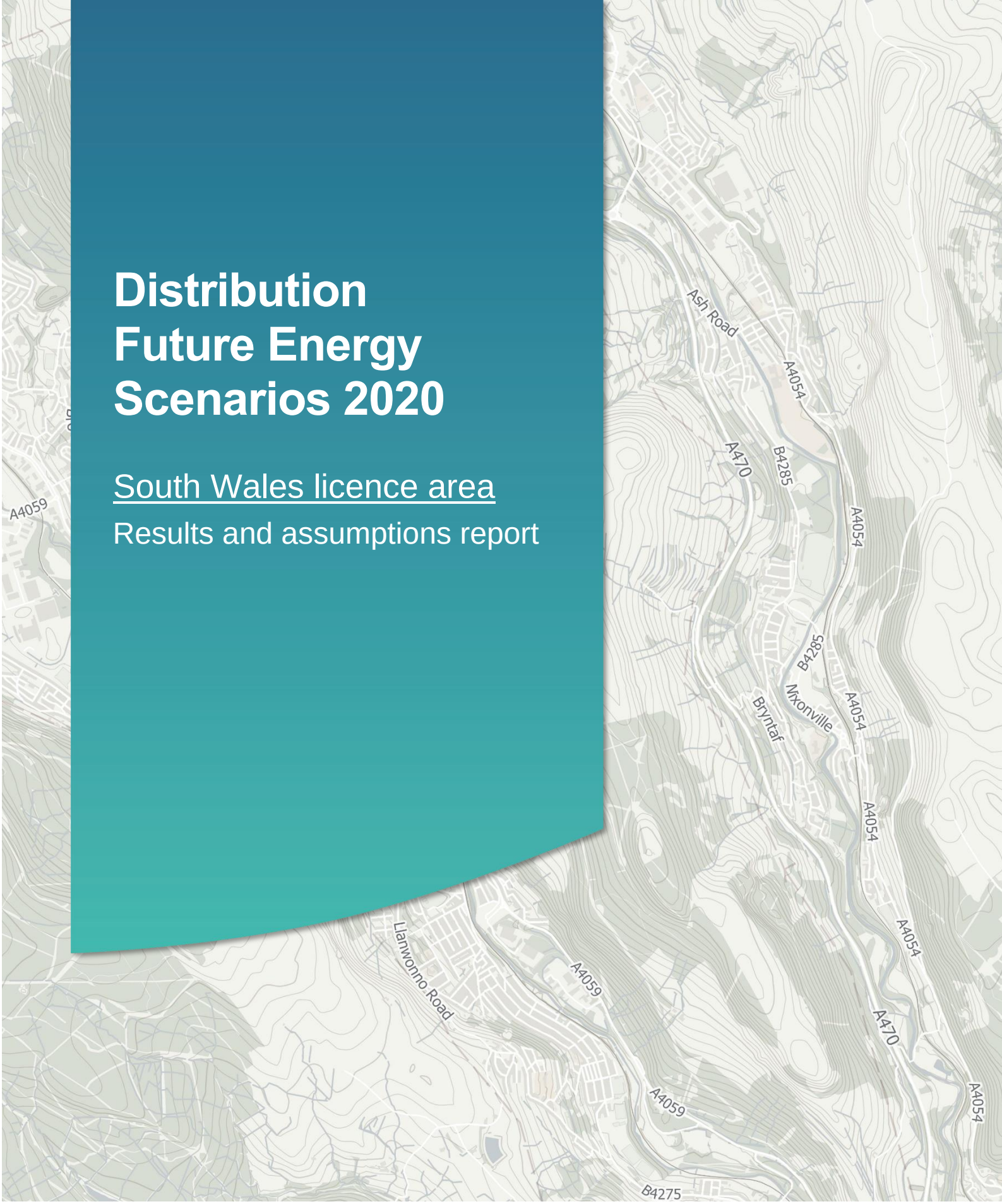
Distribution Future Energy Scenarios 2020

South Wales licence area

Results and assumptions report



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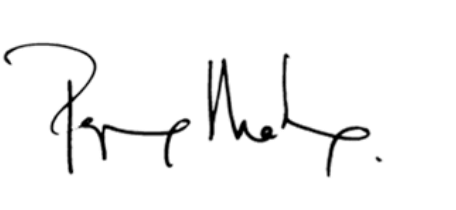
Approved by:	
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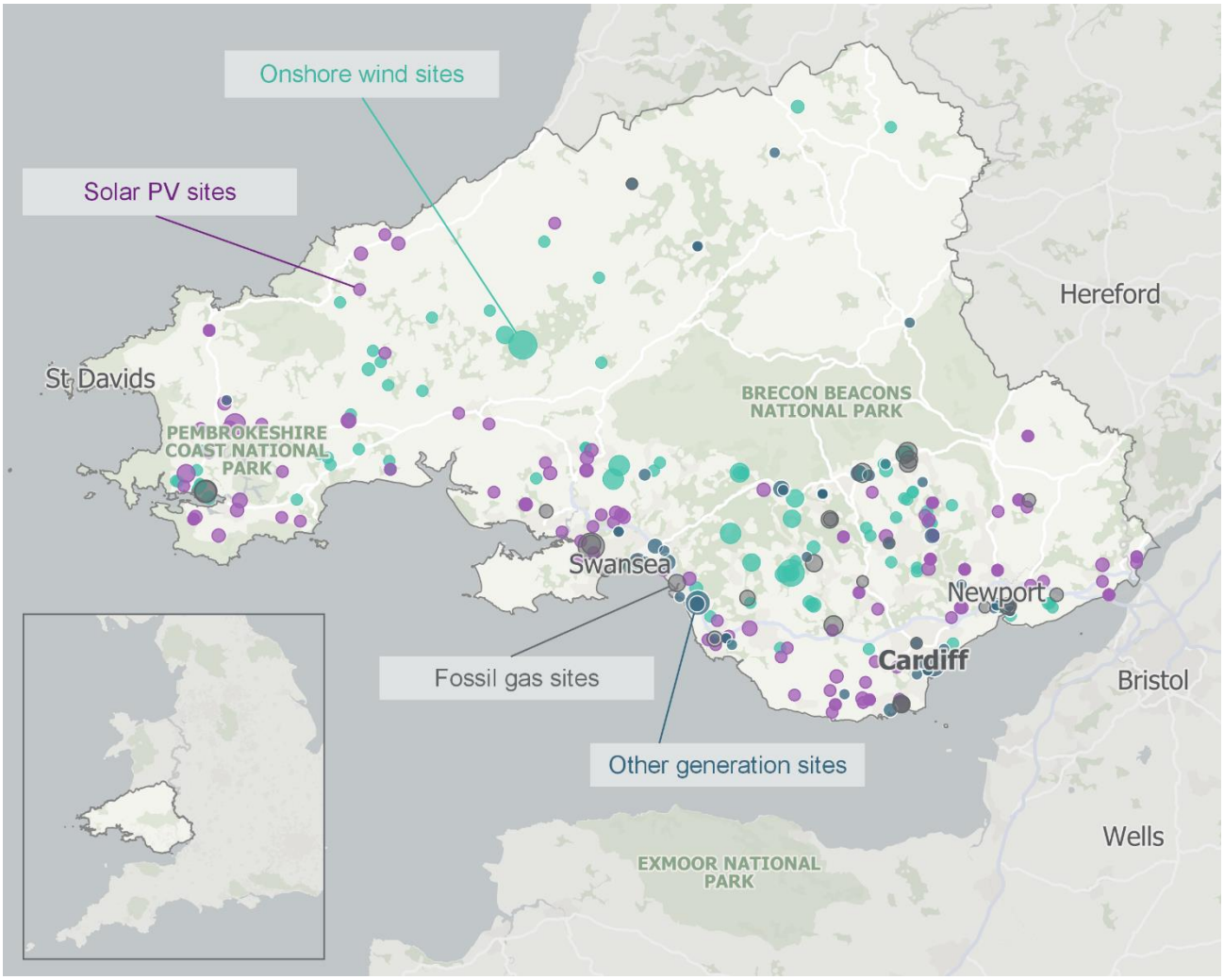
The South Wales licence area

The South Wales licence area is home to over 80% of the Welsh population, with over 1 million households and the three largest urban areas in Cardiff, Newport, and Swansea.

Distributed electricity generation has changed a lot in recent years, with over 50% of capacity having only connected since 2015. Over half of total generating capacity is from onshore wind and solar PV. The remainder of capacity is fossil gas power plants, hydropower, biomass and other generation. The largest power generation site in the licence area is the 40 MW Margam biomass energy plant, near Port Talbot.

Distributed electricity demand is also changing. Average annual domestic energy demand has fallen over the last 10 years, however new low carbon technologies are expected to change consumption patterns of both homes and businesses within the next two decades. Though currently only 0.4% of homes currently have a heat pump and 0.4% of cars are electric, widespread change is projected across all sectors in the WPD DFES 2020 with the potential to radically change the current shape of demand.

Figure 1 – The South Wales licence area with key generation sites



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Introduction to the WPD DFES 2020

Background:

Distribution Future Energy Scenarios (DFES) provide granular scenario projections for the growth (or reduction) of generation, demand and storage technologies which are expected to connect to the GB electricity distribution networks. The WPD DFES 2020 also includes projections for new housing growth and increase in commercial and industrial developments. The projections are also informed by stakeholder engagement to understand the needs and plans of local authorities and other stakeholders.

For the DNOs, 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 provide a key data resource and evidence base to enable WPD to appraise different investment options and develop the business case necessary to support future investment, including regulated business plans.

The scope:

The WPD DFES 2020 analyses the baseline of existing connections and pipeline of future projects expected to connect to the distribution network in the four WPD licence areas, South Wales, South West, East Midlands, and West Midlands. The results exclude any asset connected at transmission level.

The DFES analyses technology types which are of a similar scope to the National Grid FES 2020, and these are standardised against the "building blocks" as reported in the FES 2020, developed by the ENA Open Networks project. The full list of technology types in the analysis is shown in Table 1.

The scenarios used for projection purposes extend from 2019 to 2050 and are aligned to the four FES 2020 scenarios: Steady Progression, Consumer Transformation, System Transformation, and Leading the Way. These scenarios are described in more detail on page 7 in this document. The technology types and assumptions are under constant review and may change with future FES and DFES rounds in line with stakeholder feedback.

The results:

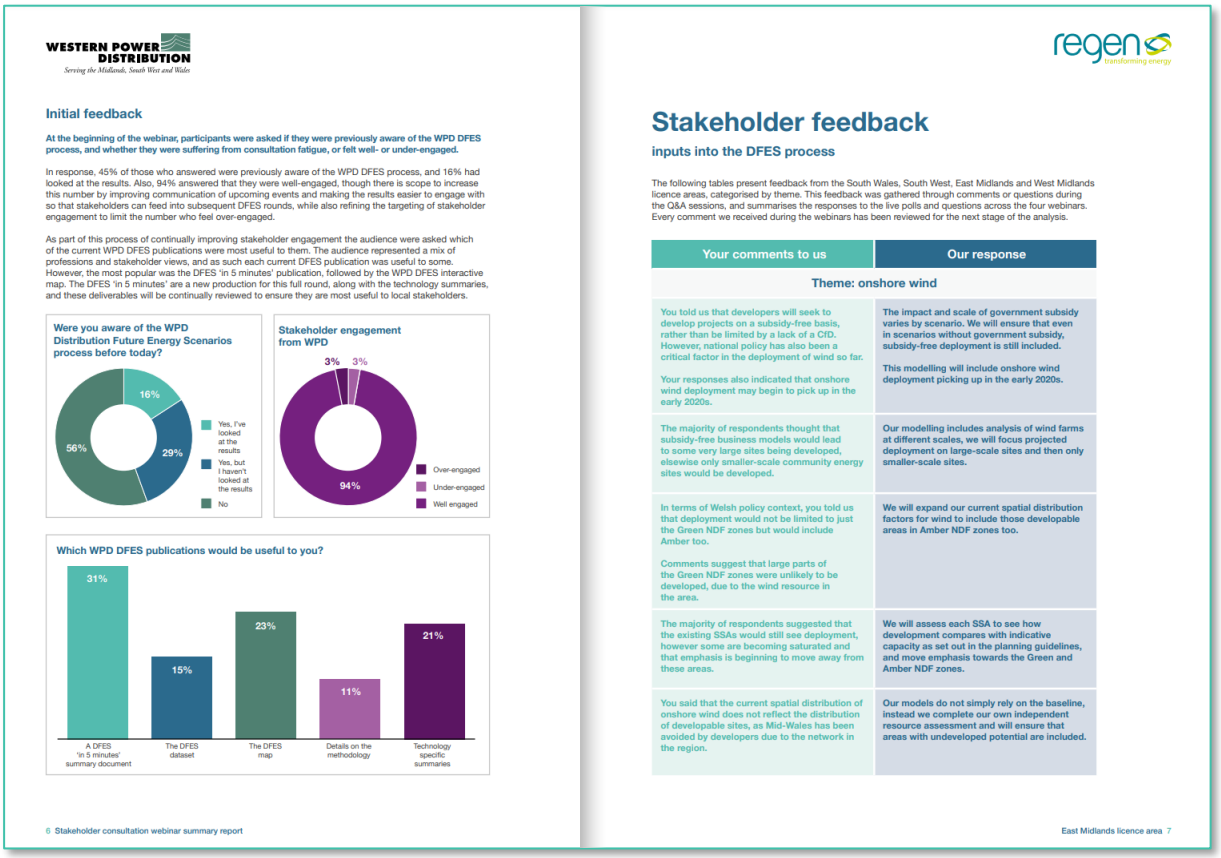
The WPD DFES 2020 is reported to areas known as Electricity Supply Areas (ESAs), which are defined as '*the geographical area supplied by a Primary Substation (which contains WPD-owned distribution substations) providing supplies at a voltage below 33 kV, or a customer directly supplied at 132, 66 or 33 kV or by a dedicated Primary Substation'.* These ESAs are also split by local authority boundaries meaning that the data can be viewed as local authority totals, or by primary substation totals. There are over 3,000 unique ESAs across the four WPD licence areas. The ESAs can be collated up to the level at which National Grid present regional FES data. The DFES is, therefore, reconciled to the FES 2020 results as far as possible.

The DFES does not include analysis of network loads, load profiles or peak demand etc. This network load analysis is run by WPD network strategy and planning teams. WPD has published the results of this process on their website.

Local stakeholder influences

The development of DFES has enabled WPD to take a more proactive approach to network planning. Stakeholders were consulted via a series of consultation events, as well as direct engagement with local authority planners and climate emergency officers. For technology projections detailed discussions were held with project developers.

This year the events were held online due to restrictions on large gatherings, and there were more attendees than ever before. To watch a recording of the stakeholder engagement events, or to read the reports summarising how the feedback has been incorporated into the DFES, visit the WPD DFES website.



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Initial feedback

At the beginning of the webinar, participants were asked if they were previously aware of the WPD DFES process, and whether they were suffering from consultation fatigue, or felt well- or under-engaged.

In response, 45% of those who answered were previously aware of the WPD DFES process, and 16% had looked at the results. Also, 94% answered that they were well-engaged, though there is scope to increase this number by improving communication of upcoming events and making the results easier to engage with so that stakeholders can feed into subsequent DFES rounds, while also refining the targeting of stakeholder engagement to limit the number who feel over-engaged.

As part of this process of continually improving stakeholder engagement the audience were asked which of the current WPD DFES publications were most useful to them. The audience represented a mix of professions and stakeholder views, and as such each current DFES publication was useful to some. However, the most popular was the DFES 'in 5 minutes' publication, followed by the WPD DFES interactive map. The DFES 'in 5 minutes' are a new production for this full round, along with the technology summaries, and these deliverables will be continually reviewed to ensure they are most useful to local stakeholders.

6 Stakeholder consultation webinar summary report

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Stakeholder feedback

inputs into the DFES process

The following tables present feedback from the South Wales, South West, East Midlands and West Midlands licence areas, categorised by theme. This feedback was gathered through comments or questions during the Q&A sessions, and summarises the responses to the live polls and questions across the four webinars. Every comment we received during the webinars has been reviewed for the next stage of the analysis.

Your comments to us	Our response
Theme: onshore wind	
You told us that developers will seek to develop projects on a subsidy-free basis, rather than be limited by a lack of a CfD. However, national policy has also been a critical factor in the deployment of wind so far. Your responses also indicated that onshore wind deployment may begin to pick up in the early 2020s.	The impact and scale of government subsidy varies by scenario. We will ensure that even in scenarios without government subsidy, subsidy-free deployment is still included. This modelling will include onshore wind deployment picking up in the early 2020s.
The majority of respondents thought that subsidy-free business models would lead to some very large sites being developed, elsewise only smaller-scale community energy sites would be developed.	Our modelling includes analysis of wind farms at different scales, we will focus projected deployment on large-scale sites and then only smaller-scale sites.
In terms of Welsh policy context, you told us that deployment would not be limited to just the Green NDF zones but would include Amber too. Comments suggest that large parts of the Green NDF zones were unlikely to be developed, due to the wind resource in the area.	We will expand our current spatial distribution factors for wind to include those developable areas in Amber NDF zones too.
The majority of respondents suggested that the existing SSAs would still see deployment, however some are becoming saturated and that emphasis is beginning to move away from these areas.	We will assess each SSA to see how development compares with indicative capacity as set out in the planning guidelines, and move emphasis towards the Green and Amber NDF zones.
You said that the current spatial distribution of onshore wind does not reflect the distribution of developable sites, as Mid-Wales has been avoided by developers due to the network in the region.	Our models do not simply rely on the baseline, instead we complete our own independent resource assessment and will ensure that areas with undeveloped potential are included.

East Midlands licence area 7

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Methodology summary

A detailed methodology report is available on the WPD DFES website, and is summarised in brief in this report.

Baseline analysis:

A database of current distribution network connected assets is created based primarily on WPD connection data, and supplemented with subsidy registers, Department for Transport data, and other national datasets. This data is used to analyse the spatial trends within a licence area, and how those trends have changed up to the present day.

