	**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

	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.	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 South West
	Leading the Way	Consumer Transformation	System Transformation	Falling Short	
Industrial energy demand	High	High	High	High	Low
Heavy transport demand	Low	Medium	Medium	High	Low
H2 transmission network coverage	Medium	Low	Medium	Low	Low
Location of maritime activity	Medium	High	High	Low	Low
Gas distribution network coverage	High	Low	High	Low	Low
Gas-powered electricity generation	Medium	High	Medium	Medium	Low
Hydrogen innovation projects	High	High	High	High	Low
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 **Consumer Transformation** and **Falling Short**, there is 0 MW of electrolysis capacity in the region until 2050 in the FES 2023 projections. The DFES projections for the South West significantly exceed this, with 132 MW and 47 MW by 2050 respectively. The DFES projections more realistically reflect the region's likely hydrogen demand for industry, transport and electricity generation under **Falling Short**. In **Consumer Transformation**, electrolysis capacity is particularly linked to hydrogen demand for shipping, where the South West has a small but significant share of the nationwide total (2.7% of port traffic by tonnage). In this scenario, hydrogen demand for aviation is also a contributing factor, and the South West has a number of airports, including Bristol and Exeter, with a combined share of over 7% of air traffic movements under Department for Transport projections for 2030.
- In **Leading the Way** and **System Transformation**, the DFES projects notably lower capacity than in the FES. In these scenarios, the FES allocates electrolyser capacity in proportion to renewable generation capacity. The South West has strong renewables potential for both wind and solar generation. As well as renewable generation, the DFES takes into account factors such as the location of plans for hydrogen networks and the coverage of the existing gas network. The South West does not feature in National Gas' plan for a hydrogen transmission backbone, and the licence area has relatively low gas network coverage, so these factors reduce capacity projections relative to other licence areas.

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 South West licence area

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

Data summary for new domestic developments in the South West licence area:

Houses (thousands)	Baseline	2028	2035	2050
Falling Short	-*	81	222	388
System Transformation		94	246	419
Consumer Transformation		94	246	419
Leading the Way		126	276	460

* there are currently around 1.5 million domestic customers in the South West licence area.

Data summary for new non-domestic developments in the South West licence area:

Floorspace (sqm, 100,000s)	Baseline	2028	2035	2050
Falling Short	-*	23	59	77
System Transformation		24	66	77
Consumer Transformation		24	66	77
Leading the Way		25	70	77

* there are currently around 170 thousand non-domestic customers in the South West licence area. Floorspace recorded in EPC and DEC data totals 72 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 388,000 and 460,000 new homes in the South West licence area across the scenarios, representing a 20-25% increase in the number of domestic houses between 2023 and 2050.
- An additional 7.7 million square meters of non-domestic floorspace is also modelled in the licence area under each DFES scenario.

Figure 11 – Cumulative planned and total modelled new housing developments by scenario, South West licence area

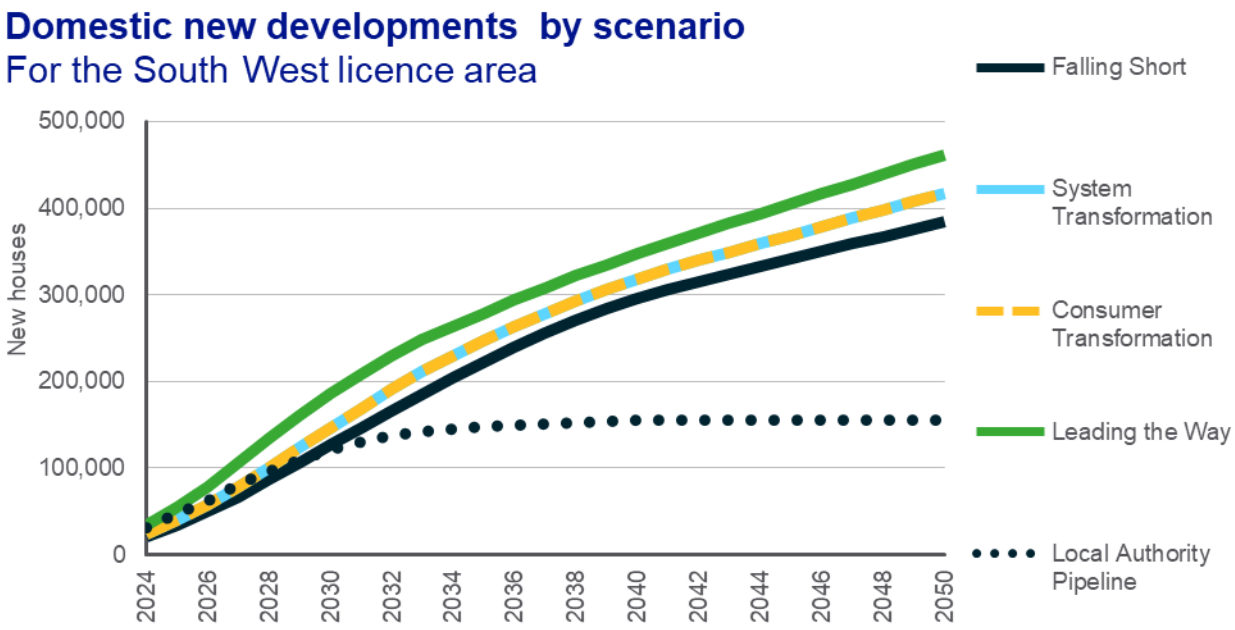
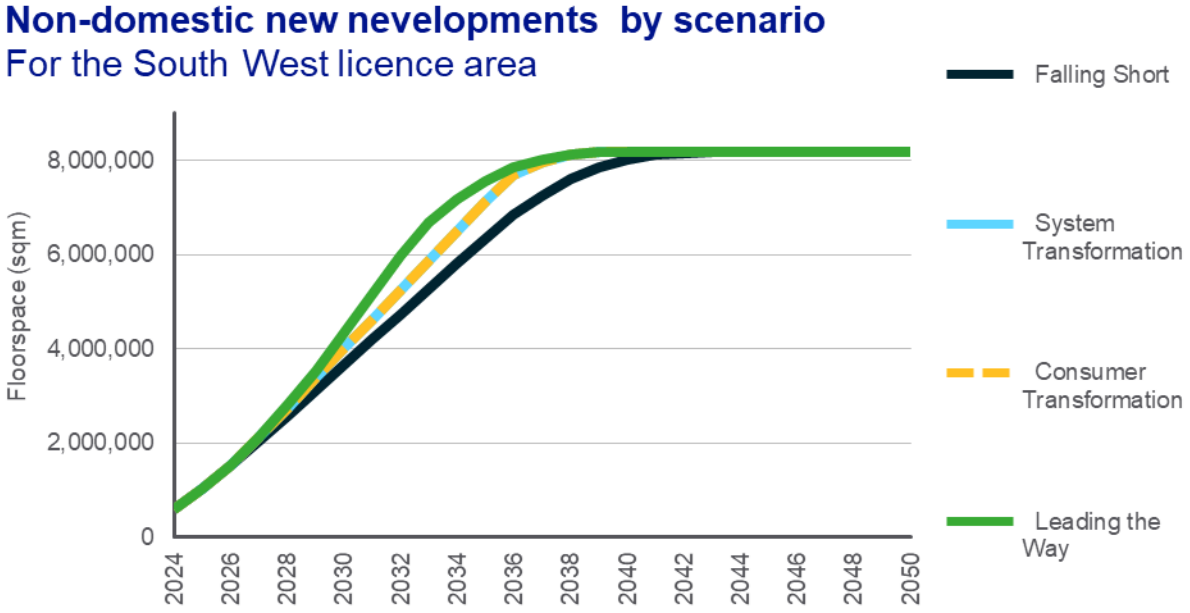


Figure 12 – Cumulative planned non-domestic developments by scenario, South West licence area



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, 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**
154,952	965

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

Local Authority	**Number of homes**	**Number of sites**	**Largest development site**
Somerset	25,915	162	Monkton Heathfield (3,280 homes)
South Gloucestershire	23,894	129	Filton Airfield (2,635 homes)
Cornwall	15,509	171	Eco Communities (1,625 homes)
Bristol, City of	12,776	97	Hengrove Park (1,435 homes)

Commentary on specific development sites:

Somerset has 162 planned sites, averaging 185 homes per site. In addition to the Monkton Heathfield development, one other site that is 1,000 homes or greater is planned in this area:

- A 2,000 homes site with planning permission that is currently listed as under construction.
- 54 sites (10,498 homes) have planning permission, with 15 currently under construction.

South Gloucestershire, which spans across two licence areas, has 31,540 homes in total planned with 23,894 located in the South West licence area. The Filton Airfield development is one of six developments in this licence area that is 1,000 homes or greater:

- The Cairns Road ESA has four major housing developments, including the Filton Airfield, and a total of 8,277 homes planned, all of which have received planning permission. Five sites still have reserved matters on the planning.
- The other two large developments of 1,290 and 1,148 homes have been allocated and have outline planning permission.

The 139 unique sites in **Cornwall** average 144 homes per site, including a 1,625 Eco Community that is set to be built into the early 2030s. This is the only development in Cornwall that is 1,000 homes or greater.

The **City of Bristol** has 12,776 homes planned, with an average of 132 homes per site. The Hengrove park development is the only site that is 1,000 homes or greater. However, it should be noted that nearly 5,450 homes provided by the **South Gloucestershire** local authority fall within the **City of Bristol**, including the Filton Airfield development.

Outside of these four local authorities, there are 13 further sites in the South West with over 1,000 planned new homes, accounting for over 26,000 homes. These range from under construction to early development, resulting in a spread of modelled housebuilding between 2024 and the 2040s:

- The Sherford New Community in **South Hams** will have 5,200 new homes once completed. This site is currently under construction, with 4,563 remaining homes at the time of writing.
- Four other sites have planning permission granted, three in **Teignbridge** (1,800, 1,500 and 2,032 homes) and site in North Somerset with 3,536 homes.
- Five major sites are in planning, with outline consent or awaiting a decision.
- The remaining four sites have no development stages allocated to them.

Non-domestic

Regen category	Non-domestic sites		Total non-domestic floorspace (sqm)	
	Number	Proportion	Total per category	Proportion of total
Factory and warehouse	275	30.7%	2,683,097	32.8%
Office	337	37.7%	2,940,448	31.8%
Retail	51	5.7%	294,122	3.6%
School and college	30	3.4%	128,873	1.6%
Other (e.g. medical, hotel, sport & leisure)	202	22.6%	2,144,078	26.2%

The majority (86%) of South West non-domestic planned floorspace is designated as 'employment land', split into factory and warehouse or office space. There is also significant planned floorspace for medical (0.5 million sqm) and sports and leisure (0.4 million sqm), which makes up a higher proportion of planned non-domestic development land than in the other NGED licence areas. **Bristol** and **Somerset** have the highest planned floorspace by local authority, with 1.7 and 1.8 million sqm respectively.

The South West licence area has 23 sites with a floorspace of 50,000 sqm or greater. This includes the mixed-use Gravity 'Smart Campus' (0.9 million sqm), the Isleport Extension (0.3 million sqm) and a new motorway service area (0.3 million sqm), all located within the **Somerset** local authority. **South Gloucestershire** also has two sites totalling 0.3 million sqm of combined floorspace designated as factory and warehouse.

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 by developments currently in planning and have as such been modelled to ensure the DFES scenarios capture a range of housebuilding trends between 2023 and 2050. These are **residual developments** and **post-plan developments**, described in more detail below:

Residual developments	These are small-scale developments of less than 20 homes, which are under the threshold of our data collection with local authorities. Analysis of previous new developments data suggests that these developments could account for approximately 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 post-plan development projections are tailored to each local authority, based on ONS household projections[ix].
Non-domestic	
The non-domestic scenario projections are based on planned developments only.	

