Distribution Future Energy Scenarios 2022

Results and assumptions report

South West licence area

Electricity Distribution

nationalgrid

Electricity Distribution

Foreword by National Grid DSO

Throughout the next RIIO-ED2 price control period, strategic planning and investment in the distribution network will be an important factor to enable our customers to reach their decarbonisation targets.

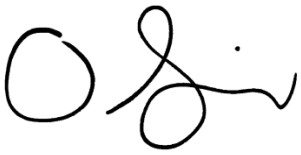
We have worked with Regen to help us understand what the changes that are forecast throughout the next decade and beyond might mean for our distribution network and the investment that may be needed to meet customers' changing needs. These forecasts are the foundation of our strategic investment process, which is an ongoing analysis published biennially through the Network Development Plan (NDP). The NDP then 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.

This report summarises the 2022 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.

Our annual DFES cycle allows incorporation of newly developed and projected technologies to the analysis. In DFES 2022, we have further developed the assumptions behind the storage pipeline and electrified heating technology demand profiles, as well as starting routine engagement with Major Energy Users to better capture future changes in demand. As local authorities develop Local Area Energy Plans (LAEPs), we are ensuring that these 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	GSHP	Ground Source Heat Pump
AD	Anaerobic Digestion	HGV	Heavy Goods Vehicle
AONB	Area of Outstanding Natural Beauty	GSP	Grid Supply Point
ASHP	Air Source Heat Pump	GW	Gigawatt
BECCS	Bioenergy with Carbon Capture, Utilisation and Storage	HNDU	Heat Network Delivery Unit
BEIS	Department for Business, Energy and Industrial Strategy	HNIP	Heat Network Investment Project
BEV	Battery Electric Vehicles	HVO	Hydrotreated Vegetable Oil
CCGT	Combined-Cycle Gas Turbine	kW	Kilowatt
CCUS	Carbon Capture, Utilisation and Storage	LA	Local Authority
CfD	Contract for Difference	LCT	Low Carbon Technology
CHP	Combined Heat and Power	LGV	Light Goods Vehicle
DFES	Distribution Future Energy Scenarios	LPG	Liquefied Petroleum Gas
DfT	Department for Transport	LV	Low Voltage
DNO	Distribution Network Operator	MCPD	Medium Combustion Plant Directive
EMR	Electricity Market Reform	MW	Megawatt
ENA	Energy Networks Association	NGED	National Grid Electricity Distribution
EPC	Energy Performance Certificate	OCGT	Open-Cycle Gas Turbine
ESA	Electricity Supply Area	PHEV	Plug-in Hybrid Electric Vehicle
ESO	Electricity System Operator	PV	(Solar) Photovoltaics
EV	Electric Vehicle	REMA	Review of Electricity Market Arrangements
FES	National Grid ESO Future Energy Scenarios	REPD	Renewable Energy Planning Database
FHS	Future Homes Standard	RHI	Renewable Heat Incentive
FiT	Feed-in Tariff	SCR	Significant Code Review
GB	Great Britain	SMR	Steam Methane Reformation
GHG	Greenhouse Gases	STOR	Short-Term Operating Reserve
GIS	Geographic Information System	UKCS	UK Continental Shelf

Introduction to the National Grid Electricity Distribution DFES 2022

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.

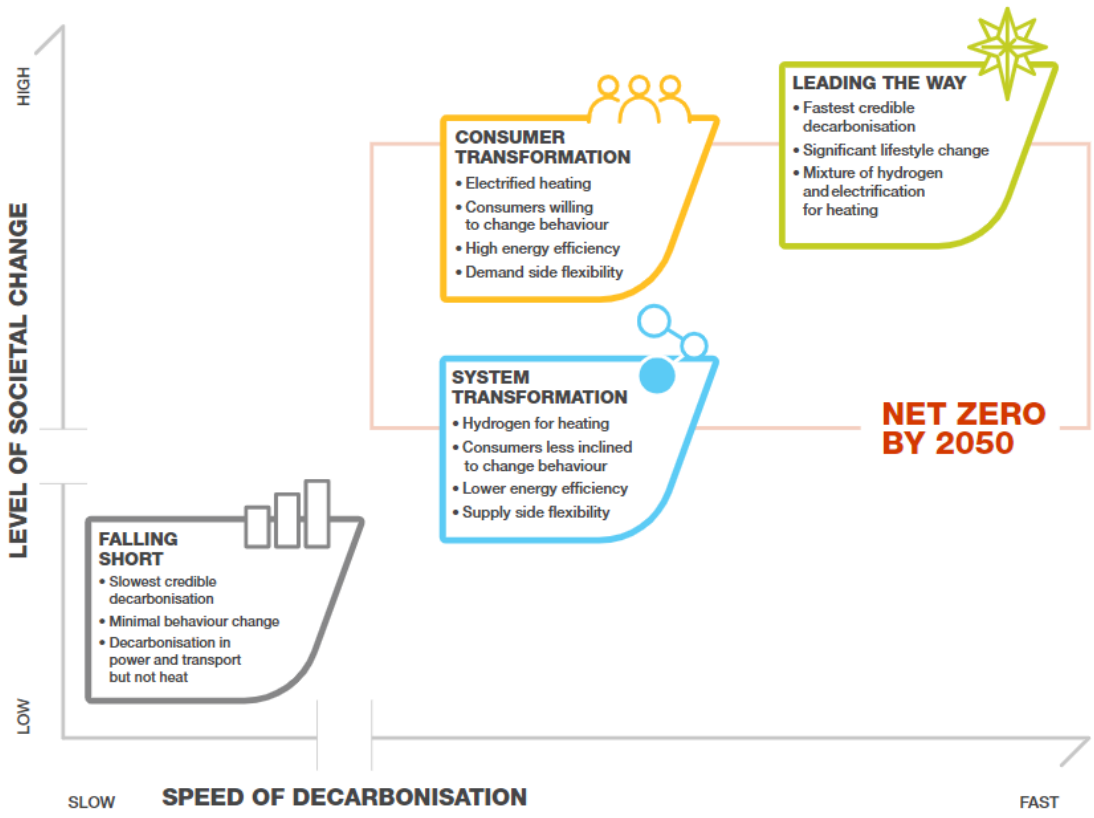
The DFES projections are directly informed by stakeholder engagement to reflect local and regional drivers, the ambitions of local authorities and national governments, and the views of other sector stakeholders, such as project developers, technology companies and community groups.

For the 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) as a framework, adopting the same national-level societal, technological, and economic assumptions as the FES 2022: **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. 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 2022 scenario framework



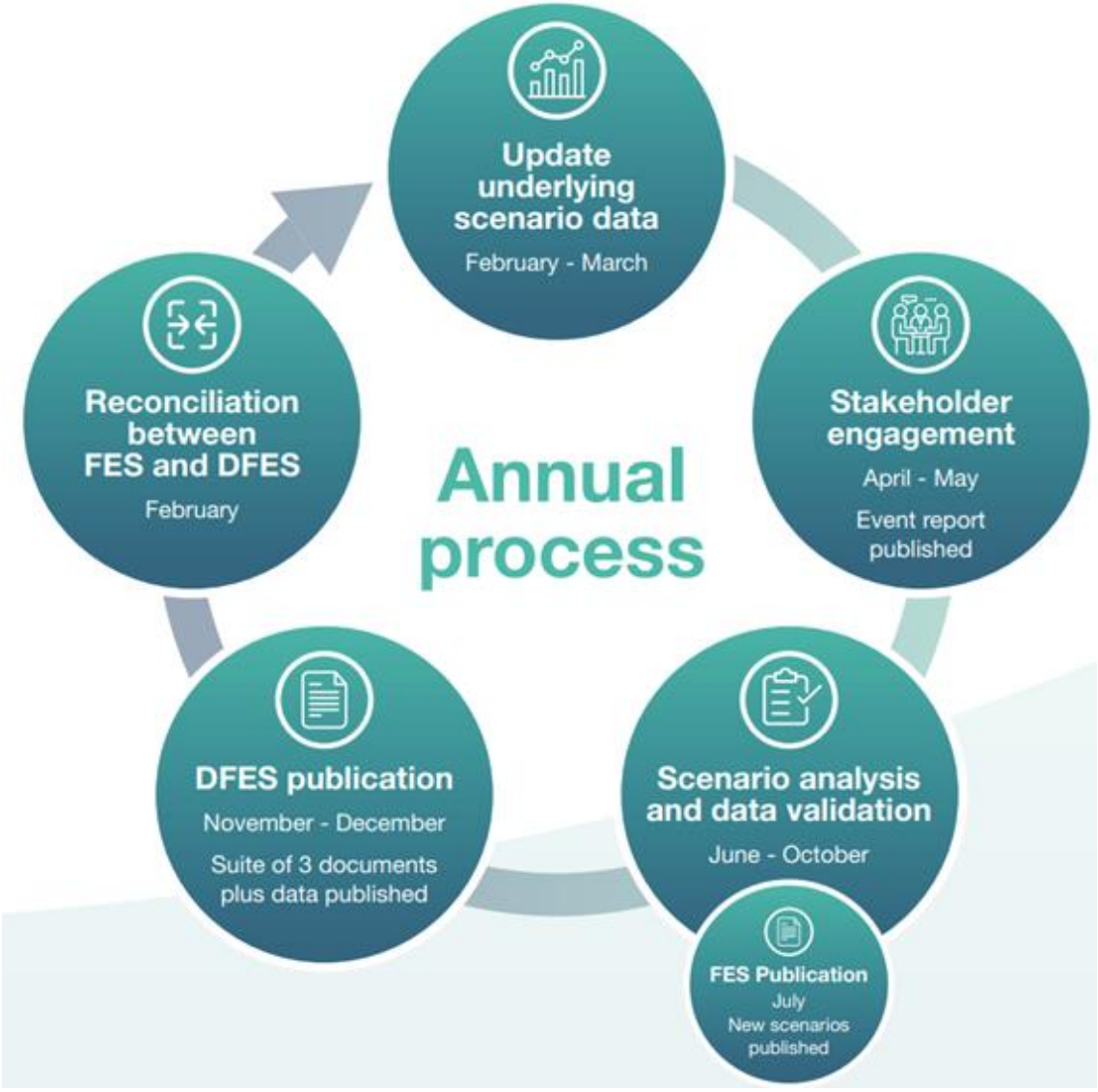
Scope

The NGED DFES 2022 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 'building blocks', developed by the ENA Open Networks project[i]. The scope does not include large-scale assets connecting directly to the National Grid transmission network, such as 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.

Figure 2 – The NGED DFES annual process



Results

The NGED DFES 2022 analysis is produced to granular geographic areas known as Electricity Supply Areas (ESAs), of which there are three 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.

These ESAs are also split by local authority boundaries, allowing DFES data to be aggregated to local authority or primary substation level.

Depending on the technology building block, the DFES provides projections of electrical power capacity (MW) and 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 network strategy and planning teams 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	Only around 1% 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 contains over 20 local authorities.

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

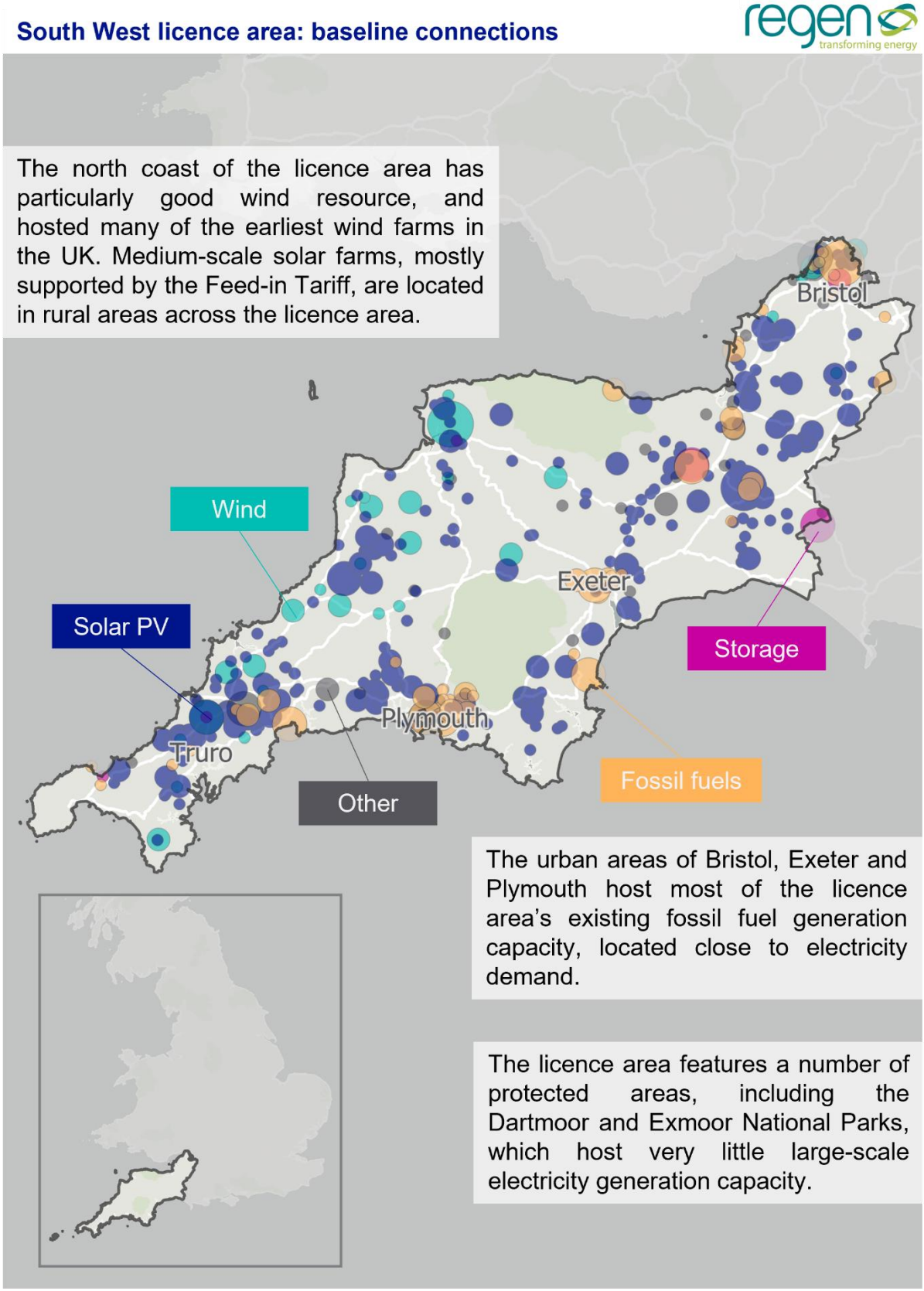
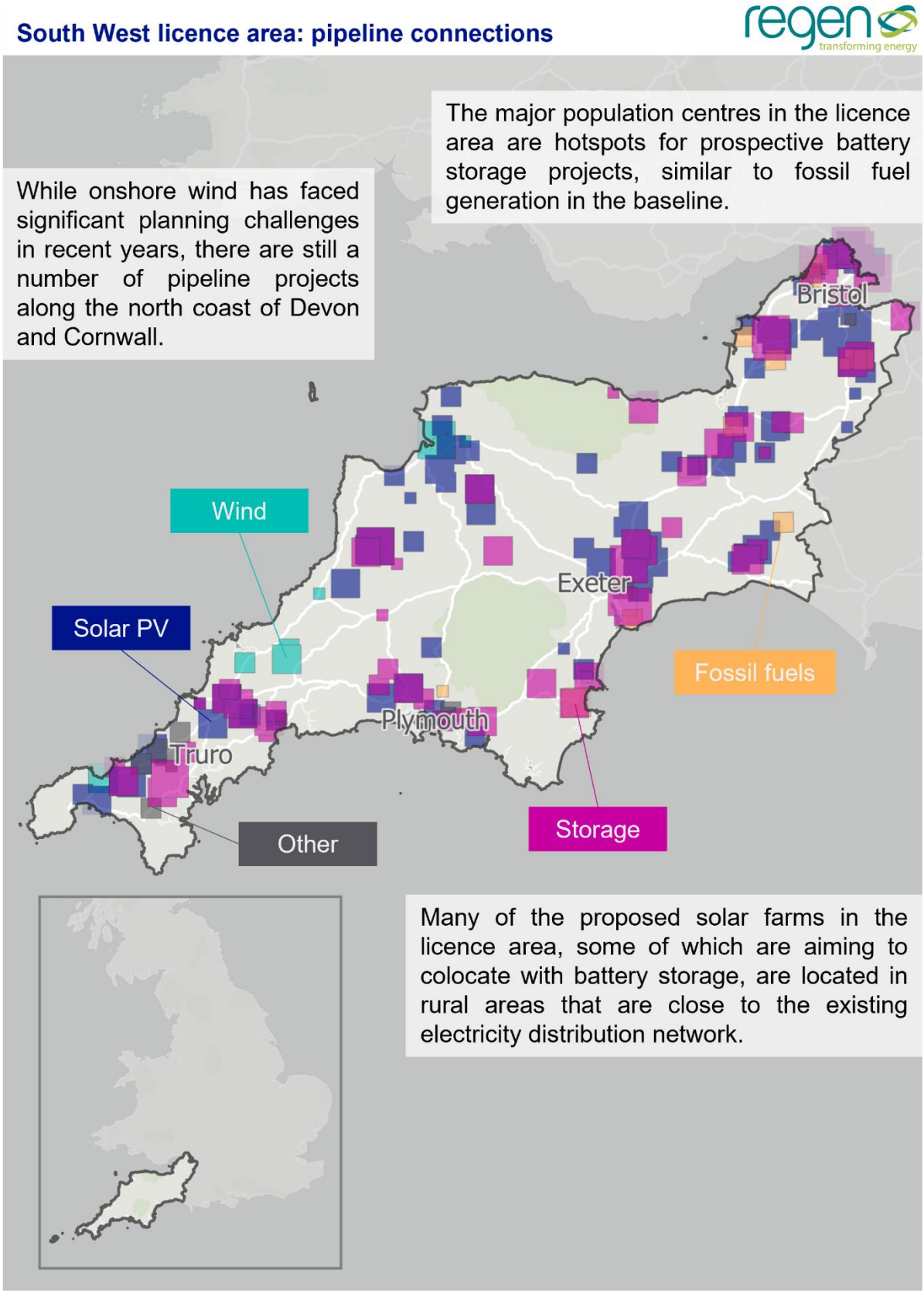


Figure 4 - The NGED South West licence area, with the location of proposed 'pipeline' large-scale generation and storage sites



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:

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 2022 baseline year represents the 2021/22 fiscal year, ending on 31 March 2022*. 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 2022 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.

* note that this baseline year differs from the FES 2022, which has a baseline year of 2021. As a result, some of the comparisons to FES are impacted by the DFES being published later in the year, with the benefit of several more months of data. The final baseline and pipeline data for DFES 2022 was updated on 1 September 2022.

Local stakeholder influences

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

Stakeholder engagement approach	Description of how feedback is fed into the DFES
Consultation webinars	Four consultation events, one per licence area, were held online in July 2022. 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 authority new developments	An online data exchange was shared with local authority planning departments, sharing and updating registers of future housing and business floorspace developments across NGED's licence areas.
Project and technology 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 2022, a number of specific aspects of the current energy system have been considered in the DFES 2022 analysis:

Aspect	Impact on DFES
Access and Forward-looking Charges Significant Code Review	In May 2022, Ofgem published their final Decision and Direction on the Access SCR, deciding to reduce the overall connection charge faced by those connecting to the distribution network. This means projects will have a lower cost to connect to the distribution network from April 2023. This is positive news for project developers, as it is intended to reduce the cost to connect to the distribution network. It is likely that the impact of the changes will be most significant for high electricity demand technologies, such as EV chargers, hydrogen electrolysers and industrial process electrification. This could lead to a potential pause in connections of high voltage charging hubs, and slower electrification of transport depots, before April 2023, followed by a short-term uptick after April 2023. Where appropriate, this has been implemented in the DFES projections. Whilst there is also some benefit to battery storage and distributed generation projects, the reduction in connection costs is less and therefore will have a less significant influence on the connection timelines for these technologies.
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, will be decommissioned 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 Short Term Operating Reserve, 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 2022 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 network planning teams at NGED.
Reflecting upstream constraints on the transmission network	Upstream constraints on the transmission network can 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. 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 Statements of Works, 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 only. This allows the net zero scenarios to represent a range of potential future connections to the distribution network, including the fast-tracking of network investment and the early releasing of capacity headroom to enable connections.

Energy policy and wider context

Similar to the network planning consideration, several areas of energy policy and wider energy sector context have been considered in the DFES analysis. The current global energy crisis has resulted in a number of energy policy shifts and announcements, such as the Review of Electricity Market Arrangements (REMA), the Energy Prices Bill 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 and an increase in electric vehicle sales, although this is showing early signs of slowing

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 2022.

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.

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[i] National Grid ESO FES building block data

Demand technologies

Results and assumptions

Domestic electric heat in the South West licence area

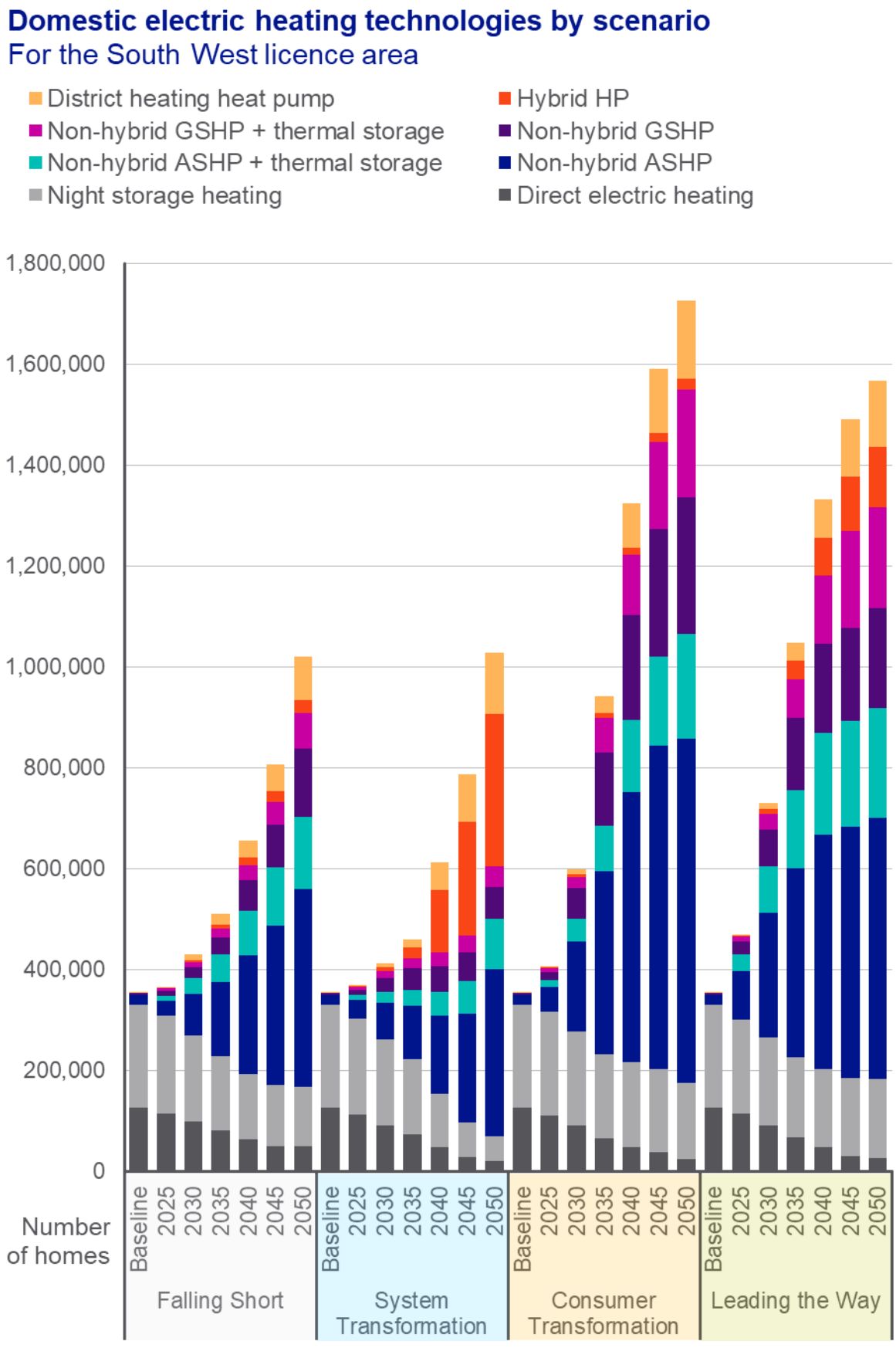
Domestic dwellings where electricity is the primary fuel for space heating and hot water, delivered through a heat pump or resistive electric heater.

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

Number of homes (thousands)		Baseline	2025	2030	2035	2040	2045	2050
Non-hybrid heat pumps* (without thermal storage)	Falling Short	25	39	104	181	295	401	526
	System Transformation		47	101	148	207	273	393
	Consumer Transformation		66	238	507	742	894	953
	Leading the Way		123	318	519	641	683	716
Non-hybrid heat pumps* with thermal storage	Falling Short	0	15	41	72	119	159	215
	System Transformation		15	35	51	73	96	141
	Consumer Transformation		20	68	159	264	350	420
	Leading the Way		42	125	230	338	401	417
Hybrid heat pumps	Falling Short	0	0	3	8	15	21	25
	System Transformation		2	8	22	124	226	302
	Consumer Transformation		1	6	9	13	17	22
	Leading the Way		2	10	37	74	108	119
Connections to heat pump-driven district heat networks	Falling Short	0.1	0	12	21	34	53	86
	System Transformation		1	7	16	54	95	122
	Consumer Transformation		1	10	35	88	128	155
	Leading the Way		1	11	36	77	113	131
Resistive electric heating	Falling Short	330	309	270	229	193	173	168
	System Transformation		304	263	223	154	99	71
	Consumer Transformation		317	279	233	217	203	177
	Leading the Way		301	266	227	203	185	185

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

Figure 5 – Summary of domestic electric heating technologies by scenario, South West licence area



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.

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[ii], 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 the 1.7% of homes with a heat pump in the licence area being a little ahead of the national average.

Sub-technology	Number of homes	Proportion of homes
Non-hybrid ASHP	21,291	1.4%
Non-hybrid GSHP	3,977	0.3%
Hybrid heat pump	0	0.0%
Heat pump-driven district heat network	144	0.0%

Due to a lack of evidence, the modelling assumes no thermal storage 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 20% of homes compared to 11% 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.	**Sub-technology**	**Number of homes**	**Proportion of homes**
	Night storage heaters	203,832	13.5%
	Direct electric heaters	126,384	8.4%

Near-term projections (April 2022 to March 2026)

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 and sociodemographic factors. Across the net zero scenarios, the uptake of heat pumps is projected to increase significantly by 2026, particularly in off-gas homes heated by oil and LPG etc., while the number of homes heated by resistive electric heating is projected to slowly decrease under every scenario in the near term.

Near-term connections to heat pump-driven heat networks are based on the existing pipeline of planned heat networks. Heat networks that are well advanced in planning, such as the Lockleaze development in Bristol, are modelled to connect in the near term under every scenario.