Pipeline analysis:

Once a baseline is established, an analysis of sites that may connect in the next five-to-ten years is completed. This includes sites that have accepted a connection offer from the DNO but that have not yet connected, or sites that are active, for example having no connection offer but have applied for planning permission. Where possible, a discussion is held with a developer or interested group directly to inform the connection dates in the scenario projections.

Demand from new domestic and non-domestic property developments is also included in the analysis. The local plans from each local authority that intersect the licence areas are analysed to inform this process. The local authority planners are then contacted to verify the information and to provide insight into the rate of development within their planning period (in most cases the next 10-15 years). This consultation with local authorities also identifies where there are plans or strategies for supporting energy efficiency measures, renewable energy deployment, or decarbonising heat and transport. These are then reflected in the analysis and spatial distribution.

Annual cycle:

WPD DFES is now scheduled to be published on an annual basis, having previously been carried out on a two-yearly cycle. The National Grid ESO FES is developed through the spring and launched in the summer while the WPD DFES will use the latest FES to build the distribution level analysis, which is produced over the summer and published in the autumn.

Data will be collected and refreshed in this yearly cycle, and the scope and scenarios may differ year to year depending on changes to the FES. Stakeholder feedback will be gathered throughout the year and may continue after the main DFES process, to be incorporated in the following year.

The WPD DFES uses the FES as a framework, however it is a bottom-up analysis of a changing energy system at a regional and sub-regional level that reflects regional and local factors. It is, therefore, likely that there will be some variance between the WPD DFES view and the FES view. The regular annual cycle allows for data sharing between the WPD DFES and the National Grid ESO FES teams, facilitating continuous improvement of the data quality and processes.

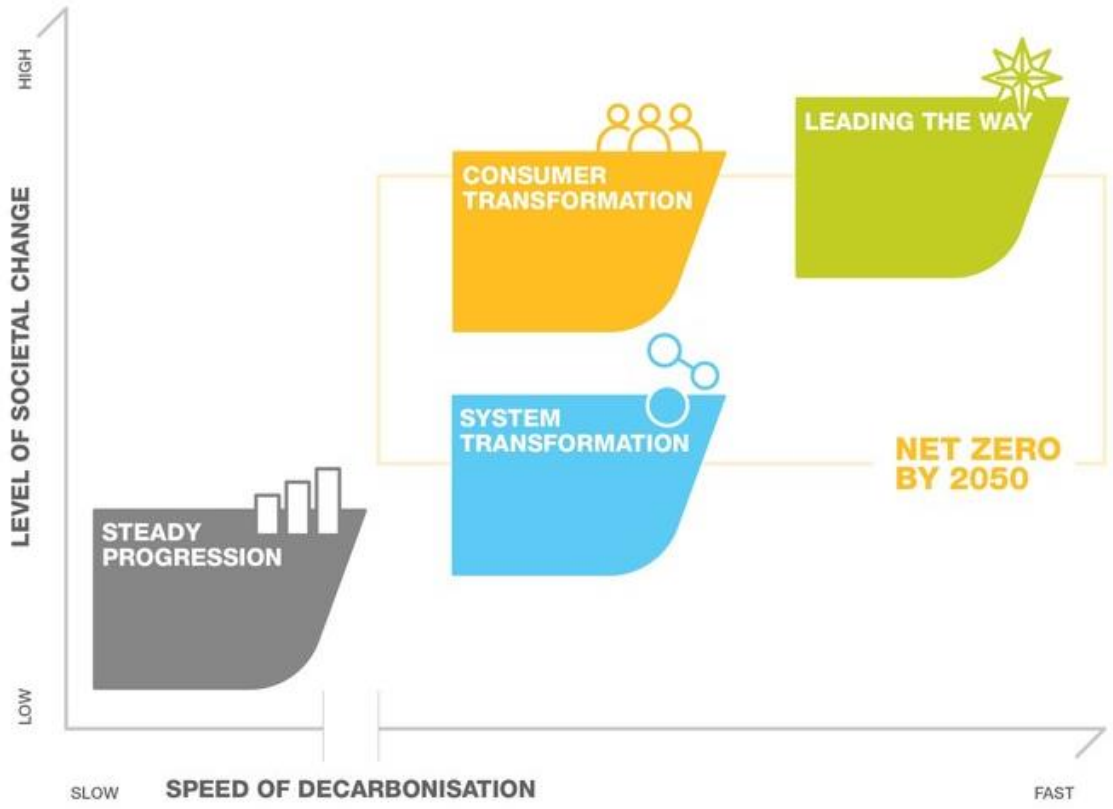
Scenario projections:

The WPD DFES 2020 uses the same four future scenarios as the National Grid ESO FES 2020. These scenarios are significantly different from those used in previous studies, reflecting changing legislation and incorporating new technology types in the analysis. The scenarios each have a different speed of decarbonisation and assume various levels of societal change. The location of these scenarios on those axes are shown in Figure 2.

Three of the four scenarios assessed in the WPD DFES 2020 meet the government target of net zero emissions by 2050, however they achieve these emissions reductions in different ways and at different rates. The net zero compliant scenarios are Leading the Way, Consumer Transformation, and System Transformation. The Steady Progression scenario is not compliant with the 2050 net zero target and has lower levels of societal change.

There are published assumptions made by in the FES 2020 which have been included in the DFES analysis and shown throughout this report. Further DFES assumptions including technology costs, spatial distribution, the development of sites in the pipeline are detailed in the technology specific sections of this report.

Figure 2 – The National Grid ESO FES 2020 scenario framework



List of technology types analysed as part of the WPD DFES 2020:

Table 1

DFES technology	DFES sub-technology	Equivalent Building block ID number
Air conditioning	-	-
Battery storage	Domestic batteries (G98)	Srg_BB002
Battery storage	Grid services	Srg_BB001
Battery storage	Co-location	Srg_BB001
Battery storage	High energy user	Srg_BB001
Biomass & Energy Crops (including CHP)	-	Gen_BB010
CCGTS (non CHP)	-	Gen_BB009
Electric vehicles	Pure electric motorcycle	Lct_BB001
Electric vehicles	Pure electric car (non autonomous)	Lct_BB001
Electric vehicles	Hybrid car (non autonomous)	Lct_BB002
Electric vehicles	Hybrid motorcycle	Lct_BB002
Electric vehicles	Pure electric bus and coach	Lct_BB003
Electric vehicles	Pure electric LGV	Lct_BB003
Electric vehicles	Pure electric HGV	Lct_BB003
Electric vehicles	Hybrid LGV	Lct_BB004
Electric vehicles	Hybrid bus and coach	Lct_BB004
Electric vehicles	Hybrid HGV	Lct_BB004
Electric vehicles	Pure electric car (autonomous)	-
Electric vehicles	Hybrid car (autonomous)	-
EV charge point	Domestic	-
EV charge point	Workplace	-
EV charge point	En-route	-

EV charge point	Destination	-
Floating wind	-	Gen_BB014
Geothermal	-	Gen_BB019
Heat pumps	Electric back-up	Lct_BB005
Heat pumps	Gas back-up	Lct_BB006
Hydropower	-	Gen_BB018
Marine	Tidal stream	Gen_BB017
Marine	Wave energy	Gen_BB017
Non renewable engines (CHP)	> 1 MW	Gen_BB001
Non renewable engines (CHP)	< 1 MW	Gen_BB002
Non renewable engines (CHP)	(G98/G83)	Gen_BB003
Non-renewable Engines (non CHP)	Diesel	Gen_BB005
Non-renewable engines (non CHP)	Gas	Gen_BB006
OCGTS (non CHP)	-	Gen_BB008
Offshore wind	-	Gen_BB014
Onshore wind	Large scale (>1MW)	Gen_BB015
Onshore wind	Small scale (<1MW)	Gen_BB016
Other generation	-	-
Renewable engines (landfill gas, Sewage Gas, Biogas)	-	Gen_BB004
Solar PV	Ground mounted (>1MW)	Gen_BB012
Solar PV	Commercial rooftop (10kw - 1MW)	Gen_BB013
Solar PV	Domestic rooftop (<10kw)	Gen_BB013
Waste Incineration (including CHP)	-	Gen_BB011

Results and assumptions

Demand technologies

New demand in the South Wales licence area

Summary of modelling assumptions and results.

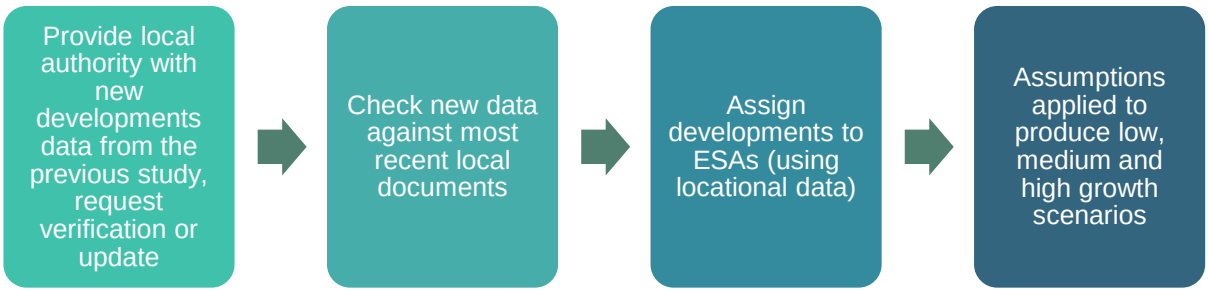
Specification:

New domestic and non-domestic development data is projected using the four FES 2020 scenarios based on an assessment of local authority plans.

Summary:

- New domestic and non-domestic buildings can have significant impact on local electricity demand. The development local plans of each local authority are analysed to create a record of the planned developments, their location, likely use, and the years over which they are expected to be built. The methodology is summarised in Figure 3.

Figure 3 – Summary of methodology for the assessment of new developments

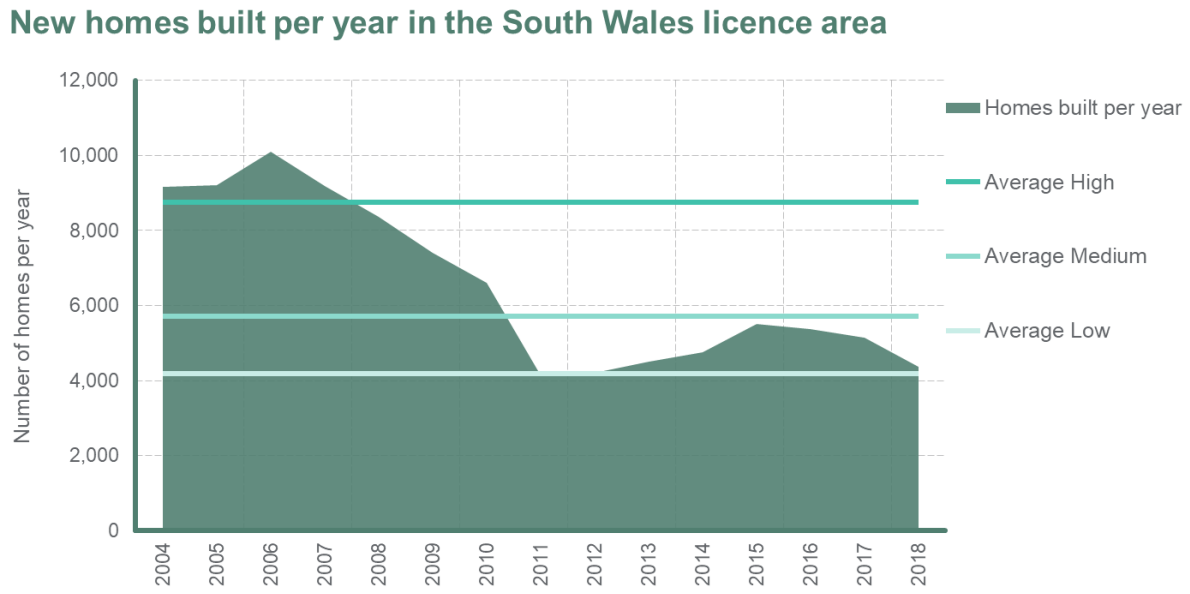


- The data from local authorities is used to create low, medium, and high growth scenarios for domestic and non-domestic developments, reported at ESA level.
- Every local authority within the licence area was contacted, with the existing DFES data presented for verification or modification. The local authorities were also asked about existing or draft decarbonisation strategies for energy, transport, waste, and heating in their local area. This data was used throughout the WPD DFES 2020.
- The minimum size of development captured through the direct analysis of local authority plans was 20 homes, with additional sites allocated based on historic development rates.

Results and assumptions:

- Historic trends in new developments are used to provide upper and lower estimates for a low, medium, and high level of deployment. These are then assigned to the FES 2020 scenarios for the near and medium term as detailed below. All scenarios trend towards the average medium trajectory in the long term.
    - Steady Progression – Low
    - Consumer Transformation – Medium
    - System Transformation – Medium
    - Leading the Way – High

Figure 4 – Example of how the levels of deployment are determined



- The numbers of homes or amount of commercial floorspace, the location, and the building type are taken from the local authority plans, or from a survey filled out by local authority planners.
- Each individual site is assigned to an ESA within the WPD network area and the rate at which new buildings will be completed is noted according to the plan. To create trajectories that fit the historic low, medium, or high rates, the scenarios apply different levels of assumed delay to building completion. In this way, the precise spatial data and scale of development is maintained, but the period over which the sites are built is varied.
- Not all plans extend out to 2030 or later, and therefore there is a natural reduction in the data for planned developments. To compensate for this reduction, additional dwellings and commercial floorspace is modelled, with location weighted towards areas of similar housing density to those of recent deployment.
- For the South Wales licence area, the high trajectory assumes around 8,750 new homes per year, and the low assumes around 4,000 new homes per year. These building rates interact with the new demand and generation scenarios for domestic technologies such as electric vehicles, heat pumps and rooftop solar PV, and the spatial data from the local plans define where on the WPD network these technologies in new builds are connected.
- A more detailed methodology is presented in the full WPD DFES 2020 methodology report, published alongside this results summary document.

Figure 5

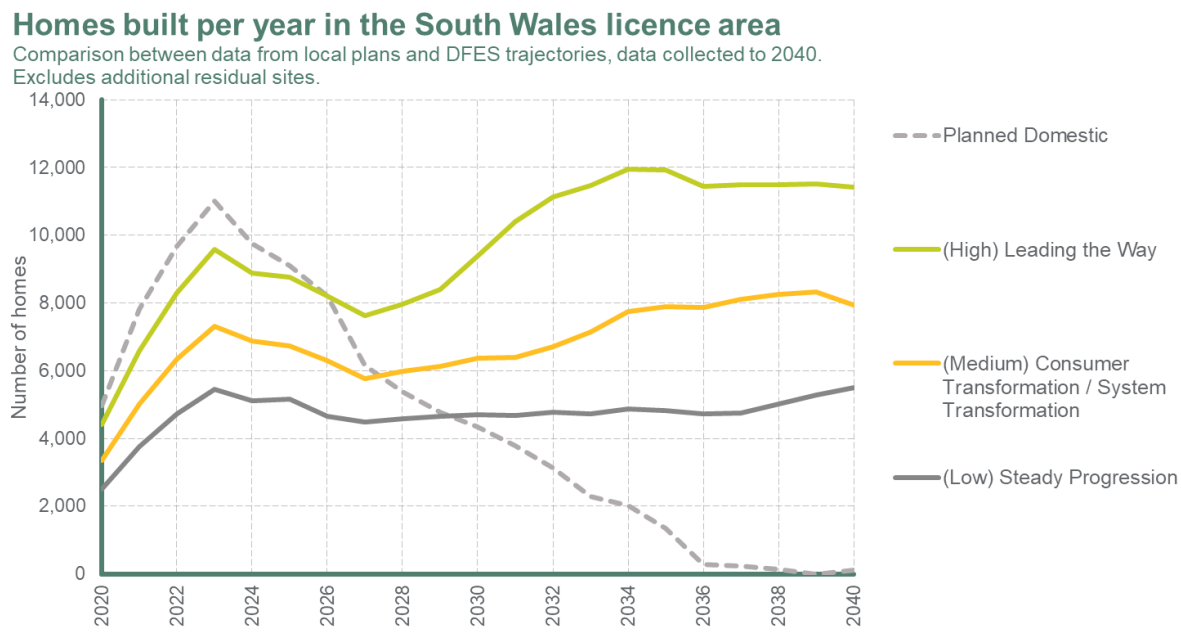
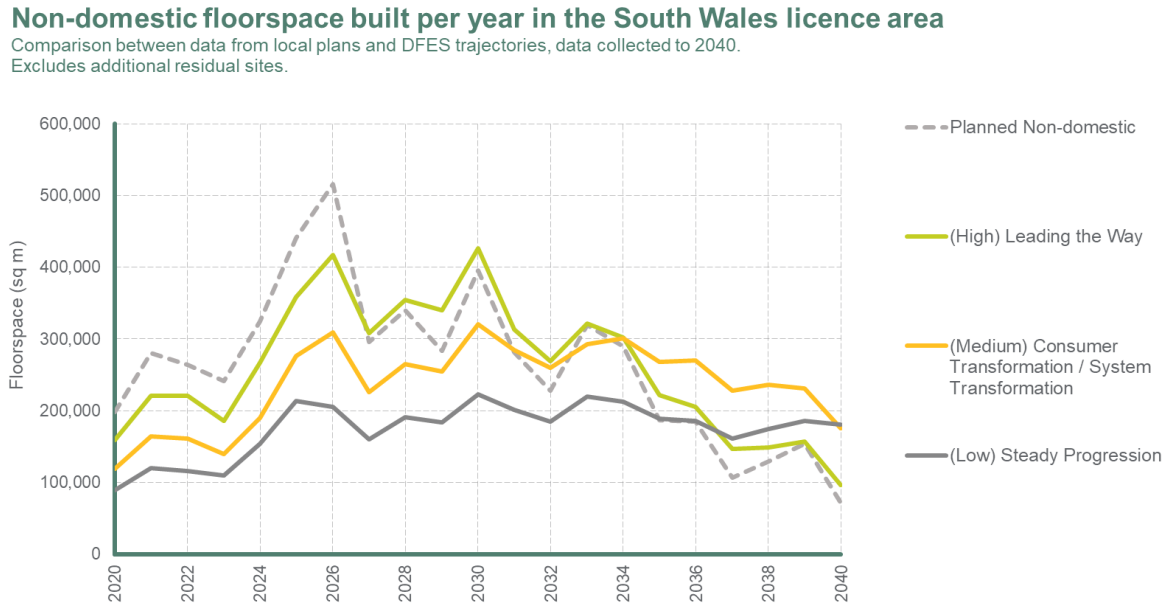


Figure 6



Stakeholder feedback from the consultation events:

Your comments to us	Our response
Theme: new developments	
You asked how the DFES can effectively feed into Local Plan Infrastructure Delivery Plans.	The DFES is designed to account for the most up to date Local Plan information available, and these projections are used in network analysis to determine potential reinforcements required. Our DFES projections are also disseminated to Local Authorities to review our assumptions and understand how WPD can feed into future Infrastructure Delivery Plans.
You asked at what point in the Local Plan process do WPD want to know about development sites – when the plan has been adopted or when it is in draft.	Draft local plans offer an updated position over previously adopted local plans. Plans in the draft stage are therefore preferred.
You asked if half-hourly metered data is used or peak figures with a diversity factor applied, and whether WPD has their own benchmarks to forecast demand based on floor area.	WPD use a combination of half hourly metered customer data and profiles derived from innovation projects applied to the DFES projections for electrical analysis. More information on the electrical profiles used can be found in our Shaping Subtransmission reports: www.westernpower.co.uk/smarter-networks/network-strategy/strategic-investment-options-shaping-subtransmission

References:

Local plan data as verified with all local authorities which intersect the WPD region.