Reconciliation with National Grid FES 2023

- The FES scenarios include the same proportional growth of domestic customers across all four scenarios and at every GSP. In the DFES, a range of scenario outcomes have been modelled to aid 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 in.	Local authority engagement
Modelled sites 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 South West licence area

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

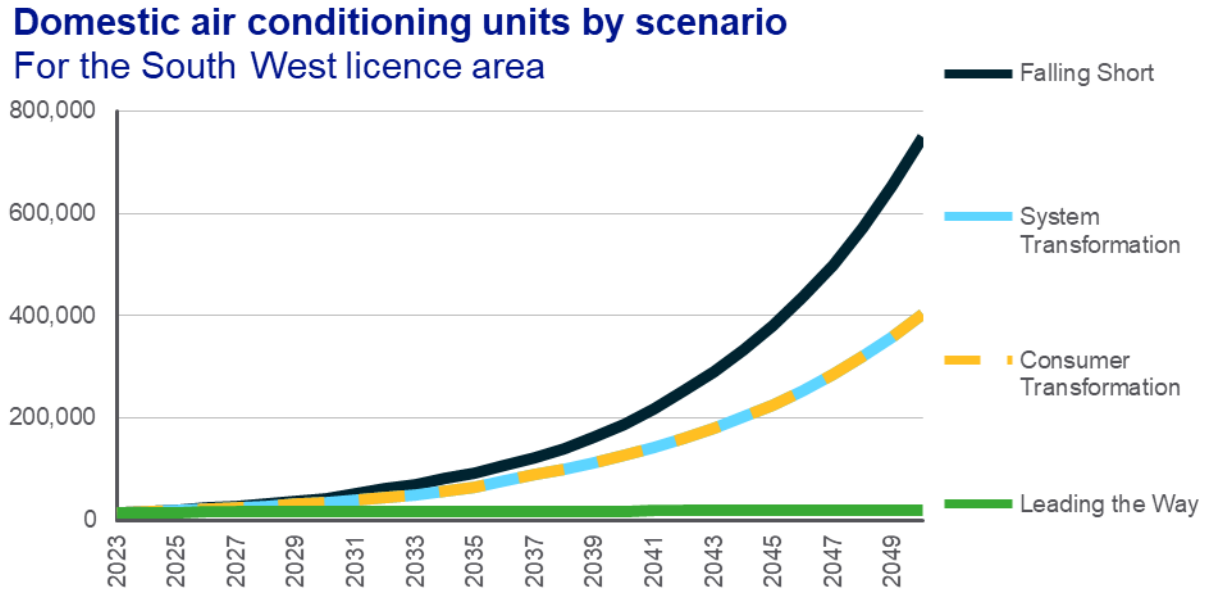
Data summary for air conditioning uptake in the South West licence area:

A/C units (thousands)	Baseline	2028	2035	2050
Falling Short	15	31	93	750
System Transformation		27	65	403
Consumer Transformation		27	65	403
Leading the Way		16	17	20

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 South West licence area, modelling suggests around 1% of homes currently have an air conditioning 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 Bristol.
- 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 air conditioning units by scenario, South West licence area



Modelling assumptions and results

Baseline		
There is limited baseline data on domestic air conditioning 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 air conditioners (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 air con unit
	c. 15,000	1.0%

Projections (April 2023 to March 2050)		
Scenario	**Description**	**2050 projection**
Falling Short	Increasing frequency of heat waves and low uptake of passive cooling methods leads to high uptake of air conditioning, as the 'easiest' route to comfortable internal temperatures.	c. 750,000 homes
System Transformation	Over time, air conditioning becomes common in all types of dwellings. Uptake of domestic air conditioning accelerates in urban areas due to heat island effects and the prevalence of smaller dwellings such as flats.	c. 403,000 homes
Consumer Transformation		
Leading the Way	Uptake of domestic air conditioning is minimal, with households opting for passive cooling methods such as shading, ventilation and insulation.	c. 20,000 homes
New build homes		
The Overheating: Approved Document O statutory guidance published by UK government in late 2021 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, uptake of air con 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 air conditioning units by region, making a direct comparison to the DFES not possible.
- The South West licence area sees uptake of air conditioning below the national level seen in FES 2023, as the licence area is below the national average for both cooling demand and population density.

Factors that will affect deployment at a local level

Factor	Source
Early uptake of domestic air conditioning is focused in denser urban areas such as Bristol and Plymouth. In scenarios where domestic air conditioning 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 air conditioning, due to the relatively high upfront and running costs of domestic air conditioning units.	ONS Income Estimates for Small Areas

Generation technologies

Results and assumptions

Large-scale solar in the South West licence area

Solar generation sites of installed capacity of 1 MW and above

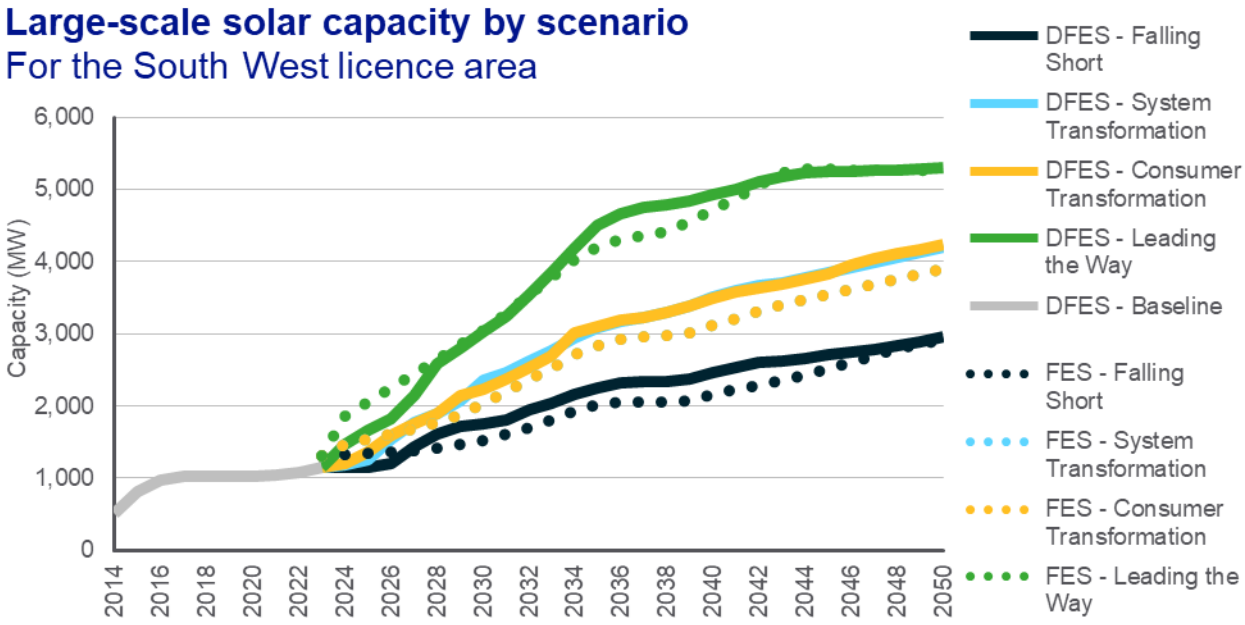
Data summary for large-scale solar power in the South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	1,141	1,610	2,257	2,952
System Transformation		1,894	3,085	4,200
Consumer Transformation		1,897	3,107	4,242
Leading the Way		2,591	4,496	5,293

Summary:

- The South West 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 124 sites totalling 2.8 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, local authorities in the South West have high levels of local ambition, evidenced through renewable energy targets, and a history of planning friendliness by regional local authorities. This combines with a significant amount of suitable land for solar farm development and high levels of solar irradiance.
- Scenario outcomes by 2050 range from 3.0 GW under **Falling Short**, almost three-times the current baseline, to 5.3 GW under **Leading the Way**, over four-times the baseline.

Figure 14 – Electrical capacity of large-scale solar by scenario, South West licence area



Baseline		
The majority of current installed large-scale solar PV capacity was deployed between 2012 and 2015, when Feed-in Tariff rates for solar PV were highest, with over 820 MW connecting during that time. The baseline continues to grow with ten new sites connecting in the 2020s, including a 15.6 MW site in North Somerset that is significantly larger than the average site size of 4.75 MW, illustrating a move towards larger scale sites.	**Number of sites**	**Total capacity (MW)**
	230	1,141

Pipeline (April 2023 to March 2028)		
The pipeline of projects with an accepted connection offer in the licence area now totals almost 3.0 GW, increasing by over 400 MW over the past year. This includes a 90 MW site in Somerset and four sites at installed capacity nearing 50 MW. The average capacity of pipeline sites in the South West is 23 MW, substantially greater than the baseline average.	**Number of sites**	**Total capacity (MW)**
	115	2,945

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Under Construction	An 11 MW site in Teignbridge is modelled to connect in 2024 under all scenarios.	1	11
Planning Permission Granted	East Devon has the most approved solar capacity in the South West, with six sites totalling 142 MW. This includes the two sites over 50 MW. South Gloucestershire is home to 91.5 MW of approved solar capacity. Sites with planning granted are modelled to connect under all four scenarios with a timeframe between 2024 and 2029, based on developer engagement and individual site research.	22	509
Planning Application Submitted	Two sites with scales larger than 40 MW were modelled to connect under **Leading the Way**. Under **Consumer Transformation**, ten sites with an installed capacity of 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. Under **Falling Short**, only sites with high levels of historic planning success for large-scale solar PV are modelled to connect.	11	323

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 500 MW of sites that fall into this category in the South West. 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%.	24	579
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.	52	1,305
Rejected, Withdrawn or Abandoned	Sites that were rejected in planning, withdrew their application or have abandoned development were not modelled to connect under any scenario.	4	86
Contract for Difference Allocation Round 5	Four sites were identified as having been awarded a contract for difference in allocation round 5: **South Gloucestershire:** Perinnpitt Road Solar (38.6 MW) **Mid Devon:** Tale Lane Solar (35 MW) **Somerset:** Mounsel House Solar Farm (30 MW) **Torridge:** Gammaton Moor Solar Park (28 MW) All sites were modelled to connect under all four scenarios by the delivery year of 2028. The only exception was the **Mid Devon** sites, where pipeline analysis was able to conclude that the sites had planning permission refused.	4	132

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 triple the baseline by 2050. Pipeline sites connecting with delayed timelines drive medium-term growth, before the late 2030s when growth levels off, reaching 2.9 GW by 2050. Repowering is assumed to have minimal impact under this scenario, with most site owners choosing to extend the life of their	2,952

	existing panels rather than increase capacity.	
System Transformation	Solar PV deployment increases steadily under this scenario, reaching over 4 GW by 2050. Repowering of baseline sites at the end of their operational life is modelled to increase capacity by 25%.	4,200
Consumer Transformation	Solar PV deployment increases steadily under this scenario, driven by high levels of local ambition, reaching over 4 GW by 2050. Repowering of baseline sites at the end of their operational life is modelled to increase capacity by 25%.	4,242
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 5 GW by 2050 in the licence area.	5,293

Reconciliation with National Grid FES 2023

- The FES 2023 baseline is around 200 MW higher than the DFES 2023 baseline for the South West licence area. This could be due to erroneous assignment of solar farms to GSPs on the edge of the licence area in the FES data.
- Over the scenario timeframe beyond the baseline, the FES and DFES projections are closely aligned.

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[x]
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 South West 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.

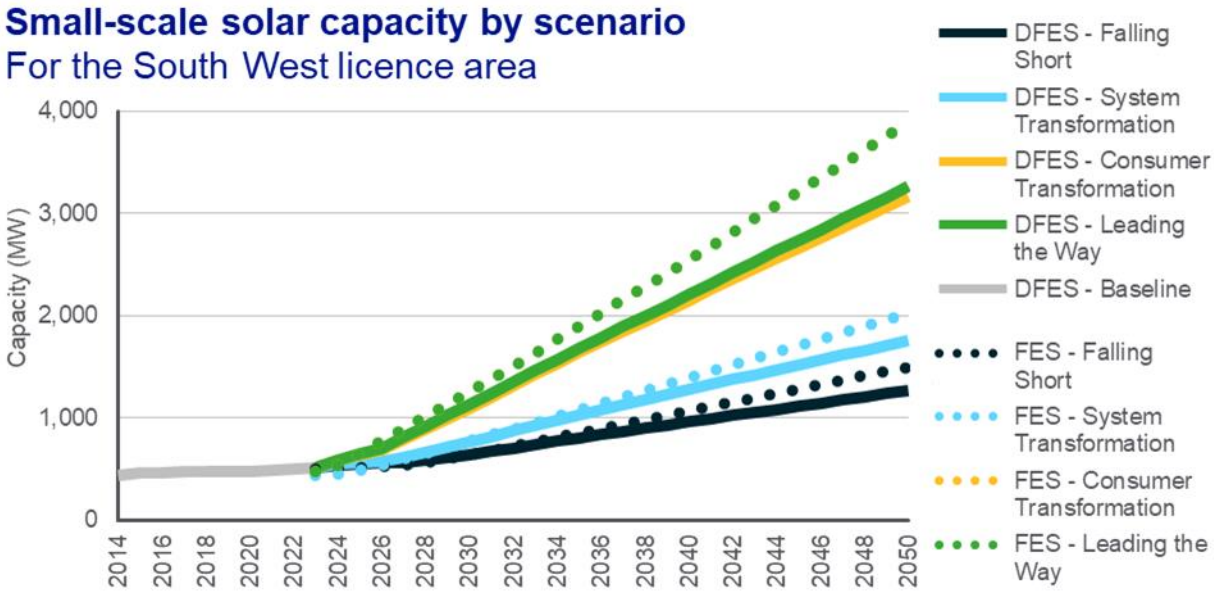
Data summary for small-scale solar generation in the South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	512	580	785	1,229
System Transformation		661	1,008	1,713
Consumer Transformation		883	1,607	3,111
Leading the Way		909	1,648	3,208

Summary:

- The recent increase in energy prices has resulted in an increase in solar PV deployment, with 65 MW of small-scale solar installed within the last year. The South West baseline now totals 511 MW, with over 325 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 Feed-in-Tariff era. Across GB, installations in the first quarter of 2023 doubled compared to the previous year[xi].
- 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. 3.2 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 nearly four times and over two times the current capacity by 2050, respectively.