Heat pumps			
Scenario	**Description**	**Proportion of homes with a heat pump in 2026**	
		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%	10%
Consumer Transformation		8%	4%
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**.	5%	3%
Falling Short		5%	2%

Resistive electric heating			
Scenario	**Description**	**Proportion of homes with resistive heating in 2026**	
		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.	19%	8%
Consumer Transformation	A similar proportion of direct electric heated homes convert to night storage heaters in order to reduce heating costs. 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.	20%	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.	19%	8%
Falling Short		19%	8%

Medium-term projections (April 2026 to March 2035)

Heat decarbonisation accelerates in the medium-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[iii].

Heat pumps			
Scenario	**Description**	**Proportion of homes with a heat pump in 2035**	
		South West	**GB (FES)**
Leading the Way	In the medium term, the South West remains ahead of the national trajectory for heat pump uptake. 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	46%	42%
Consumer Transformation		40%	35%

	and 2030s, enabling shifting of domestic demand to lower cost periods of the day.		
System Transformation	Heat pump uptake in on-gas homes is minimal 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. As a result, the South West heat pump uptake is significantly ahead of the GB trend.	13%	7%
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. As a result, the South West heat pump uptake is significantly ahead of the GB trend.	16%	11%

Resistive electric heating			
Scenario	**Description**	**Proportion of homes with resistive heating in 2035**	
		South West	**GB (FES)**
Leading the Way	The overall number of resistive heated homes continues to decrease in the medium term, 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.	13%	6%
Consumer Transformation		14%	7%
System Transformation	The overall number of resistive heated homes decreases in the medium term, 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.	13%	6%
Falling Short		14%	6%

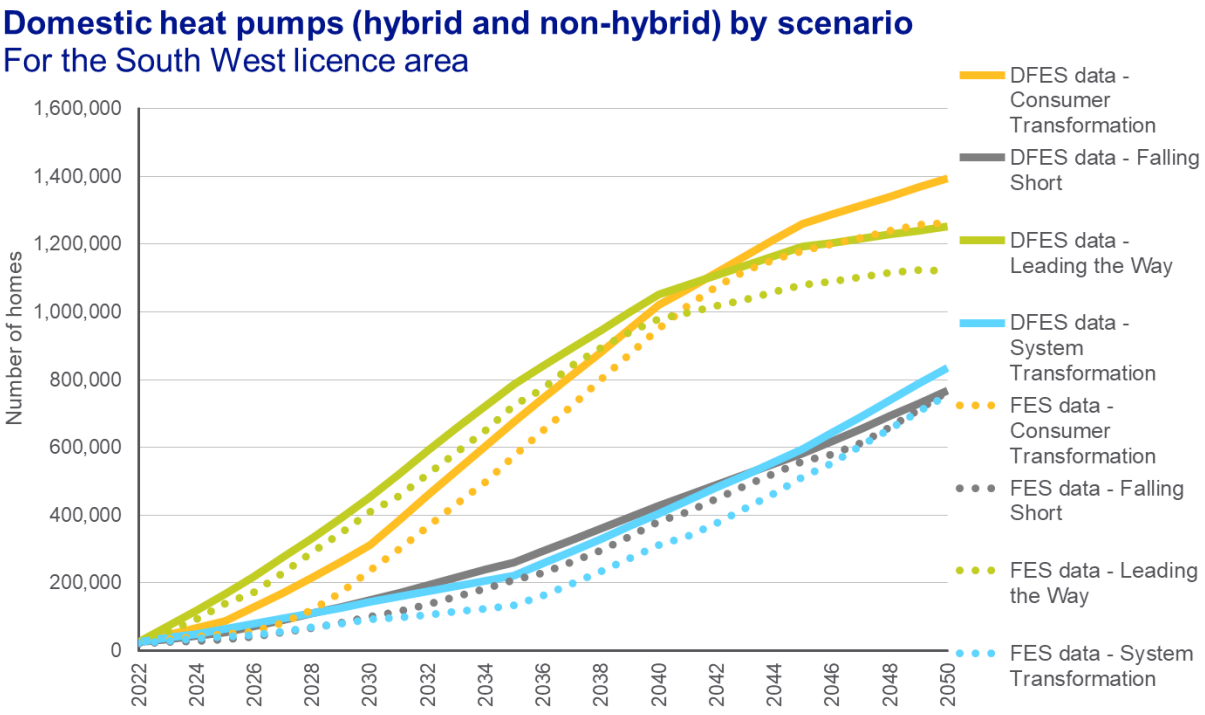
Long-term projections (April 2035 to March 2050)			
The heat decarbonisation trends established in the medium term continue out to 2050, especially under the net zero scenarios, as the country aims to meet its decarbonisation targets.			
Heat pumps			
Scenario	**Description**	**Proportion of homes with a heat pump in 2050**	
		South West	**GB (FES)**
Leading the Way	By 2050, almost all domestic properties are heated by heat pumps, district heating or resistive electric heating by 2050. Hydrogen boilers become available in some population centres, modelled to be installed in 10% of domestic properties in 2050.	66%	64%

Consumer Transformation	By 2050, almost all properties are heated by standalone heat pumps, district heating or resistive electric heating by 2050.	76%	73%
System Transformation	Uptake of heat pumps increases substantially in the 2040s, particularly hydrogen hybrid heat 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.	45%	44%
Falling Short	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.	43%	41%

Resistive electric heating			
Scenario	**Description**	**Proportion of homes with resistive heating in 2050**	
		South West	**GB (FES)**
Leading the Way	Under these scenarios, the proportion of homes heated by resistive electric heating continues to decrease, replaced by district heating, heat pumps and hydrogen boilers, depending on the scenario.	10%	5%
Consumer Transformation		10%	5%
System Transformation		4%	2%
Falling Short		9%	5%

Reconciliation with National Grid FES 2022

Figure 6 – Number of domestic heat pumps by scenario, South West licence area



- The DFES outcomes for total heat pumps under each scenario are broadly aligned with the FES 2022 data by 2050, though slightly above under the three net zero scenarios.

- 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. This is likely due to the high proportion of off-gas housing and lower proportion of homes with the potential for district heat networks or other forms of low carbon heating, such as hydrogen.
- The Building Block data provided in the FES 2022 classifies an 'ASHP with a resistive heating element' as a hybrid heat pump, whereas the DFES analysis considers this to be a variation of a non-hybrid heat pump. Accordingly, the reconciliation has been undertaken using combined figures for both non-hybrid and hybrid heat pumps together. Building block data for resistive electric heating and heat pump-driven district heat networks are not specifically provided in the FES 2022 data, and as such, a direct reconciliation is not possible.

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
Current levels of energy efficiency, categorised into well-insulated homes (EPC B and above) and less well-insulated homes	EPC data
Areas with potential for district heat networks, or an existing heat network pipeline project	Heat network pipeline data[iv], and Opportunity Areas for District Heat Networks in the UK[v] - BEIS

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Battery electric cars, LGVs and motorbikes	Falling Short	24	64	243	675	1,389	2,007	2,207
	System Transformation		73	328	1,032	1,897	2,171	2,060
	Consumer Transformation		148	678	1,611	2,126	2,162	2,063
	Leading the Way		118	662	1,710	2,126	2,031	1,680
Plug-in hybrid electric cars, LGVs and motorbikes	Falling Short	13	27	71	135	202	139	53
	System Transformation		26	64	111	84	36	0
	Consumer Transformation		23	48	70	49	20	0
	Leading the Way		28	62	59	31	0	0
Battery electric HGVs, buses and coaches	Falling Short	0	0	1	2	8	21	30
	System Transformation		0	2	7	17	22	20
	Consumer Transformation		0	2	9	24	34	35
	Leading the Way		0	3	10	23	34	32

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

Number of chargers (thousands)		Baseline	2025	2030	2035	2040	2045	2050
Domestic chargers	Falling Short	19	45	135	370	750	1,074	1,174
	System Transformation		52	198	587	1,026	1,132	1,134
	Consumer Transformation		106	375	861	1,134	1,160	1,160
	Leading the Way		86	413	1,006	1,198	1,204	1,213
Non-domestic chargers	Falling Short	1	2	5	13	27	41	49
	System Transformation		2	7	21	40	47	49
	Consumer Transformation		3	12	28	37	39	41
	Leading the Way		2	11	27	36	38	40

Summary:

- 2% of cars in the South West licence area are currently battery electric or plug-in hybrid, slightly below the national average of 2.5%. This is anticipated to increase substantially under every scenario as the UK looks to decarbonise the transport sector.
- In all scenarios, petrol and diesel vehicles are replaced by low emissions vehicles between now and 2050.
    - Under **Consumer Transformation** and **Leading the Way**, passenger vehicles such as cars and LGVs are rapidly electrified, bolstered by a ban on sales of new petrol and diesel vehicles from 2030. 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.
    - Under **System Transformation**, the electrification of vehicles is slightly slower, with the ban on sales of new petrol and diesel cars being pushed back until 2032. Additionally, a higher availability of low carbon hydrogen in this scenario results in a minority of passenger and non-passenger vehicles converting to 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, and there are still petrol and diesel vehicles on the road in 2050 under this scenario.
- In the latter years of the scenarios, some autonomous EVs are projected. This is strongly dependent on technological advances and societal change, and as such has been directly aligned with national projections. This results in a decline in the overall number of vehicles on the road, particularly under **Leading the Way** in the 2040s and less so under **Falling Short**.
- Regen's EV charger model determines the EV charger capacity required to charge the number of vehicles projected under each of the four DFES scenarios. This capacity is converted to a subsequent number of EV chargers, 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. This allocation is driven predominantly by the number of each vehicle type in the projections, and assumptions around how EVs may be charged under each of the FES scenarios. These charging behaviour assumptions are primarily driven by the National Grid ESO FES data.
- By 2050, all four of the future scenarios feature around 1.2 million EV chargers, predominantly in the form of domestic chargers.

Modelling assumptions and results

Baseline

Electric vehicles

While the electric vehicle baseline represents less than 2% of all 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 for ultra-low emissions vehicles
- Increasing consumer confidence and awareness of electric vehicles
- Electrification of commercial vehicle fleets
- Financial benefits of high mileage vehicles compared to petrol or diesel vehicles.

While the vast majority of electric vehicle uptake has centred on cars, other vehicles such as LGVs and buses are beginning to see uptake.

Vehicle type	Thousands of vehicles
Pure electric car	22.1
Plug-in hybrid car	12.8
Pure electric LGV	1.2
Plug-in hybrid LGV	0.0
Other electric vehicles	0.7

EV chargers		
As the number of electric vehicles has increased, the number of EV chargers has similarly grown steadily. In addition to most domestic EV owners having a home charging port, 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**	**Thousands of chargers**
	Domestic	18.9
	Non-domestic	1.2

Near-term projections (April 2022 to March 2025)

The acceleration in EV uptake over the past few years is anticipated to continue under every scenario. The number of EVs on the road is expected to increase notably by 2026, however, the extent to which this occurs depends heavily on the scenario, as detailed below.

Scenario	Description	Total electric vehicles by 2025 (000s)	Total EV chargers by 2025 (000s)
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. By 2025, almost 10% of cars are electrified under these scenarios, and over 3% of LGVs and buses.	146	88
Consumer Transformation		171	109
System Transformation	Uptake of electric vehicles increases substantially, but less rapidly than the other two net zero scenarios due to lower consumer engagement. However, over 5% of cars are electrified by 2025 under both scenarios.	99	54
Falling Short		91	47

Medium-term projections (April 2025 to March 2035)

The uptake of electric vehicles and EV chargers is modelled to continue accelerating between 2025 and 2035 across all scenarios. Between 2030 and 2035, bans on the sale of petrol and diesel cars and vans result in electric vehicles representing the vast majority of new vehicles in this period.

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.

Scenario	Description	Total electric vehicles by 2035 (000s)	Total EV chargers by 2035 (000s)
Leading the Way	EVs dominate new car and LGV sales from the late 2020s under these scenarios, and from 2030 almost all new cars and LGVs are electric. Harder-to-electrify vehicles such as buses and HGVs also see accelerated uptake in the medium-term, with the majority of road vehicles electrified by 2035. With such a rapid shift toward battery electric vehicles, plug-in hybrid vehicles see relatively little uptake, and begin to decline in the 2030s. EV uptake is facilitated by a widespread rollout of domestic and non-domestic charging.	1,778	1,033
Consumer Transformation		1,690	888

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, but battery electric vehicles are 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.	1,151	608
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.	812	383

Long-term projections (April 2035 to March 2050)

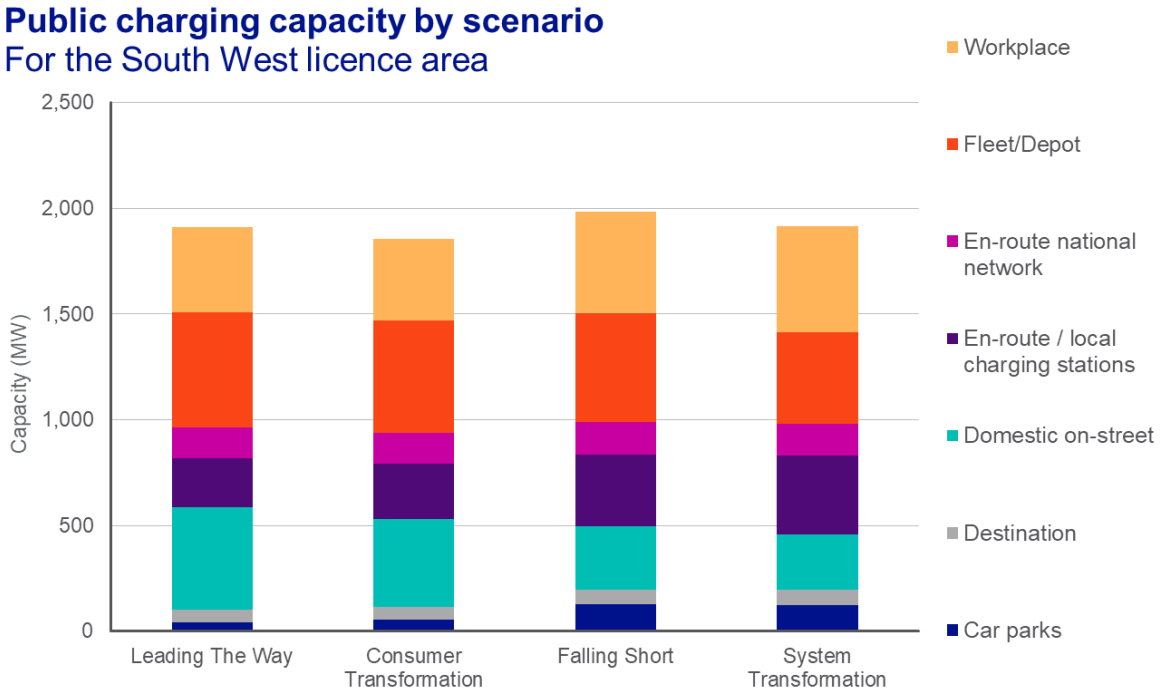
Under the three net zero scenarios, EV adoption approaches saturation and new EV uptake slows in most areas. Harder-to-electrify vehicles that saw lower uptake in the near term, such as HGVs, see a higher uptake out to 2050.

The uptake of EVs slows and then 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 electric vehicles by 2050 (000s)	Total EV chargers by 2050 (000s)
Leading the Way	Both EV adoption and associated EV charger capacity peak in the early 2040s. By this point, almost all road transport is electrified. Across the 2040s, the overall number of vehicles on the road decreases considerably in these scenarios, driven by an increased uptake in autonomous vehicles and greater use of public transport and active travel.	1,712	1,253
Consumer Transformation		2,098	1,201
System Transformation	Both EV adoption and associated EV charger capacity peak in 2045. By this point, almost all passenger vehicles and buses and coaches are electrified. Around half of HGVs are also electrified under this scenario, with the remainder fuelled by low carbon hydrogen.	2,081	1,183
Falling Short	EV adoption, and subsequent EV charger capacity, continue increasing out to 2050. By this point, almost all road vehicles are electrified.	2,290	1,223

Breakdown of public EV charger capacity in 2050 by scenario

While the DFES data presents numbers of EV chargers, the electrical capacity of these different charger types has a significant effect on their impact on the network. The electrical capacity of each public charger sub-technology in 2050 under each scenario is illustrated in the figure below:



Reconciliation with National Grid FES 2022

Figure 7 – Number of battery electric cars, LGVs and motorcycles by scenario, South West licence area

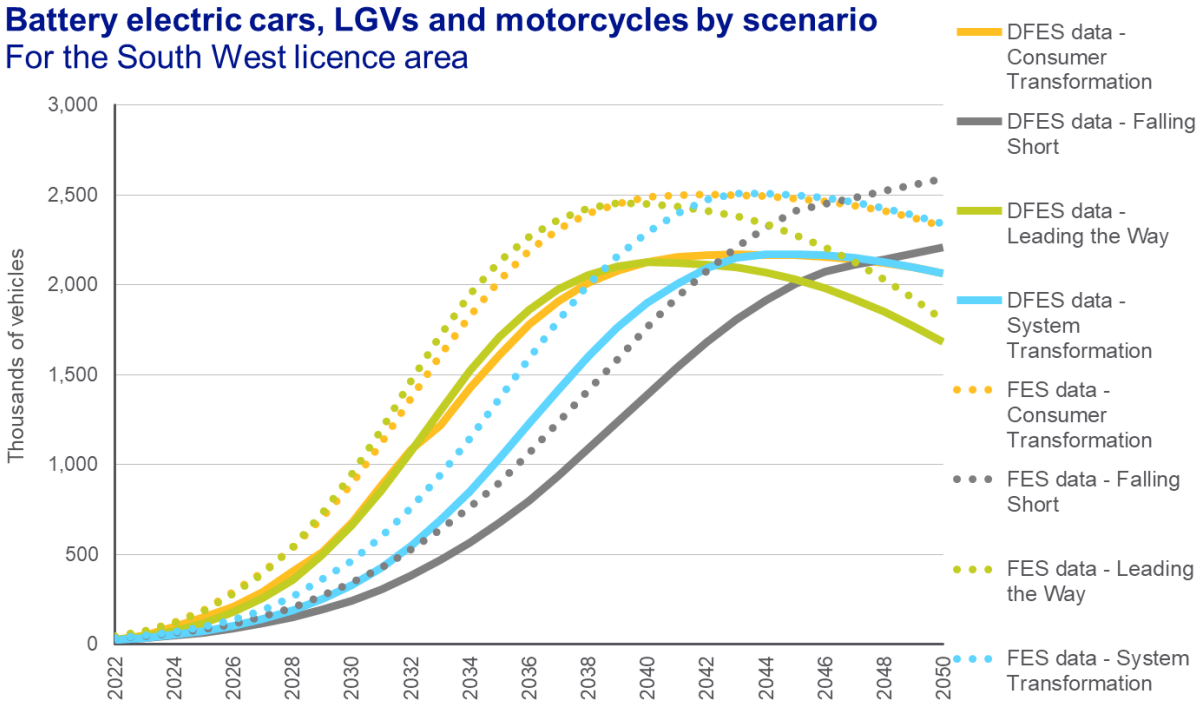


Figure 8 – Number of plug-in hybrid cars, LGVs and motorcycles by scenario, South West licence area

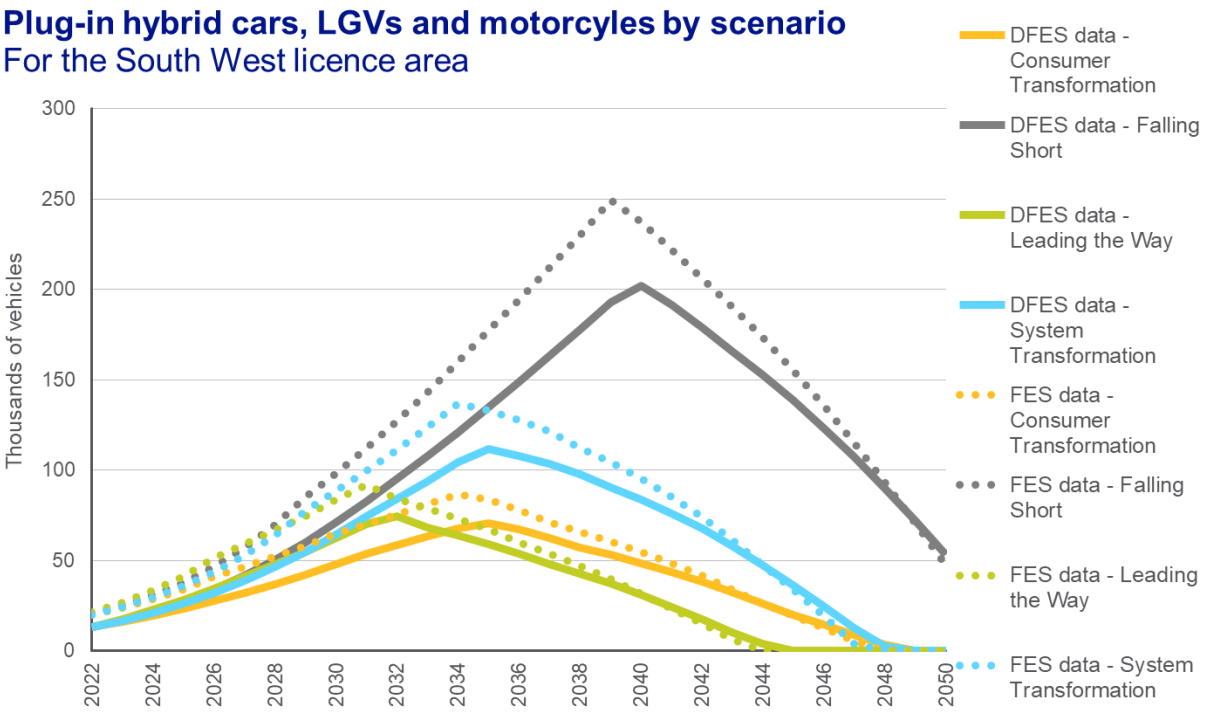
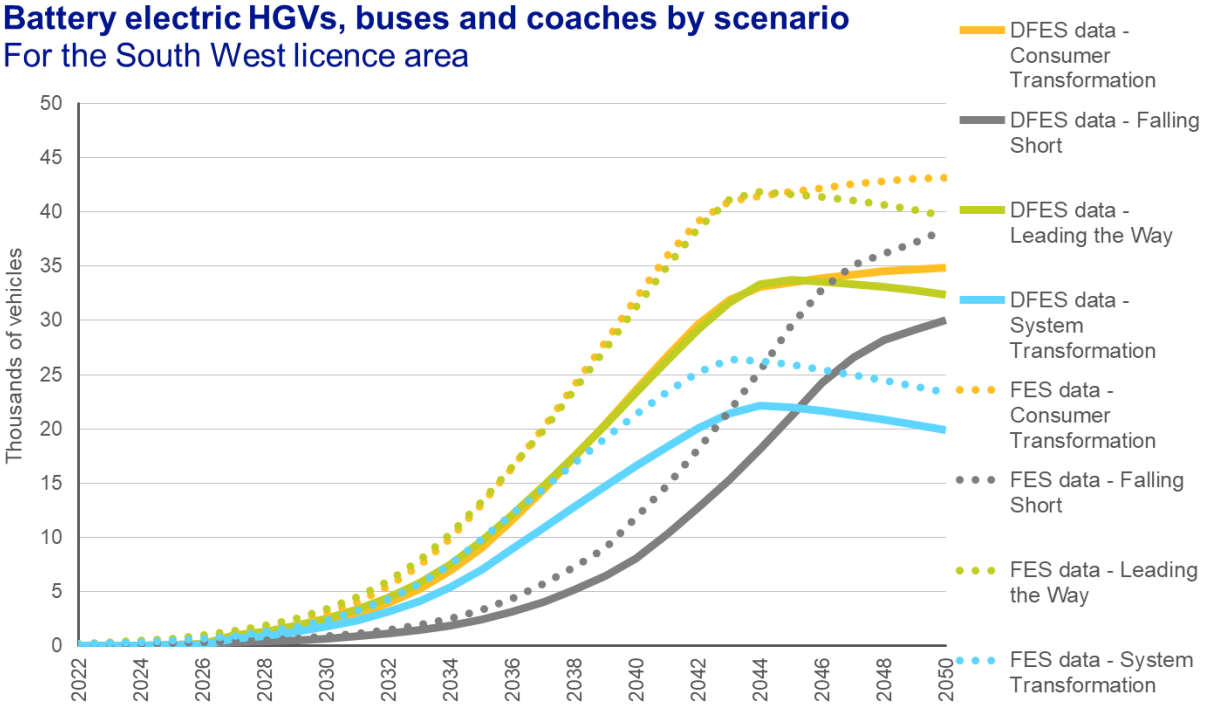


Figure 9 – Number of battery electric HGVs, buses and coaches by scenario, South West licence area



- 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.
- As illustrated in the figures above, the rate of EV uptake and 2050 figures by scenario are similar between the DFES and the FES projections.

- However, overall vehicle uptake for every vehicle type is lower in the DFES. The reason for this variance is unclear, but is likely to be due to differences in the baseline number of vehicles modelled. The DFES modelling uses DfT vehicle licencing data to inform the overall number of vehicles by body type in the licence area, which subsequently guides the uptake of electric vehicles, as these are assumed to typically replace existing petrol and diesel vehicles over time.
- The different EV charger archetypes are not broken down in the FES 2022 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 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	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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Falling Short	0	0	12	14	14	14	47
System Transformation		17	69	119	175	282	400
Consumer Transformation		11	24	65	132	192	280
Leading the Way		21	90	151	219	345	510

Summary:

- Hydrogen electrolysis is an emerging technology at the forefront of potential future low carbon hydrogen production. As an emerging sector, there is significant uncertainty around its wider role[vi] in net zero and, of specific concern to DFES analysis, the amount of capacity that could be connected to the distribution network is unclear.
- Through the British Energy Security Strategy[vii], the UK government has set an ambitious target of 10 GW of low carbon hydrogen production capacity by 2030, specifying at least 5 GW of this to come from hydrogen electrolysis. Only a handful of electrolysis projects are currently operational across the UK.
- While there are no operational hydrogen electrolysers in the South West licence area, there is a 10 MW project at Langage Energy Centre in Plymouth[viii], which was granted planning permission in August 2022. This highlights the future potential for hydrogen in the South West licence area, due to strong renewable resource and a significant maritime sector.
- There are also a number of active hydrogen initiatives within the South West licence area, including plans for hydrogen production facilities at both Bristol Port and Bristol Airport.
- From 2023, new hydrogen electrolysis projects are eligible for both capital and revenue funding support through the government's electrolytic allocation round[ix]. This programme aims to achieve 1 GW of hydrogen electrolysers being in construction or operation by 2025, by supporting projects over 5 MW to completion. This support is initially provided through up front capital grants and ongoing revenue subsidy payments, then after two years switches to a cost-competitive auction process.
- The South West is a hub for maritime activity, with numerous ports along its coastline. The Maritime UK South West ocean technology cluster accounts for £2.54 bn in GVA per year to the economy of the South Coast and supports almost 4,000 businesses and 25,000 jobs[x]. The sector includes research organisations, luxury yacht builders, ports and dockyards, and offshore renewable energy expertise, which are all well suited to capitalise on the opportunity presented by the production and use of low carbon hydrogen.
- The South West licence area also has Triassic salt field basins around Somerset that could be used for hydrogen storage in the future.
- The largest capacity of distribution-connected hydrogen electrolysers in 2050 is modelled under **Leading the Way** (510 MW) and **System Transformation** (400 MW). This reflects the large-scale rollout of hydrogen as a net zero option for transport, industry and heat, and the establishment of a national hydrogen network that is modelled in these scenarios. In contrast, the least capacity is modelled under **Falling Short** (47 MW), reflecting limited government policy support for this technology and the assumption that this scenario does not reach net zero.