Heat pumps in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Domestic heat pumps – electric heat pump systems providing space heating and hot water to domestic buildings. This technology is divided into two sub-categories:

- Non-hybrid heat pumps - powered purely by electricity
- Hybrid heat pumps - a combination of a gas boiler and electric heat pump.

Data summary for heat pumps in the South Wales licence area:

Thousands of heat pumps		Baseline	2025	2030	2035	2040	2045	2050
Non-hybrid	Steady Progression	4	7	9	22	43	84	119
	System Transformation	4	15	36	64	96	152	198
	Consumer Transformation	4	72	201	367	517	660	808
	Leading the Way	4	71	200	308	437	587	608
Hybrid	Steady Progression	0	1	9	20	26	40	64
	System Transformation	0	13	29	61	77	114	148
	Consumer Transformation	0	7	21	47	73	91	114
	Leading the Way	0	24	76	137	212	295	293

Summary:

- In line with changes nationwide, the South Wales licence area sees a dramatic shift to low carbon heating in all three of the net zero compliant scenarios. In the more electrified Consumer Transformation and Leading the Way scenarios, c.73% of homes are primarily heated by a heat pump by 2050.
- Due to the similarities in the South Wales housing stock to the national average, heat pump uptake in this licence area is projected to fall broadly in line with the GB FES 2020 average over the scenario time frame.
- Hybrid systems are slightly less prevalent in this licence area than GB overall due to a higher rate of off-gas homes which are unsuitable for the technology. The South Wales licence area has 19% of homes off-gas compared to 15% for GB as a whole.

Results and assumptions:

Baseline

- The South Wales licence area has c.4,500 heat pumps, all of which are non-hybrid. This represents 0.4% of homes, slightly below the GB national average of 0.6%.
- The primary deployment driver for domestic heat pumps in GB in recent years has been the Domestic Renewable Heat Incentive (RHI). 4% of heat pumps accredited by the Domestic RHI have been in the South Wales licence area.

Near term

- Heat pump uptake continues under the net zero compliant scenarios in the near term, as a result of a continued Domestic RHI and the Green Homes Grant, which is available from September 2020 and supports the installation of domestic energy efficiency measures and heat pumps.
- From 2022, there is a step change in installation rates under the more electrified Consumer Transformation and Leading the Way scenarios, as national heat strategy prioritises electrification and drives significant change in the heating industry. Installation rates also increase notably in System Transformation, despite a stronger focus on gas network solutions.
- With national policy likely to be targeted in off-gas homes over the next decade (indicated in the Clean Growth Strategy 2017), the slightly higher proportion of off-gas homes in this licence area leads to higher near-term deployment of heat pumps.
- Under all net zero compliant scenarios the proposed ban on gas connections in new build housing is implemented, resulting in a rise in non-hybrid deployments from 2025 onwards.

Medium term

- Installations of heat pumps in the late 2020s and 2030s are driven largely by national heat strategy and policy rather than consumer choice.
- In System Transformation, hydrogen boilers served by a repurposed gas network are pursued as the dominant low carbon heating technology and heat pump uptake is largely limited to off gas housing.
- In Leading the Way and Consumer Transformation, high carbon heating technologies are replaced in both on and off gas housing. Heat pumps make up 56% of heating system replacements in off gas homes in the 2030s.

Long term

- In the Consumer Transformation and Leading the Way scenarios, continually improving domestic energy efficiency results in almost all homes becoming suitable for a heat pump by 2050. 73% of homes in the licence area are served by a non-hybrid or hybrid heat pump by 2050 under Consumer Transformation and Leading the Way.
- Heat pump uptake under System Transformation and Steady Progression remains low, as heating fuelled by hydrogen and fossil gas boilers respectively, is preferred.

Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for the Building Block ID numbers Lct_BB005 and Lct_BB006.

- The WPD DFES 2020 projections for non-hybrid heat pump uptake is slightly higher than in FES 2020, and hybrid heat pump uptake is slightly lower. This reflects the greater proportion of off gas homes in South Wales compared to the rates nationally.
- The housing stock in this licence area is currently poorly insulated, with only 8% of homes achieving an EPC rating of C or better, compared to 12% nationally. However, the proportion of hard to insulate homes, with a maximum potential EPC of D or worse, is slightly lower than the national average (14% of homes, compared to 15% nationally). As a result, the current state of South Wales housing stock does not heavily impact the relative levels of heat pump uptake seen by 2050.

Figure 7

Domestic - Non-hybrid heat pumps by scenario
Comparison to FES 2020 GSP data for the South Wales licence area

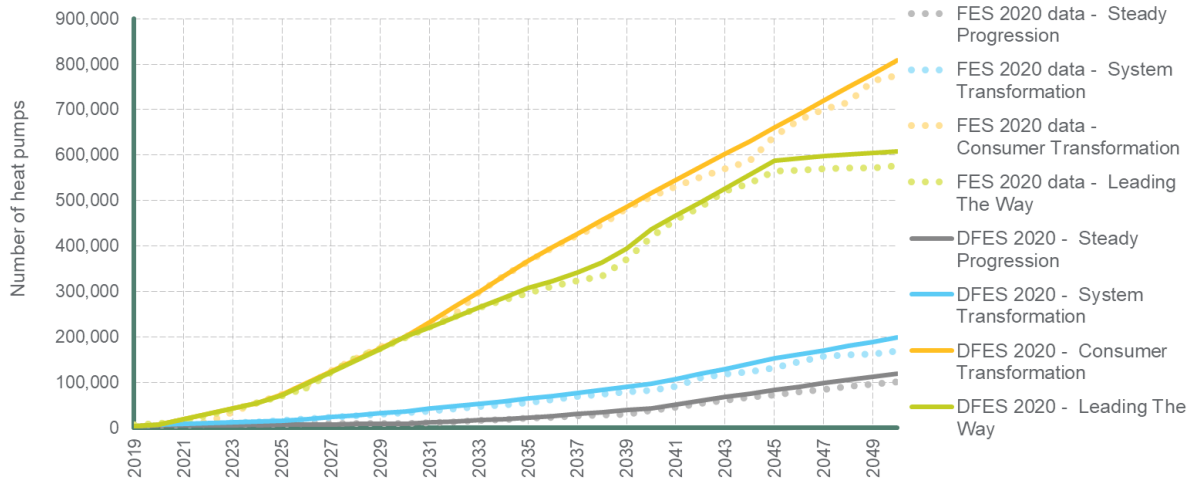
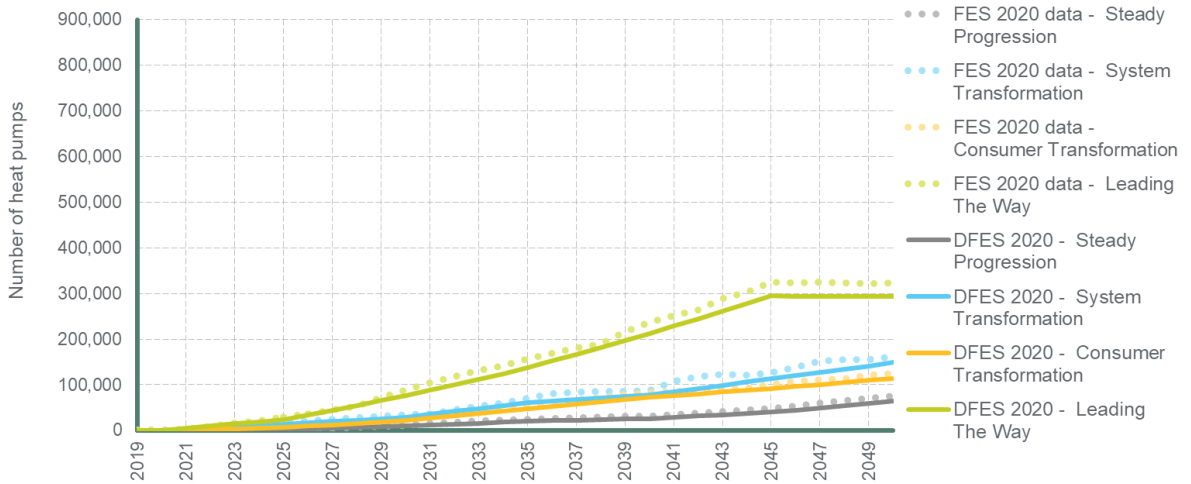


Figure 8

Domestic - Hybrid heat pumps by scenario
Comparison to FES 2020 GSP data for the South Wales licence area



Factors that will affect deployment at a local level:

- Under Consumer Transformation and Leading the Way where heat pumps become the dominant heating technology, the spatial weightings focus on those areas which are 'first movers' in the near term, and identifies which areas play catch up
- Uptake in off gas, and on gas homes is modelled separately. Within these two separate areas, weightings factors such as whether homes are detached or terraced, levels of affluence, and floorspace are used to assess deployment at a local level.
- In the near term detached, semi-detached, and owner-occupied properties see higher uptake reflecting analysis of domestic RHI-supported heat pump installations. Detached and semi-detached properties make up 81% of current installations, despite representing 27% of the housing stock.
- Additionally, as heat pumps perform best in a well-insulated building, properties with an EPC band of a C or higher see higher projected uptake in the near term.
- Weightings in the near term such as affluence, tenure and building type reduce towards zero as heat pumps become the heating solution of choice under some scenarios. Subsequently, homes that are currently less likely to adopt heat pumps, such as rental properties and poorly insulated buildings, drive the distribution of heat pump uptake in the long term.
- Hybrid heating distribution is driven by the above factors, with an additional weighting towards homes with high floor space (i.e. with the requisite space to house the dual heating appliances and likely higher peak heat demand) and with maximum potential EPC ratings of a D or below, which would be unlikely to be suitable for a non-hybrid heat pump.
- All local authorities in the South Wales licence area were surveyed regarding whether they had specific plans or strategies for low carbon heat. Those with a positive heat pump strategy were given a small positive weighting, deployment was also weighted away from areas with a district heat network strategy in the near term.

Relevant assumptions from National Grid FES 2020:

Assumption number	3.1.3
Steady Progression	Consumers continue to buy similar appliances to today
System Transformation	Low willingness to change lifestyle results in hydrogen being the preferred low carbon heating technology for consumers
Consumer Transformation	High energy prices and consumer willingness to adapt results in high levels of heat pump uptake
Leading the Way	High income, energy prices and consumer green ambition results in high levels of non-hybrid and hybrid uptake

Stakeholder feedback from the consultation events:

Your comments to us	Our response
Theme: domestic heat	
You asked what analysis of the potential uses of hydrogen do we include in our modelling?	The uptake of domestic hydrogen heating or electric heat pumps differs across the net zero scenarios, and the analysis includes both. However, we focus on electric heat pumps as we are reporting connections to the WPD network.
You told us that hydrogen produced in industrial clusters could be used to generate electricity.	We will review this for the next round of DFES and incorporate stakeholder feedback for including hydrogen peaking plants as an emerging technology by 2050.
The majority of the respondents suggested that gas boilers would continue to be installed in new homes up until 2025, however a significant minority thought that the rate would fall towards 2025.	We will incorporate these into the assumptions which feed our heat modelling work, keeping gas boiler deployment high in new builds out to 2025.
The majority of respondents suggested that though new homes and off-gas areas would receive higher heat pump installation rates, on-gas areas would also see uptake.	We will incorporate this into our spatial modelling, focussing most deployment in the early years in off-gas areas, but widening it out into other areas too.

References:

Energy Performance Certificates, Census 2011, Renewable Heat Incentive data, Climate Emergency declaration data, Regen consultation with local stakeholders and local authorities.

Direct electric heating in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

A system using electricity to provide primary space heat and hot water to domestic buildings, that is not driven by a heat pump. Typically, this is night storage heating or direct electric heating. This does not include heat networks.

Data summary for direct electric heating in the South Wales licence area:

Number of households (1,000s)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	62	65	68	70	74	77	80
System Transformation	62	66	68	69	70	70	69
Consumer Transformation	62	66	67	68	68	67	66
Leading the Way	62	66	69	71	72	72	72

Summary:

- The number of electric heating units declines in existing homes as it is gradually replaced by low-carbon heating, the majority of which are non-hybrid heat pumps. There are some installations in homes with homes with smaller floorspace, though there is an overall net reduction in existing homes. Overall, numbers increase as electric heating is projected to be installed in some new build homes. The result is a small increase in overall numbers in the near and medium term.
- In the long term, the uptake rate flattens in Leading the Way, and begins to fall in the long term in Consumer Transformation and System Transformation due to the prevalence of electric heat pumps and hydrogen heating alternatives.

Results and assumptions:

Baseline

- The baseline number of direct electric heating units is based on analysis of domestic heating technology types from Energy Performance Certificate (EPC) data.
- The installation rate of direct electric heating in new builds is also based on local EPC data. The most recent national data shows that c.11% of new builds are heated by direct electric heating, a proportion which has been relatively stable over recent years.

Near term (2020 – 2025)

- In the net zero compliant scenarios, electric heating units are projected to be replaced by other or more efficient low carbon heating solutions, projected to be mainly non-hybrid heat pump systems.
- Though electric heating has a higher running cost than a heat pump, they are assumed to not be the target of national policy to decarbonise domestic heating, based on the relative emissions of other domestic heating solutions such as oil and LPG. Therefore, in the near term there is projected to be a limited decrease in electric heating in existing homes.
- The WPD DFES 2020 analysis of new build domestic properties is used to project increases in the number of direct electric heating installations, starting at the current average of c.11% of new homes with direct electric heating, falling to c.10% in the net zero compliant scenarios by 2025.

Medium term (2025 – 2035)

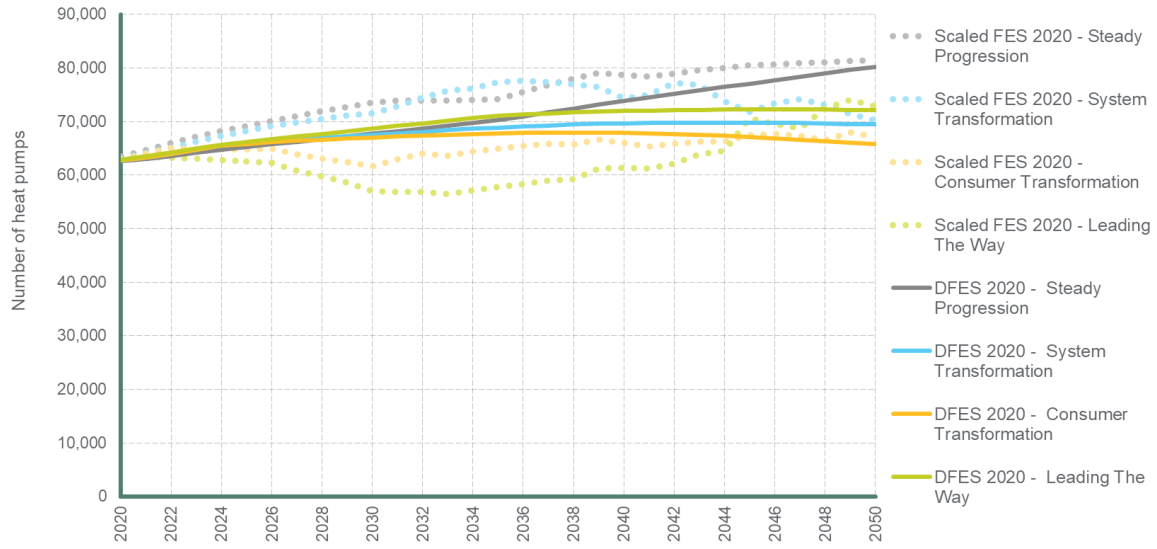
- In the medium term, there is a steady decline in the numbers of domestic direct electric heating units in existing homes. It is assumed to be a steady annual reduction in the absence of clear policy drivers within the medium term. In Steady Progression, the baseline installations are not projected to decrease across the projection period.
- The percentage of direct heating units in new builds is assumed to decrease in the medium term from c.11% to c.3-5% in the net zero compliant scenarios. No change in installation rate is assumed in the Steady Progression scenario in the medium term.