Figure 15 – Capacity of small-scale solar generation by scenario, South West licence area



Modelling assumptions and results

Baseline

The majority of small-scale solar was deployed in the Feed-in-Tariff era in the 2010s, with over 360 MW connecting during that period. The South West is currently seeing an increase of small-scale solar, with 65 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)	85,446	328	Equivalent to 5.1% of homes
Commercial (10 kW-1 MW)	3,269	183	Average array size: 56 kW

Pipeline (April 2023 to March 2024)

There are 222 small-scale solar sites in the pipeline, representing over 31 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)	70	0.4
Commercial (10 kW-1 MW)	152	31.1

Pipeline analysis

All pipeline sites are modelled to connect in 2024 under all scenarios, with the exception of two sites with connection offers prior to 2020 that were 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 is changes to Building Regulations (Part L)[xii] 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 1.3 GW under **Falling Short** to 3.3 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.	1,229

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 1.8 GW by 2050. The rate of new builds with solar module installation is modelled to increase to 25% by 2030 and 40% by 2050.	1,713
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 in c.3.2 GW of small-scale solar by 2050.	3,111
Leading the Way		3,208

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 year and in the near term.
- In the medium and longer term, the DFES capacity projections are below the FES capacity projections in every scenario. The reason for this is not definitively clear. It is possible that the FES projections put more weight on the baseline deployment, in which the South West licence area is well above the national average, while the longer-term DFES projections place a greater weight on underlying building stock and demographic factors.

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 South West licence area

Onshore wind electricity generation

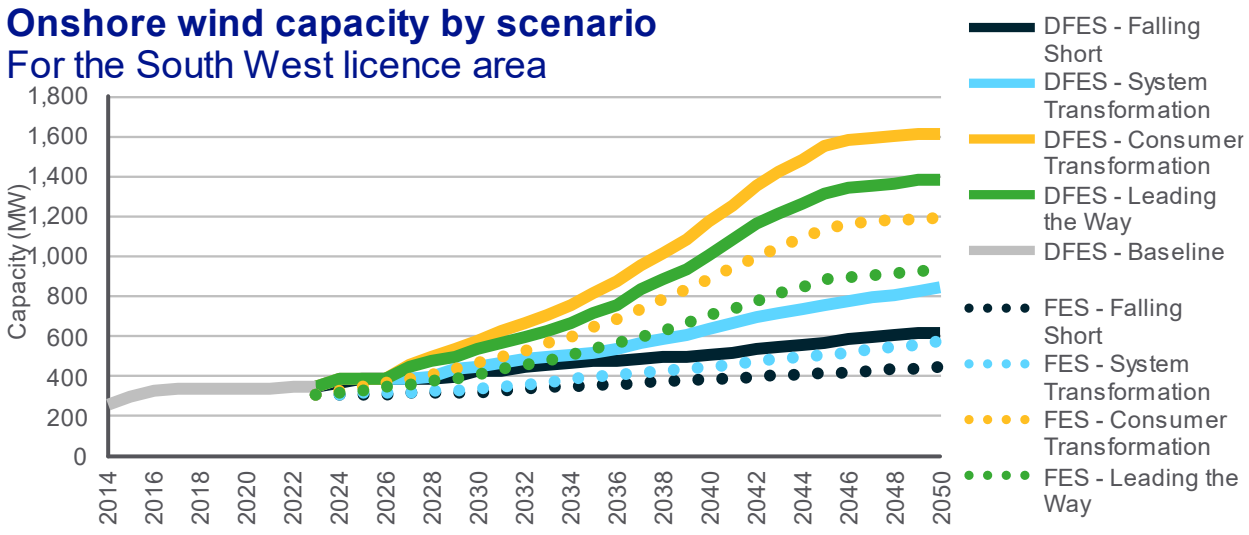
Data summary for onshore wind power in the South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	347	387	474	619
System Transformation		398	520	845
Consumer Transformation		499	809	1,609
Leading the Way		475	710	1,385

Summary:

- Home to some of the UK's first wind farms, the South West licence area hosts 347 MW of distributed onshore wind, with around half of this capacity connecting before 2012.
- There is substantial onshore wind resource in the South West, with areas of high wind speeds and suitable land. However, recent deployment has been heavily limited by the planning regime in England, resulting in almost no onshore wind deployment over the past five years. This planning obstacle is modelled to continue under **Falling Short**, resulting in limited uptake of onshore wind out to 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 project located in South Wales, are in Scotland.
- The **Consumer Transformation** and **Leading the Way** scenarios see a renewed deployment of distributed onshore wind projects, reflecting local and national ambitions to reach net zero targets through onshore wind as a low-cost technology. This is augmented by existing windfarms repowering at increased capacities at the end of their operational life. As a result, capacity reaches 1.4-1.6 GW by 2050 under these scenarios.
- There is comparatively less deployment of distributed onshore wind under **System Transformation** and **Falling Short**, as there is a greater focus on large-scale, transmission-connected power generation in these scenarios. Onshore wind capacity reaches between 0.6-0.8 GW by 2050 in the licence area under these scenarios.

Figure 16 – Electrical capacity of onshore wind by scenario, South West licence area



Modelling assumptions and results

Baseline			
The majority of the existing distributed onshore wind capacity in the South West comes from 36 sites that are 1 MW or greater, accounting for 83% of installed capacity. Cornwall hosts 14 of these larger-scale sites, totalling 114 MW. The vast majority of the baseline was constructed in the 2000s and 2010s due to UK government incentive schemes such as the Feed-in Tariff and Renewables Obligation. Changes in the planning regime in England have meant that only a very small number of new wind projects, 19 MW of installed capacity across nine sites, have been installed in the South West since 2017.	**Scale**	**Number of sites**	**Total capacity (MW)**
	Small-scale (<1 MW)	665	59
	Large-scale (>=1 MW)	36	288

Pipeline (April 2023 to March 2028)		
There are twelve sites that have a connection offer totalling 121 MW. Of these, nine are located in Cornwall and represent 96% of total pipeline capacity. The three remaining projects are located in Bristol (2.5 MW), North Devon (1.2 MW) and Somerset (0.07 MW). These have been modelled to connect under each scenario based on an analysis of each site's current development status.	**Number of sites**	**Total capacity (MW)**
	12	121

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Already operational	A 2.5 MW project in Bristol became operational in 2024, the first year of the projections.	1	2.5
Under Construction	A 20 MW project in Cornwall is currently under construction and therefore has been modelled to connect in 2024 under all four scenarios.	1	20
Planning Permission Granted	A 20 MW site – the Cold Northcott Wind Farm in Cornwall - had planning permission granted in 2020. This site has been modelled to connect between 2024-2027, depending on the scenario, based on typical development timescales for projects of this scale.	1	20
Extensions	Two existing sites (totalling 11 MW) are currently looking to expand their export capacity. These are modelled to go ahead in the net zero scenarios in the mid-2020s.	2	11
No information	Of the eight sites (37 MW) where no development information could be found, five smaller-scale sites were modelled to go ahead under **Consumer Transformation**. The remaining two larger-scale sites were not modelled to connect under any scenario.	8	67

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 very limited deployment out to 2050. While a small number of new sites are connected, the majority of increased	619

	capacity comes from the repowering of existing sites. Baseline sites with a capacity higher than 5 MW are modelled to repower with +25% capacity[xiii].	
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% added capacity results in an increased rate of capacity growth in the 2030s and 2040s.	845
Consumer Transformation	This scenario sees the largest growth in distributed onshore wind, reaching just under 1.6 GW by 2050 – more than four 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 an assumed availability of higher yield, more efficient and larger turbines.	1,609
Leading the Way	This scenario is similar to **Consumer Transformation**, albeit with marginally lower levels of deployment due to the wider energy system being less heavily electrified under **Leading the Way**. Distributed wind capacity still reaches 1.4 GW by 2050 in the licence area under this scenario.	1,385

Reconciliation with National Grid FES 2023

- The FES 2023 baseline is around 10% lower than the DFES 2023 baseline for the South West licence area. The reason for this variance is unclear.
- Accounting for the baseline variance, near-term projections in the FES and DFES are broadly aligned due to the limited pipeline of new projects currently seeking to connect.
- In the longer term, the FES projections are below the DFES in every scenario – this is likely the extrapolation of 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 variance to FES 2023 long-term projections may also reflect a potential difference in the method of modelling the repowering of onshore wind sites. 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 South West 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 and marine in the South West licence area

Tidal energy, wave energy and offshore wind (fixed and floating) electricity generation

Data summary for offshore wind and marine in the South West licence area:

Capacity (MW)		Baseline	2028	2035	2050
Offshore wind	Falling Short	0	35	135	135
	System Transformation		135	135	135
	Consumer Transformation		135	170	170
	Leading the Way		170	170	170
Marine	Falling Short	0	0	0	0
	System Transformation		0	0	0
	Consumer Transformation		0	5	5
	Leading the Way		0	0	0

Summary:

- There are no operational grid-connected offshore wind or marine energy projects in the South West licence area. However, there is an active pipeline of floating offshore wind projects.
- Two floating offshore wind projects, the 100 MW White Cross Wind Farm and 35 MW TwinHub site, have secured connection offers and are progressing through development. These are modelled to connect around the late 2020s under every scenario.
- A further 35 MW extension has been modelled at the TwinHub site under two scenarios. Beyond this, floating offshore wind projects are anticipated to connect at transmission level.
- A further 15 MW of tidal stream capacity has also been modelled to connect in North Devon under the **Consumer Transformation**. While there are no developing projects in the area currently, it has been identified as an area of significant tidal stream resource.

Figure 17 – Capacity of offshore wind generation by scenario, South West licence area

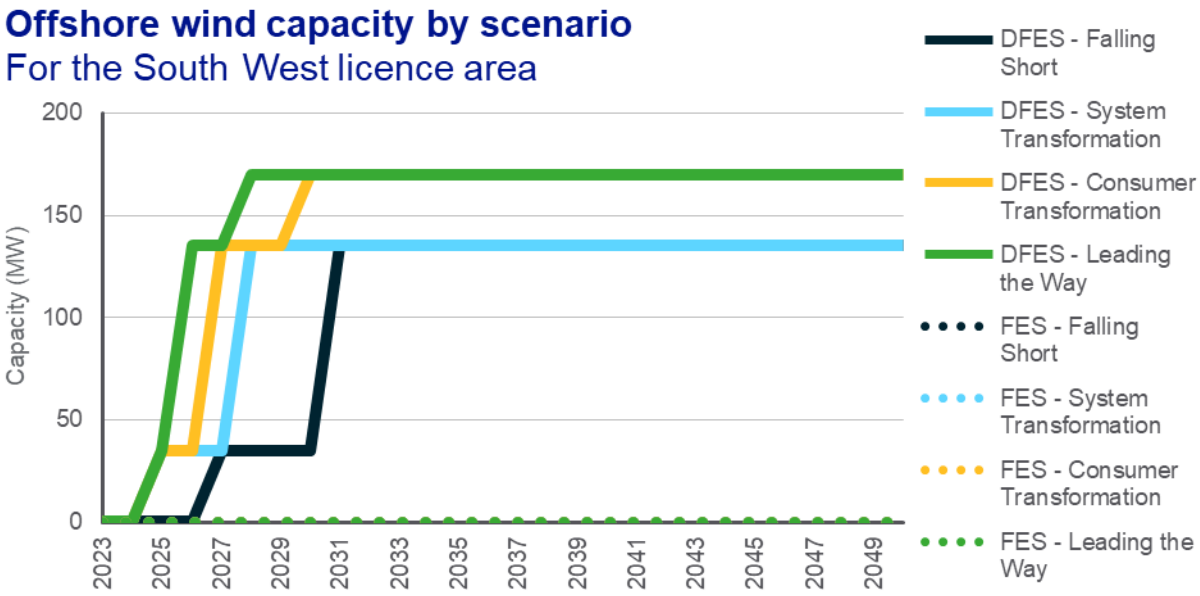
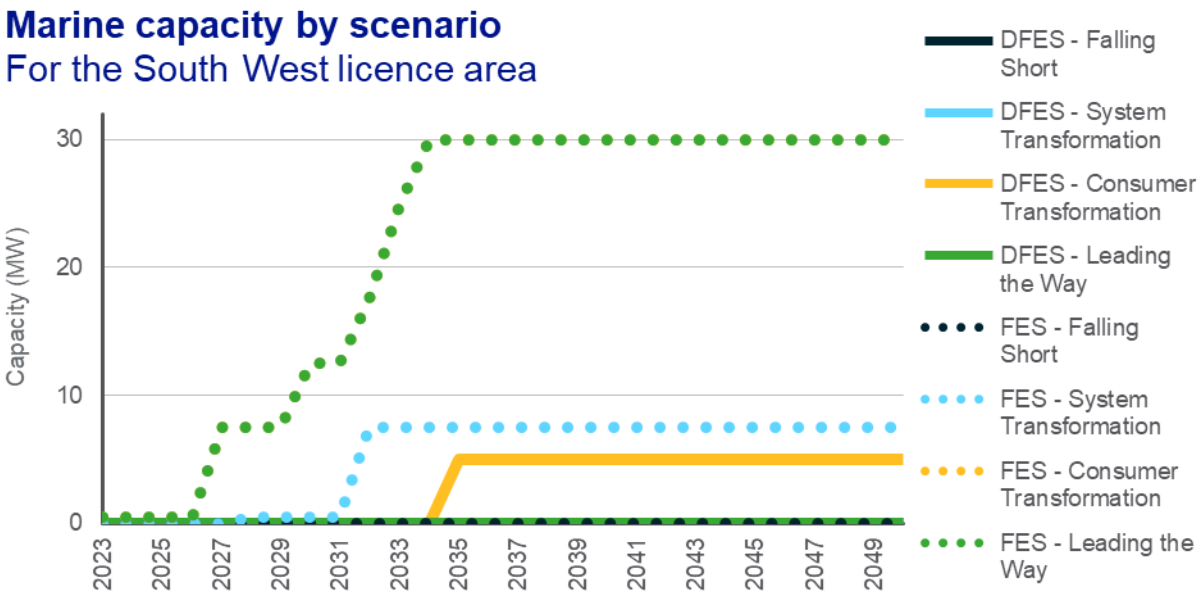


Figure 18 – **C**apacity of marine generation by scenario, South W**est** licence area



Modelling assumptions and results

Baseline
There are no operational marine energy or offshore wind projects connected to the distribution network in the South West licence area.