Baseline
There are currently no operational hydrogen electrolysers connected to National Grid's distribution network in the South West licence area. This is due to hydrogen's nascent level of development. Electrolytic hydrogen activity to date has been focused around industrial clusters, such as Humberside, Teeside and South Wales and heavy transport hubs, such as in the midlands.

Near-term (April 2022 to March 2025)		
Pipeline project details	**Scenario**	**Modelled connection date**
There is one known hydrogen electrolysis pipeline site in the licence area, a 10 MW project at Langage Energy Centre in Plymouth. This project highlights the future potential for hydrogen in the South West licence area, due to strong renewable resource and a significant maritime sector. The project received planning permission from South Hams District Council in August 2022. This project is hoping to receive funding support through the government's electrolytic allocation round.	**Falling Short**	Not modelled to connect due to uncertainty around financial support.
	System Transformation	2025
	Consumer Transformation	2024
	Leading the Way	2024

'Hydrogenesis', a hydrogen-powered ferry, also operates on Bristol's floating harbour. This project initially included a hydrogen refuelling station on the dock; however, this has since been removed and instead hydrogen is purchased in cylinders instead.

There are a number of additional active hydrogen initiatives in the South West licence area:

- Plans to configure Bristol Port to accept hydrogen or ammonia by ship and produce hydrogen on site[xi]
- The second phase of Project Acorn[xii] which is exploring hydrogen-powered ground support equipment at Bristol Airport.
- A green hydrogen plant near Bristol which has secured £2.5 million in funding from the West of England Combined Authority in October 2022[xiii].
- The Cornwall Marine Hydrogen Centre[xiv] is a new research and development facility in Falmouth which will explore the optimum setup for the storage and conversion of hydrogen into electricity, in the context of marine vessels.

Due to the nascent stage of the hydrogen sector, these initiatives have been used to influence the DFES projections for the near term; however, there is still limited information on them, and hence they have not been modelled as pipeline sites.

The UK government has set a target of 1 GW of electrolytic hydrogen power capacity by 2025. Whilst the South West licence area could see some projects being developed under this support programme, it is unlikely that significant electrolysis capacity will seek to connect to the distribution network by 2025.

Under this timescale, **Leading the Way** is modelled to have the most installed capacity (17 MW), while **Falling Short** is not modelled to have any capacity installed by 2025. This is due to a supportive policy environment assumed under the **Leading the Way**, as well as an earlier rollout in the mid-2020s. Under **System Transformation**, these same projects are supported, but slightly later, with **Consumer Transformation** seeing deployment in the mid-2030s. **Falling Short** has less supportive government policy, and projects are less likely to get developed in the near term.

Medium-term (April 2025 to March 2035)

The UK government has set a further target of 10 GW of low carbon hydrogen production capacity by 2030, with at least half coming from hydrogen electrolysis. From consultation with electrolyser manufacturers, 5-10 MW electrolyser units are anticipated to become commercially viable by 2030, and the demand for hydrogen from hydrogen-fuelled heavy vehicle fleets and public transport will increase across all scenarios in this timeframe.

In particular, the use of electrolysis in industry, power generation, transport and as a source of flexibility increases and hydrogen clusters begin to form. Under **System Transformation** and **Leading the Way**, hydrogen is blended into the existing gas network and is able to be transported to areas of demand.

The DFES has referenced the FES 2022 GB projections and projections for the licence area to inform the medium and long-term capacity projections. This has been augmented by Regen's analysis of potential future sources of local hydrogen demand for each licence area.

Scenario	Percentage of GB capacity on the distribution network (FES 2022)	Total capacity by 2030
Falling Short	100%	14 MW
System Transformation	35%	119 MW
Consumer Transformation	36%	65 MW
Leading the Way	24%	151 MW

Long-term (April 2035 to March 2050)

The South West is a hub for maritime activity, with numerous ports along its coastline. The sector includes research organisations, luxury yacht builders, ports and dockyards, and offshore renewable energy expertise, which are all well suited to capitalise on the opportunity presented by hydrogen electrolysis under some scenarios. This is most likely to happen in the long term due to the long decarbonisation timeline for maritime activities, which are highly dependent on international regulation.

The South West licence area also has Triassic salt field basins around Somerset that could be used for hydrogen storage in the future. If upon exploration these are found to be suitable, large-scale hydrogen production facilities could locate in these areas, as this would reduce transportation miles, enable a more efficient hydrogen supply chain and ultimately reduce the cost of hydrogen.

In the longer term, hydrogen electrolysers are expected to scale up their capacity by increasing the number of modules connecting to a compressor. The total capacity of distribution network connected electrolysers rapidly increases out to 2050, due to wider hydrogen sector developments, such as:

- The repurposing of large-scale storage facilities for hydrogen
- A decrease in upfront capital costs to deploy electrolysers
- Increased demand for low carbon gases such as electrolytic hydrogen
- The colocation of hydrogen electrolysers with renewable generation to provide invaluable balancing services to a high-renewable net zero electricity system.

Scenario	Percentage of GB capacity on the distribution network (FES 2022)	Total capacity by 2050
Falling Short	85%	47 MW
System Transformation	17%	400 MW
Consumer Transformation	17%	280 MW
Leading the Way	20%	510 MW

Comparison to DFES 2021

There are a number of key differences between the scenario projections for hydrogen electrolysis capacity in DFES 2021 and DFES 2022. This is due to substantial modelling and data improvements resulting in notably different projections in the near, medium and long term. The reasons for the variations include:

- The FES 2022, for the first time, has detailed specific data on the split of hydrogen electrolyser capacity that could be connected to the distribution and transmission networks separately. This has allowed for more accurate reference projections for capacity that will connect at distribution network voltages, which was a key source of uncertainty in the DFES 2021 modelling. This has resulted in an overall reduction in the projections of distribution-connected electrolysers, in particular for **Consumer Transformation**. In DFES 2021, it was assumed that c. 74% of total electrolyser capacity would be connected to the distribution network in **Consumer Transformation**; however, in the latest FES 2022 analysis, only 17% is modelled to be distribution connected. Hence, following FES 2022 assumptions has resulted in a decrease in capacity projected under this scenario in DFES 2022.
- The UK government's increased ambition for hydrogen electrolysis capacity (1 GW by 2025 and at least 5 GW by 2030) has increased the potential uptake of electrolysis in the near term. Combined with the 2022 energy cost crisis, the FES 2022 analysis shows a larger focus on electrolytic hydrogen over CCUS-enabled hydrogen, particularly in **System Transformation**.

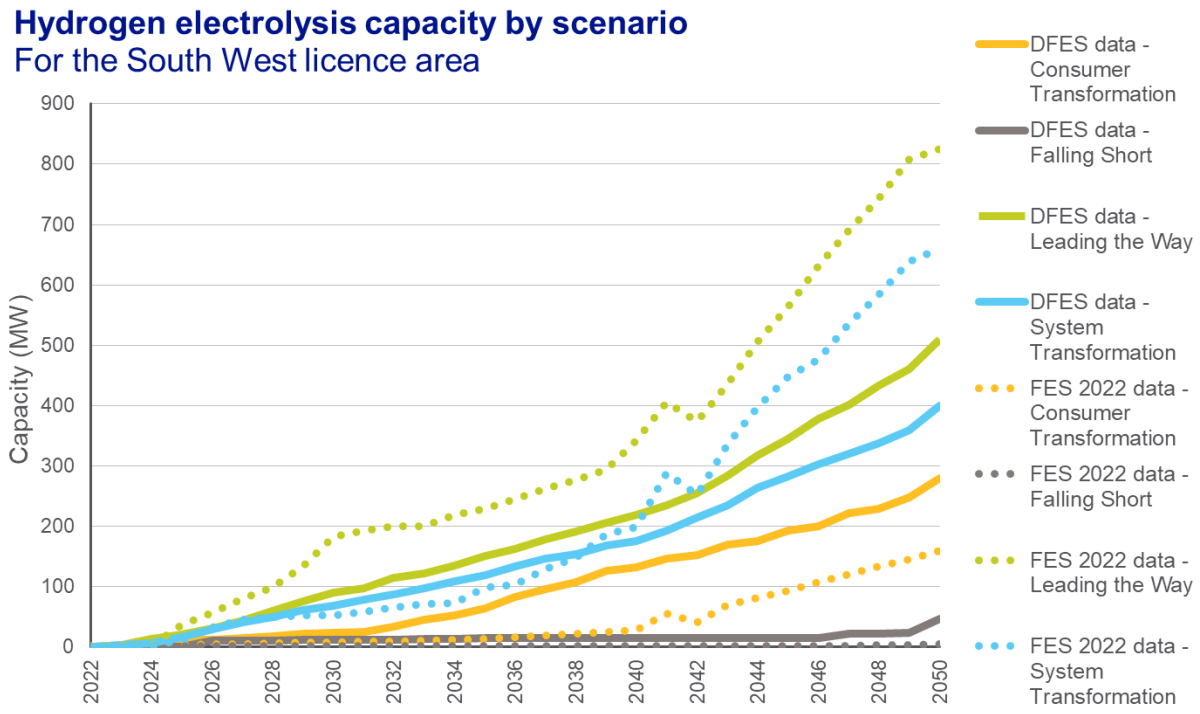
Key modelling assumptions for DFES 2022

From engaging with key stakeholders, electrolyser manufacturers and project developers, a number of factors that could influence the location and use-cases of distribution connected hydrogen electrolysers were identified. These factors were weighted based on the assumptions underpinning the FES scenarios and the resultant scenario projections (2023-2050) were based on Regen's analysis of the presence of these factors in the licence area.

Hydrogen distribution factors

Factor	Leading the Way	Consumer Transformation	System Transformation	Falling Short	Presence of this factor in the South West
Industrial energy demand	Medium	Medium	Medium	High	Low
Heavy transport demand	Medium	Medium	Medium	Medium	Low
Large-scale hydrogen storage	Low	Low	Low		Medium
Location of maritime activity	Low	Medium	Low		High
Access to the gas network	Low		Low	Low	Low
Renewable energy resource	Medium	Medium	Medium		High
Hydrogen innovation projects	High	High	High	High	Medium
Rail network decarbonisation	Low	Low	Low		Low
Existing grey hydrogen sites	Low	Low	Low	Low	Low

Figure 10 – Installed capacity of hydrogen electrolysis by scenario, South West licence area



- The FES 2022, for the first time, has regional projections for hydrogen electrolysis, allowing for a more accurate reconciliation between Regen's licence area projections and the FES 2022 GSP datasets.
- Under **System Transformation** and **Leading the Way**, the DFES projections for the South West licence area are significantly lower than the FES projections in the longer term. In comparison, under **Consumer Transformation** and **Falling Short**, the DFES projections are higher than those in the FES projections.
- This is likely to be due to differences in modelling approaches around the scale and sources of demand for hydrogen present in the licence area and the prioritisation of some future demand customers being met by distribution-scale or transmission-scale electrolyser projects.
- DFES 2022 analysis for the South West licence area finds **Leading the Way** to have the highest capacity in the projection period (510 MW), due to a focus on colocated electrolysers with renewable energy and potential future demand for hydrogen within the maritime sector.
- By 2050, **Leading the Way** has the most installed capacity in the South West licence area (510 MW). This represents c.6% of all GB-distribution connected electrolysis capacity under this scenario, which is viable based on the region's size, transport infrastructure, storage resources and existing hydrogen activity.

Factors that will affect deployment at a local level

Description	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, BEIS
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

Location of larger-scale renewable energy generators, based on Regen's spatial distribution of ground-mounted solar PV and onshore wind resource, as potential sites for colocation.	Regen analysis

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Falling Short	0	29	93	156	206	250	293
System Transformation		34	106	177	232	282	331
Consumer Transformation		34	106	177	232	282	331
Leading the Way		41	126	202	265	323	380

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

Floorspace (sqm, 100,000s)	Baseline	2025	2030	2035	2040	2045	2050
Falling Short	0	12	32	61	72	72	72
System Transformation		14	40	66	71	72	72
Consumer Transformation		14	40	66	71	72	72
Leading the Way		15	42	64	72	72	72

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.
- These new developments have been modelled based on direct engagement with local authorities planning departments and analysis of local planning documents. These detail ‘under construction’ and ‘planned’ developments, as well as land areas that are allocated for future developments.
- Longer-term new housing developments, beyond the timeframe of local planning documents, have also been modelled, based on an analysis of ONS household projections.
- By 2050, this modelling results in between 290,000 and 380,000 new homes in the South West licence area, representing a 19%-25% increase in the number of domestic customers.
- An additional 6.6 million square meters of non-domestic floorspace is also modelled to be developed in the South West licence area under each scenario, predominantly composed of office and factory and warehouse developments.

Modelling assumptions

Baseline
As the scope of the new developments analysis in the DFES is focused on future additional/new developments of domestic and non-domestic buildings, no baseline is defined for this technology.

Planned developments (April 2022 to March 2042)	
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 (2021) DFES analysis. The local authorities then provide updates or 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, supplemented where necessary from other online data sources, and added to the database. Where new data was not provided, the data is gathered through publicly available planning documents such as 5-year housing land supplies and local plans, where necessary.
ESA assignment	Sites are assigned spatially mapped to NGED's network infrastructure based on locational data. 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 data on housebuilding and construction of new non-domestic premises.

Domestic

Number of development sites identified	**Total number of houses**
684	133,732

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

Local authority	**Number of homes**	**Largest development site**
Somerset West and Taunton	14,427	Comeytrowe Urban Extension (2,000 homes)
Plymouth	13,795	Sherford New Community (3,146 homes)
Cornwall	13,346	Broadmoor Farm, Saltash (800 homes)

Non-domestic

Subcategory	**Number of sites**	**Total non-domestic floorspace (sqm)**
Factory and warehouse	249	2,470,015
Office	228	2,479,085
Retail	66	348,549
School and college	31	394,777
Other (e.g. medical, hotel, sport & leisure)	152	1,603,388

In the South West licence area, the vast majority of planned non-domestic development is employment land in the form of offices and factory and warehouse floorspace. This includes the mixed-use Gravity 'Smart Campus'[xv] in Sedgemoor, the largest site in the collected data.

Where possible, the planned development floorspace for each site from the data collection has been used in the modelling. Where planned floorspace was not available, overall planned site areas have been converted into floorspace based on benchmarking figures for specific development types (school, retail, office etc.) based on the sites in the data that have both floorspace and site area detailed.

Modelled developments (April 2022 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 2022 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[xvi].
Non-domestic	
The non-domestic scenario projections are based on planned developments only.	

Results

Figure 11 – Non-cumulative planned and total new housing developments by scenario, South West licence area

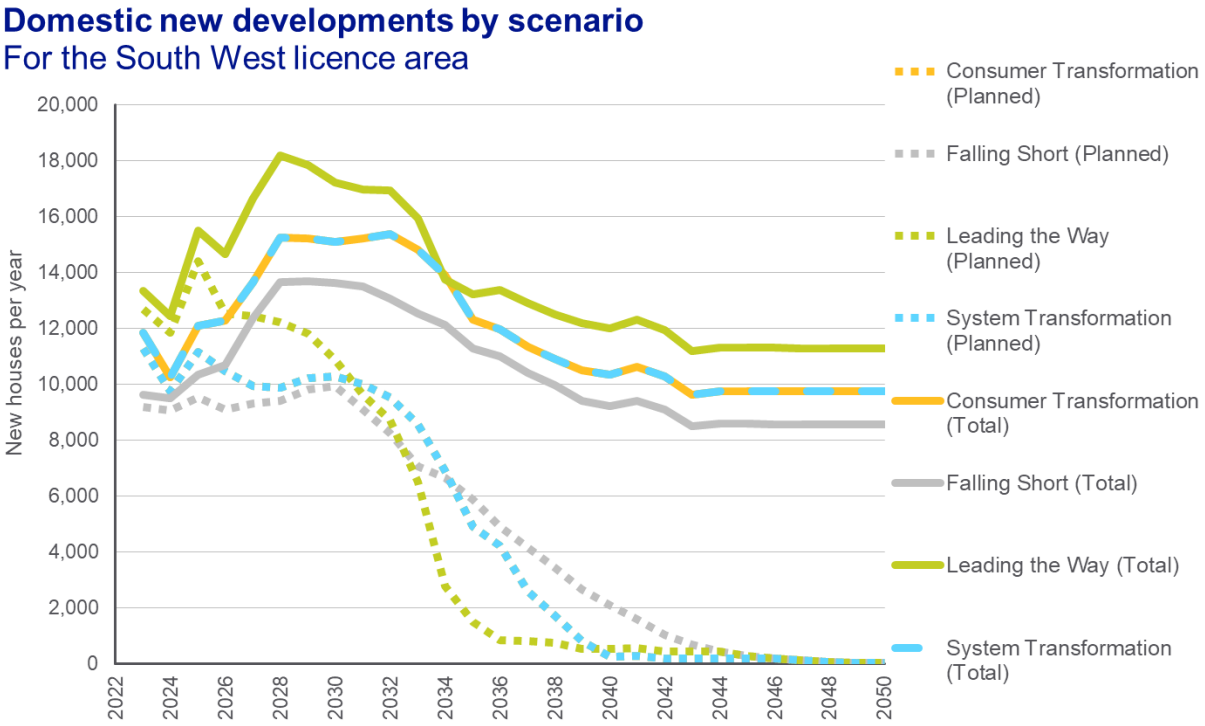
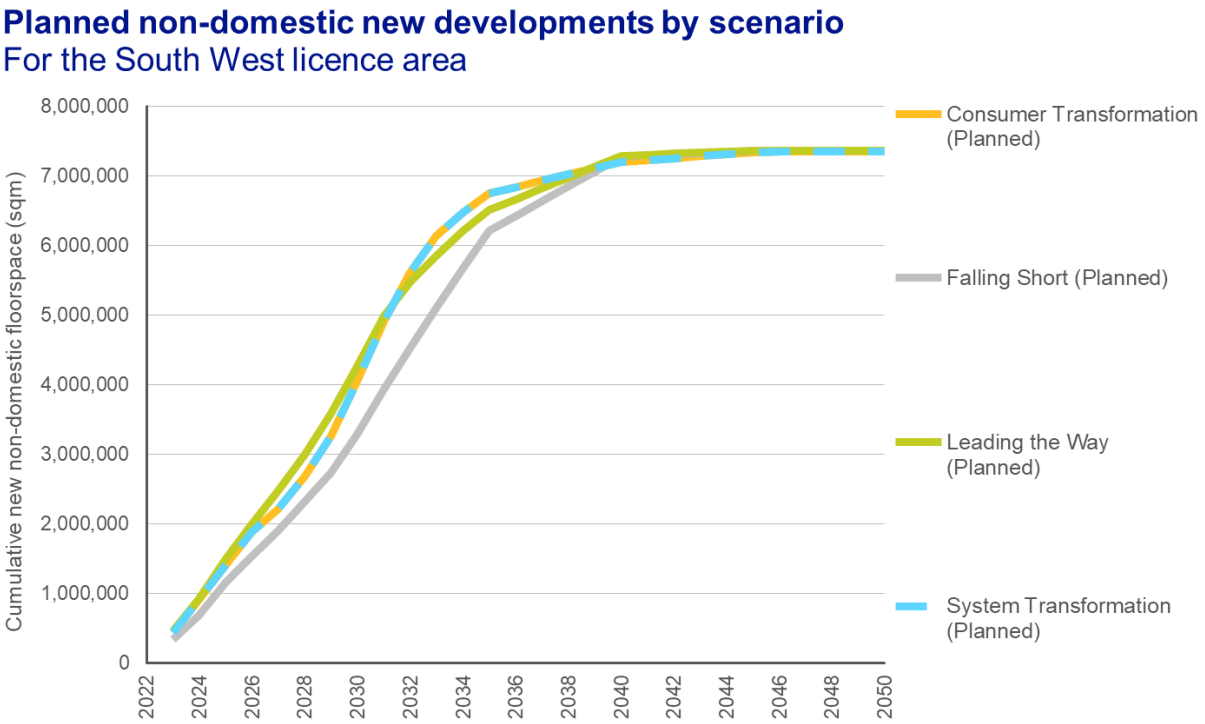


Figure 12 – Cumulative planned non-domestic developments by scenario, South West licence area



Reconciliation with National Grid FES 2022

- 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 that denser city centres or highly rural areas.	Census 2011, EPC records

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

Air conditioning in the South West licence area

Domestic air conditioning units, based on a typical portable or window-mounted air conditioner

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

Air conditioning units (thousands)	Baseline	2025	2030	2035	2040	2045	2050
Falling Short	12	18	35	75	152	311	625
System Transformation		17	30	53	101	185	335
Consumer Transformation		17	30	53	101	185	335
Leading the Way		12	12	12	12	12	12

Summary:

- Domestic air conditioning is not currently common in the UK, with only c.1% of UK homes currently containing an air conditioning unit.
- In the South West licence area, modelling suggests around 0.8% of homes currently have an air conditioning unit.
- Increased summer temperatures, extended heat waves and reducing costs could result in an increased uptake of air conditioning units over the coming decades. In addition to these factors, the UK building stock is not optimised around passive cooling, which could drive increased levels of active cooling, such as air conditioners.
- Air conditioning uptake is likely to be focused in urban areas such as Bristol, due to the 'heat island effect' causing increased temperatures in built-up areas, alongside the greater number of smaller dwellings, such as flats, that are more susceptible to high temperatures.
- Given the small baseline and uncertainty around future domestic cooling methods, there is a broad range of scenario outcomes, from minimal further uptake under **Leading the Way** to air conditioning becoming commonplace under **Falling Short**.

Modelling assumptions and results

Baseline	
Number of domestic units	Proportion of homes with an air con unit
11,517	0.8%
Modelling assumptions	
There is limited baseline data on domestic air conditioning levels in the UK. A 2016 report by Tyndall Manchester suggested that 1-3% of UK households reported some form of air conditioning. We have aligned with the National Grid FES 2022 data, which has a national baseline of around 330,000 domestic air conditioners, equivalent to around 1.1% of homes nationally. To estimate the licence area baseline, this national figure has been distributed based on regional temperate data and housing density.	

Near-term (April 2022 to March 2025)	
Scenario	**Description**
Falling Short	Uptake of domestic air conditioning increases due to more frequent summer heat waves. The majority of uptake is assumed to be in denser urban areas where active cooling demand is highest. This results in c. 17,000-18,000 units in homes by 2025 in these scenarios.
System Transformation	
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. As a result, very few new air conditioning units are installed by 2025.

Medium-term and long-term (April 2025 to March 2050)		
Scenario	**Description**	**2050 homes with air conditioning**
Falling Short	Increasing frequency of heat waves and societal reluctance to engage in passive cooling methods leads to exponential uptake of domestic air conditioning, as the 'easiest' route to comfortable internal temperatures.	c. 625,000 homes c. 40% of total housing stock
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. 335,000 homes c. 21% of total housing stock
Consumer Transformation		
Leading the Way	However, aims to limit carbon emissions and electricity consumption temper uptake, with passive cooling measures also seeing uptake.	c. 12,000 homes c. 1% of total housing stock

Modelling assumptions

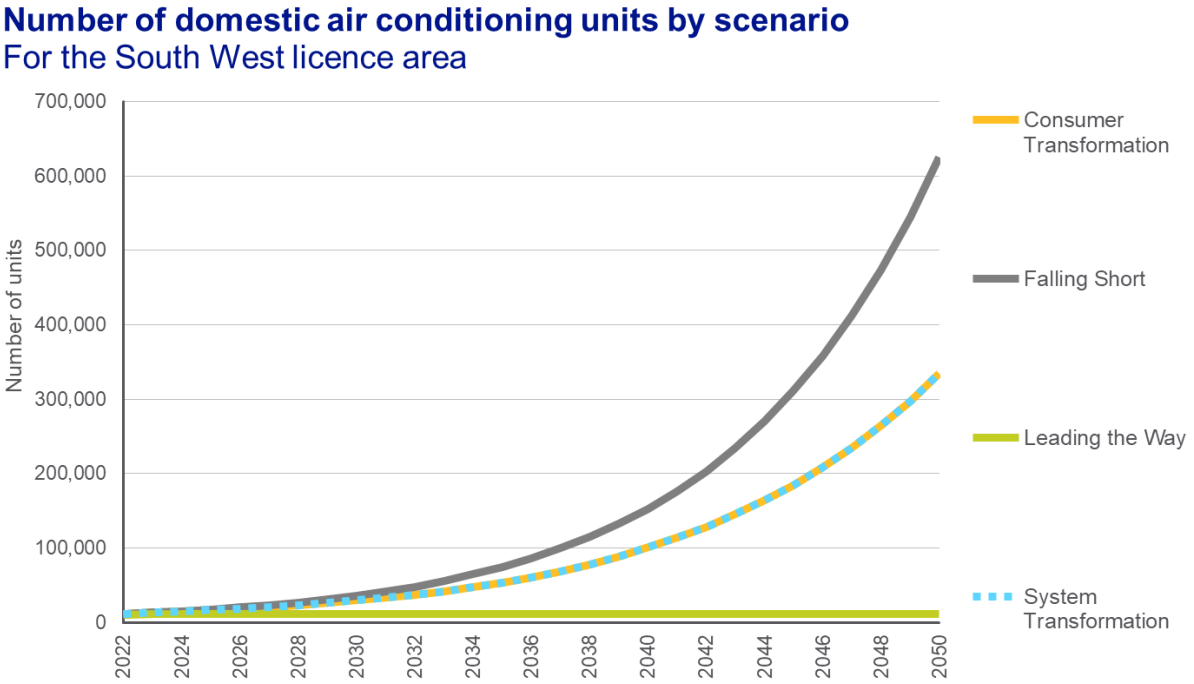
The uptake of domestic air conditioning in each scenario is modelled using:

- Cooling degree days at 18.5 °C, where the South West is slightly below the national average due to its maritime climate. This metric is used in every scenario.
- Proportion of households in very dense urban areas, with the South West 42% below the national average. This metric is used in every scenario.
- Proportion of households in fairly dense urban areas, with the South West 24% below the national average. This metric is used in every scenario except **Leading the Way**, which has minimal domestic air conditioning uptake.
- Proportion of households in any form of urban area, with the South West 16% below the national average. This metric is used in **Falling Short**, as air conditioning becomes common even outside of 'heat island' areas.

Future Homes Standard

The draft Future Homes Standard stipulates high energy efficiency for air conditioning and limits to oversizing cooling systems in new homes. As a result, the DFES 2022 modelling assumes that the vast majority of domestic air conditioning uptake is retrofitted in existing homes under every scenario.