Long term (2035 – 2050)

- The installation rate of direct electric heating in new build domestic properties reduces to zero in Consumer Transformation, and to c.2% in Leading the Way and System Transformation. This reduction in new installations and the continued replacement of the baseline installations leads to a falling total in Consumer Transformation, and a flattening projection in Leading the Way and System Transformation.
- In Steady Progression, the total number of installations rises to 80,000, compared to a 66,000 in Consumer Transformation.

Figure 9

Domestic direct electric heating by scenario
Comparison to scaled FES 2020 data for the South Wales licence area



Reconciliation with National Grid FES 2020:

- There are no direct electric heating numbers presented at GSP level in the FES 2020, therefore the comparison is presented to FES 2020 totals scaled to the baseline level of domestic direct electric heating installations in the licence area.
- The WPD DFES 2020 is broadly in line with FES 2020, although the WPD DFES 2020 trajectory shows less variation within the projection period. At a more granular level the trajectories are less smooth due to the discrete location of planned new domestic developments in the licence area and the clustering of current direct electric heating installations in off gas areas.

Factors that will affect deployment at a local level:

- The spatial distribution of the baseline installations, and therefore the reduction in total numbers of direct electric heating units, is based on EPC data and are typically located in off gas properties and homes with smaller floorspace.
- The spatial distribution of new builds is based on data collected from the plans of local authorities.

References:

Energy Performance Certificate data, BEIS local off gas properties data, Regen consultation with local stakeholders and analysis of local authority local plans.

Electric Vehicles in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Electric Vehicles (EVs) – including non-autonomous cars, autonomous cars, buses and coaches, HGVs, LGVs and Motorcycles, including battery EVs and plug-in hybrid EVs.

Data summary for EVs in the South Wales licence area:

Number of EVs (total, 1000s)		Baseline	2025	2030	2035	2040	2045	2050
Battery EVs	Steady Progression	3	22	109	359	801	1,243	1,382
	System Transformation	3	34	176	596	1,156	1,361	1,304
	Consumer Transformation	3	61	332	887	1,229	1,253	1,141
	Leading the Way	3	78	416	1,035	1,272	1,183	922
Hybrid EVs	Steady Progression	5	17	51	113	160	96	3
	System Transformation	5	19	51	85	58	12	-
	Consumer Transformation	5	11	25	35	18	-	-
	Leading the Way	5	18	37	26	6	-	-

Summary:

- At present, EVs represent approximately 0.4% of all vehicles in the South Wales licence area, which is half the GB average of 0.8%, though the licence area is expected to align with the GB average as EVs become ubiquitous by the late 2020s.
- While the number of plug-in hybrid EVs is currently higher than battery EVs, across all scenarios battery EVs become the dominant technology in the near term and quickly eclipse plug-in hybrids as a result of their higher efficiencies and lower carbon emissions. All net zero compliant scenarios have zero plug-in hybrids by the 2040s, and so this assumptions report focusses on trends for battery EVs.
- Analysis of Autonomous Vehicles (AVs) was introduced in FES 2020. FES expect these vehicles represent between 9% and 23% of all cars by 2050. This is, therefore, the first WPD DFES to include a preliminary analysis of AVs.

Results and assumptions:

Baseline

- There is a total of 2,915 battery EV cars in the South Wales licence area.
- There is a total of 4,677 plug-in hybrid EV cars in the South Wales licence area.

Near term (2020 – 2025)

- Across all scenarios the uptake of EVs is expected to increase dramatically by 2025, pushed particularly by second car owners in the near term.
- A further factor in near term deployment is the Welsh Government clean air plans published in August 2020 to support the decarbonisation of public transport, implement an electric vehicle charging strategy, and to investigate measures such as Clean Air Zones and air quality monitoring.
- It is projected that by 2025, there could be between 22,000 battery EVs in Steady Progression and 78,000 in Consumer Transformation.
- Autonomous vehicle uptake starts at the earliest in 2023 under all scenarios, however, uptake is very slow in the near term.

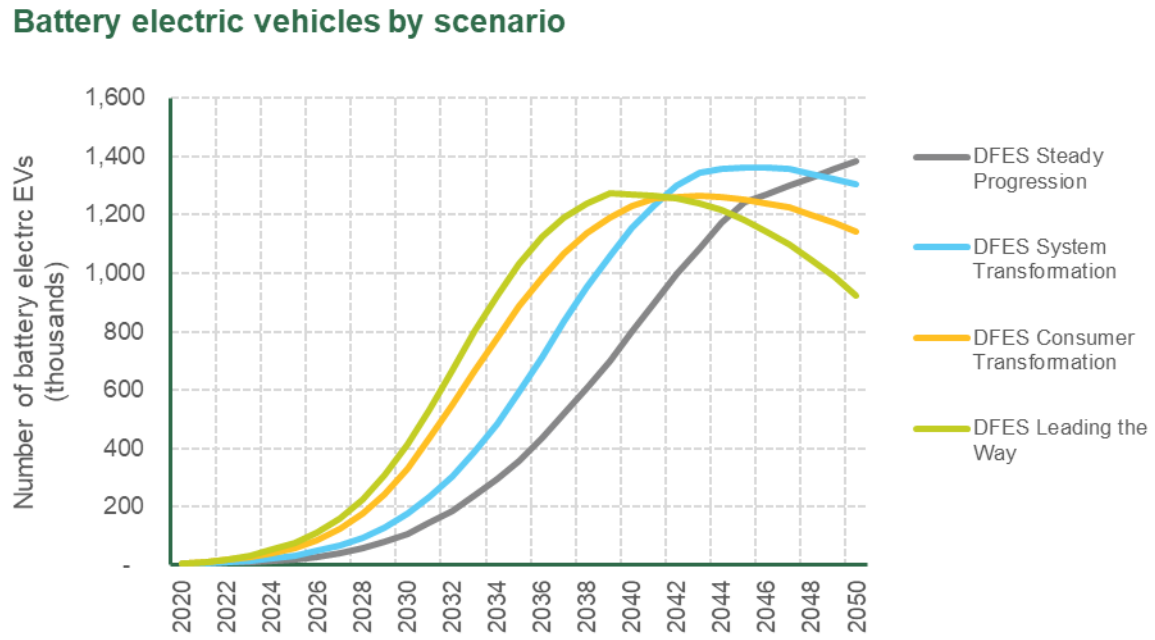
Medium term (2025 – 2035)

- Uptake of EVs is expected to accelerate between 2025 and 2030 across all scenarios.
- Steady Progression has the fewest estimated battery EVs in 2035, with nearly 0.4 million. Leading the Way remains the scenario with the most, with nearly 1 million battery EVs by 2035.
- EV uptake begins to slow in the mid-2030s as EV adoption approaches saturation and only the hardest-to-electrify vehicle such as HGVs, remain as fuelled by petrol or diesel. Other factors also contribute to uptake slowing, including the total number of vehicles reducing, increased use of AVs, and increased use of public transport and active travel.

Long term (2035 – 2050)

- The uptake of EVs continues to increase in Steady Progression, right up until 2050 when battery EVs total nearly 1.4 million. In System Transformation, the uptake of battery EVs approximately flattens from the early 2040s at around 1.3 million.
- In Leading the Way and Consumer Transformation, the numbers of EVs reduces from the late 2030s and mid 2040s respectively. This is due to the high levels of societal change resulting in high use of AVs, public and active travel, which leads to many homes opting to have fewer cars or no car at all.
- In Leading the Way, the number of battery EVs and total vehicles reduces substantially, peaking at around 1.2 million before reducing to 0.9 million in 2050.

Figure 10



Reconciliation with National Grid FES 2020:

The WPD DFES 2020 projections are in line with the FES 2020 projections in this licence area, as reported for the Building Block ID numbers Lct_BB001, Lct_BB002, Lct_BB003, Lct_BB004.

- Interim assumptions have been made for the distribution of AVs in the absence of other information including:
    - Their spatial distribution is treated the same as non-autonomous EVs due to a lack of information about their future uptake.
    - It is assumed that the uptake of EVs in on and off street settings is the same as for non-autonomous EVs.
- The uptake and distribution of AVs is an area that needs to be considered for future analysis when more evidence is available.

Factors that will affect deployment at a local level:

- The spatial distribution of EVs in the near term is based on second car ownership, affluence, rurality, existing vehicle baselines and the distribution of on and off street parking.
- However, in the late 2020s under all net zero compliant scenarios, uptake is assumed to be ubiquitous. This means almost all consumers are assumed to have the same likelihood of adopting an electric vehicle.

Relevant assumptions from National Grid FES 2020:

Assumptions	
Steady Progression	Steady Progression assumes autonomous vehicles will be privately owned. In this scenario, this increases average miles travelled, as they can make longer commutes less effort or run errands during the working day.
System Transformation	System Transformation assumes that in some cases a two car household becomes a one car household, where shared autonomous vehicles meet some transport needs. However, most households still have two vehicles, which leads to a modest decrease of only 8% in the number of vehicles compared to Steady Progression.
Consumer Transformation	In Consumer Transformation autonomous vehicles, acting as a taxi service, often replace the need for a second car. They are used by consumers to commute to work or for leisure trips. Combined with greater use of public transport, this results in a 15% decrease in vehicles in this scenario, compared to Steady Progression.
Leading the Way	In Leading the Way, the high levels of societal change have led us to assume that use of autonomous vehicles and public transport reduces the overall number of cars as many homes opt to have no car at all, relying instead on shared mobility solutions, using AVs, which can accommodate four people. Total number of cars is one third less in 2050 than in Steady Progression.

Stakeholder feedback from the consultation events

Your comments to us	Our response
Theme: electric vehicles (EVs)	
You told us that in the long term under a net zero scenario, that both the number of vehicles, and the miles those vehicles drive, would be reduced.	Only 9% of respondents thought there would be no change, a clear message, though vehicle number reduction is not an assumption that is currently included in the FES. We will seek to include it in this round of the DFES under the most ambitious net zero scenario.
You asked what assumptions our model makes about the planned phase-out of petrol and diesel vehicles.	The previous FES incorporated the 2040 target, which has now been brought forward. Our modelling incorporates the new 2035 target, however there are other barriers and drivers which will strongly impact near-term uptake too.
You asked if the projections take into account the new houses and commercial buildings planned in the area, and how does we model deployment in existing homes?	Home-based electric vehicles such as electric cars, motorcycles, and some LGVs are modelled used demographic data such as off-road parking and vehicle ownership. Projected new builds are used to inform the spatial distribution of domestic electric vehicle chargers.

References:

Department for Transport data, Climate Emergency declaration data, Regen consultation with local stakeholders, Census 2011.

Electric Vehicle chargers in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Electric vehicle chargers – including eight charger archetypes:

1. Off street domestic – homes with somewhere to park a private vehicle off street
2. On street residential – charging at roadside car parking spaces
3. Car parks – charging at areas solely provided for parking only, thus excludes supermarkets
4. Destination – supermarkets, hotels for instance where parking is provided
5. Workplace – daytime parking for commuters, at places of work
6. Fleet/depot – charging for vehicles which return to a depot to park
7. En-route local – charging service stations excluding motorway or A-road services
8. En-route national – motorway or A-road charging stations

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

Number of EV chargers (thousands)		Baseline	2025	2030	2035	2040	2045	2050
Domestic off-street EV chargers	Steady Progression	2	13	60	194	416	613	642
	System Transformation	2	20	93	304	565	643	643
	Consumer Transformation	2	40	200	494	617	620	620
	Leading the Way	2	50	242	559	646	646	646
Non-domestic EV chargers	Steady Progression	1	2	5	15	32	47	50
	System Transformation	1	2	8	26	49	59	61
	Consumer Transformation	1	4	13	33	46	49	51
	Leading the Way	1	5	17	40	49	51	53

Summary:

- At present, the installation of public EV chargers in the South Wales licence area is below the GB average for the number of EVs. However, the licence area is projected to align with the FES GB average in the 2020s as demand for charging increases.
- These projections aim to represent the envelope of the possible spread and rate of deployment of EV chargers. In many modelling areas there is a lack of behavioural evidence and so interim assumptions have been made.

Results and assumptions:

Baseline

- There are a total of 340 public EV chargers in the South Wales licence area
- It is estimated that there are around 2,000 domestic EV chargers in the South Wales licence area.

Near term (2020 – 2025)

- Across all scenarios the uptake of EV changers is expected to increase dramatically in the near term.
- It is projected that by 2025, there could be between 13,000 domestic off street chargers in Steady Progression and 50,000 in Leading the Way.
- In addition, it is projected that by 2025, there could be between 25 MW of non-domestic off street chargers in Steady Progression and 70 MW in Leading the Way.

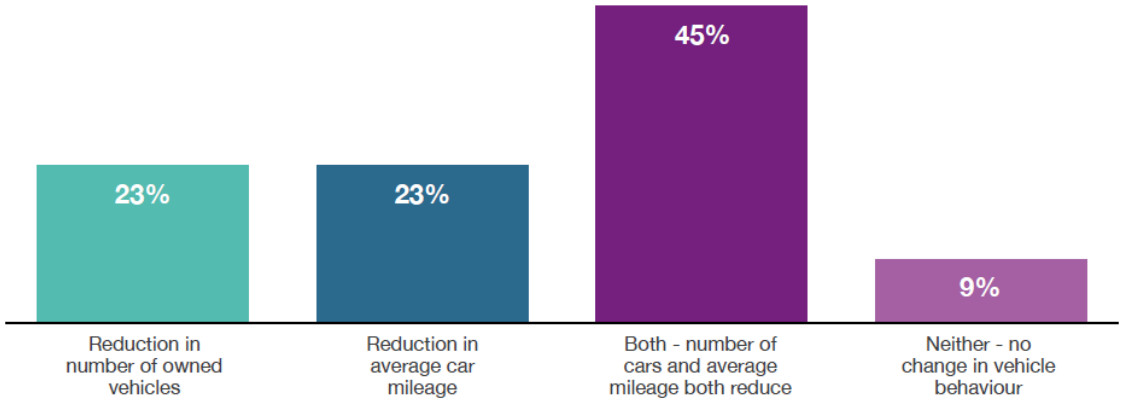
Medium term (2025 – 2035)

- Charger installations are expected to accelerate between 2025 and 2035 across all scenarios.
- Steady Progression has the lowest estimated EV charger capacity in 2035, with around 194,000 domestic EV chargers and 249 MW of non-domestic capacity. Leading the Way has with the highest capacity, with 559,000 domestic EV chargers and approaching 0.6 GW of non-domestic capacity.
- EV uptake begins to slow in the mid-2030s as EV adoption approaches saturation. Therefore, the installation rate of EV chargers also slows.

Long term (2035 – 2050)

- While the uptake of EVs slows and then reduces in some scenarios in the long term, it is assumed that charger capacity will not reduce in line with EVs. An assumption has been made that EV charger capacity will not reduce and remain at the peak achieved in the years between 2040-2050.
- The uptake of EVs and EV chargers continues to increase in Steady Progression, right up until 2050 when there are over 0.6 million domestic EV chargers.
- In Leading the Way and Consumer Transformation, the total capacity of EV chargers is static from the late 2030s and mid 2040s, respectively.

Figure 11 - Results of stakeholder feedback regarding how vehicle use may change in the long term

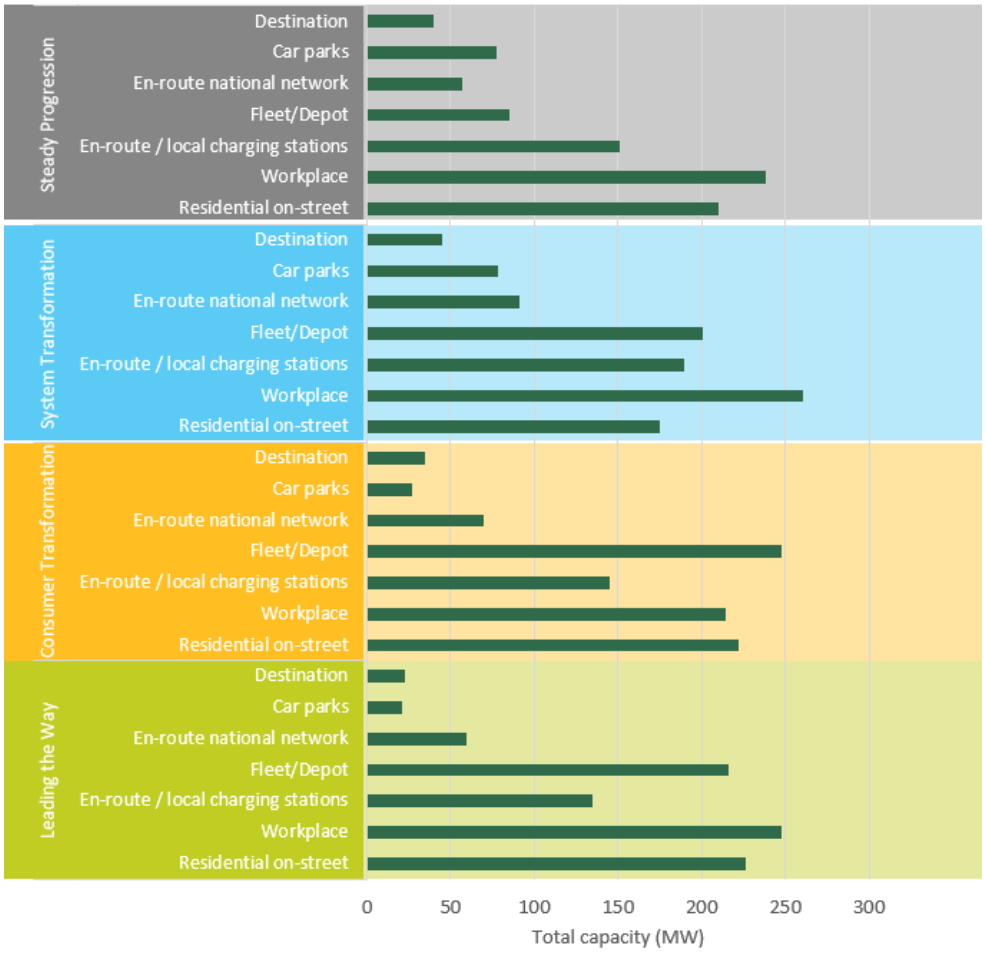


Reconciliation with National Grid FES 2020:

- The FES 2020 results do not provide sufficient breakdown of information to reconcile the EV charger information within the DFES with national projections.
- To project EV charger capacities without a FES 2020 framework, assumptions have been made as to the behaviour of EVs and subsequent use of EV chargers, including:
    - Where each EV category will charge (and at which type of EV charger e.g. at home, on street, at work etc.).
    - The EV charger utilisation at each type of charger.
    - The assumptions have been made using industry input and Regen analysis. As more behavioural data and other evidence becomes available, these assumptions will be further refined in the future.
- Interim assumptions have been made as to the behaviour of AV cars in the absence of other information, including:
    - The proportion of AVs that are private or shared in the absence of further information.
    - AV charging behaviour is similar to EVs, the key difference being an increase in fleet/depot charging.
    - AVs are associated with on and off street households and charging at the same rate as EVs.
- The uptake and distribution of chargers associated with AVs is an area that needs to be considered for future analysis.