Pipeline (April 2023 to March 2028)		
There are two floating offshore wind projects with an accepted connection offer in the licence area.		
Project	**Status**	**Capacity (MW)**
White Cross	The project is currently undertaking pre-planning and environmental assessments, ahead of applying for marine licence and planning consents. Aiming to connect in the mid-2020s, the project connects between 2026 and 2028 in the net zero scenarios and in 2031 under **Falling Short**.	100
TwinHub	The TwinHub demonstration project, at the former WaveHub site off the coast of Hayle, secured a Contract for Difference as part of the Allocation Round 5, for which the contractual arrangement begins in 2026. Based on previous engagement with developers Hexicon, the project connects in 2025 in the net zero scenarios, and in 2027 under **Falling Short**.	35

Medium and long-term projections (April 2028 to March 2050)
Offshore wind
TwinHub developers Hexicon identified the potential for the TwinHub demonstration site to be expanded with another 35 MW of capacity. This site extension is modelled to go ahead in the late 2020s under **Consumer Transformation** and **Leading the Way**. Beyond the pipeline and the potential TwinHub extension, it is anticipated that floating offshore wind projects will scale up to connect to the transmission network, rather than connecting at distribution level. This results in no further capacity under any scenario.

Marine
While there are no tidal stream projects in the connection pipeline, the North Devon Tidal Demonstration Zone off the coast of Lynmouth was previously identified as having potential for tidal stream projects. Due to the current lack of development in this area, this has only been modelled under **Consumer Transformation**, with 5 MW of tidal stream capacity coming online in the mid-2030s. With the WaveHub site being repurposed for the TwinHub floating offshore wind demonstration project, there are no utility-scale wave projects in development in the South West licence area. Engagement with developers and sector representatives did not identify any prospective wave energy projects off the coast of the South West licence area despite good wave energy resource. No wave energy capacity has been modelled to connect under any of the future scenarios. Stakeholder engagement also highlighted the potential for tidal and wave energy deployment off the Isles of Scilly. This is currently not reflected under any of the scenarios due to the early stage of development for this resource and uncertainty over whether this would be connected to the NGED distribution network on the island.

Reconciliation with National Grid FES 2023

- For offshore wind, the National Grid FES 2023 projects no deployment in the South West licence area under any scenario. The DFES projections are based on projects with accepted connection offers and clear evidence of development.
- For marine energy, the DFES projections are lower than the FES in the three net zero scenarios. Other than the potential tidal stream development off Lynmouth, engagement with regional sector representatives for the DFES analysis did not identify potential marine energy projects that could connect to the distribution network in the South West licence area. Developer focus has shifted strongly towards floating offshore wind. Based on this stakeholder evidence, DFES projections are notably below the FES in all three net zero scenarios.

Factors that will affect deployment at a local level

Factor	Source
Locations of potential future sites have been identified through desk research and extensive developer engagement.	Desk research, developer engagement, engagement with sector representatives

Hydro in the South West licence area

Hydropower electricity generation

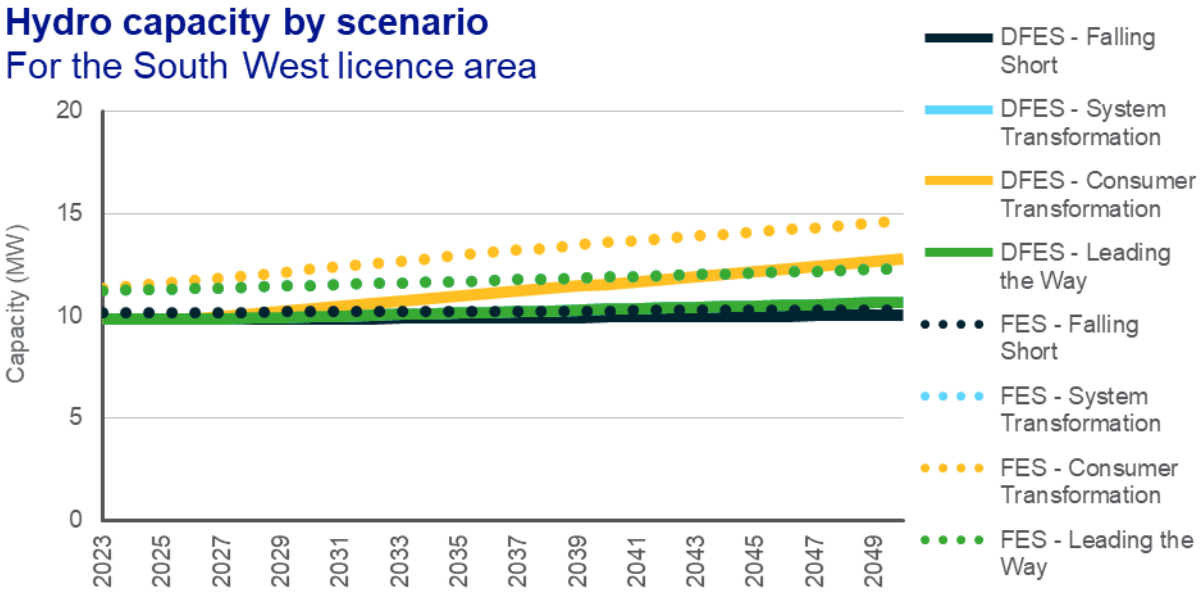
Data summary for hydropower in the South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	10	10	10	10
System Transformation		10	10	11
Consumer Transformation		10	11	13
Leading the Way		10	10	11

Summary:

- While the South West licence area does not contain the topography for large-scale hydropower generation, there are a number of small-scale hydropower sites around elevated areas such as Dartmoor.
- Following the closure of the Feed-in Tariff in 2019, deployment of small-scale hydropower has stalled. There are resultantly no hydropower pipeline sites in the South West licence area.
- Due to a lack of subsidy support and increased abstraction licencing costs[xiv], all scenarios see limited hydropower deployment in the licence area out to 2050. The scenario with the highest deployment, **Consumer Transformation**, sees an additional 3 MW of hydropower modelled to connect to the South West distribution network by 2050.

Figure 19 – Electrical capacity of hydropower by scenario, South West licence area



Modelling assumptions and results

Baseline			
The majority of hydropower capacity in the licence area, totalling 6.6 MW from five sites, is at reservoirs and water treatment works owned by South West Water. The majority of this capacity connected to the distribution network in the 1990s or earlier, including Mary Tavy Power Station in Tavistock in Devon, which is one of the oldest hydro sites in the UK, commissioned in the 1930s. The remaining capacity was almost entirely delivered through the Feed-in Tariff scheme in the 2010s. These small-scale sites are located across Devon, Cornwall and Somerset.	**Scale**	**Number of sites**	**Total capacity (MW)**
	Small-scale (<1 MW)	60	5.4
	Large-scale (>=1 MW)	2	4.4

Pipeline (April 2023 to March 2028)
There are no hydro pipeline sites with an accepted connection offer in the South West licence area. As a result, near-term deployment of hydropower is projected to be minimal under every scenario. The previously developing Nethan Weir hydropower project in Bristol was abandoned in late 2022[xv].

Medium and long-term projections (April 2028 to March 2050)		
With hydropower deployment completely stalled in the South West, projections beyond the pipeline period are strongly dependent on scenario assumptions and still remain very limited out to 2050.		
Scenario	**Description**	**Capacity by 2050 (MW)**
Consumer Transformation	With a focus on decarbonisation through consumer engagement, this scenario sees minimal but steady deployment of small-scale hydropower out to 2050. Hydropower deployment is driven by onsite electricity generation and community energy schemes.	13
Leading the Way	Under these scenarios, small-scale hydropower deployment is even more limited, as large-scale solutions are prioritised. Hydropower is therefore modelled to deploy at some select locations, to aid decarbonisation - particularly where sites above 1 MW capacity could be deployed.	11
System Transformation		
Falling Short	Lack of subsidy support and slow decarbonisation under this scenario results in no further hydropower deployment.	10

Reconciliation with National Grid FES 2023

- The DFES and FES projections for hydropower in the South West are closely aligned, though the FES has moderately (2 MW) higher projections by 2050 than the DFES.

Factors that will affect deployment at a local level

Factor	Source
Future hydropower sites are modelled to be in similar geographical areas to existing hydropower, representing watercourses with an appropriate head difference for hydropower deployment.	NGED, Feed-in Tariff register

Geothermal in the South West licence area

Geothermal energy sites producing electrical power

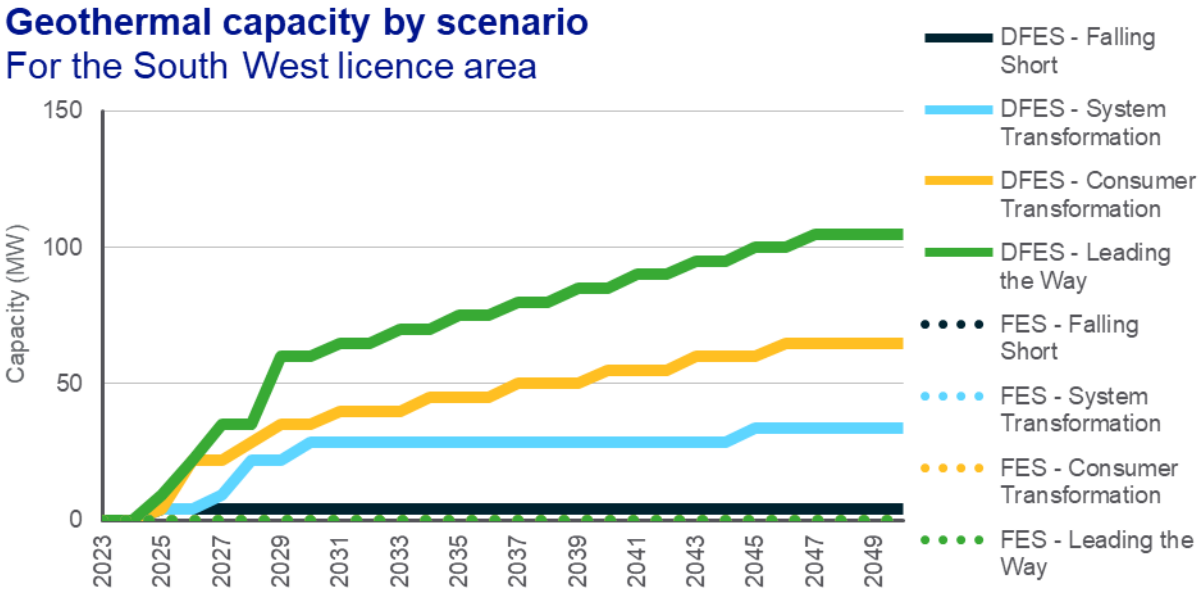
Data summary for geothermal power in the South West licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	0	4	4	4
System Transformation		22	29	34
Consumer Transformation		29	45	65
Leading the Way		35	75	105

Summary:

- Whilst there is no operational geothermal power generation capacity connected to the distribution network in the South West licence area, there is a strong pipeline of projects in development.
- The business case for geothermal power has historically proved challenging, with projects facing high costs, long lead times and lengthy permitting processes. The success of the projects under development near Redruth and St Austell will have a major impact on geothermal deployment in the South West licence area.
- As a result of the challenges and uncertainty around the development of this technology in the UK, the scenario results for geothermal power in the licence area represent a broad range of outcomes in both the near term and the long term.