Figure 13 – Number of domestic air conditioning units by scenario, South West licence area



- The FES 2022 does not directly detail the number of domestic air conditioning units, making a direct comparison to the DFES not possible. However, FES 2022 does contain national-level data on annual domestic air conditioning demand by scenario, and an assumed consumption of 500 kWh/year for a typical domestic air conditioning unit. These factors allow for reconciliation at a high level.
- The South West licence area sees uptake of air conditioning below the national level seen in FES 2022, due to the analysis of cooling degree days and dense urban areas, in both of which the South West licence area is below the national average.

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. Later uptake expands to areas of lower housing density in scenarios where domestic air conditioning becomes more prevalent.	OS Addressbase
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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

[ii] Boiler Upgrade Scheme
[iii] Future Homes Standard
[iv] Heat network pipelines
[v] Opportunity Areas for District Heat Networks in the UK, BEIS
[vi] Building the hydrogen value chain, Regen, 2021
[vii] British Energy Security Strategy, HM Government, 2022
[viii] Langage green hydrogen:
[ix] BEIS Electrolytic Allocation Round 2022
[x] UK ocean technology cluster, Maritime UK South West
[xi] Bristol Airport - Bristol Port hydrogen opportunity:
[xii] The Acorn Project
[xiii] New hydrogen plant near Bristol secures £2.5m funding
[xiv] Cornwall Marine Hydrogen Centre
[xv] Gravity Smart Campus
[xvi] 2018-based household projections by local authority

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	2025	2030	2035	2040	2045	2050
Falling Short	1,101	1,167	1,721	2,115	2,212	2,348	2,483
System Transformation		1,464	1,859	2,497	2,912	3,210	3,567
Consumer Transformation		1,645	1,903	2,551	2,966	3,263	3,621
Leading the Way		1,744	2,447	3,832	4,209	4,538	4,586

Summary:

- The South West has historically been a hotspot for large-scale solar PV deployment, with over 1 GW of distribution connected capacity connected over the past decade.
- There is a significant pipeline of projects in the licence area, representing a renewed developer interest in the region compared to recent years. The number of sites with an accepted network connection offer has more than doubled since DFES 2021, from 42 (962 MW) to 97 sites (2,093 MW) – a 118% relative increase in total pipeline capacity since 2021.
- Solar remains one of the cheapest forms of renewable energy, with further cost reductions helping the technology to realise economies of scale. The South West is expected to see a continued increase in projects due to the significant amount of available resource, relatively high irradiance levels, and land availability.
- Planning friendliness is quite high in the region, with approximately 77% of projects being successful in planning. The licence area has the highest level of local ambition evidenced through renewables target setting and net zero policy, further increasing the likelihood of strong solar buildout to 2050.
- Current business models are based around larger-scale standalone solar farms, or co-location with battery storage. In the future, solar PV could also potentially be co-located with hydrogen electrolysis, in order to mitigate generation constraints or export limitations.
- Under the most ambitious scenario, **Leading the Way**, solar reaches almost 2.5 GW by 2030, and continues to nearly 4.6 GW by 2050. Under **Consumer Transformation**, c. 2 GW is reached by 2030, and c. 3.5 GW by 2050.

Modelling assumptions and results

Baseline		
Number of sites	**Total capacity**	**Description**
230	1,101 MW	2021 was a positive year for new ground mount solar deployment[xvii]. The recent uptick in solar projects follows a period of limited growth since 2017, indicating that the post-FiT lull in project development could be coming to an end. The vast majority of historic solar development was a result of the FiT scheme, which supported solar projects of up to 5 MW with subsidy payments for all electricity generated. At the height of the FiT period, over 830 MW of capacity was deployed between 2012 and 2015 in the South West. Installed capacity has reached 1 GW by 2022, bringing the average installed capacity of large-scale distributed solar to 4.8 MW in the region. The largest distribution-connected site Llanwern Solar Park in South Somerset at 54 MW of installed capacity, connected in 2020.

Pipeline (April 2022 to March 2028)	
Number of pipeline sites	**Total capacity**
97	2,039 MW

Installed solar capacity in the UK is forecast to grow by over 1 GW in 2022 and over 2 GW in 2023. In the South West alone, the number of identified pipeline projects has doubled compared to the number of sites looking to connect to the network in the past year and a half, from 42 (962 MW) by the end of Q1 2021 to 97 (2,039 MW) in Q3 2022, representing a relative increase of 118%. When asked how much of this pipeline of projects is likely to connect, stakeholders responded that lots would likely connect, but over time out to the mid-2030s. The average capacity of sites accepted to connect to the network is 21 MW. More than half of the pipeline capacity is represented by projects of 35 MW or larger. To gather specific project insight, Regen has engaged with project developers to determine project pipeline status and target delivery years.

Pipeline analysis

Status	Scenario outcomes	Sites	Capacity
Under Construction	One new solar site has been confirmed to be under construction, Bowerhouse II in North Somerset (15 MW), recently acquired by Kent County Council.	1	15 MW
Planning Permission Granted	384 MW of solar capacity has been approved in planning in the South West, notably up from just 77 MW identified in DFES 2021. Five sites are located in Devon (totalling 129 MW), three in Torridge (totalling 111 MW), and other sites in Ellbridge, Cornwall (50 MW); Frampton Cotterell, South Gloucestershire (29 MW); Bridgwater, Sedgemore (20 MW); near Saltram Beach, Plymouth (10 MW); Farmborough, Bath and North East Somerset (15 MW); near Blackpool Corner, Dorset (5 MW); Langport, South Somerset (5 MW) and near Hartcliffe, Bristol (1 MW). The largest site with planning approval is a 53 MW Peradon Farm solar farm in East Devon.	17	437 MW
Planning Application Submitted	Several large solar sites have submitted a planning application in the region, all of which are modelled to connect under the three net zero scenarios due to high planning friendliness and local ambition in the South West licence area. The largest site with a submitted planning application is Coldharbour Farm Solar Park (50 MW) in Torridge. The second largest, Treviscoe Solar Farm in Cornwall (32 MW), is aiming for completion by 2023.	4	142 MW
Pre-planning	Many sites were found to be in various stages of pre-planning, at least six of which were seeking an environmental pre-screening application or had already received a pre-screening opinion. At least three consultation websites were identified, including a website for the 20 MW Preston Solar Farm.	16	300 MW
No information	No development evidence could be found for c. 1 GW of pipeline capacity. Due to the sheer volume of pipeline sites, sites with no information are only modelled to connect under the most ambitious scenario, **Leading the Way**, and only in local authorities where planning applications have a very high success rate.	56	1,096 MW

Rejected, Withdrawn or Abandoned	Two sites were rejected or withdrawn in planning, or assumed abandoned due to the age of the offer and stalled pipeline activity. One site in Mid Devon (35 MW) and one in South Somerset (10 MW), and one presumed abandoned site in Mendip (4 MW).	3	49 MW

Planning logic and assumptions

The assumptions around the proportion of pipeline sites and capacity that make it through planning at each stage, under each scenario, are derived from a statistical analysis of solar projects in the Renewable Energy Planning Database.

Scenario	Planning Granted or Under Construction	Planning Application Submitted	Pre-planning	No information	Years from Planning Submitted to completion
Falling Short	100%	25%	10%	Removed from analysis	3-7 years
System Transformation	100%	75%	25%	Removed from analysis	2-7 years
Consumer Transformation	100%	75%	25%	Removed from analysis	2-7 years
Leading the Way	100%	90%	50%	30%	2-5 years

Medium-term (April 2028 to March 2035)

There are key scenario-specific assumptions in the analysis that account for a mix of geographic factors that may influence solar PV uptake. The total modelled solar capacity by 2035 varies widely depending on the scenario. The main factor determining solar capacity growth is unconstrained solar resource – land that has sufficient irradiance levels, is in proximity to the existing distribution network, sited on medium-to-low agricultural grade, outside of flood zones, and not located within protected areas, such as AONBs. A varying proportion of this solar resource is modelled to be exploited under the scenarios, reflecting the assumptions of the level of ambition for distributed renewables under each scenario. In addition to this, some repowering occurs in the early-2030s under **Leading the Way**, slightly later in other scenarios, as legacy sites are retrofitted with new generation solar modules.

Scenario	Description	Capacity by 2035
Falling Short	Capacity growth remains limited, with a small resurgence from 2026-2030 as some pipeline sites connect on delayed timelines. Past 2030, there is limited projected capacity growth, which reaches just over 2 GW by 2035, favouring areas with high historic planning friendliness and available resource. Early repowering of older sites is rare, leaving baseline sites at their original capacities.	2,115 MW
System Transformation	Historic planning friendliness plays a larger role than local ambition in determining where post-pipeline solar projections are located. There is steady but limited solar deployment out to 2035.	2,497 MW
Consumer Transformation	Local ambition plays a larger role than historic planning friendliness in determining where projections are located. As under **System Transformation**, 2.5 GW is deployed by 2035.	2,551 MW
Leading the Way	Pipeline projects with less development evidence continue to connect in the late 2020s and early 2030s (in addition to those	3,832 MW

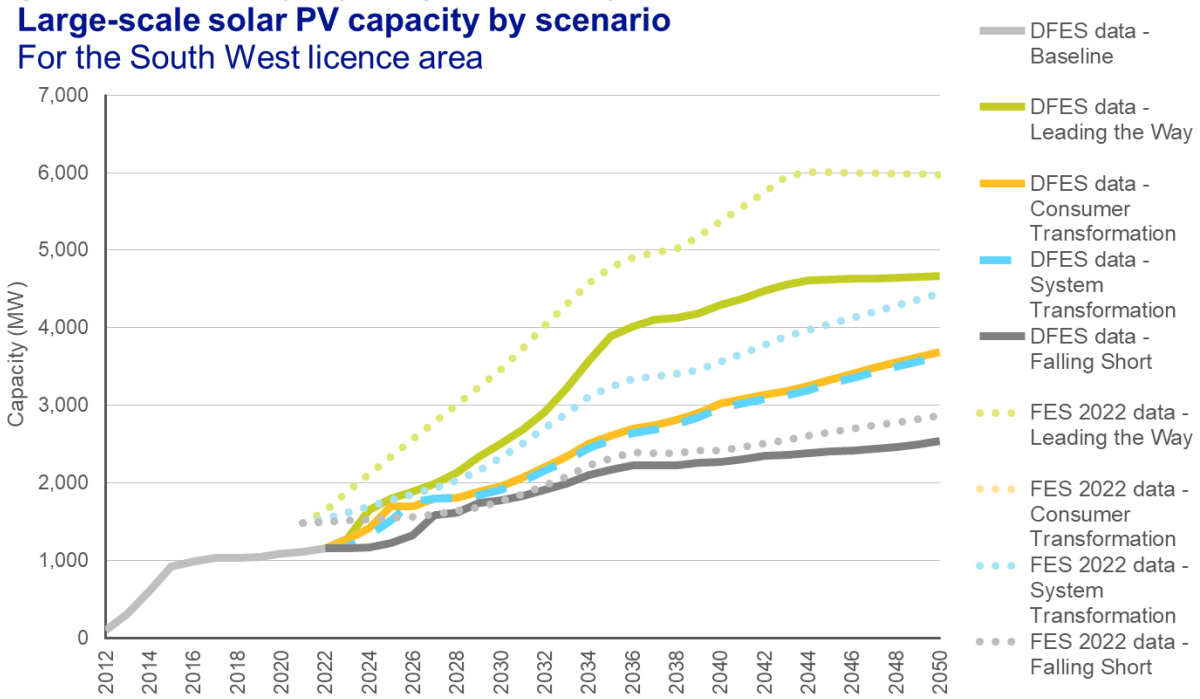
	modelled to connect in the mid-2020s). This includes projects that have yet to apply for planning permission. At the same time, areas with high solar resource and local government ambition see additional growth, reaching close to 4 GW of capacity installed by 2035. Historic planning friendliness plays a relatively small role.	

Long-term (April 2035 to March 2050)

Post-2035, long-term projections are determined by solar resource availability above all other factors. This is due to the assumption that factors like planning friendliness and local government ambition are less likely to reflect past trends, due to changes in local administration, public opinion and broader energy system policies. Deployment saturation is seen in areas with strong historic planning friendliness, which in turn pushes developers to seek connections in other high solar resource areas. Repowering legacy sites with new higher-yield solar PV modules takes place from the 2030s onwards, peaking in the late 2030s under **Consumer Transformation** and **System Transformation**. Standard modules in the 2010s were 250 W, with today's standard offering at 540 or above for ground-mounted solar farms[xviii]. In the future, modules of over 600 W are likely to be deployed. As with the medium-term, the total installed solar PV capacity by 2050 ranges significantly by scenario, from 2.5 GW under **Falling Short** to 4.6 GW under **Leading the Way**.

Scenario	Description	Capacity by 2050
Falling Short	Repowering of sites is rare, leaving most baseline sites at their original capacities. Additional capacity growth begins to stagnate in the late-2030s, reaching less than 2.5 GW by 2050 – though still more than double the baseline capacity.	2,483 MW
System Transformation	Modelled deployment continues out to 2050 at a steady rate, with a focus on sites with high resource availability across the licence area. Older solar sites are modelled to repower at +25% of their original capacity.	3,567 MW
Consumer Transformation		3,621 MW
Leading the Way	Very high levels of solar development sees risk of self-cannibalisation, where low demand and high supply on sunny days leads to oversupply, constraints and low electricity prices. This contributes to a deceleration in newbuild ground-mount solar growth towards the end of the 2040s. The threat of self-cannibalisation is mitigated by co-location with battery storage and, in some cases, hydrogen electrolysis, as well as demand-side flexibility to meet peak generation. Older solar sites are modelled to repower at +50% of their original capacity.	4,586 MW

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



- The FES 2022 baseline is c. 400 MW higher than the DFES 2022 baseline for the South West licence area. The reason for this significant variance is unclear. This variance was present in DFES 2021.
- DFES 2022 models a strong near-term uptake of solar in the licence area under all three net zero scenarios, compared to a strong near-term uptake solely under **Leading the Way** in the FES 2022. This is due to the rigorous pipeline status analysis undertaken by the DFES, where projects with accepted connection offers and high likelihood of planning acceptance are modelled to connect to the network under varying timeframes. The increase in positive development evidence in the pipeline strongly supports this near-term increase. This includes a quadrupling of accepted planning applications compared to DFES 2021.
- From the mid-2020s onwards, DFES 2022 projections largely follow the FES 2022 trends and rates of development. The overall capacity buildout is lower, in-part due to the baseline variance and in part due to a re-allocation of projections, particularly under **Leading the Way**, to the other three licence areas to account for the available unconstrained resource in these regions. Whereas the FES modelling assumes that installed capacity will spread more evenly across the country as installed solar capacity increases, the DFES analysis allocates licence area level projections to areas with high levels of solar irradiance and land availability.

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.	NOABL wind speed 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[xix]
Proportion of solar sites that are successful with a planning application in the local planning authority.	Renewable Energy Planning Database

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

Small-scale solar generation 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	2025	2030	2035	2040	2045	2050
Falling Short	444	482	550	639	727	815	905
System Transformation		524	746	999	1,252	1,504	1,757
Consumer Transformation		627	1,104	1,621	2,140	2,671	3,204
Leading the Way		630	1,118	1,653	2,190	2,739	3,293

Summary:

- During the 2010s, the South West licence area saw particularly high levels of small-scale solar deployment as a result of the Feed-in Tariff support scheme. The number of homes in the baseline with solar PV is almost twice the GB average.
- Deployment of small-scale solar had stalled in recent years. However, recent increases in energy prices have resulted in a strong uptick in deployment in 2022, and a pipeline of homes and businesses looking to install solar PV in the coming months and years.
- Beyond the near term, future deployment of small-scale solar varies strongly by scenario. Under **Consumer Transformation** and **Leading the Way**, high levels of electrified transport and heating drives small-scale solar uptake to reach over seven times today's levels.
- Despite lower levels of electrification, **System Transformation** and **Falling Short** still see high levels of deployment, at four times and double today's levels respectively, as reducing costs and uptake of electric vehicles drives solar PV uptake under every scenario.
- By 2050, small-scale solar capacity is highest under **Leading the Way** at 3.3 GW.

Modelling assumptions and results

Baseline			
Scale	**Number of sites**	**Total capacity**	**Notes**
Domestic (Under 10 kW)	76,909	270 MW	Equivalent to 5.1% of homes
Commercial (10 kW–1 MW)	3,123	174 MW	Average array size: 56 kW
Feed-in Tariff deployment			
The vast majority of historic development occurred between 2010 and 2016, when Feed-in Tariff generation payments were highest. Over 360 MW of capacity, 86% of the baseline, was deployed in the South West licence area in these years.			
Recent deployment			
The Feed-in Tariff closed to new entrants in 2019, and Smart Export Guarantee rates have not proven lucrative enough alone to drive significant further deployment of small-scale solar PV. As such, deployment in the licence area had stalled, with only 10 MW deployed between 2019 and 2021. However, since April 2021 over 12 MW of capacity has been installed in the licence area in response to substantial increases in retail electricity and gas prices. This deployment is anticipated to continue into the near term as the cost-of-living crisis is causing further increases in energy bills.			

Pipeline (April 2022 to March 2024)

There are nearly 400 small-scale solar sites in the pipeline, representing over 17 MW of potential additional capacity in the licence area. The vast majority of this capacity is commercial-scale sites, between 10 kW and 1 MW in size. However, this is partly due to domestic solar sites often commissioning quickly and not holding a connection agreement for long before being installed.

Scale	Number of pipeline sites	Total capacity
Domestic (Under 10 kW)	237	1.2 MW
Commercial (10 kW–1 MW)	147	16.2 MW

Pipeline assessment

Scale	Number of sites	Total capacity	Scenario outcomes
Below 50 kW	324 (84% of total)	3.4 MW (20% of total)	This includes notified domestic rooftop arrays that are very unlikely to rescind their connection agreements. These sites are modelled to connect in 2023 under every scenario.
50-500 kW	55 (15% of total)	9.8 MW (56% of total)	These sites go ahead in 2023 under the three net zero scenarios. Under **Falling Short**, the most recent applications are not modelled to connect until 2024, while agreements that have been held for longer connect in 2023.
Above 500 kW	5 (1% of total)	4.1 MW (24% of total)	Two of these sites are under construction and are modelled to connect in 2023 under every scenario. The remaining sites were not found in planning and are modelled to connect between 2023 and 2024 in the net zero scenarios, and between 2024 and 2025 under **Falling Short**.

Rooftop PV on new build homes (April 2022 to March 2050)

Rooftop PV on new build homes is modelled using the outputs of the DFES modelling of new housing developments. Currently, around 10% of recently built homes in England have been built with rooftop solar PV[xx].

This proportion of homes with rooftop solar is anticipated to increase, as changes to Building Regulations (Part L)[xxi] to reduce carbon emissions for new-build homes have been introduced in June 2022, with further changes expected in 2025.

The impact of these regulations has been modelled to vary by scenario. In Scotland, more ambitious building regulations have already been in place for a number of years, resulting in an estimated 60-80% of new-build homes having rooftop solar[xxii].

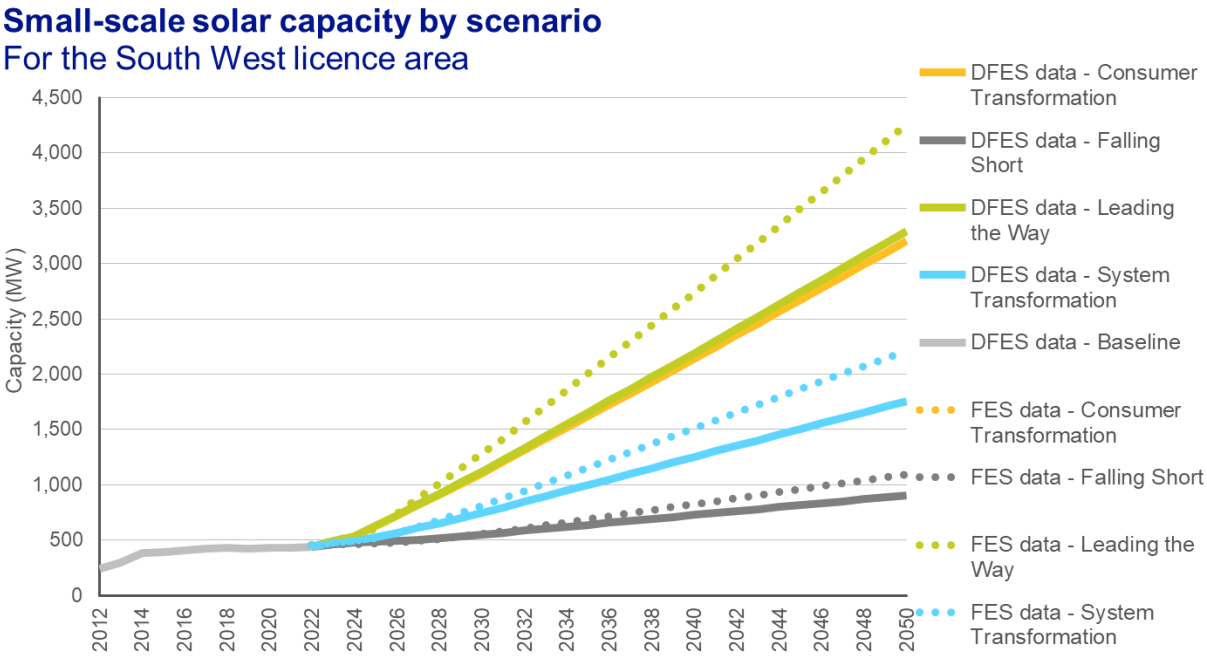
Under **Consumer Transformation** and **Leading the Way**, deployment of rooftop solar on new-build homes accelerates towards this figure over the 2020s and early 2030s. However, under **System Transformation,** the changes to Building Regulations Part L have been modelled to have a lower impact, and under **Falling Short** deployment remains unchanged at 10% of new homes.

Scenario	Proportion of new-build homes with rooftop solar PV		
	2025	2030	2050
Falling Short	10%	10%	10%
System Transformation	15%	25%	40%
Consumer Transformation	20%	50%	70%
Leading the Way	20%	50%	70%

Medium and long-term projections (April 2024 to March 2050)		
In addition to modelled deployment on new-build homes, small-scale solar PV uptake accelerates from the mid-2020s in all scenarios. This is due to a combination of falling installation costs, and opportunities to increase self-consumption, such as through smart electric vehicle charging, domestic batteries and thermal storage.		
Scenario	**Description**	**Capacity by 2050**
Leading the Way	Under **Consumer Transformation** and **Leading the Way**, deployment is bolstered by high levels of consumers engaging with smart electricity usage, dynamic electricity tariffs and general green ambition. This results in a very high uptake of small-scale solar under these scenarios, peaking at just under 3.3 GW by 2050 under **Leading the Way**.	3,293 MW
Consumer Transformation		3,204 MW
System Transformation	Due to the need to decarbonise electricity demand quickly to meet carbon reduction ambitions, solar PV uptake is also high under **System Transformation**. However, greater use of larger-scale solutions and a reliance on low carbon hydrogen for space heating (rather than electrification), results in a lower uptake in small-scale solar, than is seen in the other two net zero scenarios.	1,757 MW
Falling Short	**Falling Short** reflects a lower uptake of low carbon technologies, smart tariffs and less engaged consumers. This results in a much lower demand for small-scale solar on homes and businesses.	905 MW

Licence area building stock and demographic factors		
The licence area projections for small-scale solar PV are based on a number of building stock and demographic factors, based on engagement with local and regional stakeholders. These are detailed below:		
Factor	**Reason for inclusion**	**Licence area relative to GB**
Baseline	The proportion of homes and businesses with solar PV in the baseline is used as a key indicator of where solar is currently most active. The impact of this factor decreases in the 2030s and 2040s, as rooftop PV becomes more widespread.	Well above the GB average
Irradiance	Sunnier licence areas have been modelled to see greater uptake of rooftop PV, as higher levels of irradiance reduce the payback periods for rooftop PV installations.	Well above the GB average
Affluence	The average level of affluence in the licence area has a small impact on the deployment of domestic rooftop PV in the near term, due to the capital costs of solar PV installations. The impact of this factor decreases quickly as rooftop solar quickly becomes much more common under each scenario.	Slightly below the GB average
Building type	The number of semi-detached and detached homes in the licence area impacts the uptake of domestic PV. These buildings typically have more roof space and less shading.	In line with the GB average
Building tenure	Owner-occupied and socially rented homes are anticipated to see greater levels of domestic rooftop PV deployment now and in the future, compared to private rented homes.	Slightly below the GB average
Local authority	Local authority ambitions, in the form of climate emergency declarations or renewable generation targets, are modelled to have a small impact on commercial rooftop PV uptake. Similarly, analysis of historic planning application success for solar projects has a small impact on the modelling.	Slightly below the GB average

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



- 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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Falling Short	337	362	399	433	472	530	581
System Transformation		367	417	509	636	741	836
Consumer Transformation		404	571	820	1,219	1,588	1,649
Leading the Way		380	506	706	1,041	1,333	1,405

Summary:

- There is a notable baseline (337 MW) of distributed onshore wind in the South West licence area, hosting some of the first commercial wind farms in the UK. More than half of the baseline capacity, 174 MW, was connected in 2011 or earlier.
- There is potential for significant growth in additional wind capacity in the licence area, due to available wind resource, land availability and high levels of local ambition. Planning friendliness is mixed, with around 52% of onshore wind projects that have been through the planning process securing approvals. Due to these factors, stronger growth in connected capacity is seen under **Consumer Transformation** and **Leading the Way**, while **Falling Short** sees a more limited uptake, due to lack of support from planners accepting the pipeline of new projects, failing to reach net zero goals.
- Onshore wind capacity grows significantly across the 2030s and early 2040s, levelling out in the late 2040s as decarbonisation targets are largely met a few years ahead of target, especially under **Consumer Transformation** and **Leading the Way**.
- In all scenarios, baseline sites accredited under the Feed-in Tariff between 2012 and 2018 are modelled to repower at the end of their operational life of 25-30 years in the late 2030s and early 2040s
- By 2030, connected capacity is highest under **Consumer Transformation** at 569 MW, reaching 1.6 GW by 2050 under the same scenario.

Modelling assumptions and results

Baseline			
Scale	**Number of sites**	**Total capacity**	**Description**
Total	647	337	The vast majority of sites (c. 95%) are made up of small turbines of below 1 MW. However, the majority of installed capacity (c. 80%) is made up of sites of over 1 MW. The South West has a large amount of developable land and high wind speeds, which contributes to its attractiveness for wind development.
Above 1 MW	34	272	Fifteen of the large-scale distributed wind sites are located in Cornwall. There are six sites in Devon, 5 in Bristol, and 5 in Torridge. The average installed capacity of sites is 8 MW. The largest site connected to the distribution network in the licence area is the 66 MW Fullabrook Down Windfarm site[xxiii].

Below 1 MW	613	65	The South West has the highest amount of small-scale installed capacity out of the four NGED licence areas, with the majority of sites connecting between 2012 and 2017. Approximately 490 projects with an average capacity of 41 kW were supported by the FIT scheme.

Pipeline (April 2022 to March 2028)

Number of pipeline sites	Total capacity
11	85 MW

There is a moderate pipeline of potential new onshore wind capacity in the licence area, 11 sites totalling 85 MW. The majority of pipeline capacity comes from three sites, totalling 57 MW.