Figure 12

Non-domestic EV charger capacity results arranged by scenario (2050)



Factors that will affect deployment at a local level:

- The take up of home EV chargers is distributed in the near term towards more rural and affluent areas and those where there are high levels of off street parking.
- The spatial distribution of non-domestic chargers was produced differently for each archetype.
    - En-route local and national charging locations were distributed based on the density of local housing, the volume of local traffic, the distribution of existing petrol stations and the road classification on where the site is located.
    - Car parks, workplace and fleet depot locations were identified from Ordnance Survey data.
    - The on street residential analysis was undertaken in parallel with the off street parking analysis to identify vehicles associated with on street parking.
- The distribution analysis uses affluence and second car ownership as one of the key factors driving the uptake of EV chargers in the near term. For the more ambitious scenarios, from mid to late 2020s, the underlying assumption is that EVs will become ubiquitous. Therefore, the growth in demand for EVs in both on street and off street areas, lower and higher affluence areas begins to increase at equivalent rates.

Relevant assumptions from National Grid FES 2020:

Assumptions	
Steady Progression	Charging at home is limited by a lack of via solution for those without off street parking.
System Transformation	Emphasis on public rollout of fast chargers to allow rapid charging. More rapid and fast public charging is demanded from consumers.
Consumer Transformation	Charging predominately happens at home. Emphasis on home chargers, taking advantage of consumer engagement levels in flexibility. Leads to some disruption (e.g. reinforcing local networks)
Leading the Way	Charging happens similarly to how it happens today, with various types receiving investment to support an accelerated uptake of electric vehicles. Accelerated rollout of charging infrastructure at home and in public places.

References:

Department for Transport data, Climate Emergency declaration data, Regen consultation with local stakeholders, Census 2011.

Air conditioning in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Number of domestic air conditioning units.

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

Percent of homes (%)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	1.1	2.1	4.1	8.1	16.1	31.9	62.9
System Transformation	1.1	1.9	3.4	6.0	10.8	19.4	34.6
Consumer Transformation	1.1	1.9	3.4	6.0	10.8	19.4	34.6
Leading the Way	1.1	1.1	1.1	1.1	1.1	1.1	1.1

Summary:

- Air conditioning has limited uptake in the UK at present. However, higher extremes of temperatures from heatwaves and warmer summers due to climate change could increase demand for air conditioning towards the end of the scenario period.
- There are approximately 1,000,000 homes in the South Wales licence area, projected to increase to 1,300,000 by 2050.
- Uptake of air conditioning is likely to be focused in urban areas, such as Cardiff, not just due to the number of homes but also the higher temperatures from heat island effects.

Results and assumptions:

Baseline

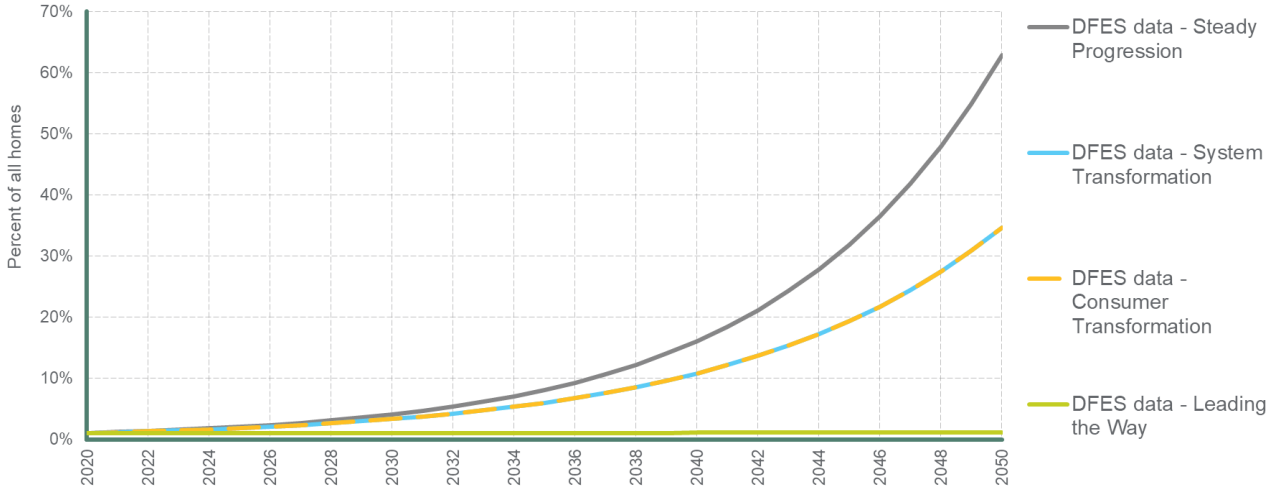
- There is a lack of reliable baseline data for air conditioning installations, although one study estimates that 203,000 air conditioning were sold in the UK in 2018, up from 153,000 in 2013.
- Due to the lack of data on current installation rates of air conditioning, national data from FES 2020 has been used as a benchmark. To create the baseline, FES 2020 data has been distributed pro rata to the licence area based on the number of homes. In FES 2020 1.1% of homes in GB have air conditioning installed in 2019, applied uniformly to this licence area there are assumed to be c.11,000 homes with air conditioning.
- The analysis for this section is limited to domestic air conditioning.

Projections (2020 – 2050)

- Near and medium term deployment of air conditioning is limited, with under 10% of homes installing air conditioning in all scenarios. This reflects the high upfront cost and the relative lack of demand in the current climate.
- Deployment accelerates after 2035, due to assumed higher extremes of temperatures, as a result of climate change, and some economies of scale, however air conditioning is a mature technology with relatively small cost reductions expected.
- In Steady Progression there are projected to be much higher levels of uptake of air conditioning units in GB homes, due to increasing temperatures and limited regulation to avoid active cooling measures.
- From an assumed baseline of 11,000 homes (1.1%) in 2019, 45,000 homes in Steady Progression have air conditioning by 2030, and 800,000 by 2050.
- Leading the Way has very little increase in the number of air conditioning units installed, as more sustainable means of cooling and improved building design are preferred.
- Consumer Transformation and System Transformation both have medium levels of air conditioning uptake as society adopts a mix of different actions to maintain comfort levels. In these scenarios 40,000 homes have air conditioning by 2030, and 440,000 by 2050.

Figure 13

Percent of homes with air conditioning by scenario
DFES projections for the South Wales licence area



Reconciliation with National Grid FES 2020:

- The DFES projection results broadly align with the FES 2020 projections at national level. There are no licence area level projections to compare directly against in FES 2020.
- The FES 2020 percent of homes projection was used as a starting point before applying local factors relative to GB, such as:
    - Cooling degree days (number of days that average temperature is below 15.5°C)
    - Population density
    - Affluence
    - Home ownership
- The FES 2020 projects that 63.7% of homes in GB will have air conditioning installed by 2050 in Steady Progression. South Wales has roughly average levels of affluence (20.0% in social grade A or B compared to 20.3% in GB) but lower population density which results in a slightly lower DFES projection with 62.9% of homes having air conditioning installed by 2050.

Factors that will affect deployment at a local level:

- The spatial distribution of air conditioning units in the South Wales licence area is influenced by factors such as:
    - New developments – new-build regulations aim to improve passive cooling measures e.g. the Future Homes Standard.
    - Affluence – early uptake is heavily influenced by upfront and running cost therefore affluence is a key factor. As deployment becomes more widespread in the long term, affluence becomes less of a factor and uptake is weighted more towards urban areas.
    - Home ownership – homeowners are assumed to be more likely to invest in home improvements.
    - Population density – reflects the impact of heat islands in high density urban areas in the licence area.

Relevant assumptions from National Grid FES 2020:

Assumption number	3.1.2
Steady Progression	Low willingness to change means society takes the easiest route to maintain comfort levels, therefore increased levels of air conditioning.
System Transformation	Medium uptake as society takes a mix of actions to maintain comfort levels (mix of air conditioning, tolerance of higher temperatures, changes to building design)
Consumer Transformation	Medium uptake as society takes a mix of actions to maintain comfort levels (mix of air conditioning, tolerance of higher temperatures, changes to building design)
Leading the Way	Low uptake as society changes to minimise uptake (e.g. personal tolerance of higher temperatures, changes to building design)

References:

National Grid's FES 2020 data, UK Heat Degree Days data.

Results and assumptions

Generation technologies

Onshore wind in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Onshore wind - including comparison to FES 2020 small scale (< 1 MW) and large scale (≥ 1 MW) data.

Data summary for onshore wind in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	548	548	563	629	730	809	906
System Transformation	548	573	691	869	1,086	1,250	1,318
Consumer Transformation	548	684	1,016	1,340	1,886	2,507	3,094
Leading the Way	548	645	867	1,152	1,513	1,862	2,248

Summary:

- High wind speeds and a supportive policy framework have contributed to the South Wales licence area having the highest current installed onshore wind capacity of the WPD licence areas.
- A relatively large pipeline of new sites contributes to high deployment in all net zero compliant scenarios, as developers seek to build out subsidy-free sites.

Results and assumptions:

Baseline

- There are 37 large scale onshore wind sites in the licence area, totalling 504 MW.
- The average capacity of large scale onshore wind sites is 14 MW, the highest among the four WPD licence areas.
- Since 2016, deployment has stalled due to changes to the subsidy regime, with only 1.5 MW connecting since 2018.

Near term (2020 – 2025)

- There are 25 pipeline sites with an accepted grid connection offer, some of which are projected to connect in the near term under a high growth scenario.
- The proposed sites tend to follow the current distribution in South Wales, with the majority targeting the more southerly areas around the existing development areas set out by the Welsh Government in their 2005 planning guidance, which is superseded by a new National Development Framework due to be published in Autumn 2020.
- Several of the sites have recently had planning permission approved. Near term development sites in South Wales could therefore be among the first subsidy-free developments in Great Britain.
- Developers have suggested that the COVID-19 pandemic will have a limited impact on development of new sites, as these are already lengthy, though sites awaiting construction may face some delays.

Medium term (2025 – 2035)

- There are high levels of deployment under all three net zero compliant scenarios, some of the existing pipeline sites are developed between 2025 and 2030 in the net zero compliant scenarios, leading to steady capacity growth in the medium term.
- Proposed changes to the Welsh National Development Framework could see deployment moving into new areas; however stakeholders suggested that wind speed and network connection remain the critical factors driving site location, rather than planning.
- Feedback from consultation events suggests that although renewed subsidy support through the Contract for Difference scheme would be welcome, obtaining financial support is likely to be extremely competitive. As a result, developers are primarily seeking to develop larger sites in high windspeed areas that can operate profitably without subsidies.

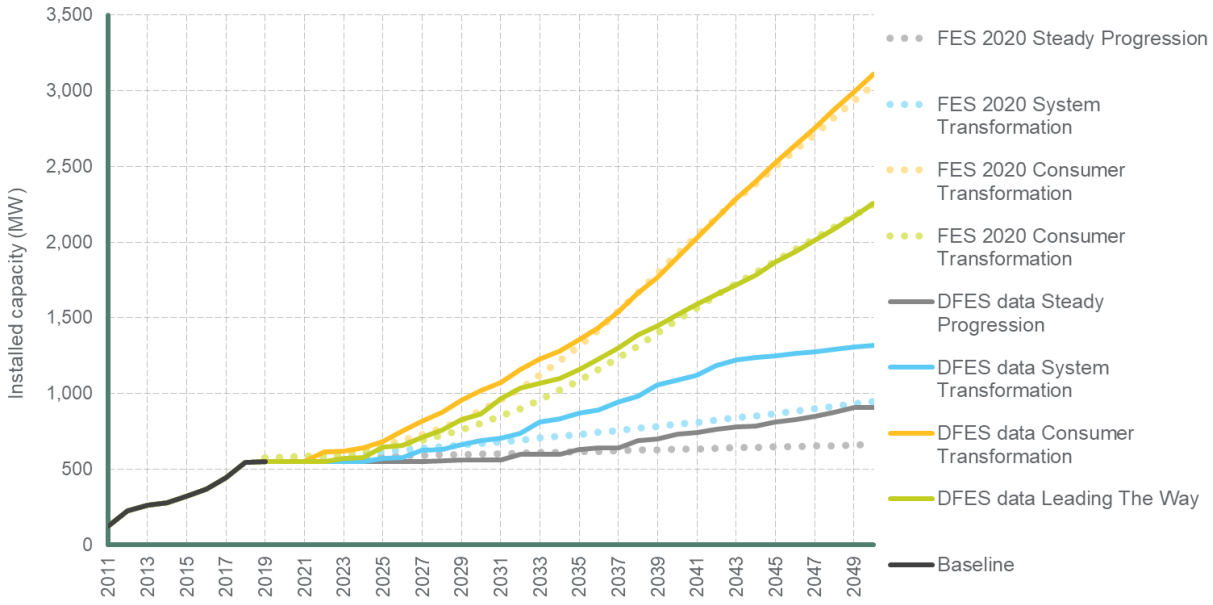
Long term (2035 – 2050)

- In the long term, there are many sites which may seek to repower at the end of their operational life and are likely to use the opportunity to increase capacity.
- There are 37 large scale sites currently in the baseline which will come to the end of their operational life before 2050. They may opt to repower which could significantly increase their installed capacity. Though some sites may not increase their capacity, an assumption has been made that the scenarios with greater green ambition result in earlier repowers with greater increases in capacity.

Figure 14

Onshore wind capacity by scenario

Comparison to FES 2020 GSP data for the South Wales licence area

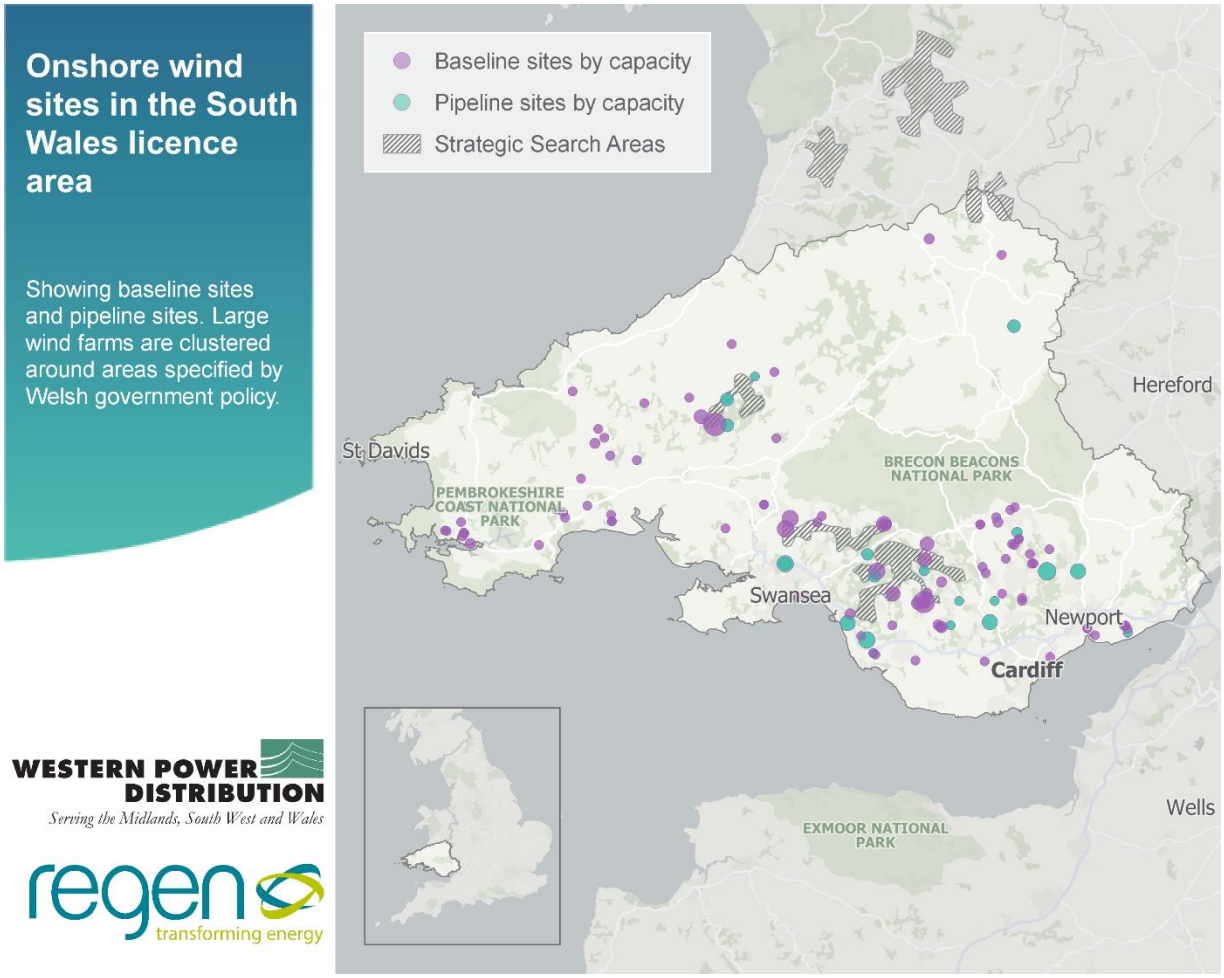


Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for Building Block ID numbers Gen_BB015 and Gen_BB016.