Figure 20 – Electrical capacity of geothermal energy by scenario, South West licence area



Baseline
There are no geothermal sites currently producing electrical power. Whilst the United Downs site in Cornwall has drilled production wells and has completed the majority of testing, the commissioning of the power generation plant is not expected until 2024.

Pipeline (April 2023 to March 2028)		
There is an active pipeline of geothermal power generation projects. The United Downs site is modelled to commission shortly under all scenarios, whilst the site at the Eden Project in St Austell is modelled to come online under the three net zero scenarios. Several further sites have secured a connection offer, but are currently in earlier stages of development.	**Number of sites**	**Total capacity (MW)**
	6	35

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Under Construction	The 4 MW United Downs site is expected to begin commissioning in mid-2024. This is included under all four scenarios.	1	4
Planning Permission Granted	A 5 MWe site at the Eden Project in Cornwall has planning permission and is looking to secure investment to progress this second phase. The project is modelled to come online between 2025 and 2027 under the three net zero scenarios and does not go ahead under **Falling Short**. Two further sites, developed by Geothermal Engineering Ltd, achieved planning permission in late 2023 and early 2024 respectively, and each won a Contract for Difference in September 2023. These are modelled to come online between 2026 and 2028 under the three net zero scenarios.	3	18
Planning Application Submitted	Two further Geothermal Engineering Ltd sites are in the planning application process. One of these sites is facing considerable opposition in the planning process and is, therefore, only modelled to go ahead under two scenarios, **Consumer Transformation** and **Leading the Way**, in the late 2020s. The other site is facing less opposition and is modelled to connect under the three net zero scenarios in the late 2020s.	2	13

Medium and long-term projections (April 2028 to March 2050)
Beyond the current pipeline, developer engagement has suggested a further ten sites, each with an electrical capacity of around 5 MW, could be developed in Cornwall. In addition, oil and gas company Angus Energy is aiming to develop up to 60 MWe of geothermal power capacity on the eastern edge of Dartmoor in the late 2020s[xvi]. In the long term, deployment of geothermal heat and power capacity will depend on a viable business model, for example through private wire agreements with neighbouring industrial heat and

power off-takers, ringfenced CfD funding for geothermal or the ability for geothermal power producers to obtain revenue from participating in markets such as the Capacity Market. Lithium extraction from geothermal brines could also provide an additional revenue stream for geothermal heat and power producers in the South West[xvii].

The high level of uncertainty around these policy and business case considerations, alongside the need to secure planning permission and mineral rights at each site, results in a wide range of scenario outcomes for geothermal power out to 2050.

Scenario	Description	Capacity by 2050 (MW)
Leading the Way	All ten sites identified from developer engagement are modelled to come online between 2029 and 2047. In addition, the prospective Angus Energy site goes ahead in the late 2020s with a capacity of 20 MW.	105
Consumer Transformation	Six further 5 MW sites are developed across the 2030s and 2040s, continuing development seen in the 2020s, driven by demand for heat for use by complementary industrial processes.	65
System Transformation	A further 5 MW is deployed in the 2040s, following the delayed rollout of the pipeline sites. With a full hydrogen network available for heat, the CHP element of geothermal energy is less valuable under this scenario.	34
Falling Short	No further geothermal capacity is developed under this scenario.	4

Reconciliation with National Grid FES 2023

- There is no distribution-connected geothermal capacity in the FES 2023 in the South West licence area despite the high levels of project development underway in the region.
- The DFES projections have been modelled based on known projects and direct engagement with geothermal power developers.

Factors that will affect deployment at a local level

Factor	Source
Sites already in the NGED connections pipeline or identified through developer engagement.	NGED, developer engagement
The location of future geothermal sites is based on subsurface heat flows, with prospective geology around Penzance and Redruth.	British Geological Survey

Biomass in the South West licence area

Biomass-fuelled power generation, including standalone and CHP generation

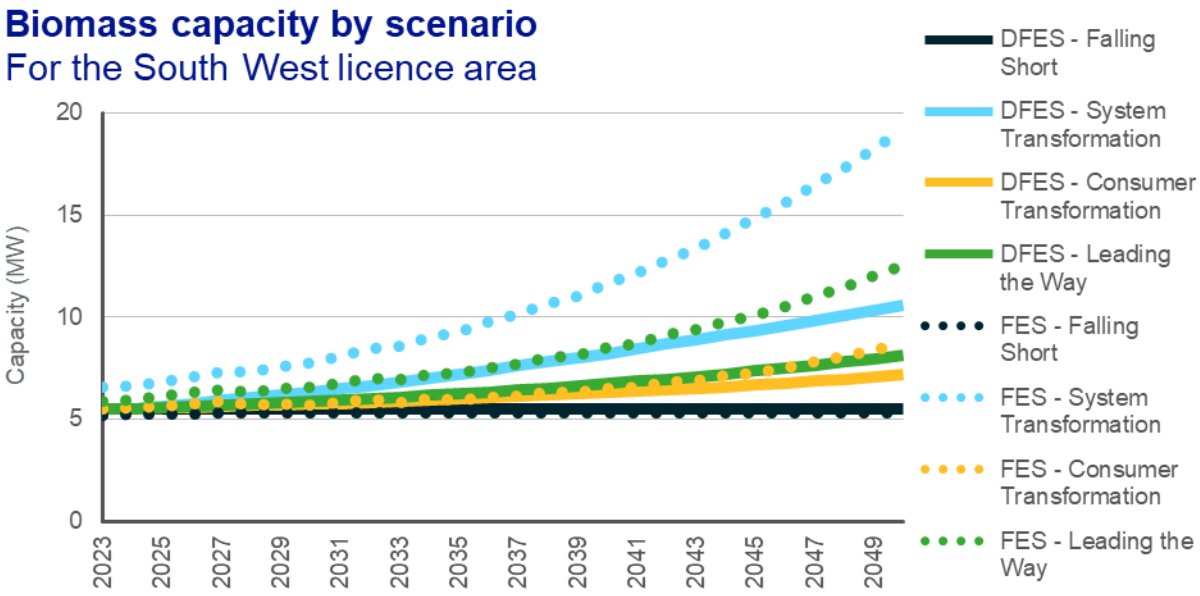
Data summary for biomass power in the South West licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	6	6	6	6
System Transformation		6	7	11
Consumer Transformation		6	6	7
Leading the Way		6	6	8

Summary:

- Biomass power generation in the South West consists entirely of small-scale sites of under 5 MWe. This includes sites providing combined heat and power at a china clay extraction and processing site, a business park and a supermarket distribution centre.
- Small-scale biomass CHP sees growth in all three net zero scenarios as a means of decarbonising local heat and industrial energy, particularly under **System Transformation**, due to there being less focus on electrification of heat and industry in this scenario.
- Under **Falling Short**, biomass capacity remains stable as progress to decarbonise heat and industrial energy demand is limited.

Figure 21 – Electrical capacity of biomass by scenario, South West licence area



Modelling assumptions and results

Baseline			
There are six operational biomass baseline sites in the South West, which all appear to use biomass for CHP. This includes a 3 MWe Imerys kaolin clay extraction and processing site at Lee Moor and a 1.3 MWe supermarket distribution centre in Bristol.	**Scale**	**Number of sites**	**Total capacity (MW)**
	Under 1 MW	4	1.2
	1-5 MW	2	4.3

Pipeline (April 2023 to March 2028)
There are no biomass pipeline sites with accepted connections in the South West licence area.

Medium and long-term projections (April 2028 to March 2050)		
The prospects for biomass CHP generation on the distribution network is dependent on the extent to which limited biomass resource is used by hard-to-decarbonise sectors under each scenario.		
Scenario	**CHP generation**	**Capacity by 2050 (MWe)**
Leading the Way	Greater electrification of heat in these two scenarios results in less demand for biomass CHP. However, there is still some deployment, particularly for heating at business parks and industrial sites – similar to the current baseline.	8
Consumer Transformation		7
System Transformation	While heat is dominated by hydrogen, biomass CHP is used in the longer term in areas not connected to the hydrogen network.	11
Falling Short	Biomass CHP sees no further growth under this scenario, as decarbonisation is slow and many sectors do not fully decarbonise.	6

Reconciliation with National Grid FES 2023

- The DFES and FES baselines are closely aligned. The FES baseline varies slightly in the 2023 year due to the FES analysis having a baseline year of 2022. This does not materially impact the reconciliation.
- The growth of biomass capacity in the South West follows similar trends in the FES and DFES scenarios, albeit to a lesser extent in the DFES. The lower projections in the DFES are due to the lack of a pipeline of projects under development in the licence area.

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 South West licence area

Electricity generation from sewage gas, landfill gas and anaerobic digestion

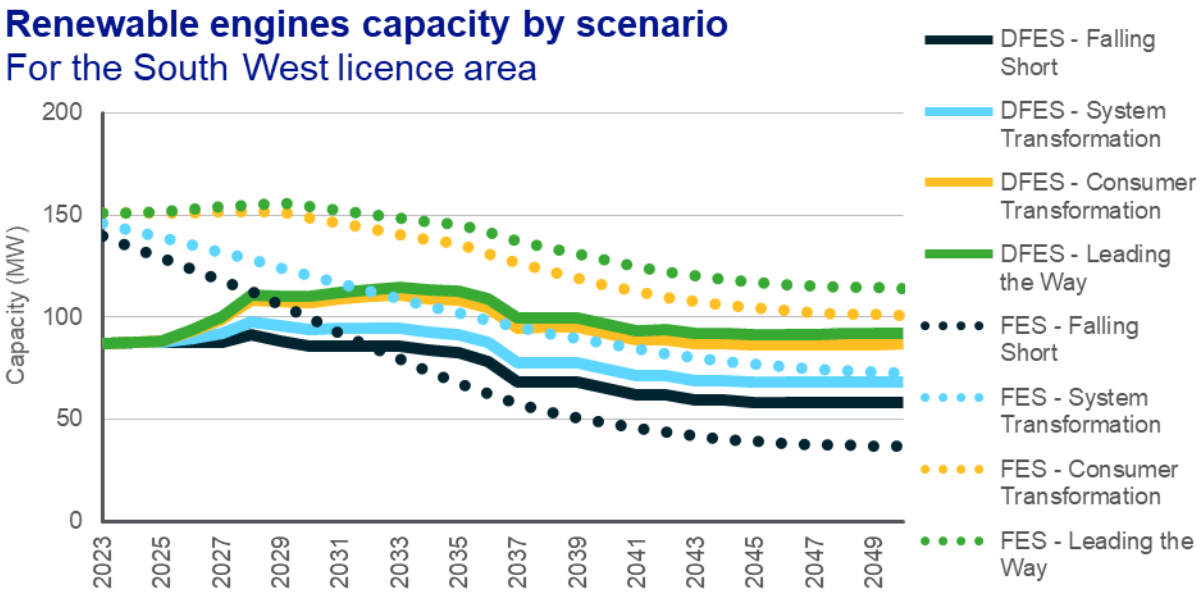
Data summary for renewable engines in the South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
Falling Short	87	91	82	58
System Transformation		98	92	68
Consumer Transformation		108	108	87
Leading the Way		111	112	92

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 around 40% of the renewable engines baseline capacity in the South West, is modelled to decommission over time in every scenario, as the UK moves towards more sustainable waste treatment and an overall reduction in waste production.
- Anaerobic digestion, accounting for around one-quarter of the baseline, 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-third 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 22 – Electrical capacity of renewable engines by scenario, South West 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. Three-quarters of this capacity is located in Devon.

The landfill gas baseline consists of sites near urban areas such as Plymouth and Bristol. These sites are typically 1-5 MW in scale and all connected from 1996 to 2014.

The sewage gas baseline consists of generation at Wessex Water and South West Water treatment works. The vast majority of these sites connected in the 1990s and 2000s, with only two new sites connecting since 2008.

Type	Number of sites	Total capacity (MW)
Anaerobic digestion	26	20
Sewage gas	20	35
Landfill gas	15	32

Pipeline (April 2023 to March 2028)

There are just five projects in the pipeline, totalling 7.5 MW.

The largest of these sites, a 4 MW Wessex Water sewage gas site in Bristol, is currently in planning and expected to take five years to construct. This goes ahead in 2028 in all scenarios.

Two further sites, a 1.6 MW landfill gas site and a 0.8 MW anaerobic digestor, have had their planning applications refused and expired respectively, and do not go ahead in any scenario.

A 0.5 MW anaerobic digestor in Mid Devon is currently under construction and projected to connect in late 2024 in all four scenarios.

The final pipeline site, a 0.6 MW anaerobic digestor in Somerset, is already operational but as a gas-to-grid site. This is projected to switch to providing electricity under **Consumer Transformation** and **Leading the Way** in the mid-2020s, as these scenarios feature a reduced role of the gas network in the coming years.