Since the pipeline consists of small and medium-sized projects, build-out remains fairly limited. All known projects are modelled to connect before 2029. In terms of planning status, two sites are currently under construction, one site has been granted planning permission, one is in pre-planning, and the remaining five sites have no information or specific considerations. More information is shown in the table below.

In-depth analysis of new wind developments shows that sites can take a range of years to commission, depending on the capacity of the project. On average, larger sites take longer to commission, yet some of the smallest sites may also have longer construction timelines. Pipeline information has been derived from direct developer engagement as well as Renewable Energy Planning Database and local authority planning portal analysis, and has been used to inform the medium-term projection years modelled in the DFES.

Pipeline analysis

Status	Scenario outcomes	Sites	Capacity
Planning Permission Granted	There is a 20 MW pipeline site at Cold Northcott in Cornwall, which was approved in 2020 to increase the capacity of the existing wind site. A further 2.5 MW application has been approved at Accolade Wines in Bristol, following a site location amendment.	2	23 MW
Under Construction	Two new wind sites totalling 17 MW were under construction in Cornwall and Bristol as of Q3 2022.	2	17 MW
Planning Application Submitted	No sites were found to have a planning application in progress or awaiting a decision.	--	--
Pre-planning	One site has been identified as being in pre-planning, which is likely to be a proposed extension to an existing 12.3 MW site that is already under construction in Cornwall.	1	10 MW
No information	A total of 6 sites have no additional information that is publicly available. These are only modelled to connect under the net zero scenarios, as per the pipeline logic below.	6	36 MW

Planning logic and assumptions

The assumptions around the proportion of pipeline sites and capacity that make it through planning at each stage are derived from a statistical analysis of the Renewable Energy Planning Database.

Scenario	Planning Granted or Under Construction	Planning Application Submitted	Pre-planning	No information	Years from Planning Submitted to completion
Falling Short	100%	30%	25%	removed from analysis	6-10 years
System Transformation	100%	75%	40%	25%	5-9 years
Consumer Transformation	100%	80%	60%	50%	3-7 years
Leading the Way	100%	75%	40%	25%	5-9 years

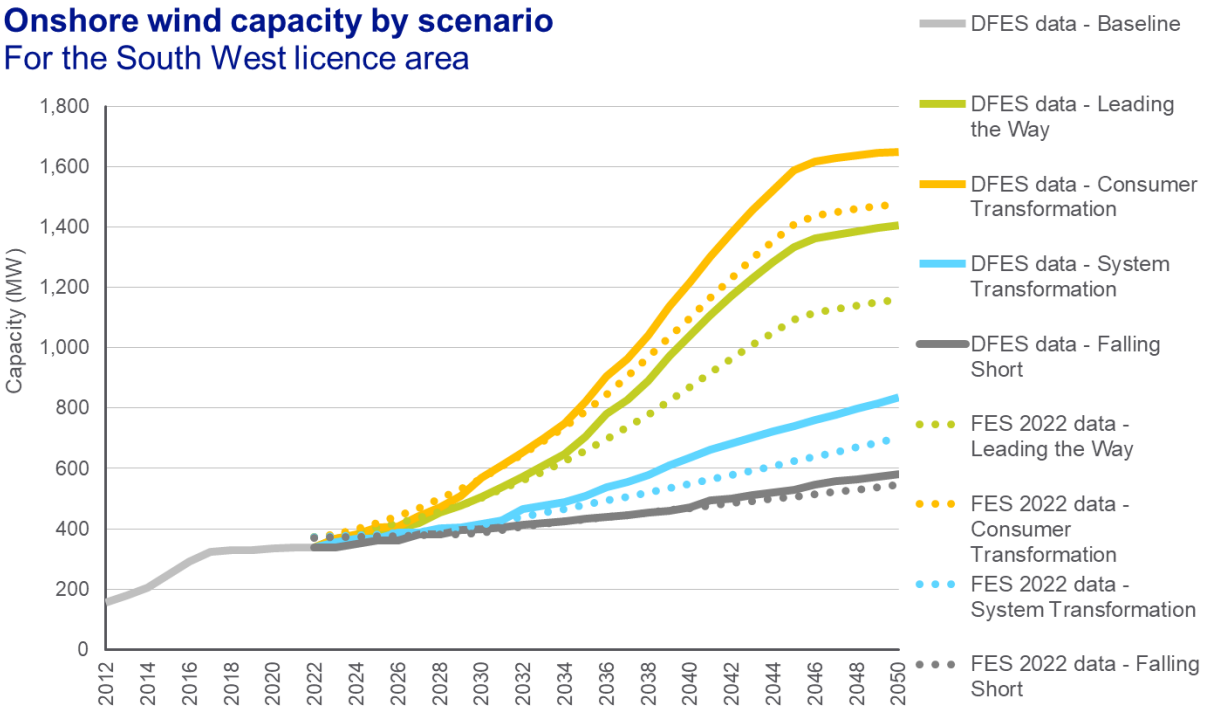
Medium-term (April 2028 to March 2035)		
Scenario	**Description**	**Capacity by 2035**
Falling Short	Wind capacity development in the region remains limited, with only a few pipeline sites coming through in the late 2020s to early 2030s. This is due to an assumption that planning regimes remain largely inhibitory towards new wind farm developments under this scenario. New sites connect at similar levels to historic rates. Only one legacy wind farm is repowered in this scenario.	433 MW
System Transformation	Wind farms see limited development as a result of low levels of planning friendliness and a general preference for transmission network-connected wind farms to achieve net zero targets.	509 MW
Consumer Transformation	A significant proportion of the pipeline continues to connect across the late 2020s and early 2030s, with as much as 80% of sites with a live planning application being successfully progressing through to development. Distributed onshore wind is seen as a key technology to reducing carbon emissions in the electricity system under this scenario.	820 MW
Leading the Way	This scenario sees significant onshore wind capacity connecting in the licence area, although some of this new capacity connects to the transmission network. This results in a slightly lower capacity connected to the distribution network than that seen under Consumer Transformation.	706 MW

Long-term (April 2035 to March 2050)		
Scenario	**Description**	**Capacity by 2050**
Falling Short	Distributed wind capacity in the region falls short of doubling the amount of the current baseline by 2050. Some new sites continue to connect at similar levels to historic rates. Sites larger than 5 MW experience a repowering of +25%.	581 MW
System Transformation	Long-term deployment of onshore wind sees steady yet limited growth as more large-scale wind farms connect at transmission-level voltages. Repowering rates remain modest, accounting for some of the new capacity connecting in the 2030s and 2040s. Sites larger than 5 MW experience a repowering of +25%[xxiv]. All other sites repower at +50% of their original capacity.	836 MW

Consumer Transformation	Small-scale distributed wind capacity sees the highest growth under this scenario, reaching 1.6 GW by 2045 and levelling out to over 1.6 GW by 2050. Sites larger than 5 MW experience a repowering of +50%. All other sites repower at +100%.	1,649 MW
Leading the Way	Repowering and unconstrained wind resource continue to spur development out to 2050 under this scenario. Sites larger than 5 MW are repowered at +50%. All other sites repower at +100%. The flattening of new capacity from 2045 in **Leading the Way** and **Consumer Transformation** reflects assumptions in the FES 2022, and can be seen as a cannibalisation of onshore wind as land and resource becomes saturated in the licence area.	1,405 MW

Reconciliation with National Grid FES 2022

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



- The FES 2022 baseline (372 MW) is closely aligned with the DFES 2022 baseline (337 MW) for the South West licence area. Near-term pipeline projections are also largely aligned, seeing an uplift to 500 MW by 2028 under **Consumer Transformation** under the FES, compared to 467 MW under the DFES.
- There is a moderate variance in the long term between the DFES and FES, which reflects a potentially different approach to the repowering of existing turbines and wind farms in the DFES. This includes the repowering of existing sites at a higher capacity at the end of their operational life, as well as the addition of extra turbines and retrofitting of existing blades with newer, higher-yield models. This has a specific near-term impact in the South West from 2026 onwards, as it is a licence area that hosts some of the oldest onshore wind farms in the UK.

- Another reason for long-term ambition in **Consumer Transformation** and **Leading the Way** that exceeds the FES is due to the bias imposed on projections by the ban on new onshore wind capacity in England. This bias is reflected in previous long-term projections under FES that favour licence areas in Wales and Scotland, due to more favourable planning environments. This approach is not fully reflective of the wind resource availability in other English licence areas. The DFES projections are evidenced by an in-house wind resource assessment that redistributes licence area projections in proportion to several factors, including available and unconstrained resource, as well as a regional analysis of planning friendliness.
- Compared to FES 2021, FES 2022 long-term projections by 2050 have increased from c. 1.1 GW to 1.3 GW under **Consumer Transformation**. This suggests that the FES figures are approaching a similar level of ambition to the DFES methodology.

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 proclivity 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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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 geothermal power in the South West licence area:

Capacity (MW)		Baseline	2025	2030	2035	2040	2045	2050
Offshore wind	Falling Short	0	0	35	135	135	135	135
	System Transformation		35	135	135	135	135	135
	Consumer Transformation		35	167	167	167	167	167
	Leading the Way		35	167	167	167	167	167
Tidal stream	Falling Short	0	0	0	0	0	0	0
	System Transformation		0	0	5	5	5	5
	Consumer Transformation		0	5	10	15	15	15
	Leading the Way		0	5	10	15	15	15

Summary:

- While there are no operational grid-connected offshore wind or marine energy projects in the South West licence area to date, there is an active pipeline of floating offshore wind projects.
- Two floating offshore wind projects, totalling 132 MW, have secured connection agreements. Beyond these projects, floating offshore wind is anticipated to scale up to connect to the transmission network.
- Up to 15 MW of tidal stream capacity has also been modelled to connect in North Devon under the three net zero scenarios.

Modelling assumptions and results

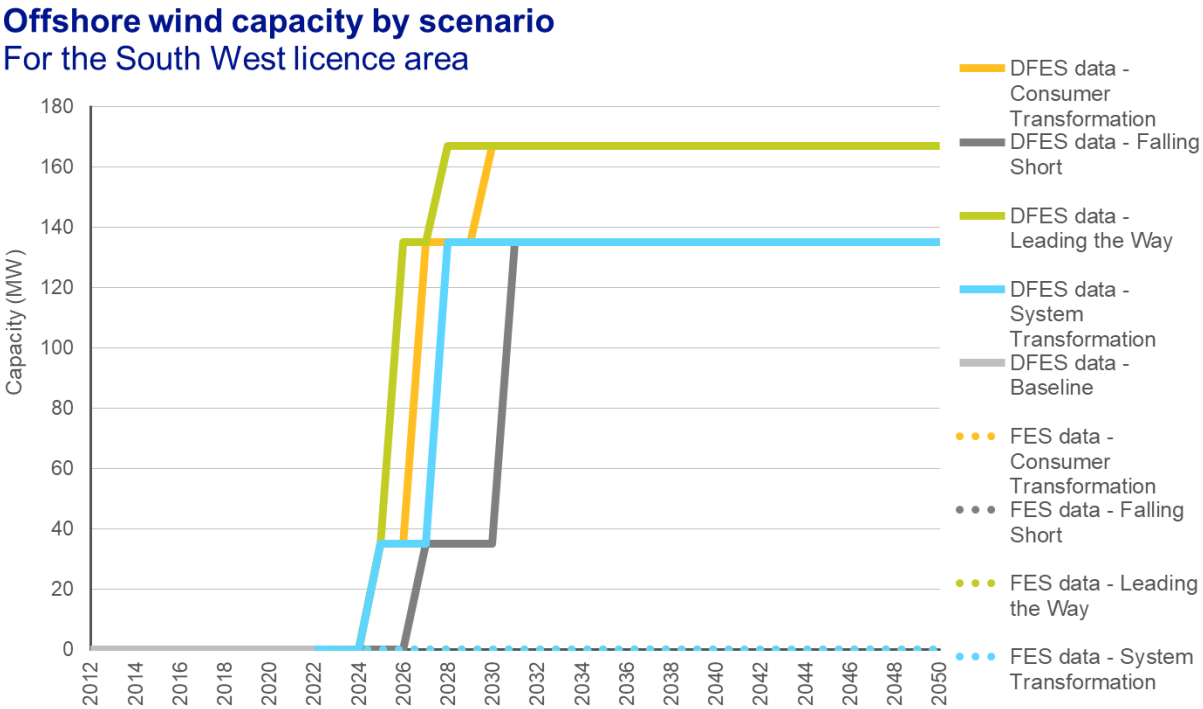
Baseline
There are no operational baseline marine energy or offshore wind projects connected to the distribution network in the South West licence area.

Pipeline (April 2022 to March 2030)		
There are two floating offshore wind projects with an accepted connection offer in the licence area:		
Project	**Capacity**	**Status**
White Cross[xxv]	100 MW	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**.
TwinHub[xxvi]	32 MW	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 engagement with developers Hexicon, the project connects in 2025 in the net zero scenarios, and in 2027 under **Falling Short**.

Medium and long-term projections (April 2030 to March 2050)
Offshore wind
TwinHub developers Hexicon identified the potential for the TwinHub demonstration site to be expanded with another 32 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. As a result, floating offshore wind deployment plateaus after the early 2030s.
Tidal stream
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 hosting tidal stream potential. Engagement with representatives from the marine energy industry suggested that Under **Consumer Transformation** and **Leading the Way** this results in 15 MW of tidal stream capacity modelled to come online over the 2030s, and a smaller 5 MW deployment modelled under **System Transformation**.
Wave energy
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 or areas of the coast of the South West licence area, despite the presence of wave energy resource. As such, no wave energy capacity has been modelled to connect under any of the future scenarios.

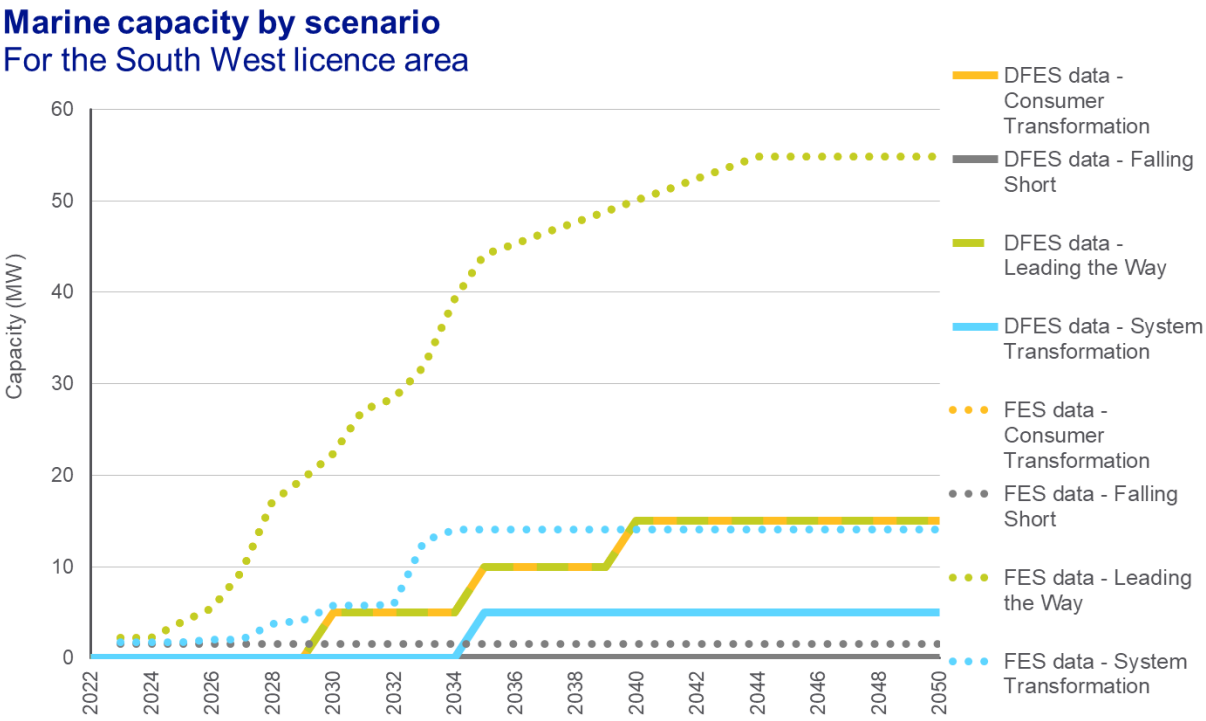
Reconciliation with National Grid FES 2022

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



- The National Grid FES 2022 projections for offshore wind in the South West licence area project no deployment under any scenario. The DFES projections are based on projects with accepted connection agreements and clear evidence of development.

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



- The DFES projections are lower than the FES projections in the three scenarios that see deployment of marine capacity. The variance peaks at 40 MW under the **Consumer Transformation** and **Leading the Way** scenarios.
- Other than the potential tidal stream development off Lynmouth, engagement with regional sector representatives did not identify further potential marine energy capacity that could connect to the distribution network in the South West licence area, with developer focus shifting strongly towards floating offshore wind.

Factors that will affect deployment at a local level

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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

Hydro in the South West licence area

Hydropower electricity generation

Data summary for hydropower in the South West licence area:

Capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Falling Short	12	13	13	13	13	13	13
System Transformation		13	13	13	14	14	14
Consumer Transformation		13	14	14	15	16	17
Leading the Way		13	13	13	14	14	14

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.
- With the closure of the Feed-in Tariff, deployment of small-scale hydropower has stalled. There is only one hydropower site with an accepted connection agreement in the licence area, a community energy scheme in Bristol.
- Due to lack of subsidy support and increased abstraction licencing costs, all scenarios see limited hydropower deployment. The scenario with the highest deployment, **Consumer Transformation**, sees an additional 4 MW of hydropower modelled to connect to the South West distribution network by 2050.

Modelling assumptions and results

Baseline			
Scale	**Number of sites**	**Total capacity**	**Description**
Above 1,000 kW	3	6.3 MW	These three sites operated by South West Water in Mary Tavy, Okehampton and Plymouth represent over half of the licence area's baseline capacity.
100-1,000 kW	14	4.4 MW	Several of the sites in the 100-1,000 kW range are at Dartmoor reservoirs, some dating back to the 1930s. The remainder were delivered through the Feed-in Tariff scheme in the 2010s.
Below 100 kW	66	1.7 MW	Very small-scale sites below 100 kW were predominantly supported via the Feed-in Tariff scheme.

Pipeline (April 2022 to March 2025)

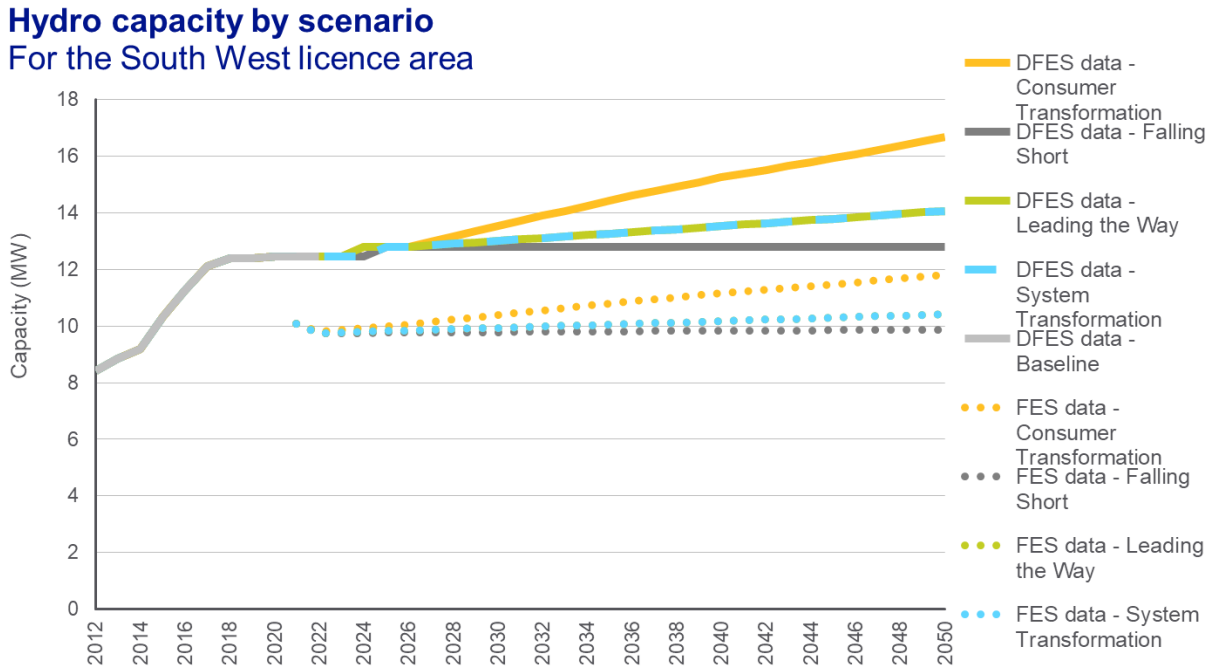
The only hydropower site in the South West licence area pipeline is the 360 kW Bristol Community Hydro Scheme at Netham Weir in central Bristol, developed by Bristol Energy Cooperative. This site achieved planning permission in early 2019, and recently tendered for groundworks and installation of Archimedes screw turbines at the site. This site is modelled to come online in all scenarios between 2024 and 2025.

The lack of further pipeline projects may be attributed to recent increases in Environment Agency abstraction licence costs[xxvii] that have made most small-scale hydro projects in development unfeasible.

Medium and long-term projections (April 2025 to March 2050)		
Scenario	**Description**	**Capacity by 2050**
Consumer Transformation	With a focus on decarbonisation through consumer engagement, this project sees steady deployment of small-scale hydropower out to 2050. Hydropower deployment is mainly driven by demand for onsite electricity generation and community energy schemes.	17 MW
Leading the Way	Under these scenarios, small-scale hydropower deployment is limited as large-scale solutions are prioritised. However, hydropower is deployed at select sites to aid decarbonisation, particularly where sites above 1 MW capacity could be deployed.	14 MW
System Transformation		
Falling Short	Lack of subsidy support and slow decarbonisation results in no further hydropower deployment.	13 MW

Reconciliation with National Grid FES 2022

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



- There is a small difference between the DFES and FES 2022 baselines for hydropower in the South West licence area, likely due to visibility and treatment of micro-scale hydropower sites. Beyond the near-term pipeline, the FES scenario assumptions for small-scale hydro are reflected in the DFES projections.

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	2025	2030	2035	2040	2045	2050
Falling Short	0	4	4	4	4	4	4
System Transformation		4	16	29	35	40	40
Consumer Transformation		9	35	45	55	60	65
Leading the Way		9	60	75	85	100	105

Summary:

- While there is no operational geothermal power generation capacity in the South West licence area to date, there is a strong development pipeline of prospective projects.
- The business case for geothermal power is challenging, with projects often facing high costs, investment challenges, long lead times and lengthy permitting processes. The outcome of progressing developments near Redruth and St Austell will have a major impact on geothermal deployment in the South West licence area in the longer term.
- 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.

Modelling assumptions and results

Baseline
There are no geothermal sites in the baseline producing electrical power. While 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 yet completed.

Pipeline (April 2022 to March 2028)	
Number of pipeline sites	**Total capacity**
6	35 MW
There is an active pipeline of geothermal power generation projects looking to develop in the near term. The United Downs site is expected to commission shortly under all scenarios, while a site at the Eden Project in St Austell is modelled to come online under the three net zero scenarios, having attained full planning permission. Several further sites have secured a connection agreement, but are currently in earlier stages of development.	

Pipeline analysis

Status	Scenario outcomes	Sites	Capacity
Under construction	The 4 MW under-construction United Downs site is modelled to come online in all scenarios around the end of 2022.	1	4 MW

<table>
<tr><td>Planning permission granted</td><td>A 5 MWe second phase of the Eden Project site, looking to produce heat and power from deep geothermal energy. The site has planning permission and is looking to secure investment to progress this second phase. As a result, the project is modelled to come online between 2023 and 2025 under the three net zero scenarios and does not go ahead under Falling Short.</td><td>1</td><td>5 MW</td></tr>
<tr><td>Planning application submitted</td><td>Four projects, located in south-western Cornwall around Redruth and Helston, are being developed by Geothermal Engineering Limited, following the progress of their United Downs site. These sites submitted planning applications in late 2021 and are currently awaiting decisions.

Given the greater uncertainty around these sites, the scenario outcomes are broader:
<table>
<tr><th>Scenario</th><th>Sites going ahead</th><th>Deployment timescale</th></tr>
<tr><td>Leading the Way</td><td>4</td><td>2026-2027</td></tr>
<tr><td>Consumer Transformation</td><td>4</td><td>2027-2030</td></tr>
<tr><td>System Transformation</td><td>4</td><td>2029-2038</td></tr>
<tr><td>Falling Short</td><td>0</td><td>n/a</td></tr>
</table></td><td>4</td><td>26 MW</td></tr>
</table>

Long-term projections (April 2028 to March 2050)

Beyond the current pipeline, developer engagement identified ten additional sites, each with an electrical capacity of around 5 MW. 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.

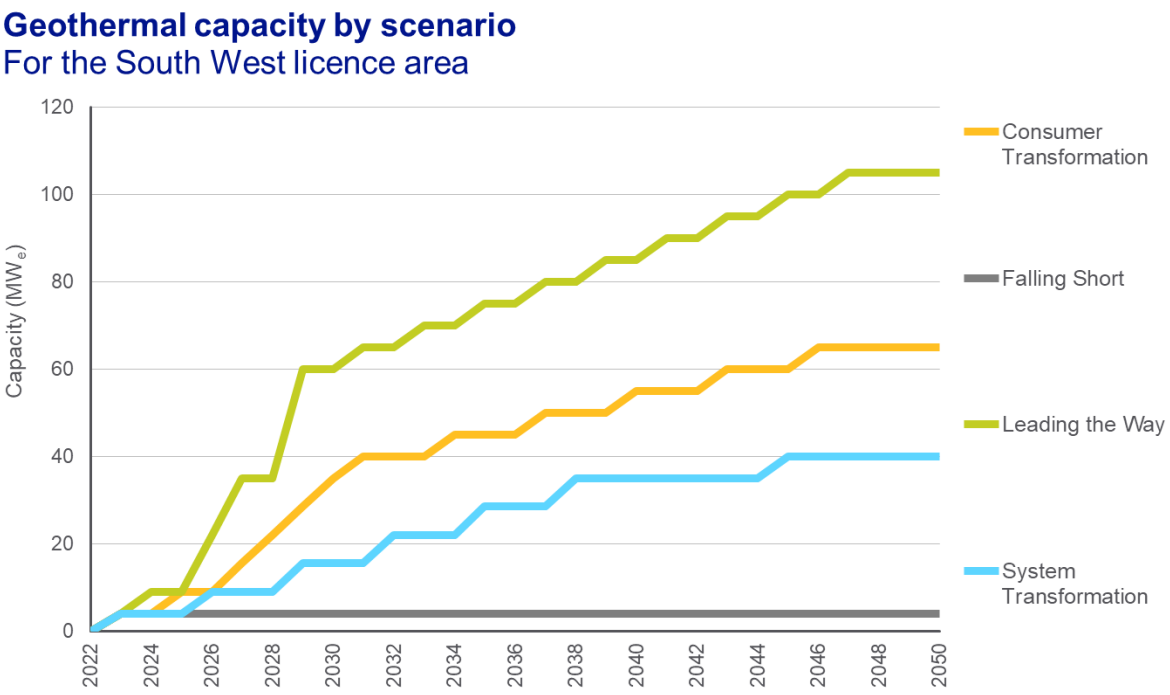
In the long term, deployment of geothermal heat and power capacity will depend on a viable and available business model, for example through private wire agreements with neighbouring industrial heat and power off-takers, ringfenced CfD funding for geothermal or the ability for geothermal power producers to participate in the Capacity Market. 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	Number of sites by 2050	Capacity by 2050
Leading the Way	Under this scenario, 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.	17	105 MW
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.	12	65 MW

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.	7	40 MW
Falling Short	No further geothermal capacity is developed under this scenario.	1	4 MW

Reconciliation with National Grid FES 2022

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



- There is no distribution-connected geothermal capacity in the FES 2022 Building Block ID number Gen_BB019 in the NGED licence areas.
- The DFES projections have been modelled based on known projects and direct engagement with geothermal power developers. The previous year has seen progress for individual projects and long-term plans for the sector.