- Reflecting a relatively large pipeline of sites, the WPD DFES 2020 projections for the South Wales licence area are higher than the FES 2020 projections out to the medium term, with large resource areas and strong developer interest producing consistent deployment in Consumer Transformation and Leading the Way.
- The potential increase in capacity from repowered sites increases deployment under Steady Progression in the long term, to a higher level than under the FES 2020 projection.
- Community preference for large scale offshore technologies leading to low deployment under System Transformation in FES 2020 has less impact in this area due to supportive devolved Welsh Government policies.

Figure 15



Factors that will affect deployment at a local level:

- The spatial distribution of new onshore wind sites in the near term is based on the location of the pipeline sites, which show a similar distribution to the current baseline sites – most proposed sites are in the southern part of the region.
- The other local factors used are:
    - Areas identified as 'Green' or 'Amber' in the Welsh National Development Framework draft.
    - Areas close to the existing electricity network outside of environmental designations such as AONBs or National Parks and excluding areas of housing.
    - Areas with significant wind speed
    - Planning permission records for the local authority
- Local policies identified by stakeholders are included as weightings within the spatial distribution, for example this includes Local Development Plans and the Neath Port Talbot 'Decarbonisation and Renewable Energy Strategy' which has been out for consultation recently.

Relevant assumptions from National Grid FES 2020:

Assumption number	4.1.3
Steady Progression	Slower pace of decarbonisation.
System Transformation	Focus on renewables but limited by societal preference for offshore turbines (less impact on land use and visibility)
Consumer Transformation	Strong support for onshore wind across all networks. Some of these projects may be in community ownership.
Leading the Way	High growth driven by the decarbonisation agenda and high demands from hydrogen production from electrolysis.

Stakeholder feedback from the consultation events:

Your comments to us	Our response
Theme: onshore wind	
You told us that developers will seek to develop projects on a subsidy-free basis, rather than be limited by a lack of a CfD. However, national policy has also been a critical factor in the deployment of wind so far. Your responses also indicated that onshore wind deployment may begin to pick up in the early 2020s.	The impact and scale of government subsidy varies by scenario. We will ensure that even in scenarios without government subsidy, subsidy-free deployment is still included. This modelling will include onshore wind deployment picking up in the early 2020s.
The majority of respondents thought that subsidy-free business models would lead to some very large sites being developed, elsewise only smaller-scale community energy sites would be developed.	Our modelling includes analysis of wind farms at different scales, we will focus projected deployment on large-scale sites and then only smaller-scale sites.
In terms of Welsh policy context, you told us that deployment would not be limited to just the Green NDF zones but would include Amber too. Comments suggest that large parts of the Green NDF zones were unlikely to be developed, due to the wind resource in the area.	We will expand our current spatial distribution factors for wind to include those developable areas in Amber NDF zones too.
The majority of respondents suggested that the existing SSAs would still see deployment, however some are becoming saturated and that emphasis is beginning to move away from these areas.	We will assess each SSA to see how development compares with indicative capacity as set out in the planning guidelines, and move emphasis towards the Green and Amber NDF zones.
You said that the current spatial distribution of onshore wind does not reflect the distribution of developable sites, as Mid-Wales has been avoided by developers due to the network in the region.	Our models do not simply rely on the baseline, instead we complete our own independent resource assessment and will ensure that areas with undeveloped potential are included.

References:

WPD connection offer data, System Wide Resource Registers (GB), the TEC register, the Renewable Energy Planning Database, Climate Emergency declaration data, Regen consultation with local stakeholders and discussion with developers.

Solar generation in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Ground mounted solar - solar generation sites of installed capacity of 1 MW and above.

Data summary for ground mounted solar PV in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	497	553	636	736	911	938	957
System Transformation	497	655	865	1,070	1,116	1,340	1,562
Consumer Transformation	497	655	865	1,070	1,116	1,340	1,562
Leading the Way	497	850	1,174	1,536	1,840	2,166	2,394

Summary:

- The current capacity of ground mounted solar PV in the South Wales licence area is less than half that of the South West or East Midlands licence areas. However, there is now substantial interest from developers in the area with a pipeline of over 800 MW of projects that have accepted grid connections.
- With a supportive planning policy in Wales, land availability and strong developer interest the South Wales licence area could see extensive development of ground mounted solar PV.

Results and assumptions:

Baseline

- There is c.500 MW of ground mounted solar PV in the South Wales licence area, largely installed in 2014 and 2015 as developers widened their search areas from their initial focus in the south of England.
- Development focussed on the southern areas of the licence area where there is higher irradiance and greater electricity network coverage. No new projects have been connected since March 2017.

Near term (2020 – 2025)

- Since 2018 a strong pipeline of ground mounted solar PV projects has secured grid connections across the UK, as costs have fallen and interest from investors in 'subsidy-free' business models has grown.

- There is a significant pipeline of over 800 MW of grid consented projects in the South Wales licence area, which are typically around 50 MW. If all these are installed, this would more than double the capacity of ground mounted solar PV installed in the licence area.
- The Welsh Government 'Planning Policy Wales' framework is supportive of renewables and less than 0.5% of the suitable land for ground mounted solar PV has been developed.
- Consultation with stakeholders indicates the COVID-19 pandemic has put back the date at which ground mounted solar PV projects are likely to be built and energised. Developers and investors currently expect the projects to begin to be built in 2022.
- The speed at which the pipeline of projects is built is the key assumption in the scenarios. In all the net zero compliant scenarios the pipeline of projects with accepted grid connections is built during this decade. Larger sites with planning permission are assumed to connect earlier. Smaller sites that have had unsuccessful planning applications are assumed to go ahead only in Leading the Way.

Medium term (2025 – 2035)

- The South Wales licence area will continue to offer good opportunities for ground mounted solar PV developers, provided grid constraints are addressed.
- In a Leading the Way scenario the deployment rate is close to that seen at the peak of deployment in 2012-2015. In Steady Progression it could take until 2035 for the current pipeline to be built as the investment case for ground mounted solar PV remains challenging.

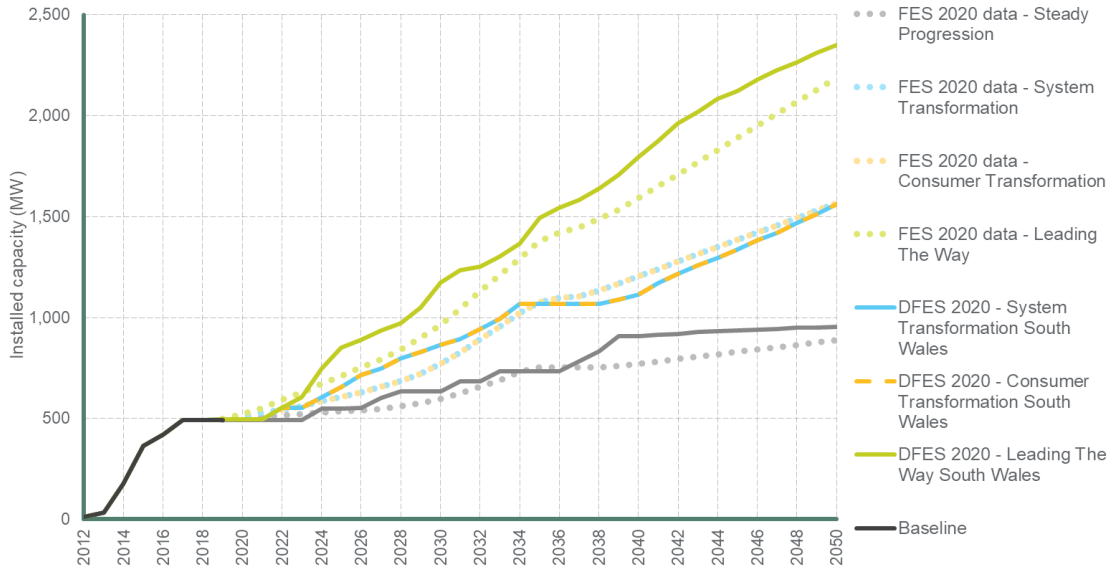
Long term (2035 – 2050)

- The development of ground mounted solar PV could be limited by the relatively low demand for power during summer daytime.
- Price cannibalisation as the amount of solar installed increases is a key concern for investors looking at merchant projects with no guaranteed price for the power generated. Co-location with storage or using surplus power to produce hydrogen may be required to overcome this.
- The Leading the Way scenario shows nearly 2.5 GW of ground mounted solar PV could be installed in the South Wales licence area as this technology becomes a key part of the UK's energy mix.

Figure 16

Ground mounted solar capacity by scenario

Comparison to FES 2020 GSP data summated for the South Wales licence area



Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for Building Block ID number Gen_BB012, Solar Generation - Large (G99).

- Stakeholder feedback indicates the COVID-19 pandemic will delay the point at which investors are comfortable to make final investment decisions to build ground mounted solar PV projects. WPD FES 2020, therefore, shows the first new projects being energised later than FES 2020 GSP data.
- Due to the pipeline of projects that have recent network connection offers agreed, there is more ground mounted solar PV in WPD DFES 2020 in this licence area than FES 2020 under a Leading the Way scenario.

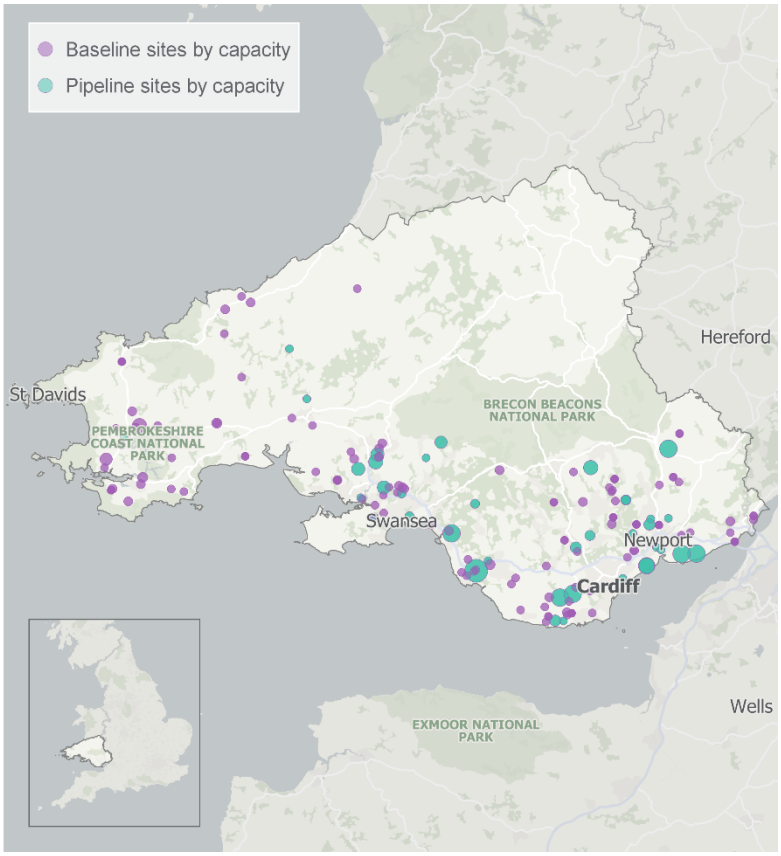
Factors that will affect deployment at a local level:

- The spatial distribution of new ground mounted solar PV in the South Wales licence area out to 2030 in WPD DFES 2020 is based on the location of projects in the pipeline with an accepted grid connection offer. This shows a similar distribution to the current baseline sites which are located close to the high voltage electricity network.
- The other local factors that are used to develop these scenarios are:
    - Areas close to the existing electricity network outside of environmental designations such as AONBs or National Parks
    - Solar irradiance
    - Planning permission records for the local authority

Figure 17

Ground mounted solar PV in the South Wales licence area

Showing baseline and pipeline sites. There is a large pipeline of potential sites, typically around 50 MW, in the South Wales licence area.



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Relevant assumptions from National Grid FES 2020:

Assumption number	4.2.15
Steady Progression	Slower pace of decarbonisation.
System Transformation	Transition to net zero results in strong deployment of solar.
Consumer Transformation	Transition to net zero results in strong deployment of solar.
Leading the Way	Very high ambition to decarbonise drives a focus on technologies that are low carbon. Supports production of hydrogen by electrolysis.

Stakeholder feedback from the consultation events:

Your comments to us	Our response
Theme: solar PV	
You suggested that solar farm deployment would begin to increase again in the early 2020s, from 2022 onwards.	We will incorporate this trajectory into our models. There are many projects with accepted connection offers which could potentially be sites of development in the early 2020s.
You said that there is high potential for solar farm deployment, which could deploy at a high rate in the medium to long term.	

References:

WPD connection offer data, System Wide Resource Registers (GB), the TEC register, the Renewable Energy Planning Database, Climate Emergency declaration data, Regen consultation with local stakeholders and discussion with solar developers.

Solar generation in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Small scale solar generation - commercial rooftop installations up to 1 MW, and domestic solar PV installations below 1 MW.

Data summary for small scale solar (<1 MW) in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	187	213	248	296	348	393	443
System Transformation	187	245	375	524	666	786	867
Consumer Transformation	187	307	573	892	1,217	1,532	1,802
Leading the Way	187	255	393	556	700	824	925

Summary:

- There is currently 187 MW of small scale solar PV in South Wales, 64% of installations are at the domestic scale with an average capacity of 3.3 kW.
- Almost one third of homes in the South Wales licence area host rooftop solar PV by 2050 in Consumer Transformation, the highest capacity growth scenario. This is alongside widespread adoption of electric cars and electric domestic heating, provided by heat pumps.

Results and assumptions:

Baseline

- The South Wales licence area currently has 36,000 domestic solar PV installations, representing 3.4% of homes, the highest in WPD's four network areas.
- 1,500 commercial properties currently have a solar PV array, with an average capacity of 45 kW.
- Most of this existing capacity has been commissioned since 2011 in line with government support via the feed-in-tariff, with deployment slowing significantly since 2015 following a reduction in the subsidy rate.

Near term (2020 – 2025)

- There is very low deployment in the early-2020s due to the challenging business case for smaller scale solar, as well as construction delays due to COVID-19 This reflects stakeholder feedback.
- There is a pipeline of 74 commercial solar sites totalling 9 MW that have accepted a grid connection offer. These form most of the new capacity installed out to 2025.

Medium term (2025 – 2035)

- Capacity growth is projected to accelerate from 2025 onwards as the cost of solar panels continue to decrease. This is combined with increasing financial viability due a combination of the Smart Export Guarantee, high uptake of electric vehicles and in combination with domestic batteries and heat pumps.
- The installed capacity of small scale solar increases to 900 MW by 2035 in Consumer Transformation.

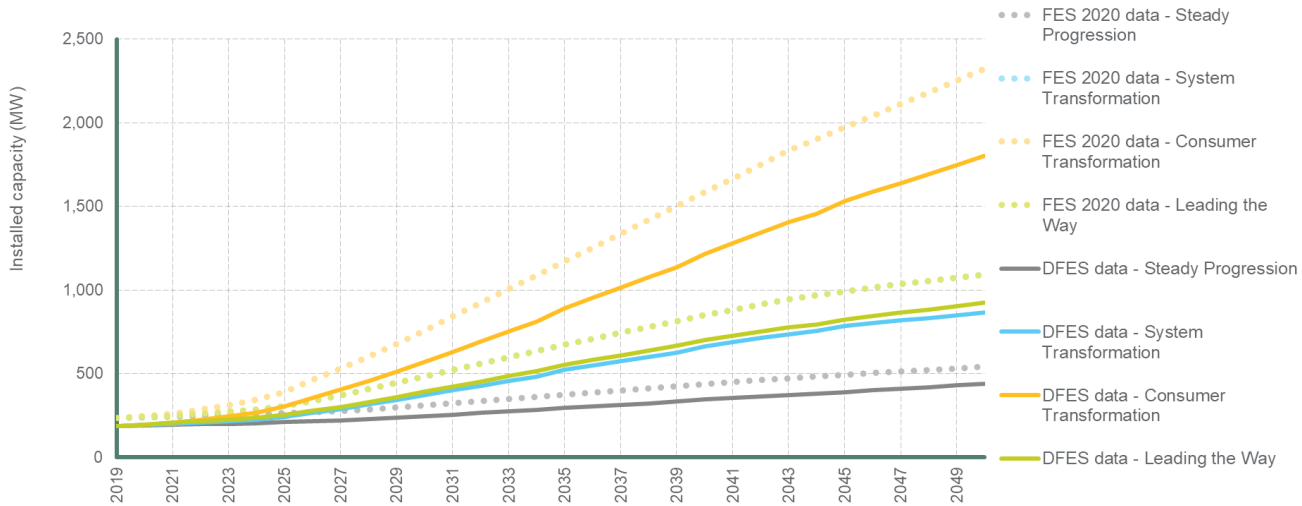
Long term (2035 – 2050)

- The continued uptake of small scale solar PV begins to slow in the long term as the most suitable homes and commercial properties are fitted in the baseline, near, and medium term.
- 30% of homes are fitted with rooftop PV by 2050 in Consumer Transformation, and around a sixth in Leading the Way.
- The proportion of new homes built with solar PV fitted is assumed to increase across the projection period in the all scenarios. Three quarters of the homes built in 2050 are projected to be fitted with rooftop PV in Consumer Transformation and Leading the Way, and around half in System Transformation and Steady Progression. The spatial distribution of new homes with solar PV is based on data from the local plans of local authorities in the South Wales licence area.
- The number of commercial properties with PV installed goes up from 1,500 in 2020 to 13,000 in Consumer Transformation, 6,000 in Leading the Way and System Transformation, and 3,000 in Steady Progression by 2050.