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

Type of site	Scenario outcomes
Anaerobic digestion	The South West has high potential for anaerobic digestion deployment due to the amount of farmland in 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 baseline is almost double the DFES baseline. The reason for this is unclear, as the previous year's FES baseline was closely aligned with the DFES.
- The scenario trends and 2050 outcomes are similar between the FES and DFES. In the near term, the DFES features more growth in capacity due to the pipeline of projects combined with potential for anaerobic digestion deployment in the region.
- The DFES projection for **Falling Short** does not reduce as far as in the FES projection. This is due to reductions in capacity being driven by landfill gas in the DFES modelling, which represents less than half of the overall renewable engines baseline in the South West.

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 land, animal slurry and local authority food waste collection	Regen local authority engagement, Natural England, DEFRA

Diesel generation in the South West licence area

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

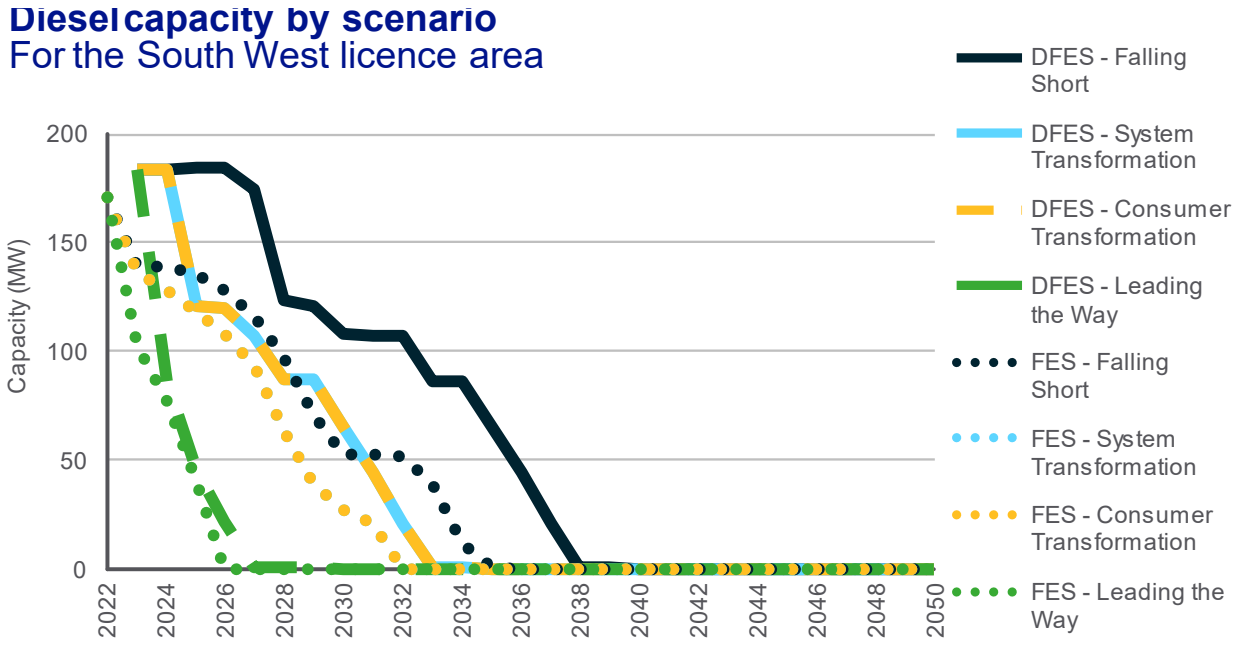
Data summary for diesel generation uptake in the South West licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	197	122	33	0
System Transformation		62	0	0
Consumer Transformation		62	0	0
Leading the Way		9	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 South West licence area, with no new diesel generators looking to connect to the network. 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 capacity over 5 MWth (c. 2 MWe) to adhere to stringent air quality limits 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 23 – Installed capacity of diesel generation by scenario, South West licence area



Modelling assumptions and results

Baseline

The 201 MW of 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). One 15 MW site was re-classified from diesel to gas following this year's DFES asset owner/operator engagement process.

Type	Number of sites	Total capacity (MW)
Backup	25	165
Commercial	7	32

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 that their decarbonisation strategy for back-up power involved using HVO in the short term.

In some circumstances, substituting diesel with biofuels for power generation can reduce CO2 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	Commercial sources of flexible generation are assumed to move to lower carbon alternatives, such as electricity storage. 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
Consumer Transformation		

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 (totalling 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

- There is considerable variation between the DFES 2023 and FES 2023 baseline. The FES baseline has reduced from c. 150 MW to under 100 MW. The reason for this is unclear.
- 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 South West licence area

Fossil gas-fired power generation exporting 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 South West licence area:

Capacity (MWe)		Baseline	2028	2035	2050
OCGT (non-CHP)	Falling Short	129	129	129	6
	System Transformation		6	6	0
	Consumer Transformation		6	6	0
	Leading the Way		6	0	0
Reciprocating engines (non-CHP)	Falling Short	100	231	231	194
	System Transformation		179	172	0
	Consumer Transformation		179	172	0
	Leading the Way		81	0	0
Gas CHP	Falling Short	190	190	190	148
	System Transformation		137	126	0
	Consumer Transformation		137	126	0
	Leading the Way		134	0	0

Summary:

- There is a moderate baseline (c. 420 MW) of existing operational fossil gas-fired generation connected to the distribution network in the South West licence area.
- There are 12 sites with accepted connection offers with NGED in the licence area, all reciprocating engines totalling 159 MW.
- The primary role of distribution-scale fossil gas-fired generation is to provide flexibility and back-up 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 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 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 24 – Electrical capacity of OCGTs by scenario, South West licence area

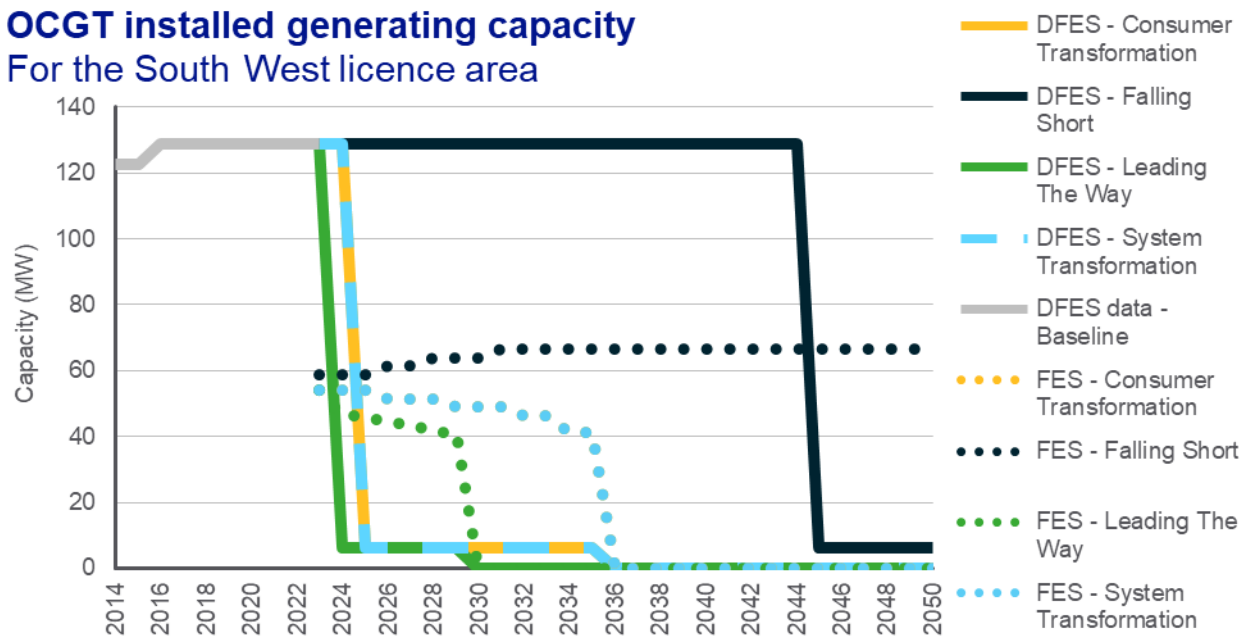


Figure 25 – Electrical capacity of fossil gas reciprocating engines by scenario, South West licence area

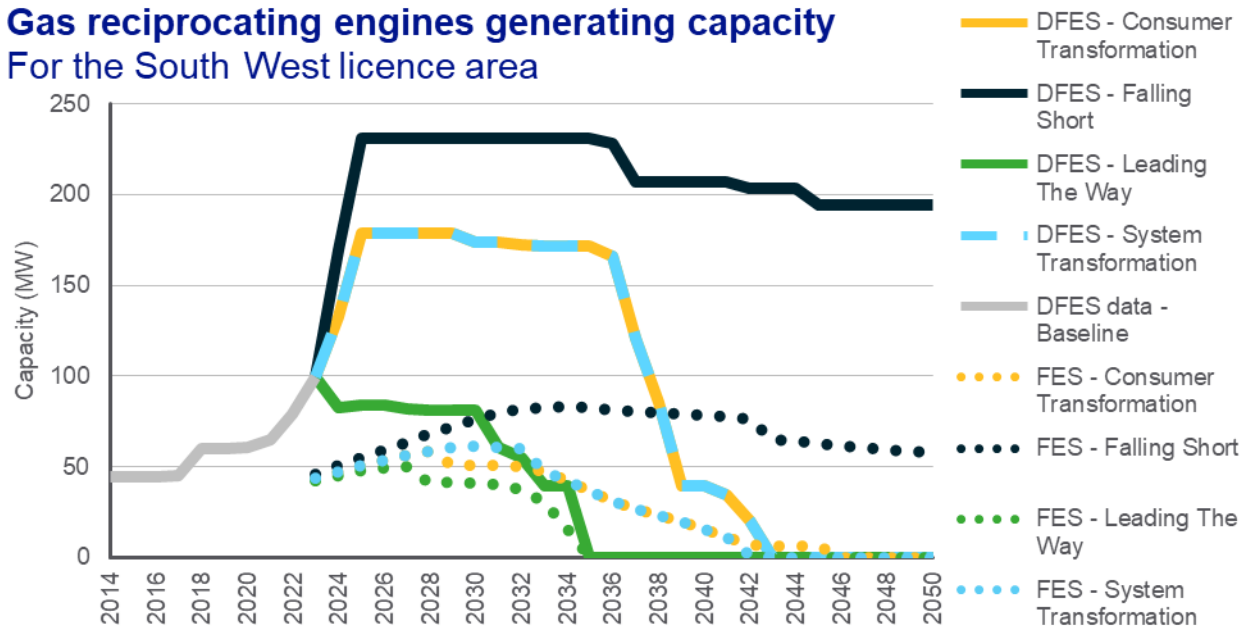
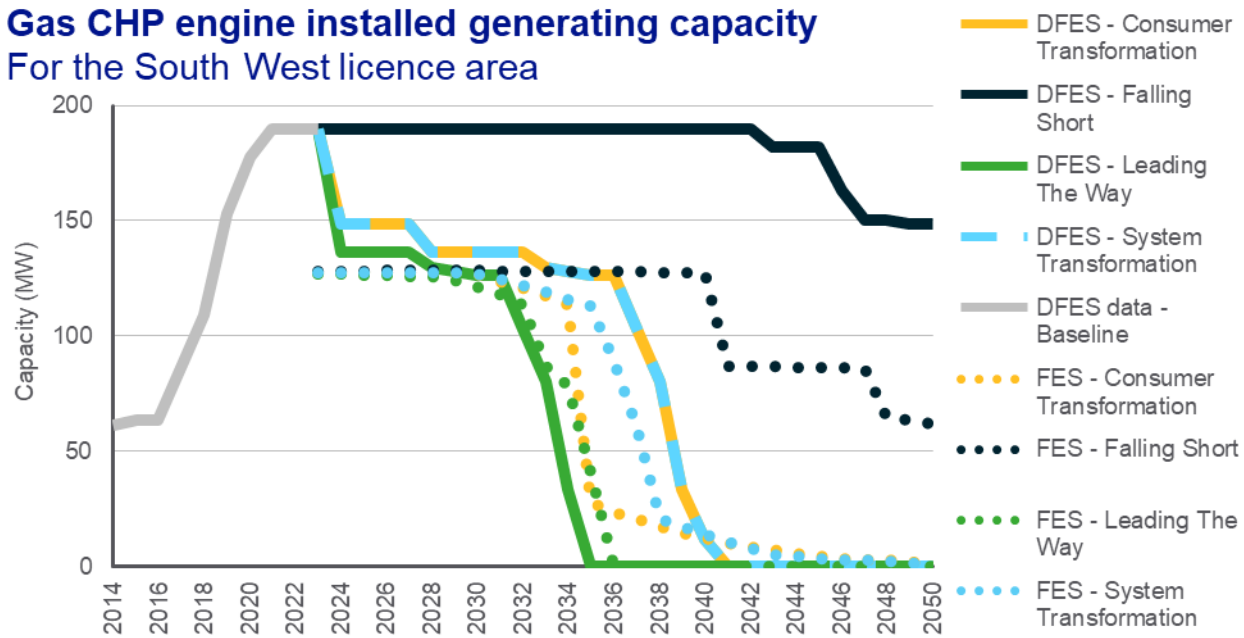


Figure 26 – Electrical capacity of fossil gas CHPs by scenario, South West licence area



Modelling assumptions and results

Baseline			
There are 64 fossil-gas generation sites connected in the South West licence area, totalling 422 MW. This is broken down into the following fossil gas technologies.	**Type**	**Number of sites**	**Total capacity (MW)**
	OCGT	3	129
	Reciprocating engines	19	100
	Gas CHP	41	190

Pipeline (April 2023 to March 2028)			
There are 12 fossil-gas generation sites with an accepted connection offer in the South West licence area, totalling 159 MW. These are all reciprocating engines: • The largest is a 25 MW plant in Torbay, Devon. • Nine of the twelve sites are located near Bristol (in South Gloucestershire and North Somerset), with capacities ranging from 5 MW to 20 MW. Of these, four are larger 20 MW sites. • The smallest site is a 4.5 MW plant at Langage near Plymouth	**Type**	**Number of sites**	**Total capacity (MW)**
	Reciprocating engines	12	159

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Planning Permission Granted	There are six sites, totalling 83 MW, with an accepted connection offer from NGED that have also received planning permission. These include:	6	83

	• A 25 MW site in Torbay, Devon • A 20 MW site in Bristol • A 20 MW site that has secured a Capacity Market agreement in North Somerset • A 7.2 MW site that has secured a Capacity Market agreement in Somerset • A 6 MW site that has secured a Capacity Market agreement in East Devon • A 4.25 MW site near Plymouth, Devon		
No information	There are six sites, totalling 76 MW, with an accepted connection offer from NGED that have no evidence of progress through the planning system.	6	76

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.