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 modelled based on subsurface heat flows, with prospective geology around Penzance and Redruth.	British Geological Survey

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Falling Short	6	6	6	6	6	6	6
System Transformation		6	6	7	8	9	11
Consumer Transformation		6	6	6	6	7	7
Leading the Way		6	6	6	7	7	8

Summary:

- The biomass baseline in the South West consists of small-scale sites, predominantly providing combined heat and power to kaolin clay extraction and processing sites and business parks.
- In other areas of the country, biomass capacity decreases in the three net zero scenarios as larger-scale standalone biomass power generation is progressively decommissioned. However, as the South West mainly hosts smaller-scale CHP biomass generation, there is some growth in the capacity in all three net zero scenarios as a means of decarbonising heat and industrial energy, particularly under **System Transformation**.
- Under **Falling Short**, biomass capacity remains relatively static as alternative uses of bioenergy in harder-to-decarbonise sectors are not achieved under this scenario.

Modelling assumptions and results

Baseline

The six operational biomass baseline sites in the South West appear to use biomass for CHP.

The sites heated and powered by this biomass generation include an Imerys kaolin clay extraction and processing site at Lee Moor and a Tesco distribution centre in Bristol.

Scale	Capacity	Number of sites
1-5 MW	4.3 MW	2
Below 1 MW	1.2 MW	4

Details of largest baseline sites

Site name	Location	Connection date	Capacity
Lee Moor	Plymouth, Devon	March 2011	3.0 MW
Tesco G Park HVM	Western Approach, Bristol	April 2021	1.3 MW
Hill Barton Business Park	Exeter, Devon	April 2017	0.6 MW

Pipeline (April 2022 to March 2026)

There is only one pipeline biomass site in the South West licence area, with a capacity of 3 kW. This is too small to need planning permission and is assumed to progress in 2023 in all scenarios.

Medium-term and long-term projections (April 2026 to March 2050)

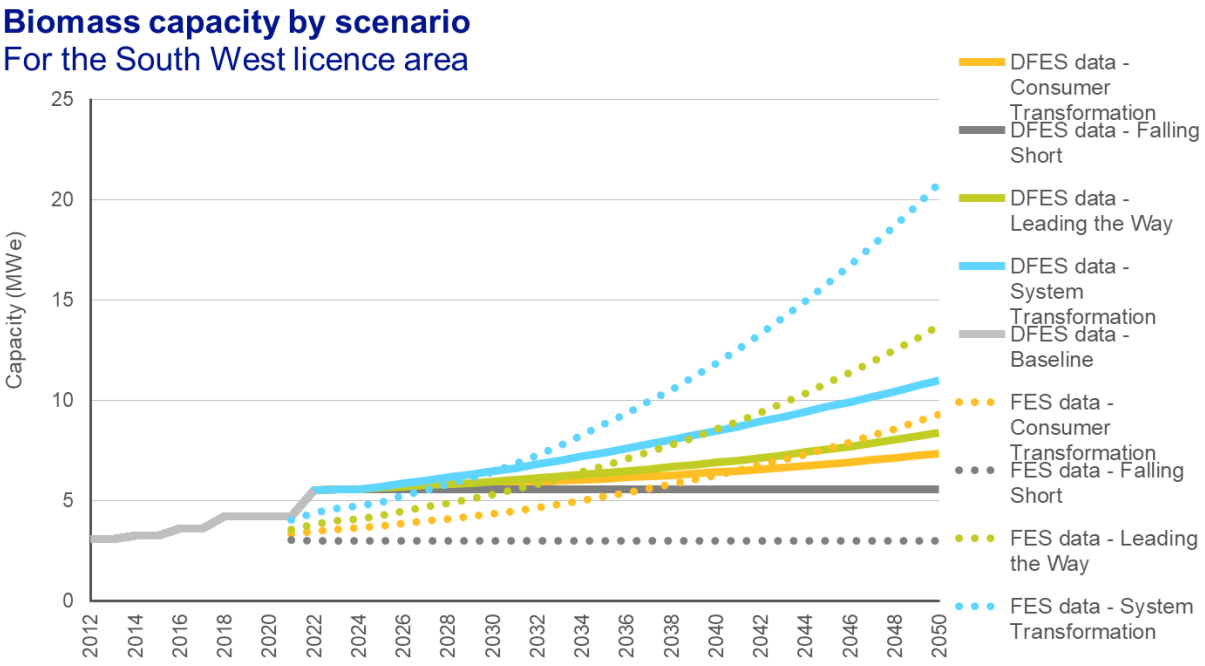
The fate of biomass CHP generation on the distribution network is strongly dependent on the demand for biomass from non-power sectors under each scenario.

Scenario	CHP generation	Capacity by 2050

Leading the Way	Greater electrification of heat in these two scenarios results in less demand for biomass CHP. However, there is still some growth in biomass CHP capacity, particularly for heating in heat networks, business parks and industrial sites such as the Imerys baseline site.	8 MW
Consumer Transformation		7 MW
System Transformation	While heat is dominated by hydrogen, biomass CHP sees uptake in the longer term in areas not connected to the hydrogen network.	11 MW
Falling Short	Biomass CHP sees no further growth under this scenario, as decarbonisation is slow and many sectors do not fully decarbonise.	6 MW

Reconciliation with National Grid FES 2022

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



- The FES GSP-level baseline for the South West licence area broadly aligns with the DFES baseline.
- There are similar scenario trends between the FES and DFES data. However, the growth in each DFES scenario is lower than the corresponding FES scenario. This is primarily due to the lack of pipeline sites in the South West licence area, limiting near-term deployment and longer-term outcomes.

Factors that will affect deployment at a local level

Factor	Source
Sites already in the NGED connections baseline and pipeline, categorised into standalone power generation and CHP sites.	NGED

For input, evidence and assumptions based on stakeholder engagement for this licence area, a separate summary report can be found here

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 (MWe)	Baseline	2025	2030	2035	2040	2045	2050
Falling Short	88	88	77	74	56	51	50
System Transformation		88	99	86	69	63	63
Consumer Transformation		92	109	109	93	88	88
Leading the Way		92	112	113	97	92	93

Summary:

- The 88 MW baseline of renewable engines in the South West licence area consists mainly of landfill gas, with smaller proportions of anaerobic digestion and sewage gas capacity. The pipeline of projects with accepted connection agreements is relatively small, consisting of six projects totalling 14 MW.
- Sewage gas, landfill gas and anaerobic digestion capacity projections are modelled separately, as these technologies see different outcomes in each of the four scenarios.
- Landfill gas 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.
- Sewage gas 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.
- Anaerobic digestion of other feedstocks sees an 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.
- Overall, **Consumer Transformation** and **Leading the Way** see an increase in capacity across the 2020s and early 2030s, as a result of anaerobic digestion deployment before capacity reduces over the longer term as a result of landfill gas site decommissioning.
- **System Transformation** and **Falling Short** see a reduction in the capacity of renewable engine technologies over the scenario timeframe, as the reduction in capacity from landfill gas decommissioning is not countered by anaerobic digestion uptake in these scenarios.

Modelling assumptions and results

Baseline

The renewable engines baseline has been categorised into anaerobic digestion, sewage gas and landfill gas. The baseline totals 88 MW in the licence area.

While these sub-technologies fall under the renewable engines umbrella, the potential future outcomes for each of these types of sites are markedly different under the DFES scenarios.

Type of site	Number of sites	Capacity	Details
Anaerobic digestion	30	22 MW	The majority of anaerobic digestion baseline capacity is at sites of less than 2 MW capacity at farms in rural areas. Three-quarters of the baseline is in Devon and Cornwall.

Sewage gas	18	18 MW	Sewage gas generation consists mainly of small-scale sites of up to 2 MW, located at sewage treatment works in the licence area. These sites mainly provide onsite CHP generation.
Landfill gas	15	49 MW	The landfill gas baseline consists of medium-scale sites near urban areas, all connected between 1990 and 2012.

Pipeline (April 2022 to March 2026)

The pipeline of projects with accepted connection agreements is relatively small compared to the baseline, indicating minimal near-term growth for these technologies. This is partly due to decreasing government support for renewable heat and electricity generation, such as the Renewable Heat Incentive and Feed-in Tariff, which supported notable renewable engine project deployment during the 2010s.

Type of site	Number of sites	Capacity	Scenario outcomes
Anaerobic digestion	3	1.9 MW	One site already has operational anaerobic digestion in place and is modelled to connect in the three net zero scenarios. The other two sites are modelled to connect under **Consumer Transformation** and **Leading the Way**.
Sewage gas	2	11.0 MW	A 4 MW site, located in Avonmouth, is part of the expansion of a wider sewage treatment works currently in development. This site is modelled to connect under the net zero scenarios. The other site, located in Plymouth, does not have any planning activity and is modelled to connect under **Consumer Transformation** and **Leading the Way**.
Landfill gas	1	1.6 MW	This site is stated as under construction in planning, but appears to have stalled. As a result, it is modelled to connect only under **Consumer Transformation** and **Leading the Way**.

Medium and long-term projections (April 2026 to March 2050)

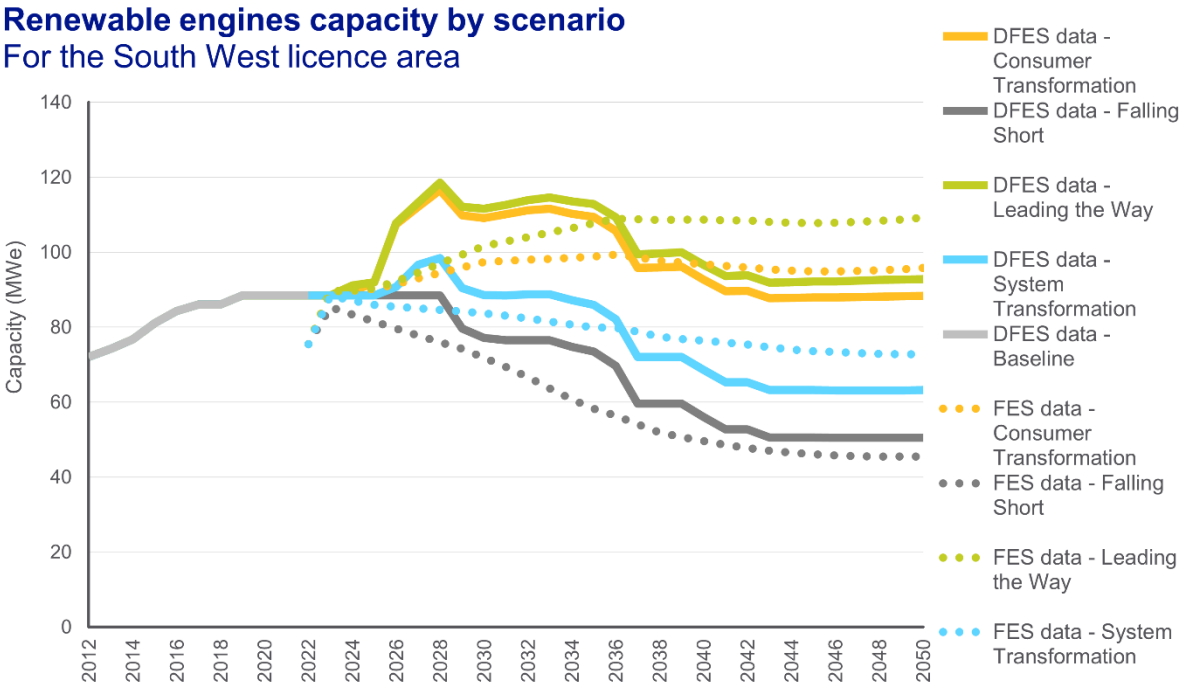
Type of site	Scenario outcomes
Anaerobic digestion	Future deployment of anaerobic digestion capacity has been informed by the existing baseline in each licence area. Under **Consumer Transformation** and **Leading the Way**, deployment peaks in the late 2020s and early 2030s, as the electricity system is rapidly decarbonised and small-scale, established renewables such as anaerobic digestion play a larger role.
Sewage gas	Sewage gas baseline and pipeline sites are modelled to remain connected at a consistent capacity out to 2050 under every scenario.
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.

As a result of the competing fates of the three site types, 2050 capacity is similar to or less than the baseline under each scenario.

Under **Consumer Transformation** and **Leading the Way**, the distribution of this capacity is shifted away from landfill gas sites and towards rural anaerobic digestion sites.

Scenario	2050 capacity
Falling Short	50 MW
System Transformation	63 MW
Consumer Transformation	88 MW
Leading the Way	93 MW

Figure 22 – Electrical capacity of renewable engines by scenario, South West licence area



- The FES baseline for renewable engines in the South West licence area is c.10 MW lower than the DFES. The reason for this variance is unclear, but could relate to differences in technology classification. The FES 2021 was more closely aligned with the DFES baseline.
- The near-term projections in the DFES diverge from the FES projections, as specific pipeline projects are modelled to connect under the net zero scenarios. The decrease in capacity in the FES projections under **Falling Short** is not reflected in the DFES, as no evidence has been found regarding decommissioning of baseline sites in the near term.
- The 2050 outcome for the four DFES scenarios is broadly aligned with the FES outcomes.

Factors that will affect deployment at a local level

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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Falling Short	212	212	110	48	0	0	0
System Transformation		110	48	0	0	0	0
Consumer Transformation		110	48	0	0	0	0
Leading the Way		97	0	0	0	0	0

Summary:

- The South West licence area has a number of existing operational diesel engines, including 87 MW of larger standalone commercial diesel generation sites and 125 MW of behind-the-meter backup generators co-located with large energy user buildings. This is substantially higher than last year's DFES baseline (136 MW) due to a number of projects being successfully reclassified from 'other generation'.
- There is one new diesel site with an accepted connection agreement from National Grid Electricity Distribution in the licence area. This is a 15 kW behind-the-meter backup generator in Falmouth. Due to its size and likely role as a standby generator, this is modelled to connect in every scenario in the 2024 financial year.
- The operation of unabated diesel generation is at odds with net zero emissions targets and is restricted through the enaction of the Medium Combustive Plant Directive (MCPD) into UK law. This requires diesel (and other combustion engine) generation plants to adhere to stringent air quality limits through environmental permitting unless they only operate for a few hours per year.
- As a result, all standalone diesel generation operating commercially is modelled to disconnect in all scenarios by 2032, with **Leading the Way** seeing the most rapid disconnection of commercial diesel capacity.
- Behind-the-meter backup generators are expected to stay connected to the network for longer under all scenarios, as they provide crucial services to many high energy users, including hospitals, industry and supermarkets, and only operate for a few hours a year. This assumption was supported by some major energy users in the National Grid Electricity Distribution licence areas that were engaged as part of the DFES 2022 process, who noted that there are limited plans in place to replace diesel backup generators in the near term, with some organisations looking into alternative fuels such as HVO in the medium-to-longer term.

Modelling assumptions and results

Baseline	
Number and capacity (MW) of standalone commercial diesel generators	**Number and capacity (MW) of behind-the-meter backup generators**
11 sites (87 MW)	25 sites (125 MW)
Largest baseline site:	49 MW diesel plant at Devonport Royal Dockyard, Plymouth.

Modelling assumptions

Existing operational sites in the licence area have been classified as either standalone commercial diesel generators or behind-the-meter backup generators. Larger diesel plants have historically targeted commercial electricity network reserve services (such as Short Term Operating Reserve (STOR) or the Capacity Market), while smaller backup generators tend to be located onsite at a number of large energy consumer buildings, such as water industry sites, supermarkets, data centres, national rail sites and hospitals.

Medium Combustive Plant Directive

In 2019, a piece of EU legislation known as the Medium Combustion Plant Directive (MCPD) was passed into UK law. This requires plants to adhere to stringent air quality limits through environmental permitting unless they only 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. This type of companion technology is unlikely to be financially viable, at least in the near term. The price of diesel has also significantly increased in recent years, further impacting the business case for future diesel generation.

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, for example for backup power generation on islands when the power supply is interrupted. The 3 MW St Mary's diesel backup generator on the Isles of Scilly is an example of where this exemption may apply.

The DFES modelling has sought to directly reflect the requirements set out under this regulation for diesel generation.

Near-term (April 2022 to March 2025)

There is one site with an accepted connection agreement from National Grid Electricity Distribution in the South West licence area; a 15 kW behind-the-meter backup generator in Falmouth. Due to its size and likely role as a backup generator, this site is modelled to connect in every scenario in the 2024 financial year.

As a fossil fuel, the operation of unabated diesel-fuelled electricity generation contributes carbon emissions that are at odds with UK net zero targets. In addition to this, the requirements under UK environmental permitting laws have driven a rapid decommissioning of unabated commercial diesel generators under the **Leading the Way**, **Consumer Transformation** and **System Transformation** scenarios.

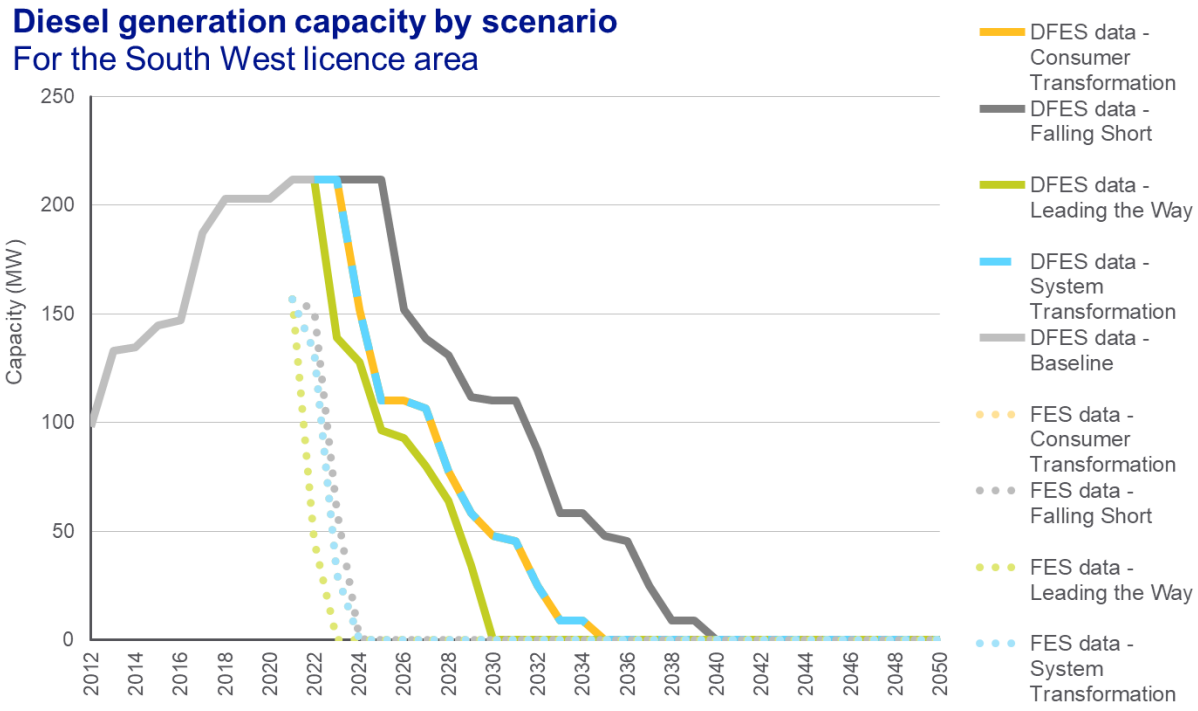
Scenario	Description	Earliest decommissioning year
Falling Short	No sites are modelled to disconnect in this timescale as it is assumed that the requirements under the MCPD do not fully encourage generator site operators to decommission or relinquish export capacity by March 2025.	2026 (standalone) 2027 (backup)
System Transformation **Consumer Transformation**	A few large standalone diesel plants are modelled to decommission in this timescale, due to the impact of the requirements under the MCPD. The largest of these is the Devonport Royal Dockyard generator (49 MW) which connected in 1991.	2024 (standalone) 2025 (backup)

Leading the Way	Due to the rapid decommissioning timescales seen in the FES 2022 diesel projections, echoing the likely decommissioning of commercial diesel sites due to the MCPD, **Leading the Way** has all standalone diesel generators (101 MW) decommissioning by 1 January 2025. A number of old backup generators also decommission in this period.	2023 (standalone) 2023 (backup)

Medium-term and long-term (April 2025 to March 2050)		
Scenario	**Description**	**Latest decommissioning year**
Falling Short	Low carbon diesel or biodiesel could still play a role for backup generators, hence, the operation of existing plants has been modelled to extend out to 2039 under **Falling Short**.	2032 (standalone) 2039 (backup)
System Transformation	Standalone sources of flexibility are assumed to move to lower carbon alternatives, such as electricity storage, demand side response and cleaner 'dispatchable' generation technologies, such as anaerobic digestion. Some backup diesel generators continue to operate out to 2035, but only in mains failure situations, for a handful of hours per year.	2029 (standalone) 2034 (backup)
Consumer Transformation		
Leading the Way	All standalone diesel generators are modelled to decommission by 2025, with a handful of backup generators (31 MW) continuing to operate into the late-2020s. At this point, it is assumed under this scenario that even more stringent measures are in place, and all forms of diesel-fuelled electricity generation are either fully abated or replaced with low carbon alternatives.	2025 (standalone) 2030 (backup)

Reconciliation with National Grid FES 2022

Figure 23 – Installed capacity of diesel generation by scenario, South West licence area



- The current installed capacity of diesel generation in the South West licence area is c.53 MW higher in the DFES data than in the FES 2022 data. This is thought to be due to DFES data also including behind-the-meter backup generators (109 MW).
- This is also reflected in the steep decommissioning timelines seen in the FES 2022 data, as it is unlikely that backup generators will adhere to the same stringent environmental permitting requirements as standalone plants.
- The DFES also has later decommissioning years for diesel generation than those assumed in the FES 2022. This delayed decommissioning timescale was considered to be more realistic, particularly for behind-the-meter backup generators.

Factors that will affect deployment at a local level

Factor	Source
Location of 34 existing and scoped diesel generation sites already in the National Grid connections data.	National Grid

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

Fossil gas-fired power 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	2025	2030	2035	2040	2045	2050
OCGT (non-CHP)	Falling Short	64	64	64	64	64	64	64
	System Transformation		6	6	6	0	0	0
	Consumer Transformation		6	6	6	0	0	0
	Leading the Way		6	0	0	0	0	0
Reciprocating engines (non-CHP)	Falling Short	66	136	245	245	221	208	208
	System Transformation		79	138	136	85	0	0
	Consumer Transformation		79	138	136	85	0	0
	Leading the Way		73	130	0	0	0	0
Gas CHP	Falling Short	195	197	197	197	197	197	189
	System Transformation		156	142	128	11	0	0
	Consumer Transformation		156	142	128	11	0	0
	Leading the Way		140	126	0	0	0	0

Summary:

- There is a moderate baseline (c. 425 MW) of existing operational fossil gas-fired generation connected to the distribution network in the South West licence area. This ranges from 20+ year-old gas power stations to small-scale gas CHPs connected behind-the-meter at commercial buildings less than 12 months ago.
- There are 16 sites with accepted connection offers with NGED in the South West licence area, comprising one 2 MW gas CHP and ten applications for reciprocating engines, which total an additional 179 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[xxviii], 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[xxix] 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.
- The need to accelerate a reduced dependence on fossil fuels in the UK, including to fuel flexible/dispatchable sources of generation, has come into sharp focus with the Russian invasion of Ukraine, necessitating the move away from Russian fossil fuels.
- Whilst the installed capacity of fossil gas generation may remain stable in some scenarios, the annual operating hours and energy output are assumed to decrease significantly by 2050 in all scenarios as the electricity system is decarbonised.
- 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 'Hydrogen-fuelled generation in the South West licence area'.

Modelling assumptions and results

Baseline		
There are 59 fossil-gas generation sites connected in the South West licence area, totalling 425 MW. This is broken down into the following fossil gas technologies:		
Sub-technology	**Number of sites**	**Total capacity**
OCGT (non-CHP)	2	64 MW
Reciprocating engines (non-CHP)	14	66 MW
Gas CHP	43	195 MW
Pipeline (April 2022 to March 2028)		
Sub-technology	**Number of pipeline sites**	**Total capacity**
Reciprocating engines (non-CHP)	15	179 MW
Gas CHP	1	2 MW

Pipeline analysis			
Status	**Scenario outcomes**	**Sites**	**Capacity**
Planning permission granted	There are three sites, totalling 26 MW, with an accepted connection offer from NGED that have also received planning permission. • One of the sites, with a capacity of 4.25 MW, also secured a Capacity Agreement from a recent Capacity Market auction, with a delivery year of 2023/24. Hence, this site has been modelled to connect in 2024 under all scenarios. • The smallest of the three sites (2 MW) is modelled to connect under all scenarios except **Leading the Way**, due to the focus on low carbon flexibility assets under this scenario. • The largest of the three sites (20 MW) was rejected in a Capacity Market auction, and so is only modelled to connect under **Falling Short**.	3	26 MW

Planning application submitted	A 25 MW reciprocating engine site is awaiting a planning decision, hence, it has been modelled to connect under **Falling Short** only.	1	25 MW
Pre-planning	The other 12 sites with connection offers from NGED are pre-planning; however, 75% of these sites have secured a Capacity Agreement from recent Capacity Market auctions. These sites have been modelled to connect in time to meet their Capacity Market delivery years under all scenarios. Sites without any information in planning or the Capacity Market have been modelled to connect under **Falling Short** only.	12	129 MW

Fossil fuel generation policy considerations

The Industrial Emissions Directive, in place since 2016, places emissions requirements on large and medium-scale power plants, with limitations on the annual operating hours. This affects some projects in the licence area, with operational hours assumed to reduce across the projection period.

In addition, in 2020, BEIS published guidance around carbon emission limits in the UK Capacity Market[xxx] , which proposed specific carbon intensity thresholds for entry into capacity auctions. Whilst this limit does not immediately restrict fossil gas generators with low annual load factors, future developments or reductions to this threshold (off the back of deep policy reviews such as REMA) could prevent unabated fossil gas from participating in some markets. The scenario assumptions and outcomes for fossil-gas generation technologies reflect a range of views for this type of policy.