Figure 18

Solar (sub 1 MW) capacity by scenario

Comparison to FES 2020 GSP data for the South Wales licence area



Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for the Building Block ID number Gen_BB013.

- Regen has used the FES 2020 GSP data as well as Feed-In-Tariff data, WPD's connections data, and stakeholder feedback. All these factors result in a DFES trajectory that is below FES 2020.
- WPD connections data and Feed-In-Tariff data suggest a baseline capacity which is slightly lower than the FES 2020 baseline for the South Wales licence area.
- The South Wales licence area has around average levels of affluence (20.0% in social grade A and B compared to 20.3% in GB) with slightly lower rates of social housing (14.0% compared to 15.7% in GB). This results in a capacity projection that is below the FES 2020, with a total of 1.8 GW in 2050 in the Consumer Transformation scenario, or 380,000 domestic PV arrays and 13,000 commercial units.

Factors that will affect deployment at a local level:

- The spatial distribution of new small scale solar PV in the South Wales licence area has been divided into domestic scale solar PV (<10 kW) and commercial scale (10 kW – 1 MW).
- Domestic uptake is mainly influenced by factors such as affluence, home ownership, and social housing. In the early years, uptake is weighted towards affluent areas and becomes more spread across all affluence levels towards 2050, especially in Leading the Way and Consumer Transformation.
- Approximately 200,000 new homes are projected to be built in the South Wales licence area between now and 2050. In Consumer Transformation (the highest growth scenario), 50% of the total new builds are assumed to have solar PV installed, making up over 300 MW, a quarter of the total domestic projection. Cardiff has the highest number of installations in new builds (15,000).

Relevant assumptions from National Grid FES 2020:

Assumption number	4.1.5
Steady Progression	Slower pace of decarbonisation.
System Transformation	Transition to net zero results in strong growth in small solar. Supports production of hydrogen by electrolysis.
Consumer Transformation	Very high growth in small solar as it supports the transition to net zero and is highly aligned to the high societal change.
Leading the Way	Transition to net zero results in strong growth in small solar. Supports production of hydrogen by electrolysis. Growth limited by overall lower annual demands than Consumer Transformation.

Stakeholder feedback from the consultation events:

Stakeholder feedback from the consultation events suggested that the current rate of rooftop solar PV deployment on new domestic development is between 5% - 10% which provided a baseline in the modelling.

Stakeholders also commented that home ownership and affluence are the most important factors for local spatial distribution in the near term.

References:

WPD connection offer data, Feed-In-Tariff data, Climate Emergency declaration data, Regen consultation with local stakeholders and discussion with local authorities and businesses.

Hydropower in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Hydropower - including comparison to FES 2020 small scale (< 1 MW) and large scale (≥ 1 MW) data. Excludes pumped hydro storage.

Data summary for hydropower in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	15.3	17.3	17.4	17.4	17.4	17.4	17.4
System Transformation	15.3	19.1	19.1	19.1	19.6	19.6	19.6
Consumer Transformation	15.3	18.8	20.2	21.6	24.2	25.3	27.8
Leading the Way	15.3	19.3	19.6	20.0	20.6	20.7	20.7

Summary:

- The South Wales licence area has the highest installed hydropower capacity of all the WPD licence areas. Many of these sites are small scale, low head schemes.
- Consultation with stakeholders, and the current high upfront costs of new hydropower sites mean there is low deployment in the near term under all scenarios. However, reflecting the relatively large pipeline, rainfall and topology of the licence area, under a Consumer Transformation scenario a total of 27 MW is installed by 2050, almost doubling current installed capacity.

Results and assumptions:

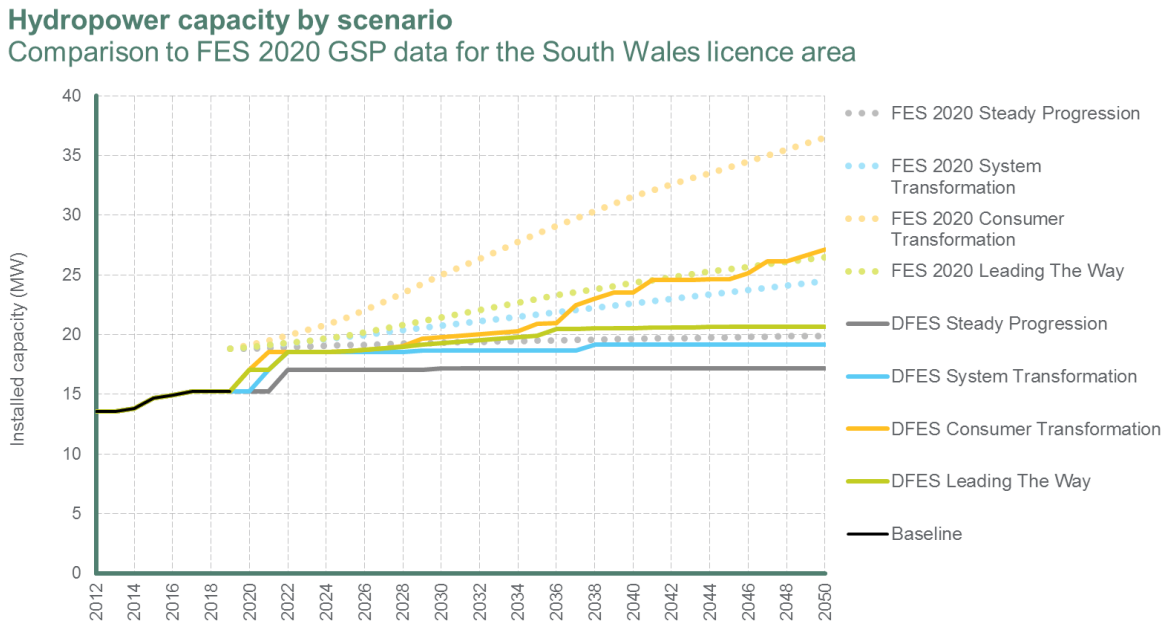
Baseline

- There is 15.3 MW of installed hydropower capacity in the South Wales licence area.
- Two thirds of the total installed capacity come from two large sites, at Llyn Brianne and Elan Valley.

Projections

- There are four pipeline sites in total, including a 1.6 MW site at the Llyn Brianne dam which is currently in the final stages of construction.
- The total pipeline is 3.4 MW, comprising two large and two small scale sites.
- In the medium and long term, deployment is limited to the Consumer Transformation and Leading the Way scenarios. Sites are likely to be limited to private wire connections or through developments where wider objectives override the need for a high return on investment, for example, sites with a link to tourism, heritage, or corporate sustainability objectives.
- The civil infrastructure installed for existing sites tends to be long-lasting, meaning that sites are expected to repower when the machinery reaches the end of its useable life. Where sites need to re-power, it has been assumed that they repower at the same capacity: as a mature technology, hydropower has limited cost reduction potential.

Figure 19



Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for the Building Block ID number Gen_BB018.

- Relative to the baseline, the WPD DFES near term deployment is higher than FES 2020 due to the pipeline projects in this licence area.
- After the near term, the projections are lower than FES 2020 under all scenarios, reflecting feedback from industry consultation. Consequently, under all scenarios the installed capacity remains below the FES 2020 projections out to 2050.
- While modelling credible pathways to net zero, the DFES must also capture the near term worst case conditions that the distribution network could see, which is important for strategic investment modelling. While National Grid ESO may discount generators without a supply contract, WPD DFES includes all generators with valid connection agreements regardless of absent supply contracts, this may lead to some discrepancies in the baseline totals.

Factors that will affect deployment at a local level:

- The spread of new hydro sites is based on the location of water features and barriers which could potentially host a hydropower site, as well as sites identified in the pipeline analysis.

Relevant assumptions from National Grid FES 2020:

Assumption number	4.1.1
Steady Progression	High costs associated with large scale projects. Little ambition or support
System Transformation	High costs associated with large scale projects. Some support is forthcoming for large scale projects, limited societal change from large scale remote generation
Consumer Transformation	Potential for a lot of small scale projects that will have larger societal impact
Leading the Way	Potential for rapid deployment of large and small scale projects; society is more in favour of disruptive projects. Limited by the reduction in energy demand

References:

WPD connection offer data, System Wide Resource Registers (GB), the Renewable Energy Planning Database, the Environment Agency, Regen consultation with local stakeholders and discussion with developers.

Marine and offshore (floating) wind in the South Wales licence area

Summary of modelling assumptions and results

Technology specification:

Small scale demonstration and early stage marine energy development projects.

- Wave energy – typically small array and demonstration projects
- Tidal stream energy– harnessing kinetic tidal flows around headlands
- Offshore floating wind – floating demonstration projects ahead of full commercial scale developments.

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

Installed power capacity (MW)		Baseline	2025	2030	2035	2040	2045	2050
Wave Energy	Steady Progression	0	0	0	0	0	0	0
	System Transformation	0	0	10	20	30	50	80
	Consumer Transformation	0	0	30	50	100	120	120
	Leading the Way	0	0	30	50	100	120	120
Tidal Stream Energy	Steady Progression	0	0	0	0	0	0	0
	System Transformation	0	0	5	10	10	10	10
	Consumer Transformation	0	0	10	15	20	20	20
	Leading the Way	0	0	10	15	20	20	20
Offshore Wind (inc. Floating)	Steady Progression	0	0	0	0	0	0	0
	System Transformation	0	0	0	0	0	0	0
	Consumer Transformation	0	0	0	0	0	0	0
	Leading the Way	0	0	0	0	0	0	0

Summary:

- The area around South Wales has been identified by the Welsh Government, and by regional bodies, as a key strategic area for the development of offshore energy resources including wave energy, tidal stream, and offshore wind.
- Withdrawal of subsidy support for wave and tidal energy in 2016 has affected industry confidence and has led to the withdrawal and delay of pre-commercial projects.
- No floating wind is projected to connect to the distribution network in this area. The focus of attention has instead switched to floating wind with a major 96 MW floating wind demonstration project (Project Erebus), a joint venture between Simply Blue Energy and oil multinational Total. This project is located in the Pembroke Marine Energy Demonstration Zone and is expected to connect to the transmission network via a new substation connected to Pembroke GSP.
- No new distribution connected marine energy is assumed to be deployed in Steady Progression.

Results and assumptions:

Baseline

- There are no baseline marine energy or offshore wind projects connected to the WPD network in South Wales.
- Withdrawal of subsidy support for wave and tidal energy in 2016 has affected pre-commercial projects.
- The DeltaStream tidal technology project which was installed in Ramsey Sound within the Haverfordwest Grid ESA has been decommissioned.

Near term (2020 – 2025)

- In the near term, it is assumed that the wave and tidal energy sector continues in a period of technology development, and that no commercial sites are connected in any scenario.
- Although the Pembrokeshire Marine Energy Development Zone is available for wave energy deployments of up to 30 MW, no developments of that scale are projected to deploy within the period to 2025.
- It is assumed that non network connected testing of wave and tidal devices will continue at, for example, the META Test site in Milford Haven in the licence area.

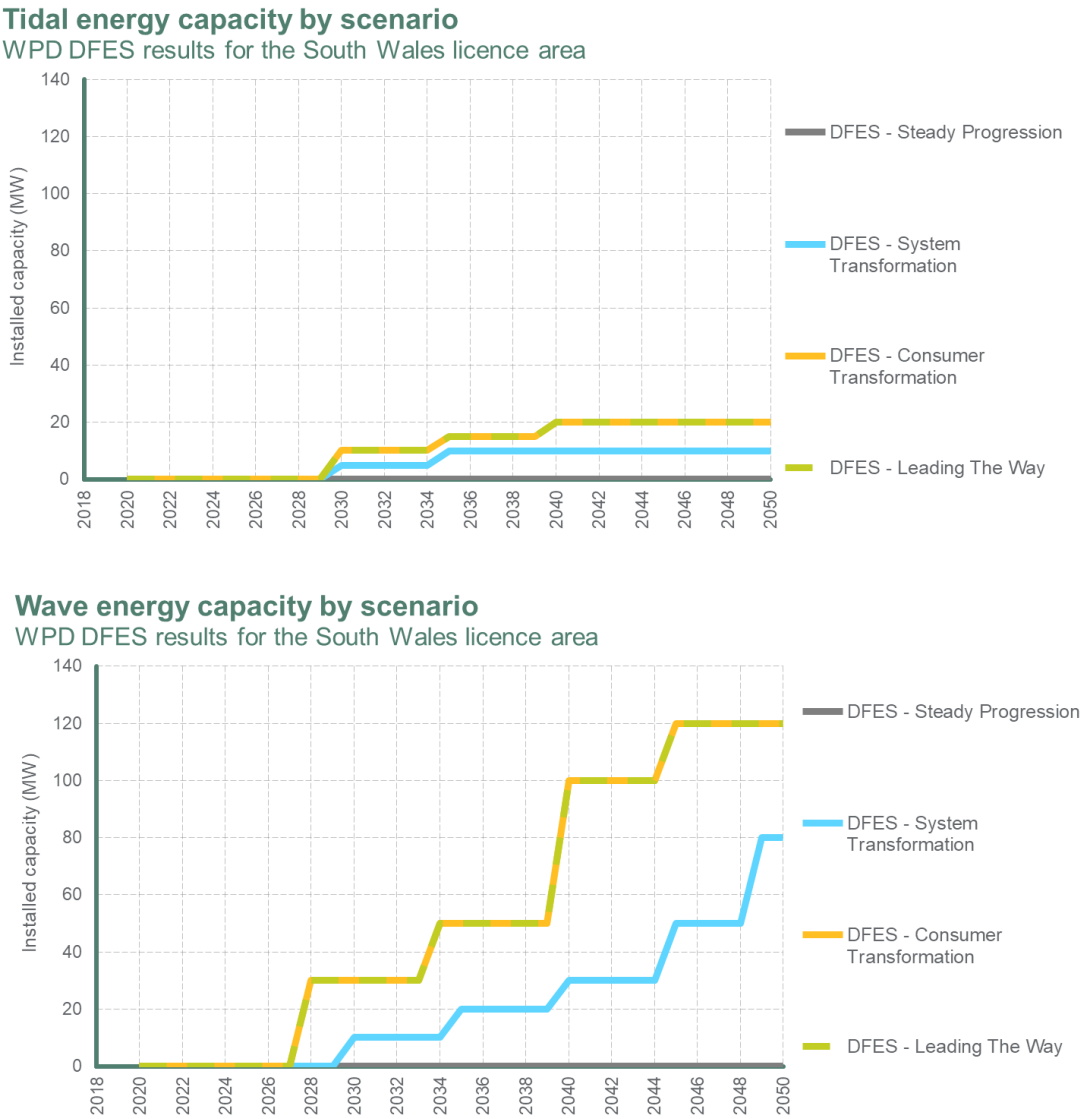
Medium term (2025 – 2035)

- UK Government is currently consulting on how the Contracts for Difference mechanism could be tailored to support marine energy and the potential for further support through capital grants and the use of innovative PPAs (IPPAs).
- In Leading the Way and Consumer Transformation some pre-commercial scale wave energy sites are projected to connect in the South Wales licence area with higher levels of UK and Welsh government support. These sites are assumed to be located within the Pembrokeshire Demonstration Zone, in Ramsey Sound and around St David's Head
- There is offshore wind resource off the coast of the licence area, however following discussion with project developers, any such deployment is assumed to be transmission network connected in the medium and long term.

Long term (2035 – 2050)

- In the long term under Leading the Way and Consumer Transformation wave and tidal energy projects are assumed to be deployed in wider zones in the Celtic Sea and in the Bristol Channel.
- The potential for tidal stream energy will be limited by resource and suitable locations and will likely consist of smaller projects that could be distribution network connected.
- It is assumed that projects larger than c.30 MW would connect to the transmission network.

Figure 20



Reconciliation with National Grid FES 2020:

Wave and Tidal Energy

Results for wave and tidal energy relate to the FES 2020 data as reported for Building Block ID number Gen_BB017 (tidal stream, wave power and tidal lagoons).

- The WPD DFES 2020 are higher than FES 2020 projections, there is no wave and tidal energy in FES 2020 for the South Wales licence area.
- The only marine capacity in the south of England projected in FES 2020 is 126 MW, projected to connect close to the decommissioned Oldbury Power Station in South Gloucestershire by 2030 in the West Midlands licence area. It is not clear what marine technology this capacity represents. It is possible that this capacity represents the projected level of deployment across the entire South West and South Wales. This should be investigated with the ESO FES team.
- The WPD South Wales DFES does include a limited amount of distributed connected wave and tidal energy to reflect the Welsh Government energy strategy and the continued development of the industry in South Wales.