Subtechnology	Scenario	Description	Decommissioning timescale
OCGT (non-CHP)	**Leading the Way**	All OCGT capacity is modelled to decommission in the three net zero scenarios.	2024 – 2030
	Consumer Transformation		2025 – 2036
	System Transformation		2025 - 2036
	Falling Short	OCGT capacity is modelled to remain operational with extended asset lifetimes. This reflects gas turbine technology providing system flexibility alongside more responsive gas engine technologies and overall less action on decarbonisation.	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.	2024 - 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.	2024 - 2042
	System Transformation		2024 - 2042
	Falling Short	Notable additional reciprocating engine capacity continues to connect to the distribution network in the medium term, reflecting this rapid-response	2036 – post-2050

		technology continuing to win flexibility and reserve ancillary service contracts. After peaking, some capacity is modelled to decommission, reflecting the transition away from fossil-fuel-driven flexibility.	
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 - 2042
	System Transformation		2024 - 2042
	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.	2048 – post-2050

Reconciliation with National Grid FES 2023

- For all of the 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 caused some potential variances between the FES and the DFES in the 2023 baseline and in the near-to-medium-term projections:
    - The DFES projections for OCGT capacity in the long-term assume 45-year lifetimes for these assets, so decommissioning in some cases begins before 2050 under **Falling Short**.
    - OCGT: The DFES baseline is significantly higher than the FES for OCGT installed capacity. The decommissioning timelines are later in all scenarios in the FES compared to the DFES.
    - Reciprocating engines: The DFES baseline is significantly higher than the FES for reciprocating engines. Other than in **Leading the Way**, both FES and DFES projections involve increases in installed capacity. The rate of growth is much faster in the DFES than in the FES.
    - Gas CHP: The DFES baseline is slightly higher than the FES. In the near term, under the net zero aligned scenarios, the DFES projects immediate decommissioning of around a quarter of the installed capacity, bringing the projections into line with the FES. In the long term, the decommissioning timescales are similar in both sets of projections.

Factors that will affect deployment at a local level

Factor	Source
The location of the known pipeline sites	National Grid
Proximity to electricity network and gas network infrastructure	Regen analysis

Hydrogen-fuelled generation in the South West 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.

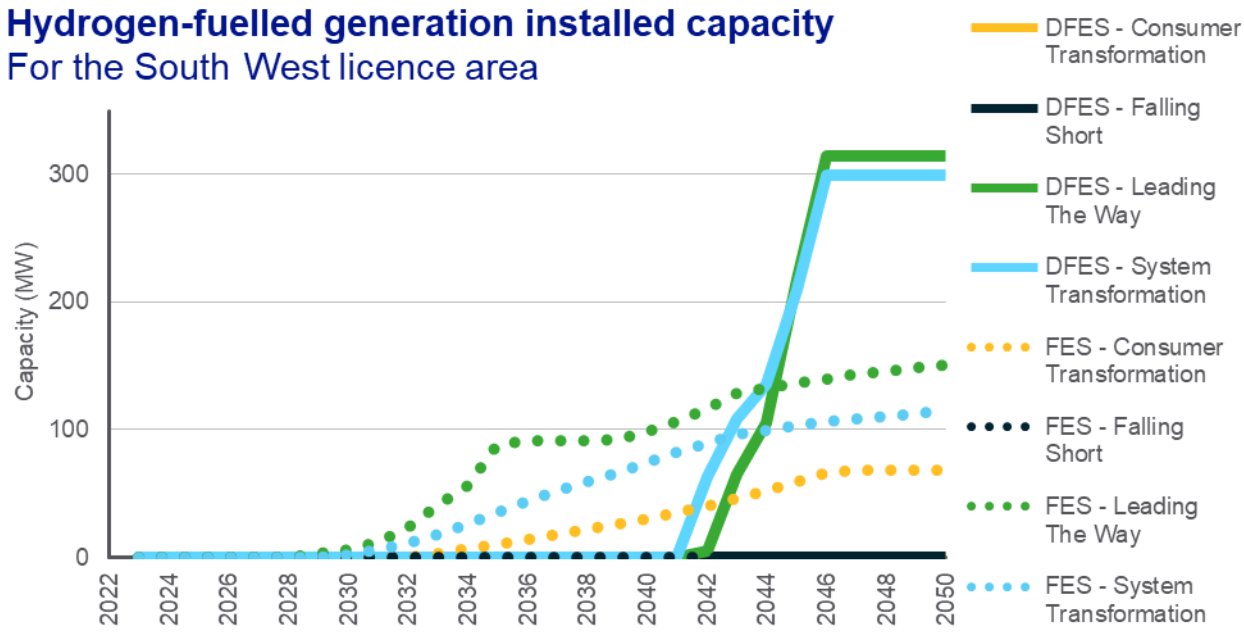
Data summary for hydrogen-fuelled generation in the South West licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	0	0	0	0
System Transformation		0	0	311
Consumer Transformation		0	0	0
Leading the Way		0	0	325

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' analysis with National Grid ESO has 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.
- 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 South West does not feature on National Gas' plan for a core hydrogen network due to the relatively small industrial base. The South West also has no plans for major industrial cluster zones. As such, there will be few opportunities for hydrogen-fuelled generation in the region.
- 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 27 – Electrical capacity of hydrogen-fuelled generation by scenario, South West 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 South West 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)

The South West licence area is unlikely to see strong uptake of hydrogen-fuelled generation in the medium term as the region does not feature on National Gas' plan for a core hydrogen network and the region has no plans for major industrial cluster zones requiring hydrogen. As such, there will be relatively few opportunities for hydrogen-fuelled generation in the region until long-term plans for nationwide hydrogen networks materialise.

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:	311

	• 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	
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. As the South West does not feature on the plans for a core hydrogen network, hydrogen-fuelled generation is deemed unfeasible in this scenario in this licence area.	0
Leading the Way	This scenario sees moderate to high levels of policy support for hydrogen and a national hydrogen transportation network is developed. 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	325

Reconciliation with National Grid FES 2023

- Neither FES nor DFES project any conversion to hydrogen under **Falling Short**.
- In the DFES, there is no conversion to hydrogen in **Consumer Transformation** as the South West does not feature on the plans for a core hydrogen network, so hydrogen-fuelled generation is deemed unfeasible.
- In both **Leading the Way** and **System Transformation**, conversion begins from 2040 in the DFES at sites nearest to the planned core hydrogen network (much later than projected in the FES). Hydrogen-fuelled generation capacity is higher initially under **System Transformation** because the installed capacity of fossil gas sites available for conversion to hydrogen is higher than in **Leading the Way**. In the long-term, in these scenarios, the DFES projections are higher than the FES but at a similar level to existing gas-fired generation capacity today. The South West has the lowest projected hydrogen-fuelled capacity of all NGED licence areas.

Factors that will affect deployment at a local level

Factor	Source
Location of existing and known commercial gas sites in the South West 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 South West licence area

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

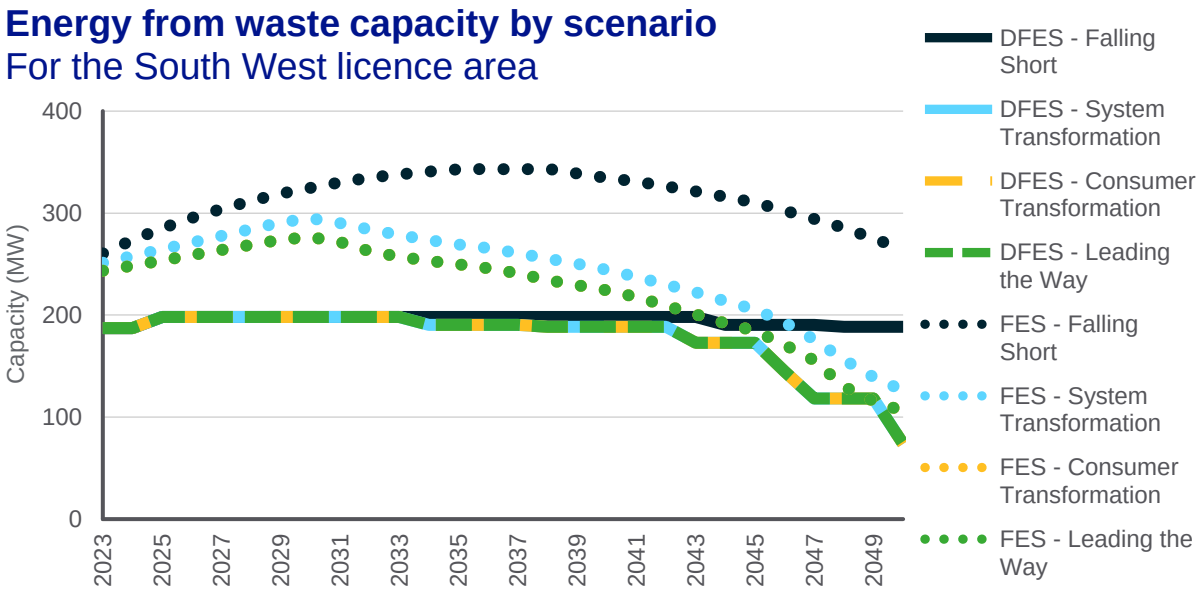
Data summary for energy from waste in the South West licence area:

Capacity (MWe)	Baseline	2028	2035	2050
Falling Short	187	198	198	188
System Transformation		198	190	74
Consumer Transformation		198	190	74
Leading the Way		198	190	74

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 187 MW baseline of projects currently operating in the South West, alongside a pipeline of two projects holding connection offers, totalling 21 MW.
- 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 28 – Energy from waste capacity by scenario, South West licence area



Modelling assumptions and results

Baseline			
The baseline of energy from waste capacity in the South West ranges from fairly old sites built in the early 2000s to newer sites commissioned in 2021. The largest site, the 48 MW Severnside Energy Recovery Centre, is an incineration site that qualifies as an Energy Recovery Facility due to its high levels of energy efficiency.	**Type**	**Number of sites**	**Total capacity (MW)**
	Incineration	8	134
	ACT	1	53

Pipeline (April 2023 to March 2028)		
There are just two waste incineration sites in the licence area with accepted connection offers with NGED, one of which has been abandoned since obtaining planning permission in 2012. The other site, an 11 MW waste incinerator in East Devon, was granted planning permission in 2019 and an environmental permit in 2021. This site is therefore modelled to go ahead in late 2024 under all four scenarios.	**Number of sites**	**Total capacity (MW)**
	2	21

Medium and long-term projections (April 2028 to March 2050)		
Beyond the project pipeline, the projections of future energy from waste capacity are 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 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.	74
Consumer Transformation		74
System Transformation		74
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 at least forty years after their commissioning date.	188

Reconciliation with National Grid FES 2023

- The DFES and FES baselines broadly align; the FES baseline is around 70 MW higher.
- The growth in energy from waste capacity seen in the FES scenarios across the 2020s is not reflected in the DFES due to the minimal pipeline capacity and development evidence seen.
- In the longer term, the DFES and FES projections broadly align.