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

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

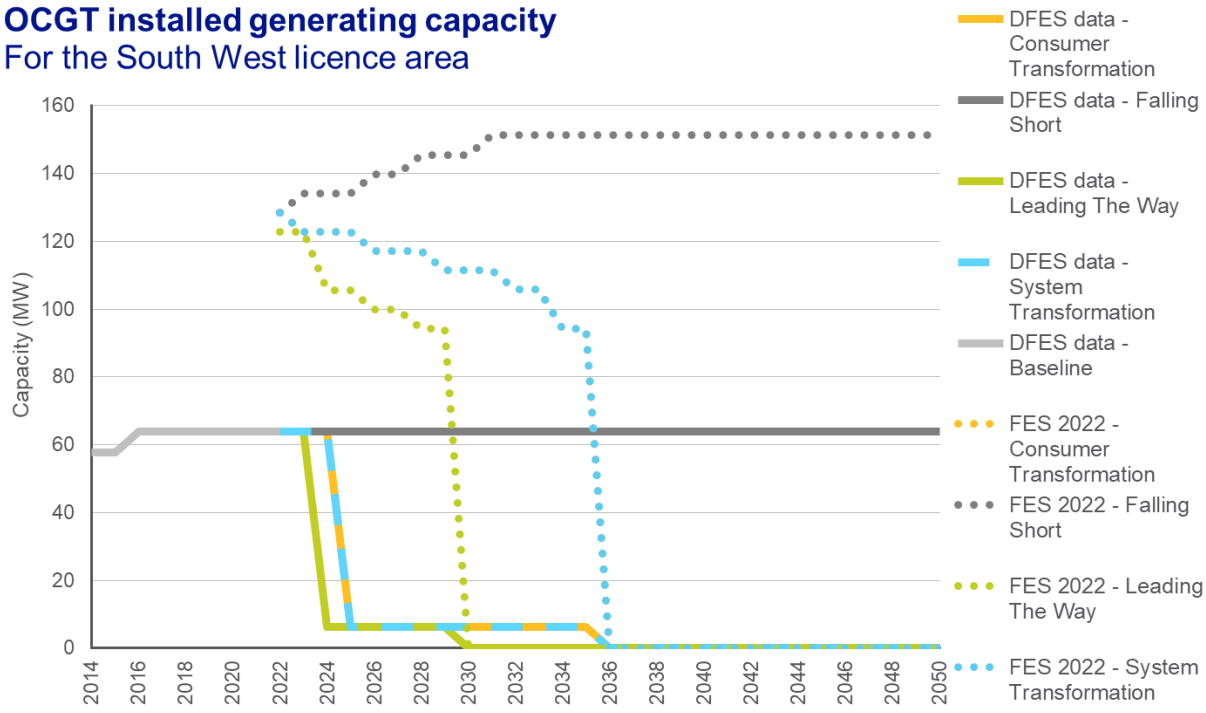
Sub-technology	Scenario	Description	Decommissioning timescale
OCGT (non-CHP)	**Leading the Way**	All OCGT capacity is modelled to decommission in the three net zero scenarios.	2024 – 2030
	Consumer Transformation		2025 – 2036
	System Transformation		2025 - 2036
	Falling Short	The existing 64 MW capacity is modelled to remain operational across the period to 2050. 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	2024 - 2035

		flexibility such as electricity storage, bioenergy and hydrogen.	
	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. Capacity then steadily decommissions into the 2040s.	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 technology continuing to win flexibility and reserve ancillary service contracts. Capacity peaks at 245 MW in 2027, after which some capacity is modelled to decommission, reflecting some transition away from fossil-fuel-driven flexibility. However, 208 MW remains in operation in 2050.	2036 – post-2050
Gas CHP	**Leading the Way**	The majority of gas CHP sites in the licence area are small-to-medium engines located onsite at commercial buildings such as factories, universities, hospitals or industrial sites. Under the three net zero scenarios, no additional increase in gas CHP capacity is modelled beyond the mid-2020s and all gas CHP capacity is modelled to decommission by 2050 at the latest.	2024 – 2035
	Consumer Transformation		2024 - 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, with 189 MW still operational by this period.	2048 – post-2050

Reconciliation with National Grid FES 2022

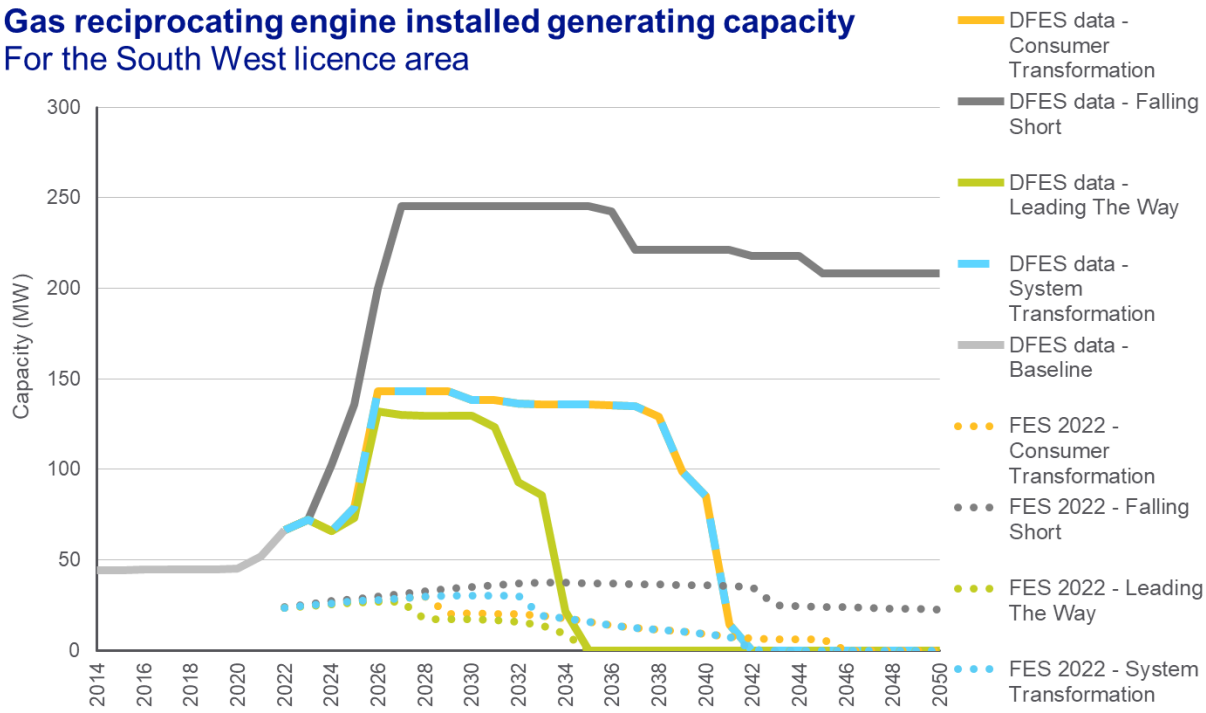
- For all of the fossil gas sub-technologies included, the DFES has sought to classify each of the baseline and pipeline sites based on connection data held by National Grid and through site-by-site reconciliation with Capacity Market registers published by the EMR Delivery Body.
- Each pipeline site 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 resultantly caused some potential variances between the FES and the DFES in the 2022 baseline and in the near-to-medium-term projections.

Figure 24 – Electrical capacity of OCGTs by scenario, South West licence area



- The DFES baseline accounts for only 50% of the FES baseline of OCGTs in the South West licence area. A number of sites have decommissioned in the last 12 months, which has resulted in a reduced capacity compared to DFES 2021.
- As there are only two operational OCGT sites remaining in the DFES 2022 baseline, the decommissioning of these is in two phases.

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

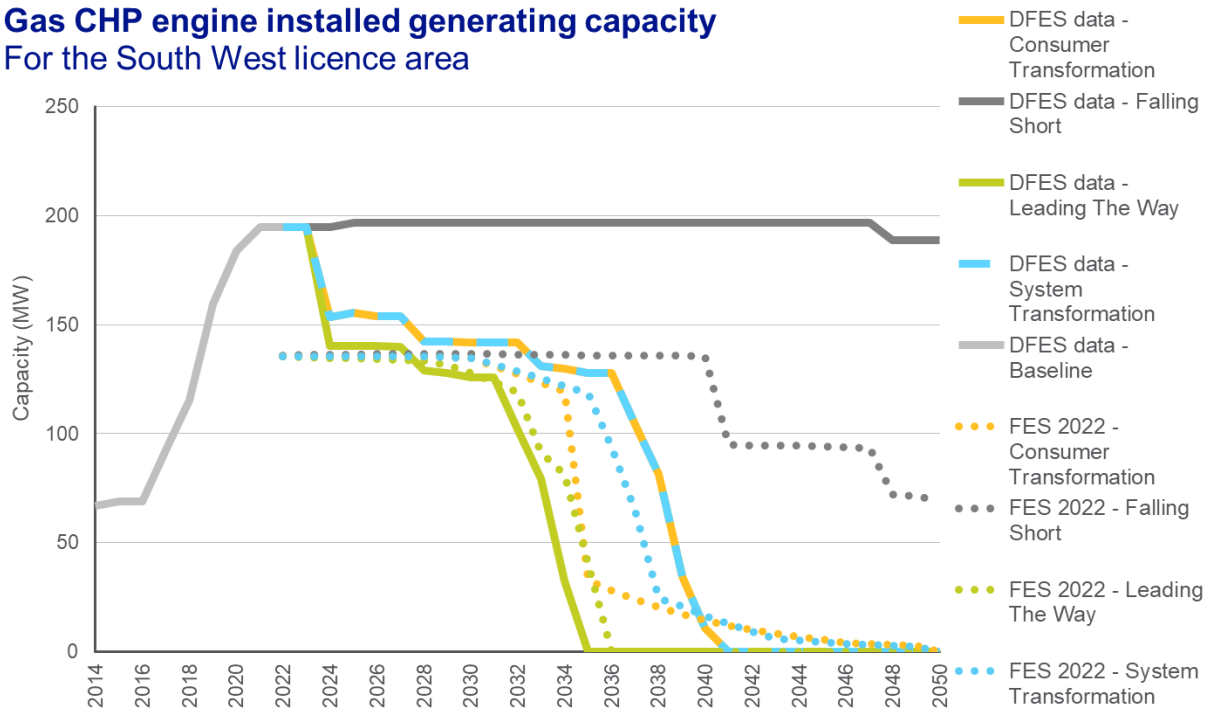


- The DFES baseline is slightly higher than that of the FES 2022, and there is significantly more near-term growth than in the FES projections. This is due to a large pipeline of

reciprocating engines with connection agreements and positive Capacity Market activity, that could connect in the next few years.

- The decommissioning of reciprocating engine capacity in the DFES is more phased and less smooth than that modelled in the FES. This modelling reflects individual sites relinquishing their connection agreements over time.

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



- The DFES baseline is notably higher than the FES 2022 baseline. The reason for this is unclear, but could be related to sub-technology classification.
- The near-term decommissioning in the DFES modelling results in the projections aligning closely to the FES in the 2030s under the three net zero scenarios.
- However, by 2050, the DFES 2022 projections have a higher capacity of gas CHPs under **Falling Short** than the FES 2022. This is more aligned with the national FES projections, which assume that under **Falling Short**, gas generators play an increasingly important role as flexible generation in the absence of strong growth in low carbon forms of flexibility.

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

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

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	2025	2030	2035	2040	2045	2050
Falling Short	0	0	0	0	0	0	0
System Transformation		0	22	81	99	236	292
Consumer Transformation		0	0	62	82	88	96
Leading the Way		0	43	141	149	357	448

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 some existing and pipeline commercial gas and diesel generation sites to convert to run hydrogen generation instead of fossil gas/diesel.
- Regen's 'A day in the life 2035'[xxxi] 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 suggested that a cold, calm and cloudy winter day might require between 10-15 GW of hydrogen-fuelled generation to be operational.
- Conversion to hydrogen generation in the DFES has been modelled to occur in regions that have been identified as potential hydrogen supply zones, based on analysis undertaken for hydrogen electrolysis capacity in the South West licence area.
- This conversion has been modelled to occur in regions within the licence area that have been identified as potential hydrogen supply zones, based on the analysis undertaken for hydrogen electrolysis capacity in the South West licence area.
- Hydrogen supply zones were identified where there is potential for hydrogen gas network conversion or are potential future hot spots for hydrogen development, such as heavy transport fuelling hubs and industrial clusters. In the South West, these include Plymouth, due to the significant maritime sector, and Bridgwater, due to the presence of potential large-scale hydrogen storage in salt field basins.
- These supply zones were identified to convert in phases, representing the likely timescales of hydrogen supply for each zone. Under **Leading the Way** and **System Transformation**, a national hydrogen network is assumed to be developed in the medium term, which enables more of the licence area to have access to hydrogen and, overall, more opportunities for hydrogen generation sites to be developed.
- All FES scenarios see hydrogen fuelled generation connecting to the transmission network. However, under **Leading the Way**, more capacity is modelled to connect at the distribution network than the transmission network, which is the inverse of the other scenarios. This results in **Leading the Way** having the most capacity projected under the DFES analysis.
- Under **Falling Short,** no hydrogen generation capacity is modelled, due to an ongoing role of fossil-gas generation and a lack of hydrogen supply availability under this scenario.
- The South West licence area has a moderate amount of existing gas and diesel generating capacity (535 MW) along with a substantial pipeline (180 MW). Therefore, in high hydrogen scenarios, the South West licence area could see some hydrogen-fuelled generation; however, it is unlikely to be a key region for this technology.

- As a general consideration, the business case for hydrogen-fuelled electricity generation is likely to be challenging, with hydrogen likely to be an expensive fuel and production at scale unlikely to be developed until the late 2020s or later.
- However, there is strong support for the role of low carbon hydrogen in providing flexible power generation, which is covered in the UK Hydrogen Strategy. In July 2021, the UK government published a call for evidence on 'decarbonisation readiness'[xxxii] for new power generation. It is expected that from 2030, plants would be capable of accepting 100% hydrogen. This is also supported by the development of hydrogen turbine technology from leading manufacturers[xxxiii].

Modelling assumptions and results

Baseline

As a technology, hydrogen-fuelled generation is a future consideration, which is not yet being trialled due to a lack of hydrogen supply across the UK. Thus, there is currently no hydrogen-fuelled generation connected to the distribution network in the South West licence area, or nationally.

However, there is currently 325 MW of gas-fired power generation and 210 MW of diesel generation connected to the distribution network in this licence area. These sites, under some scenarios, have the potential to host future low carbon hydrogen generation sites.

Pipeline (April 2022 to March 2030)

There is unlikely to be any development in grid-connected hydrogen-fuelled generation in the near term. This is due to gas-fired electricity generation still providing energy and flexibility to the system. In addition to this, the hydrogen supply chain is unlikely to be developed enough to allow hydrogen-fuelled generation to be viable in the near term.

The UK Hydrogen Strategy expects the 2020s to be focused on deploying electrolysers and scaling up long-duration hydrogen storage. This aims to enable the integration of hydrogen across the wider energy system by 2030, the availability of hydrogen as a fuel and manufacturers developing hydrogen-ready end-usage equipment, such as hydrogen turbines and generators.

Medium and long-term projections (April 2030 to March 2050)

From 2030, hydrogen-fuelled generation sites may begin to connect in regions where hydrogen is likely to be produced at scale. At a national level, these are likely to be centred around existing hydrogen trial areas and future hydrogen hubs, such as Teesside and Grangemouth.

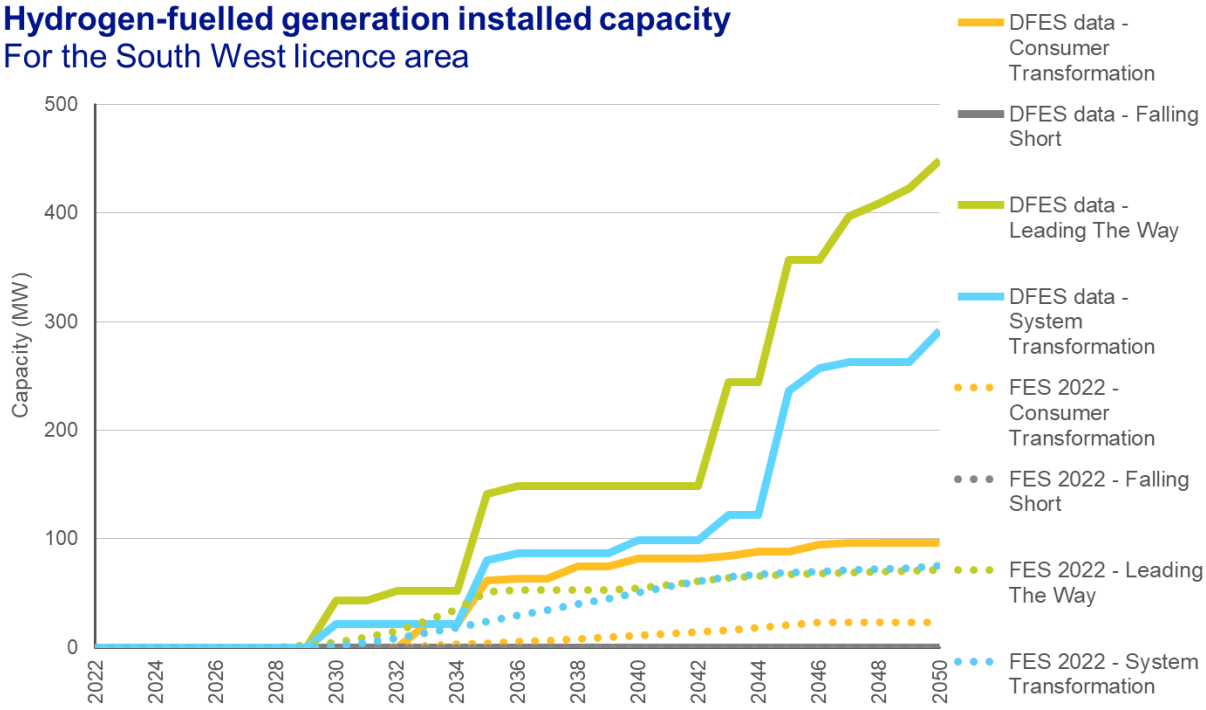
There are key sites in the South West which may be early adopters of hydrogen, including existing gas and diesel generators around Plymouth, Bristol and Bridgwater. Off the back of Regen's work with Cornwall Council[xxxiv], Cornwall is unlikely to be a hub for significant hydrogen development.

Projections have therefore centred around an analysis of existing (c.500 MW) and pipeline (c. 180 MW) sites located in potential future hydrogen development zones and the potential under each DFES scenario:

Scenario	Description	Capacity by 2040	Capacity by 2050
Leading the Way	Medium-scale sites (< 50 MW) in potential hydrogen zones are modelled to repower as hydrogen generators with 50% more capacity in the medium term, representing the most ambitious scenario for hydrogen-fuelled generation on the distribution network. Existing and pipeline fossil fuel sites outside of identified hydrogen zones are modelled to convert to hydrogen, due to the widespread availability of	149 MW	448 MW

	hydrogen transported through a national hydrogen network. Two-thirds of all hydrogen-fuelled generation in this scenario is modelled to be on the distribution network. This results in **Leading the Way** having the most capacity connected across the projection period (533 MW by 2050), reflecting the highest need for distributed low carbon flexibility.		
Consumer Transformation	The lack of a national hydrogen network under **Consumer Transformation** results in hydrogen only being produced near to demand. Therefore, existing and pipeline fossil fuel sites in identified hydrogen zones are modelled to convert to hydrogen, albeit later than **Leading the Way** and **System Transformation**, representing a slower development of the overall hydrogen sector. No sites outside of these zones are modelled to convert under **Consumer Transformation**.	82 MW	96 MW
System Transformation	Under **System Transformation**, it is assumed that fossil fuel sites currently connected to the distribution network in hydrogen development zones, repower hydrogen-fuelled generation sites at the same capacity. Existing and pipeline fossil fuel sites outside of identified hydrogen zones are also modelled to convert to hydrogen, due to the widespread availability of hydrogen transported through a national hydrogen network. Under **System Transformation**, significant capacity of hydrogen-fuelled generation is expected on the transmission network.	99 MW	292 MW
Falling Short	There is no hydrogen-fuelled generation capacity projected to connect under **Falling Short**, due to limited uptake of low carbon hydrogen, while fossil gas-fired flexible generation continues to operate out to 2050.	-	-

Figure 27 – Electrical capacity of hydrogen-fuelled generation by scenario, South West licence area



- The DFES 2022 projections echo the uptake of hydrogen-fuelled generation at a national level as modelled in the FES 2022; however, there are notable differences in overall installed capacity at a licence area level. The South West is an example of this variance.
- The FES 2022 analysis only projects 76 MW (**Leading the Way**) of hydrogen-fuelled generation to connect in the South West licence area by 2050. Given the challenging business model, it was deemed unlikely that only 76 MW would connect by 2050, as developers will need to harness economies of scale to drive down costs.
- FES 2022 has modelled a smoother, more gradual increase in connected capacity between 2030 and 2050 under **Consumer Transformation** and **System Transformation**. Whereas DFES 2022 analysis has modelled discrete sites converting within potential hydrogen supply areas, resulting in a more stepped increase in capacity across the 2030s and 2040s.
- While existing plants may be capable of accepting 100% hydrogen by 2030, the DFES analysis also takes into account the long decommissioning and repowering timelines of existing fossil fuel plants and, therefore, models a slow uptake in the 2030s, followed by a more rapid uptake from 2040 onwards.

Factors that will affect deployment at a local level

Factor	Source
Location of existing and known commercial gas and diesel sites in the South West licence area.	National Grid
Spatial analysis of potential hydrogen supply areas, factoring in locations of existing hydrogen trials, large industrial clusters, proximity to the gas network, proximity to major roads and motorways and potential hydrogen storage facilities.	National Atmospheric Emissions Inventory, DfT, Regen analysis.

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

Waste incineration in the South West licence area

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

Data summary for waste incineration in the South West licence area:

Capacity (MWe)	Baseline	2025	2030	2035	2040	2045	2050
Falling Short	187	187	208	208	208	200	198
System Transformation		187	208	200	198	183	84
Consumer Transformation		187	198	190	188	173	74
Leading the Way		187	198	190	188	173	74

Summary:

- Energy recovery from waste is considered the fourth level of the waste management hierarchy behind waste prevention, preparation for reuse and recycling[xxxv]; however, electricity generation from unabated waste incineration is at odds with net zero targets, due to the level of associated carbon emissions.
- In the South West licence area, there is 149 MW of existing operational waste incineration capacity (162 MW incineration, 16 MW ACT), as well as two incineration sites (21 MW) with planning permission and connection agreements.
- In **Falling Short**, no significant changes in how society manages waste are assumed, leaving waste available as a resource for unabated electricity generation. As a result, the majority of all baseline and pipeline capacity is modelled to continue operating past 2050, except for those that have reached the end of their operational lifetime.
- Under **Leading the Way**, **Consumer Transformation** and **System Transformation**, a shift to a more sustainable society results in less waste produced and a reduced need for waste incineration; however, even in low carbon and highly circular economies, waste incineration will likely still be needed.
- As a result, a number of large incineration sites are modelled to stay connected to the distribution network in these scenarios, under the assumption that these larger sites will have adopted abatement technologies or other innovative carbon reduction technologies.
- ACT gasification plants have lower associated carbon emissions, and any residual emissions can be abated, hence all ACT sites (16 MW) are modelled to continue operating past 2050.

Modelling assumptions and results

Baseline	
Number and capacity (MW) of incineration sites	**Number and capacity (MW) of ACT sites**
8 sites (182.5 MW)	1 site (4.7 MW)
Largest baseline site:	48 MW Severnside Energy Recover Centre in South Gloucestershire

Pipeline (April 2022 to March 2030)	
Number and capacity (MW) of incineration sites	**Number and capacity (MW) of ACT sites**
2 sites (21 MW)	None

An 11 MW project in Hill Barton Business Park, Exeter, was granted planning permission in March 2021 and forms part of the Cranbrook heat network project, which recently received £10.7 million in government funding. This has been modelled to connect in all scenarios, with a projected planning and construction period of five to six years.

There is also a 10 MW project in Cornwall Bio Park which received planning permission in November 2012. Due to the length of time since receiving planning permission, with no indication of construction, this project has only been modelled to connect under **System Transformation** and **Falling Short**.

Long-term projections (April 2030 to March 2050)

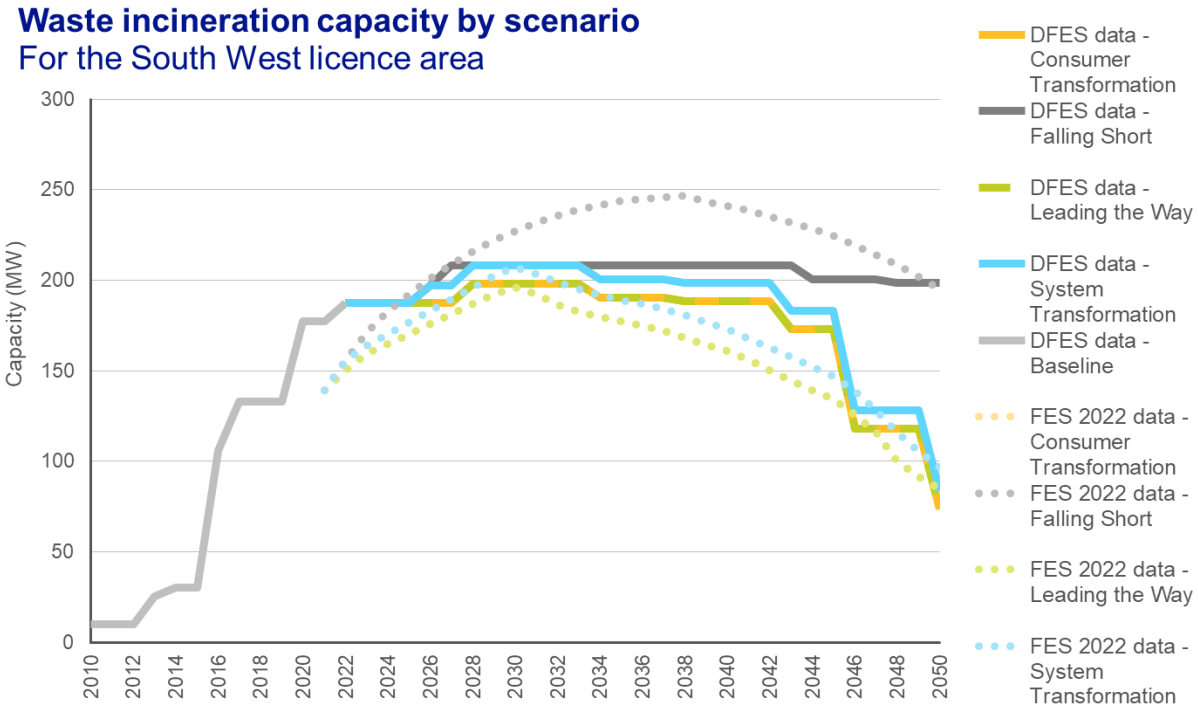
Energy recovery from waste is considered as the fourth level of the waste management hierarchy behind waste prevention, preparation for reuse and recycling; however, electricity generation from unabated waste incineration is at odds with net zero targets, due to the level of associated carbon emissions.