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 South West 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 South West licence area:

Capacity (MW)	Baseline	2028	2035	2050
All scenarios	2	4	4	4

Summary:

- There are eight connected sites in the licence area that have not been categorised as a particular technology, totalling 1.6 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 36 additional other generation sites with an accepted connection offer, totalling 2.0 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

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[xviii].

The Holtec-160 SMR, a 160 MW design, was set to enter the Generic Design Assessment process as of late 2022[xix]. At this scale, a connection to NGED's distribution network (likely at the 132kV 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 South West 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 South West licence area:

Capacity (MW)		Baseline	2028	2035	2050
Standalone network services	Falling Short	158	393	465	585
	System Transformation		535	585	585
	Consumer Transformation		585	1,020	1,020
	Leading the Way		615	1,065	1,065
	Storage Planning		615	3,813	3,813
Generation co-location	Falling Short	4	91	176	176
	System Transformation		171	291	291
	Consumer Transformation		176	292	292
	Leading the Way		444	773	773
	Storage Planning		444	773	773
Behind-the-meter high-energy user	Falling Short	2	6	22	46
	System Transformation		6	31	105
	Consumer Transformation		9	51	149
	Leading the Way		15	51	149
	Storage Planning		3	3	3
Domestic-scale batteries	Falling Short	9	16	25	138
	System Transformation		31	61	232
	Consumer Transformation		62	201	701
	Leading the Way		76	262	909

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,[1] 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 battery storage sector has grown rapidly since the first commercial-scale projects were launched in 2016, as production costs have dropped.
- The South West licence area currently has 57 operational large-scale battery storage sites, totalling 165 MW and a vast 4.8 GW pipeline.
- 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, over 700 MW of the storage pipeline has either received or submitted planning permission. A further 400 MW 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 South West licence area has a potential for long-term growth in connected storage capacity, though this is limited compared to other NGED licence areas. Factors that affect deployment of storage in the South West include:
    - Notable 33 kV and 132 kV network infrastructure across the licence area
    - High potential for both solar and wind deployment, which may be co-located with storage
    - A large number of non-domestic properties with the potential for behind-the-meter batteries
    - Significant potential for domestic rooftop solar, which is now commonly installed alongside a domestic battery. The South West has the highest number of residential properties out of NGED's four licence areas.

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

Figure 29 – Electrical capacity of large-scale battery storage by scenario (including the Storage Planning scenario), South West licence area

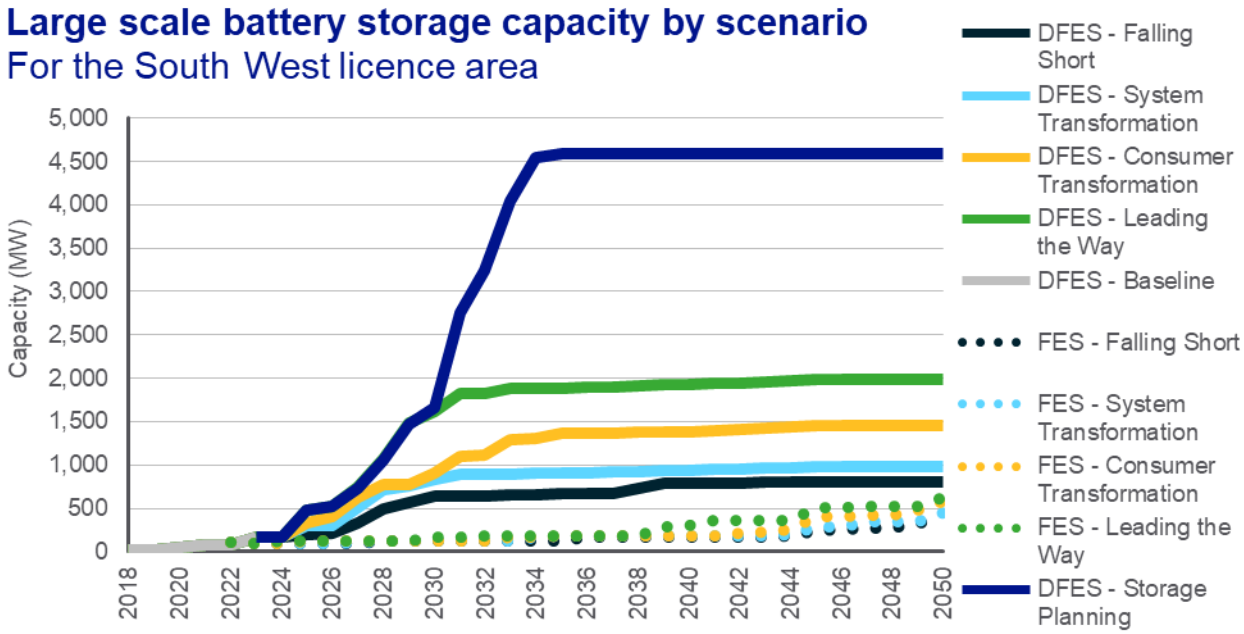
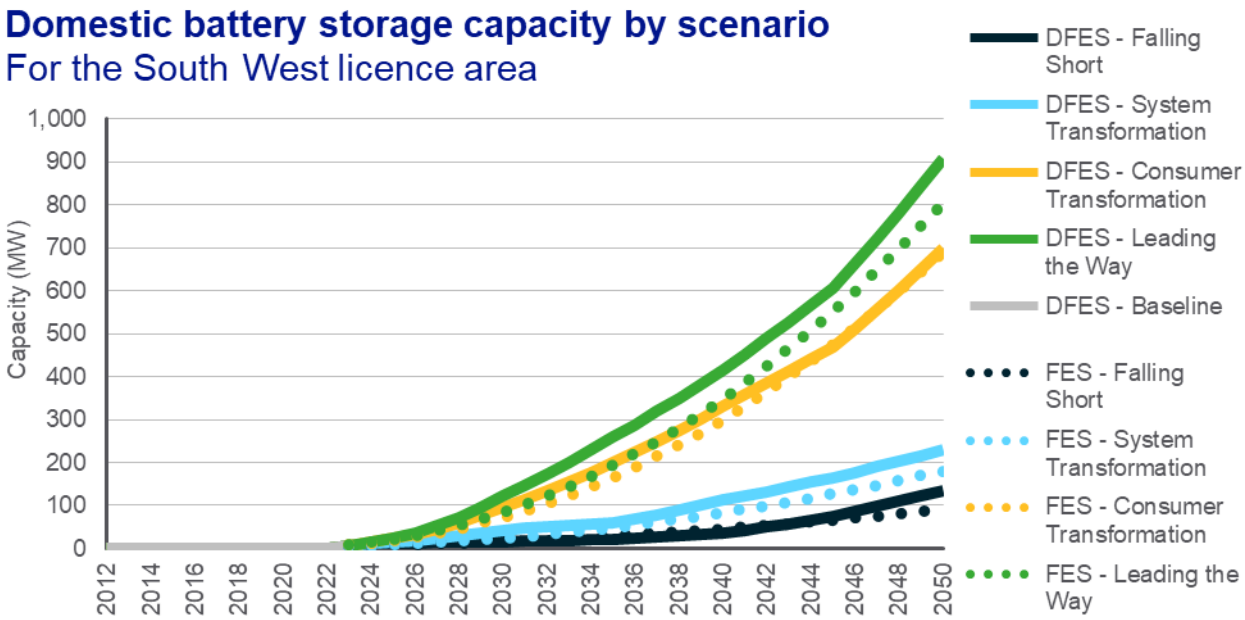


Figure 30 – Electrical capacity of domestic-scale battery storage by scenario, South West licence area



Baseline

There are 57 large-scale battery storage projects totalling 165 MW. This capacity is mostly made up of standalone batteries providing network services, with a small contribution from co-location projects.

There are also almost 1,800 domestic batteries in the South West licence area, totalling 9 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	7	158
Generation co-location	5	4
Behind-the-meter high-energy user	45	2
Domestic-scale batteries	c. 1,800	9

Pipeline (April 2023 to March 2028)

The pipeline of storage projects has surged across the country in the last couple of years. The South West licence area has a vast pipeline of 133 large-scale projects totalling 4.82 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 in 2023, 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.

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.

Type	Number of sites	Total capacity (MW)
Standalone network services	85	3,655
Generation co-location	37	1,165
Behind-the-meter high-energy user	11	0.5

Pipeline analysis			
Status	**Scenario outcomes**	**Number of sites**	**Total capacity (MW)**
Planning Permission Granted	In the South West licence area, 17 projects in the pipeline have been granted planning permission, totalling 401 MW of capacity. Of these, three projects totalling 50 MW have won Capacity Market (CM) contracts. Sites with planning permission are modelled to connect to the network in all scenarios. Where projects hold a CM contract they are modelled to connect in the relevant delivery year.	17	401
Planning Application Submitted	In the South West licence area, four projects have submitted a planning application and are waiting for approval, totalling 308 MW of capacity. Sites with a planning application submitted are modelled to connect to the network in **Leading the Way** and **Consumer Transformation**, but only in **System Transformation** if they prequalified or won a CM contract and in **Falling Short** if they have been awarded a CM contract.	4	308
Pre-planning	Nine projects have evidence of pre-planning progress, such as Environmental Impact Assessment screening, totalling 395 MW of capacity. Sites with pre-planning evidence are modelled to connect to the network in **Leading the Way** and **Consumer Transformation**, but only in **System Transformation** if they prequalified or won a CM contract and in **Falling Short** if they have been awarded a CM contract.	9	395
No information	The majority of sites in the pipeline do not have evidence of project development beyond an accepted grid connection offer. In the South West licence area, 3.7 GW of capacity has no Capacity Market contracts or planning information. In the three net zero compliant scenarios, projects that have no planning evidence are not modelled to connect if they have prequalified or won a CM contract. In **Falling Short**, they are only modelled to connect if they have been awarded a CM contract.	142	3,692

Medium and long-term (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**	465	585
		System Transformation	585	585
		Consumer Transformation	1,020	1,020
		Leading the Way	1,065	1,065
		Storage Planning	3,813	3,813
Generation co-location	Generation co-location capacity sees strong deployment in the South West licence area. This is in part due to the significant pipeline of co-located storage projects. The South West also has relatively high projections of ground-mounted solar PV and onshore wind capacity by 2035 when compared to other licence areas.	**Falling Short**	176	176
		System Transformation	291	291
		Consumer Transformation	292	292
		Leading the Way	773	773
		Storage Planning	773	773
Behind-the-meter high-energy user	The South West licence area has a significant number of non-domestic properties with the potential for a battery across NGED's network, so the uptake of behind-the-meter storage projects is relatively strong across all scenarios by 2035. 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.	**Falling Short**	22	46
		System Transformation	31	105
		Consumer Transformation	51	149
		Leading the Way	51	149
		Storage Planning	3	3
Domestic-scale batteries	The South West has significant 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**	25	138
		System Transformation	61	232
		Consumer Transformation	201	701
		Leading the Way	262	909

Reconciliation with National Grid FES 2023

- Large-scale battery storage:
    - The DFES and the FES are not aligned on the baseline of existing battery capacity in the South West. The FES 2023 projected a reduction in capacity from 2022 to 2023 (from 115 MW to 97 MW). The DFES has found 165 MW of operational battery capacity.
    - 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
Location of existing and known pipeline sites in the South West licence area.	National Grid
Standalone network services: Developable land proximate to the 33 kV and 132 kV electricity network. For 2023, this has been determined by the location of the significant number of sites with accepted connection offers across the licence area.	Regen analysis
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 development data
Domestic-scale batteries: Domestic dwellings with rooftop PV.	Regen analysis

Other storage

The DFES analysis scope also includes other forms of electricity storage such as liquid air energy storage, compressed air energy storage and pumped storage.

Pumped hydropower storage and compressed air energy storage are currently considered to be transmission-scale only. Liquid air energy storage could connect at distribution level, but stakeholder engagement with Highview Power suggested that developments are likely to be located outside of NGED's licence areas.

High-density pumped storage, currently being developed by RheEnergise, does have potential to locate within the NGED licence areas, especially in areas with higher elevation such as South Wales. There is a 0.5 MW pipeline site located at the Hemerdon mine near Plymouth, with plans to demonstrate the technology.

This pipeline site is projected to connect imminently under all four scenarios. Projections for high-density pumped storage have not been made under any of the four scenarios due to the nascent nature of the technology and uncertainty around its level of future deployment.

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] 2018-based household projections by local authority
[x] Council Climate Plan Scorecards 2022
[xi] Power Technology- Number of UK homes, 2023
[xii] Building Regulation (Part L)
[xiii] RWE completes German wind farm repowering, 2022
[xiv] British Hydropower Association - Environment Agency charges press release, 2022
[xv] Netham Weir hydropower project, Bristol Energy Cooperative, 2022
[xvi] Geothermal Energy – Angus Energy, 2023
[xvii] Lithium in Geothermal, Water, Cornish Lithium, 2023
[xviii] Rolls-Royce SMR design moves to next stage of regulatory assessment, 2023
[xix] Holtec Britain applies to join UK government process for Generic Design Assessment, 2022

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