- IEA Bioenergy, in its 'Waste Incineration for the Future' paper[xxxvi], concluded that, in order to remain relevant and continue to create value in a circular economy, the waste sector will have to innovate in energy technologies, system design and integration and business models.
- Additionally, a 2021 Deloitte study[xxxvii] into how consumers are embracing sustainability found that, while there has been a sharp increase in the number of people adopting a more sustainable lifestyle (between March 2020 and March 2021), 51% of consumers still cite a lack of interest in the issue of sustainability.

Additionally, while the operational life of an incineration facility is typically between 20 and 30 years[xxxviii]; the connection agreement may not be relinquished immediately. Therefore, incineration facilities have been modelled to disconnect after 30 years in **Leading the Way**, **Consumer Transformation** and **System Transformation** and 40 years in **Falling Short**, in order to model the operational life range and the potential delay between decommissioning and relinquishing a connection agreement.

Scenario	Description	Number of sites	Capacity (MW)
Leading the Way	A shift to a more sustainable society results in less waste produced and a reduced need for waste incineration. However, even in highly circular economies, waste incineration will likely be needed.	3	74
Consumer Transformation	A number of large incineration sites are modelled to stay connected to the distribution network, under the assumption that these larger sites will have adopted abatement technologies or other innovative carbon reduction technologies, so they can continue to operate on a net zero electricity system.	3	74
System Transformation	ACT gasification plants have lower associated carbon emissions, and any residual emissions can be abated, hence all ACT sites (16 MW) are modelled to continue operating past 2050.	4	84
Falling Short	No significant changes in waste management from society are assumed under this scenario, leaving waste available as a resource for unabated electricity generation. As a result, the majority (237 MW) of all baseline and pipeline capacity is modelled to continue operating past 2050, except for those that have reached the end of their operational lifetime.	8	198

Figure 28 – Electrical capacity of waste incineration by scenario, South West licence area



- DFES 2022 analysis has slightly more operational waste incineration capacity than the FES 2022 data. The reasons for this are unclear, but could relate to technology classifications or spatial distribution of operational sites.
- The DFES 2022 assumptions align with FES 2022; however, the capacity projections differ due to the DFES's project-based approach, which identifies and models operational and scoped projects with connection agreements.
- For example, FES 2022, under **Falling Short**, models the connection of new waste incineration capacity until 2038, whereas DFES data only has sites connecting until 2027, based on known sites with planning permission. Due to lengthy planning and construction timelines, it is assumed to be unlikely for additional sites not already with a connection agreement to be built in the 2030s. Some older sites are also modelled to decommission in the late 2030s and 2040s in the DFES 2022.

Other generation in the South West licence area

Sites in NGED connections data where the technology could not be identified.

Data summary for other generation in the South West licence area:

Capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Falling Short	2	3	3	3	3	3	3
System Transformation		3	3	3	3	3	3
Consumer Transformation		3	3	3	3	3	3
Leading the Way		3	3	3	3	3	3

Summary:

- There are ten other generation sites, that have not been categorised as a particular technology, connected to the distribution network in the South West licence area, totalling 2 MW. Based on location addresses and generating unit information, these are likely to be small-scale fossil-fuelled CHPs but could not be positively identified as such in the NGED connections data.
- There are 40 additional other generation sites in the South West with an accepted connection agreement, totalling 1 MW. As with the baseline sites, these small-scale sites could not be positively identified as a specific technology. These pipeline sites have, therefore, been modelled to connect in 2023 under every scenario.
- There are no projections for other generation beyond the pipeline of accepted connections.

[xvii] UK installed 730MW of solar PV in 2021
[xviii] The UK's solar landscape to 2030
[xix] Council Climate Plan Scorecards 2022
[xx] Future homes are solar homes – Solar Energy UK
[xxi] Building Regulations (Part L)
[xxii] Response to Scottish Building Regulations - Solar Energy UK
[xxiii] Fullabrook Down
[xxiv] RWE completes German wind farm repowering, 2022
[xxv] White Cross Offshore Wind
[xxvi] TwinHub
[xxvii] Environment Agency's outrageous fee hike 'pours cold water' on future small hydro schemes in England
[xxviii] Transitioning to a net zero energy system: Smarts Systems and Flexibility Plan 2021, BEIS
[xxix] Sixth Carbon Budget, Climate Change Committee, 2020
[xxx] BEIS Carbon emissions limits in the Capacity Market, Sept 2020
[xxxi] A day in the life of 2035
[xxxii] Call for evidence on the expansion of the 2009 Carbon Capture Readiness requirements
[xxxiii] GE hydrogen fuelled gas turbines
[xxxiv] Regen Cornwall Council Hydrogen Opportunities Study
[xxxv] The future of waste incineration in a modern circular economy, NABU, 2020
[xxxvi] Waste incineration for the future, IEA Bioenergy, 2019
[xxxvii] How consumers are embracing sustainability, Deloitte, 2021
[xxxviii] Energy from waste, A guide to the debate, DEFRA, 2014

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 batteries** – typically 5-20 kW scale batteries that households buy to operate alongside rooftop PV or to provide backup services to the home.

Data summary for battery storage in the South West licence area:

Capacity (MW)		Baseline	2025	2030	2035	2040	2045	2050
Standalone network services	Falling Short	75	208	335	338	341	345	348
	System Transformation		257	335	341	345	348	351
	Consumer Transformation		257	502	517	527	537	547
	Leading the Way		287	551	568	579	590	601
	Storage Planning		508	1,213	1,457	1,863	2,068	2,068
Generation co-location	Falling Short	5	41	78	85	86	95	96
	System Transformation		56	84	94	110	113	117
	Consumer Transformation		56	118	130	161	169	174
	Leading the Way		56	159	181	222	248	250
	Storage Planning		116	424	557	585	703	703
Behind-the-meter high-energy user	Falling Short	4	5	24	24	25	43	46
	System Transformation		5	23	29	59	97	103
	Consumer Transformation		5	23	48	71	139	147
	Leading the Way		5	25	49	89	139	147
	Storage Planning		9	27	27	27	27	27
Domestic batteries	Falling Short	0.2	2	4	10	18	40	76
	System Transformation		4	30	43	89	136	194
	Consumer Transformation		10	77	163	279	404	611
	Leading the Way		15	98	213	350	522	791

Summary:

- As a sector that saw its first commercial-scale projects in 2016, battery storage has rapidly developed into an active and significant development sector.
- Battery storage has the largest pipeline of projects with an accepted connection offer of all technologies included in the DFES analysis, totalling 13.5 GW across the four NGED licence areas. Putting this into context, NGED currently manages connections of c. 10 GW of operational fossil fuel and renewable generation assets.
- This interest in development is also reflected at a national level, with over 47 GW of battery storage projects in 'scoping' seeking a transmission network connection[xxxix].
- Many organisations have raised concern over the scale of the pipeline, how they are contributing to connection queues and potential grid constraints and the number of potentially speculative applications[xl].
- The South West licence area currently has 62 operational battery storage sites, totalling 85 MW. 34 MW of this has connected since the DFES 2021 analysis was completed.
- The South West licence area also has a large pipeline of battery storage projects with accepted connection offers across NGED's network; 162 projects totalling c. 2.7 GW.
- Based on Regen analysis, over 600 MW of the storage pipeline has either received or submitted planning permission or entered into the Capacity Market. Additionally, nearly 1.5 GW has been offered a connection agreement with NGED in 2022, alone. These sites are unlikely to have already applied for planning or the Capacity Market, and many could be speculative; however, that does not mean that none of these projects will get developed in the future.
- Upstream constraints on the transmission network can impact the timescale of projects in the pipeline to connect at distribution level and have been reflected in 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 to the distribution network.
- As a key technology providing flexibility services to the electricity system, battery storage projects are actively engaging with flexibility markets and ancillary services being procured by National Grid ESO. With the development of new frequency response services, new reserve services and system stability services, the revenue opportunities for battery operators to 'stack' is developing all the time.
- This year, due to the unprecedented pipeline of large-scale battery storage projects across NGED's licence areas, the DFES has included an additional scenario, **Storage Planning**, which is based solely on the significant pipeline of projects with connection agreements with National Grid Electricity Distribution.
- The South West licence area has good potential for long-term growth in connected storage capacity. This is due to:
    - Notable 33kV and 132kV network infrastructure across the licence area for standalone battery storage projects to provide system services
    - Good potential for distributed renewable energy deployment, enabling co-location.
    - The highest number of non-domestic properties with the potential for behind-the-meter batteries across National Grid's network.
    - A strong potential capacity for domestic rooftop solar by 2050, enabling a notable capacity of domestic batteries to be co-located in homes.
- Overall battery storage capacity in 2050 in the South West licence area ranges from 566 MW in **Falling Short** to 1.8 GW in **Leading the Way**.
- Under the **Storage Planning** scenario, which only applies to large-scale storage, 2.8 GW is modelled to connect by 2050.

Baseline

There are 62 battery storage projects totalling 85 MW currently connected to the distribution network in the South West licence area, all of which have come online since 2016. 34 MW of this has connected since April 2021, when the DFES 2021 analysis was carried out.

The largest operational site in the South West licence area is a 32 MW battery energy system in Hallen Industrial Park in Bristol, which connected in November 2021.

Business model	Number of sites	Total capacity (MW)
Standalone network services	3	75 MW
Generation co-location	17	5 MW
Behind-the-meter high-energy user	4	4 MW
Domestic batteries	38	0.2 MW

Pipeline (April 2022 to March 2029)

Business model	Number of pipeline sites	Total capacity
Standalone network services	50	1,992 MW
Generation co-location	43	655 MW
Behind-the-meter high-energy user	6	23 MW
Domestic batteries	63	0.3 MW

The South West licence area has a large pipeline of battery storage projects with accepted connection offers across NGED's network, with 162 projects totalling c. 2.7 GW. In comparison, the pipeline of projects with accepted connection offers DFES 2021 was 555 MW, showing a significant increase in developer appetite for storage projects in the last 12 months.

Based on Regen analysis, over 600 MW of the storage pipeline has either received planning, submitted a planning application or entered into the Capacity Market. Additionally, nearly 1.5 GW has been offered a connection agreement with NGED in 2022, alone. These sites are unlikely to have already applied for planning or the Capacity Market, and many could be speculative; however, that does not mean that they will not progress through to development in the future.

As a key technology that can provide rapid response flexibility services to the network, battery storage is active in a number of National Grid ESO's ancillary service market tenders and auctions. In recent years the ESO has evolved their suite of response and reserve services, notably with the evolution of the new 'trio of frequency response markets[xli]: Dynamic Containment, Dynamic Regulation and Dynamic Moderation. In addition to this, the ESO has launched a new Slow Reserve service[xlii] and continues to deliver its network options assessment pathfinders[xliii] for stability, voltage and reactive power services. Battery projects are ideally placed to bid into and secure contracts under a number of these services. Under the Government's Review of Energy Market Arrangements (REMA), these ancillary services and wider flexibility market structures could continue to evolve. The breadth of outcomes shown in the DFES reflects a range of accessible markets for battery storage assets.

This year, due to the unprecedented pipeline of battery storage projects in all of National Grid's licence areas, the DFES has included an additional scenario, **Storage Planning**, which is based solely on the pipeline of large-scale battery projects with connection agreements with NGED. This scenario does not model domestic-scale battery projects, as there are very few (c. 1MW) in the known pipeline, and these sites are included in the modelling of the four DFES scenarios.

Pipeline analysis			
Status	**Scenario outcomes**	**Sites**	**Capacity**
Operational	A 33 MW battery storage facility is currently operational, according to the developer Voltalia. This has been modelled to connect in 2023 under all scenarios.	1	33 MW
Under construction	Two projects totalling 1.5 MW are currently under construction and are modelled to connect in 2024 under all scenarios.	2	1.5 MW
Planning permission granted	• Two sites (40 MW) have secured a Capacity Market agreement and have been modelled to connect to meet their Capacity Market delivery years under all scenarios. • Three sites (33 MW) successfully pre-qualified in recent Capacity Market auctions, but have not yet won Capacity Agreements. These have been modelled to connect in: ○ **Falling Short: 2027 - 2030** ○ **System Transformation: 2025 - 2028** ○ **Consumer Transformation: 2024 - 2026** ○ **Leading the Way: 2024 - 2026** ○ **Storage Planning: 2024 - 2026** • The other eight sites (243 MW) have been modelled to connect between three and seven years from receiving planning permission, depending on the scenario.	13	316 MW
Planning application submitted	• There are ten sites (233 MW) in the licence area that have submitted a planning application. These have not been modelled to connect under **System Transformation** or **Falling Short** due to lower flexibility requirements in these scenarios.	10	233 MW
No information	• Modelling projects with positive planning information to connect already exceeds the FES 2050 projections under all scenarios; therefore, the remaining 57 sites, accounting for 2 GW, without any Capacity Market or planning information have only been modelled to connect under the **Storage Planning** scenario across the 2030s and 2040s.	57	2,080 MW
Too small for planning	• 77 sites, totalling 0.9 MW, have connection agreements with NGED but are too small to need to apply for planning. This includes all domestic installations. These sites are modelled to connect in 2024 under all scenarios.	77	0.9 MW

Medium and long-term projections (April 2029 to March 2050)

The four business models for battery storage are modelled separately, and potential deployment in the licence area is driven by different factors.

While the known pipeline mainly consists of co-located battery storage projects or standalone batteries providing balancing services to the network, the significant year-on-year increase in development we are currently seeing under these business models may lessen over time as the grid and balancing markets are saturated with flexibility assets. However, there will likely continue to be interest in developing battery projects at all scales into the medium-long term, and it is

assumed that the business case for behind-the-meter batteries collocated at high-energy user sites may increase, under some scenarios, as businesses look to manage their onsite energy consumption, reduce energy costs and move from being consumers to prosumers. This has been endorsed by DFES engagement with some key major energy users on NGED's network, with some suggesting aims to retrofit battery storage onsite at Universities, military premises, ports and water industry sites. In addition to this, there is the potential for an increased uptake of home batteries under some scenarios, with more homeowners deploying and rooftop PV seeking to increase self-consumption, as well a proliferation of domestic-level flexibility, time-of-use-tariffs and demand response.

In the long term, the biggest increase in projected battery storage capacity in the licence area is seen in **Leading the Way**, totalling 1.8 GW by 2050. This reflects a strong potential deployment of batteries across all four business models.

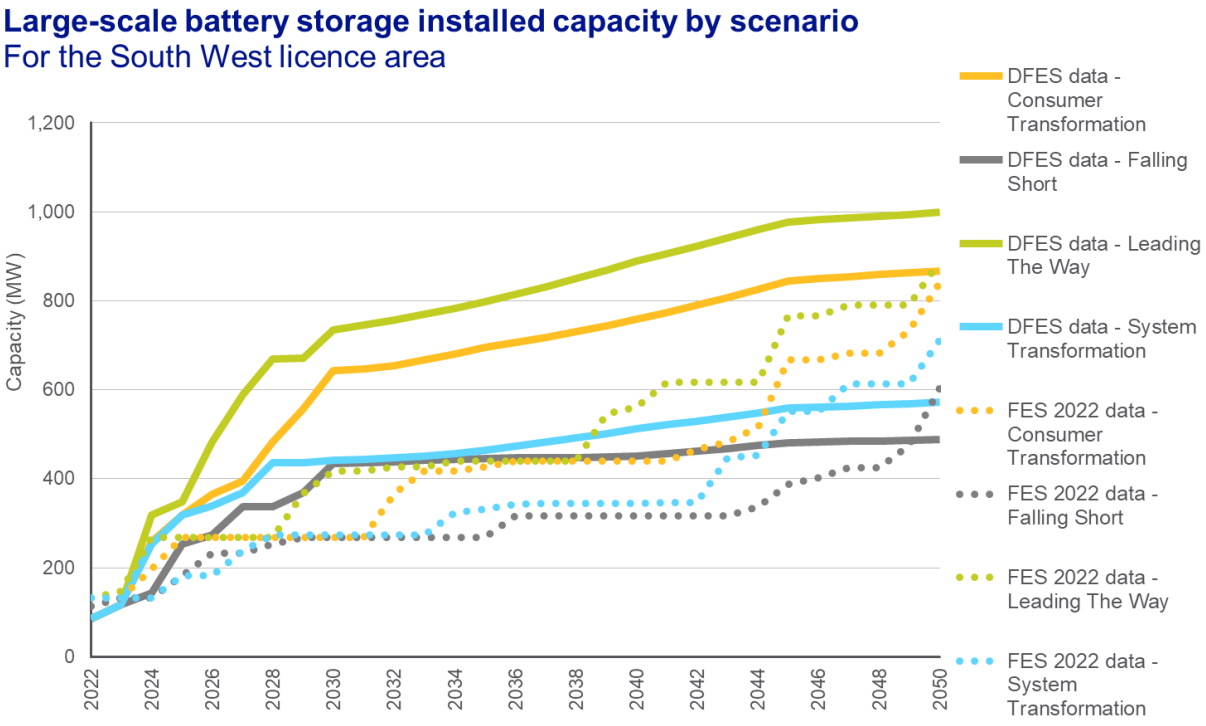
Falling Short sees the lowest overall storage deployment in the licence area, reaching 564 MW by 2050. This reflects a lesser need for electricity system flexibility, a lower renewable energy adoption and ongoing use of fossil fuel generation as a source of flex. This reduced development landscape is reflected in the longer term, out to 2050, across all four business models.

The **Storage Planning** scenario takes a bespoke view of the very large pipeline of battery storage projects with an accepted connection offer from NGED. This scenario projection considers all sites, except those that have been rejected in planning, will go through to connection across the scenario timeframe, resulting in 2.8 GW of connected battery storage by 2050. This scenario mirrors the breakdown of the current pipeline by business model, hence c.2 GW of this is standalone projects targeting grid services.

Business model	Projection methodology	Scenario	Total capacity by 2035 (MW)	Total capacity by 2050 (MW)
Standalone network services	Standalone storage accounts for a significant proportion of the existing and known near-term storage pipeline capacity, and this business model continues to see an increased deployment across all scenarios by 2035. The growth in capacity reduces beyond the late 2030s out to 2050, reflecting a saturation of distribution network capacity and flexibility markets, reducing the number of large-scale standalone projects seeking to connect in the longer term.	**Falling Short**	338	348
		System Transformation	341	351
		Consumer Transformation	517	547
		Leading the Way	568	601
		Storage Planning	1,457	2,068
Generation co-location	Generation co-location capacity also sees a moderate uptake in the South West licence area. This is in part due to seeing a moderately lower combined ground-mounted solar PV and onshore wind capacity projections by 2035, when compared to other licence areas across all scenarios.	**Falling Short**	85	96
		System Transformation	94	117
		Consumer Transformation	130	174
		Leading the Way	181	250
		Storage Planning	557	703

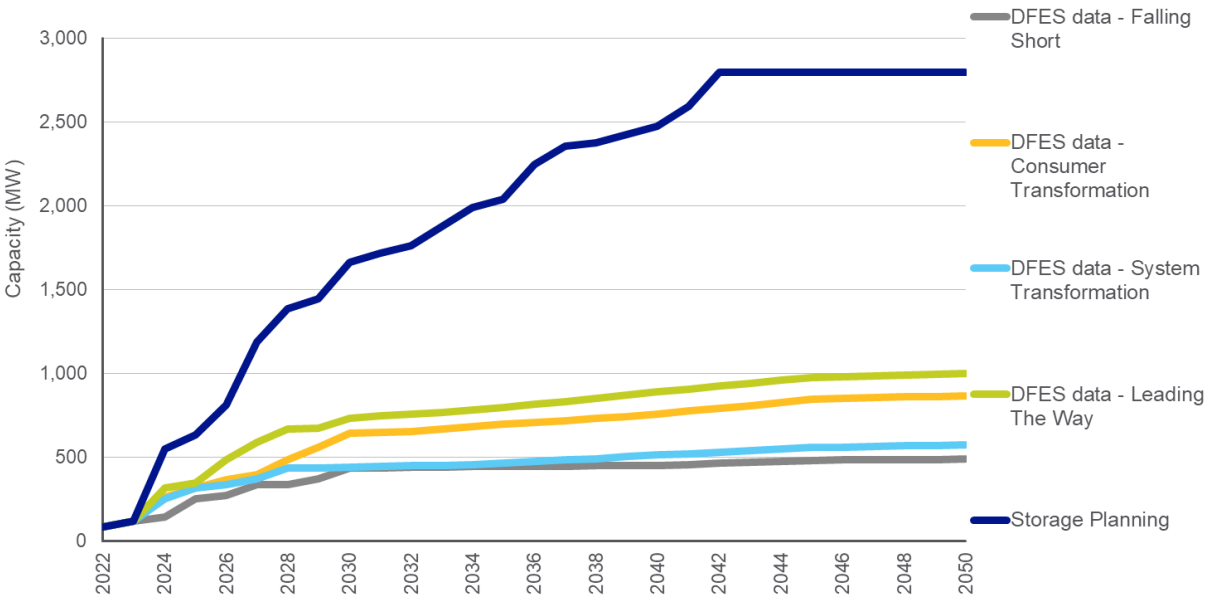
Behind-the-meter high-energy user	The South West licence area has a notable number of non-domestic properties with the potential for a battery across NGED's network. Thus, the uptake of behind-the-meter storage projects in the licence area increases in all scenarios by 2035. This reflects feedback from stakeholders that high-energy users, such as industrial customers, could drive electricity storage deployment in the medium term. Annual capacity deployment under this business model begins to increase further in the longer term out to 2050 under **Consumer Transformation** and **Leading the Way**, as more businesses seek to manage their onsite energy use and costs through flexibility technologies. The **Storage Planning** scenario does not see a strong uptake past the near-term, due to the limited pipeline of behind-the-meter projects.	**Falling Short**	24	46
		System Transformation	29	103
		Consumer Transformation	48	147
		Leading the Way	49	147
		Storage Planning	27	27
Domestic batteries	The licence area has significant potential for domestic battery deployment in the medium term, with well over one million homes in the licence area and significant domestic-scale rooftop PV deployment projections. Significant uptake of domestic storage is delayed until the longer term, with projections under **Consumer Transformation** and **Leading the Way** reflecting stakeholder feedback that domestic storage will be the business model with the lowest uptake in the near-to-medium term.	**Falling Short**	10	76
		System Transformation	43	194
		Consumer Transformation	163	611
		Leading the Way	213	791

Figure 29 – Electrical capacity of large battery storage by scenario, South West licence area



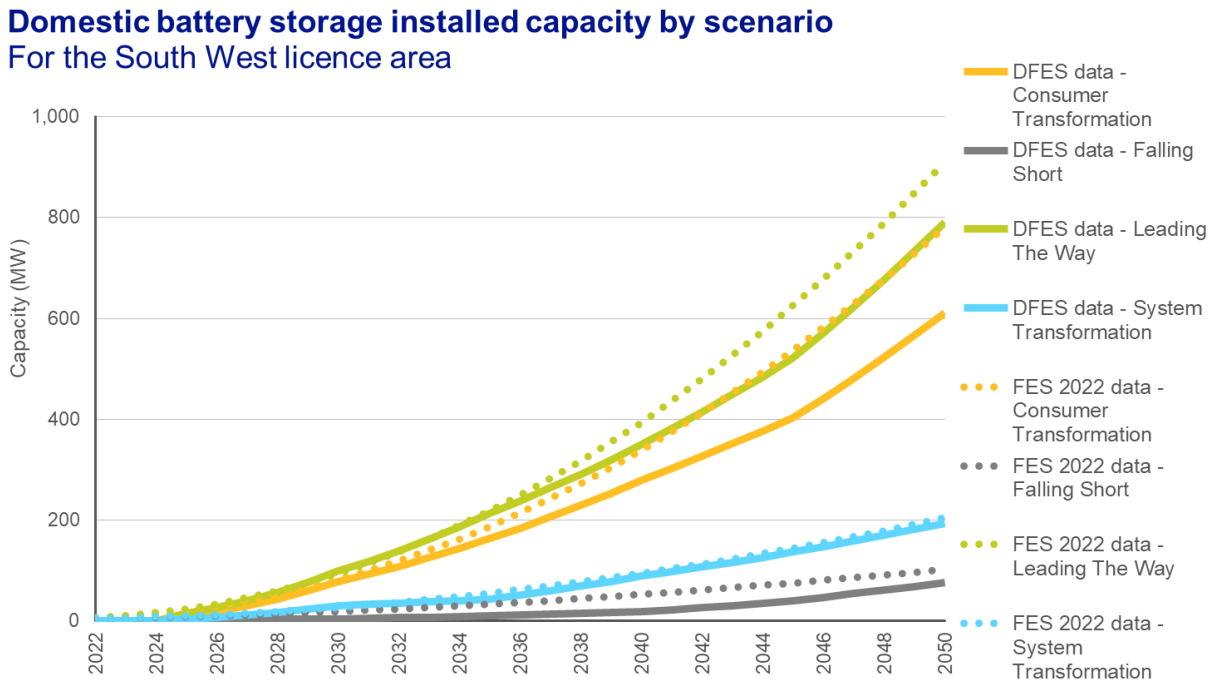
- The FES 2022 data is largely in-line with the DFES baseline for the South West licence area.
- Reflecting the very large near-term pipeline, the DFES 2022 projections significantly exceed the FES 2022 near-term projections, reaching c.700 MW by 2030 under **Leading the Way**, nearly 300 MW more than FES. This is based on a detailed assessment of planning status, Capacity Market auction activity and direct engagement with battery project developers.
- By 2050, the DFES projections are mostly aligned with the FES projections, with only **System Transformation** having less capacity in the DFES than the FES.

Figure 30 – Electrical capacity of large-scale battery storage by scenario (including the Storage Planning scenario), South West licence area



- This year, due to the unprecedented pipeline of battery storage projects in all of NGED's licence areas, the DFES has included an additional scenario, **Storage Planning**, which is based solely on the pipeline of large-scale battery projects with connection agreements with NGED.
- For context, the **Storage Planning** scenario is nearly 2 GW higher than the other DFES scenarios by 2050. This reflects a scenario where all projects currently with a connection agreement proceed to construction and operation across the scenario timeframe out to 2050, except sites that have been rejected in planning or the Capacity Market, which have been discounted.
- While it is likely that a proportion of projects in the pipeline will fall away and not proceed to operation, the **Storage Planning** scenario reflects the potential scale of storage capacity development appetite seeking to connect to the distribution network in the South West licence area, which is not accounted for in the envelope of the four FES scenarios.

Figure 31 – Electrical capacity of domestic battery storage by scenario, South West licence area



- The DFES 2022 projections for domestic batteries align well with FES 2022 across the analysis period and in all scenarios, with slightly less capacity projected under the DFES analysis due to the South West having fewer houses than the other NGED licence areas.

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 2022, 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	Addressbase, local

commercial buildings that could be suitable for battery storage installations.	authority development data
Domestic batteries: Domestic dwellings with rooftop PV.	Regen analysis

For input, evidence and assumptions based on stakeholder engagement, a separate summary report can be found here

[xxxix] Transmission Entry Capacity (TEC) register
[xl] Large-scale battery storage in the UK: Analysing the 16GW of projects in development
[xli] National Grid ESO frequency response services
[xlii] National Grid ESO Slow Reserve service
[xliii] National Grid ESO NOA Pathfinders

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