Offshore and Floating Wind

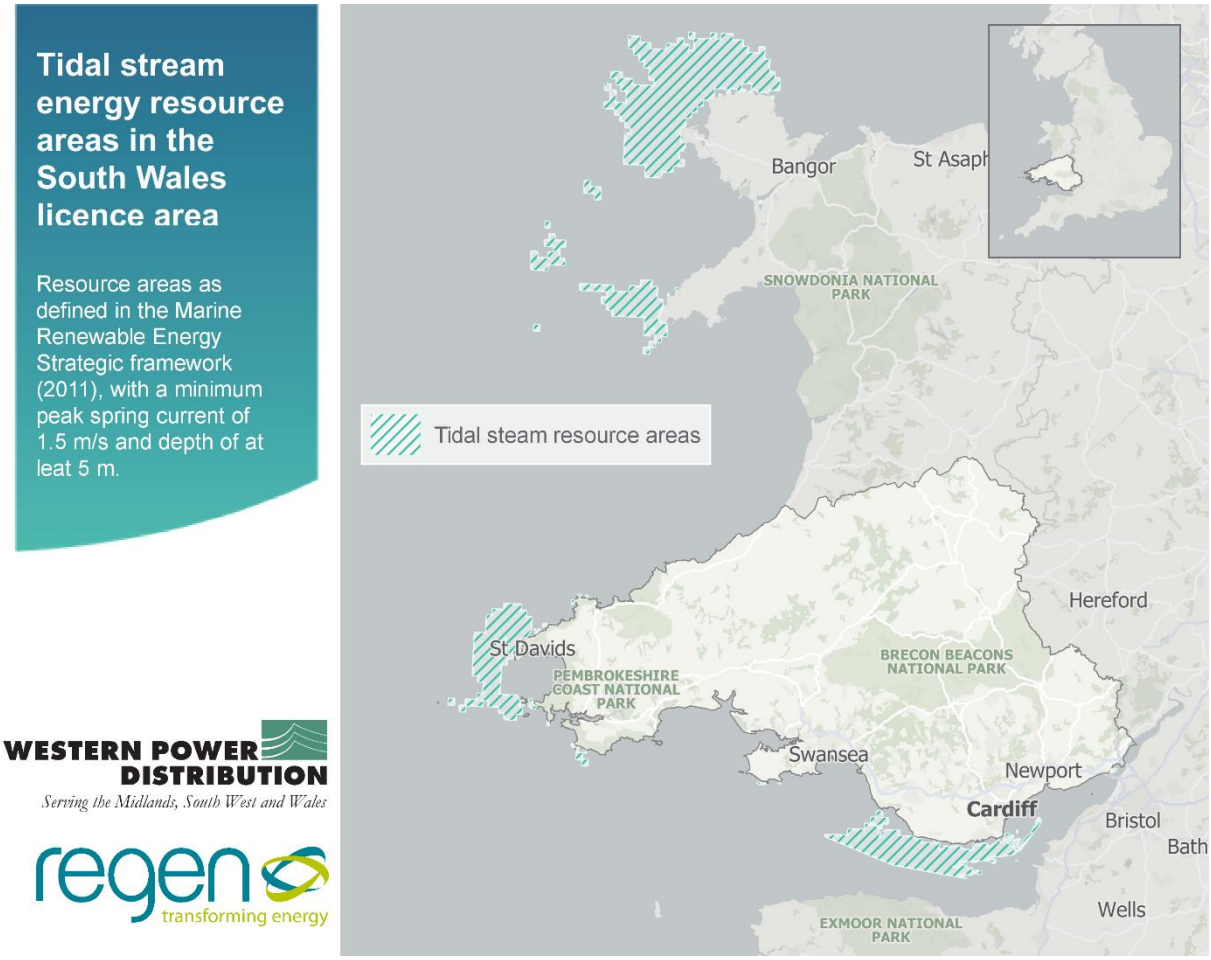
Results for offshore and floating wind relate to the FES 2020 data as reported for Building Block ID number Gen_BB014.

- There is no offshore and floating wind connected in the WPD DFES 2020, which assumes any deployments will be transmission connected. This is in line with FES 2020.

Factors that will affect deployment at a local level:

- The future of wave and tidal energy is uncertain, and it should be recognised that the industry is still in a period of technology development.
- There is however very strong support for the industry within the Welsh Government and at a regional level in both south and north Wales.
- The key assumption affecting the growth prospects of wave and tidal energy is the availability of UK and Welsh Government support both for technology development and for the first commercial projects.
- Wave, tidal and floating wind projects will be highly dependent on the available energy resource, seabed depths and conditions, marine designations and impacts on other marine users, port availability and access to the network or national grid.
- Previous studies commissioned by the Welsh Government have identified areas for
    - wave energy off Pembrokeshire and in the Celtic Sea
    - tidal energy off headlands and straits around St David's Head and Ramsey Sound and in the Bristol Channel near Aberthaw
    - Floating offshore wind at locations in the Celtic Sea and to the West of Lundy
- Demonstration areas include the Pembrokeshire demonstration zone with backing from European Structural Investment Funding (ESIF) and a Marine Energy Test Area in Milford Haven, with backing from ERDF.
- Port facilities exist at Milford Haven, Pembroke, Port Talbot and Swansea. However, connection could be impacted by the potential development of interconnectors to Ireland and to France (via south west England).

Figure 21 – Wave and Tidal Energy around the cost of Wales – courtesy Marine Energy Wales



Stakeholder input:

The Welsh National Marine Plan has identified Strategic Resource Areas for marine energy, providing clear policy support from a planning perspective. Evidence to support the DFES has however been collated from a number of recent publications including

- The Marine Energy Wales State of the Sector Report
- Analysis that was undertaken as part of the Swansea Bay City Region Energy Strategy completed by the Welsh Government Energy Service.
- The Swansea Bay City Region Deal includes proposals for the development of a major marine energy centre at Pembroke Dock.

A direct discussion was held with the developers of the Erebus Floating Wind project.

References:

Marine Energy Wales, Welsh National Marine Plan, Marine Renewable Energy Strategic Framework (MRESF) for Wales, Erebus Project and Blue Gem Wind, Swansea Bay Energy Vision 2016, UK Government Consultation on support for wave and tidal energy using Contracts for Difference (2020) Floating Wind Constraint Mapping in the Celtic Sea.

Renewable engines (landfill, sewage, biogas) in the South Wales licence area

Summary of modelling assumptions and results for anaerobic digestion.

Technology specification:

Anaerobic digestion (AD) installed capacity used for electricity generation only. This is the 'biogas' component of the building block technology "Renewable engines (landfill, sewage, biogas)".

Data summary for anaerobic digestion in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	8	8	8	9	10	12	13
System Transformation	8	9	10	11	13	14	15
Consumer Transformation	8	9	11	14	16	17	18
Leading the Way	8	10	12	15	18	19	21

Summary:

- The South Wales licence area has 8 MW of AD capacity. It has only 0.6 % of the GB installed capacity in 2019 according to NG FES 2020.
- The feedstock availability in agricultural or food waste in South Wales is relatively low due to below average agricultural land grades and small farm sizes that make investment in AD plants more difficult. Food waste is also already collected by Welsh local authorities, meaning that there are fewer new potential waste streams for additional plants.
- The licence area has one pipeline AD site with accepted connection in 2017. This connects between 2023 and 2025 except in Steady Progression.

Results and assumptions:

Baseline

- There are 7 sites in the baseline with an average capacity of 1.1 MW. Four out of the five baseline sites connected in 2015/16, when projects were still able to benefit from government subsidies. No capacity has connected in the last four years reflecting the difficulty of developing a business case for AD without subsidy.

Near term

- South Wales has one pipeline project with an accepted grid connection, this connects by 2025 in the net zero scenarios, and does not connect in Steady Progression.

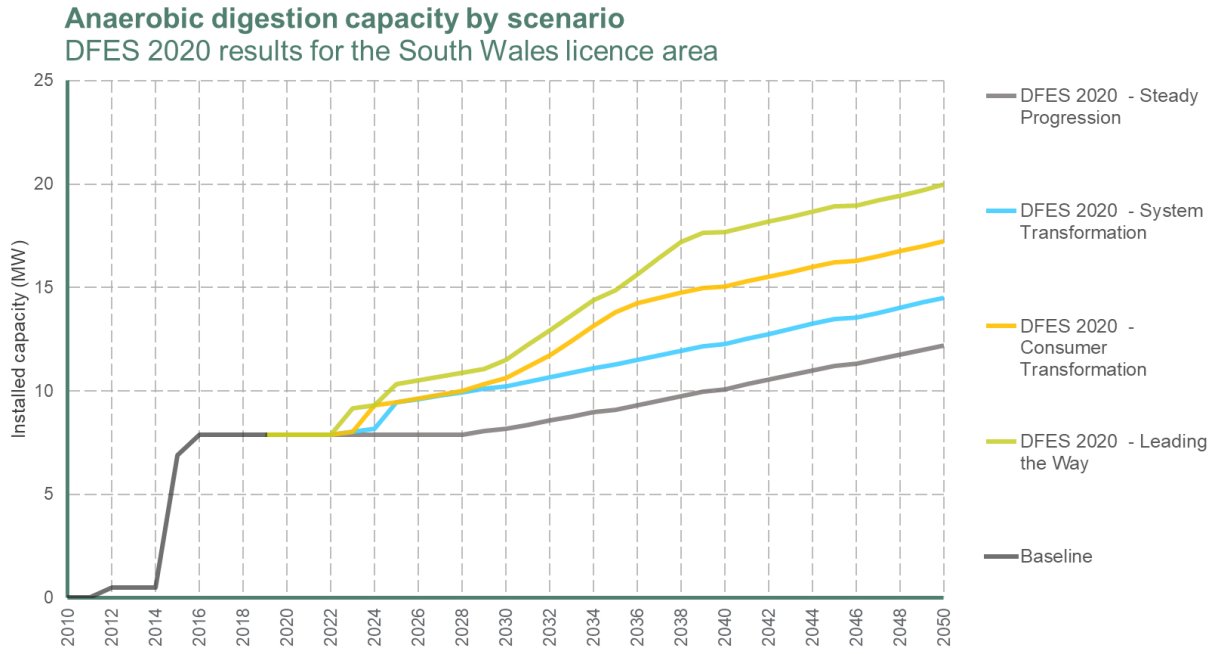
Medium term

- In the medium term, deployment in is expected to remain slow as, unlike the English licence areas, the majority of food waste is already collected and processed by local authorities in facilities such as in Stormy Down AD plant. Small farm based AD is likely to be the key source of capacity growth in South Wales in areas of good agricultural resource in the East and West of the licence area.

Long term

- AD deployment in the long term will be driven by cost reductions in the technology potentially through modularisation and high revenues that could be captured from AD plants providing flexible electricity supply and balancing services to networks, capturing high electricity prices expected in periods of low renewable generation, or high energy demand.
- However, deployment is expected to be lower long term as burning biomethane for electricity generation is likely to be competing with higher demand for biomethane for zero carbon heat or transport. This could lead to a reduction in electrical capacity deployment as the government look to incentivise a switch to 'green gas'.
- In addition, it is assumed that the food waste produced per person will decrease towards 2050 meaning there may be less available for AD processing.

Figure 22



Factors that will affect deployment at a local level:

All deployment of sites out to 2023 is based on the existing pipeline sites with an accepted grid connection offer. Outside of the pipeline projects, local factors have been used to weight deployment from 2023 onwards, such as:

- Areas with high numbers of cattle (a key feedstock for farm based AD)
- Agricultural land grades 1 & 2 as a proportion of UK average
- Local authority food waste collection potential

- Renewable energy strategies as raised during the consultation events

Summary of modelling assumptions and results for landfill gas.

Technology specification:

Landfill gas installed capacity used for electricity generation only.

Data summary for landfill gas in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	42	42	42	42	42	42	42
System Transformation	42	42	42	42	42	40	24
Consumer Transformation	42	42	42	42	42	40	24
Leading the Way	42	42	42	42	40	24	9

Summary:

- Landfill gas capacity is expected to decline over time in all scenarios as residual waste is either burnt or gasified as opposed to buried.
- This is brought about by the decommissioning of baseline sites with scenario specific assumptions made about the site lifetime.

Results and assumptions:

Baseline

- There are 16 sites connected to the distribution network in South Wales totalling 42 MW.
- One 1.2 MW site was connected prior to 2000 and 12 sites connected the following decade. The largest sites to connect is an 8 MW site in Newport that connected in 2017.

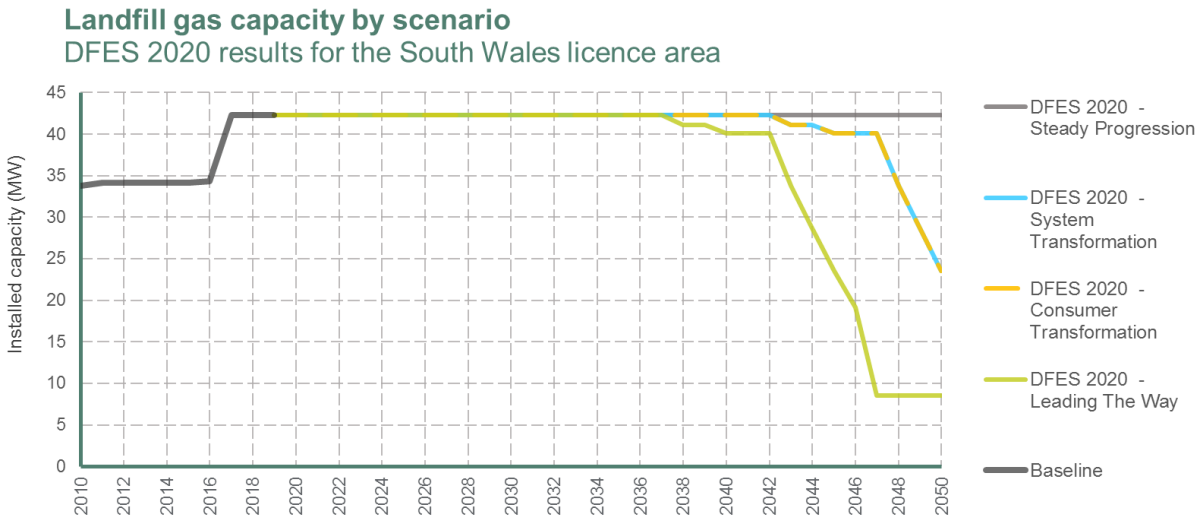
Near term

- There is no change projected in the output capacity or connections in the near term to 2030.

Medium and long term

- Older sites begin to decommission by 2040 as sites have no additional waste due to declining waste availability per person and competition with other technologies such as ACT.
- To ensure DFES captures the near-term worst-case conditions on the distribution network within the scenarios, sites have been modelled as staying online in Steady Progression, even if it is projected that they may cease operation or see running hours may significantly reduce.
- After 2038 in Leading the Way there is a reduction in capacity reflecting the declining waste availability per person and competition with other waste processing technologies. Sites going offline in Consumer Transformation and System Transformation are assumed to face at least a 45 year delay on the connection agreement date. To ensure the worst-case conditions on the distribution network are modelled, all existing sites with connection agreements stay online in Steady Progression out to 2050.
- Sites may also switch to exporting biomethane as the heat and transport market for biomethane continues to expand. This remains an uncertainty factor for this technology.

Figure 23



Summary of modelling assumptions and results for sewage gas.

Technology specification:

Sewage gas installed capacity used for electricity generation only.

Data summary for sewage gas in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	11	11	14	14	14	14	14
System Transformation	11	11	14	14	14	14	14
Consumer Transformation	11	11	14	14	14	14	14
Leading the Way	11	11	14	14	14	14	14

Summary:

- The scenario projection for sewage gas has very little change out to 2050 according to FES 2020.
- At a local level, there are currently no pipeline sites in South Wales therefore, the capacity for sewage gas does not change in any of the scenarios.

Results and assumptions:

Baseline

- There are four sites connected to the distribution network in South Wales totalling 11 MW.
- This largest baseline site is a 5 MW sewage gas plant in Cardiff which connected in 2014.

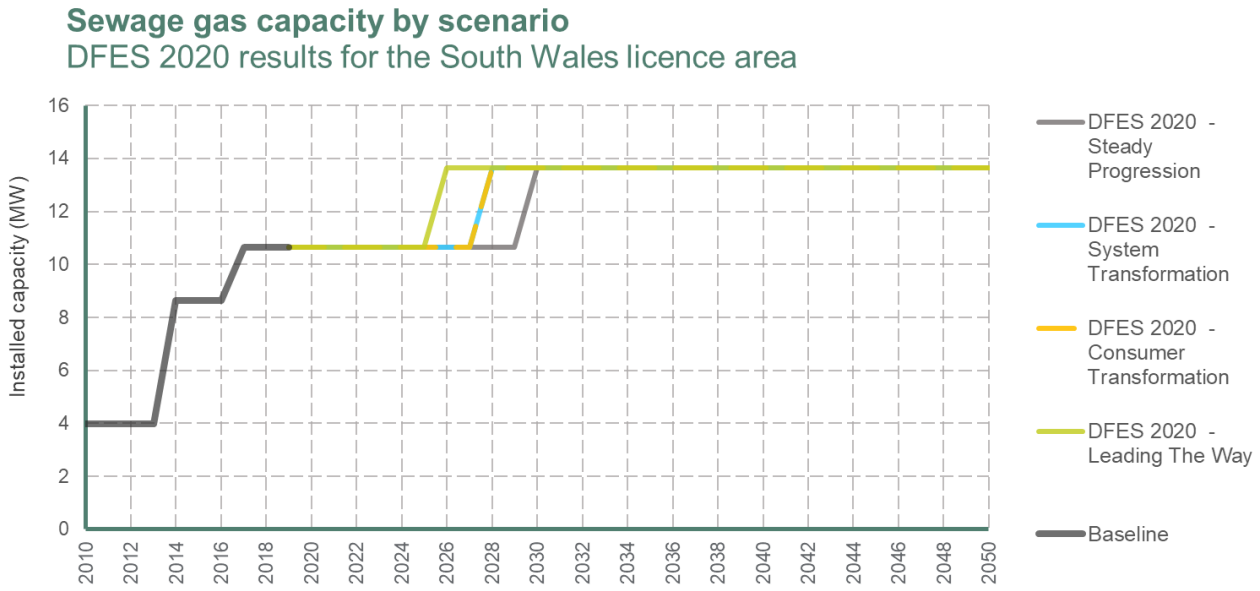
Near term

- There are no pipeline sites in the South wales licence area and therefore no change in capacity in the near term to 2025.

Medium and long term

- Population calculations suggest that the maximum potential resource for sewage gas used for electricity generation in South Wales is c.15 MW.
- An additional 3 MW sewage gas site has been projected to connect near Swansea in all scenarios between 2025 and 2030 based on the area having available resource.
- There is the uncertainty that sites may convert to biomethane at this point as the market continues to grow, but NG FES 2020 has not included this assumption.
- In the long term, the conversion of sites to biomethane remains an uncertainty factor.

Figure 24



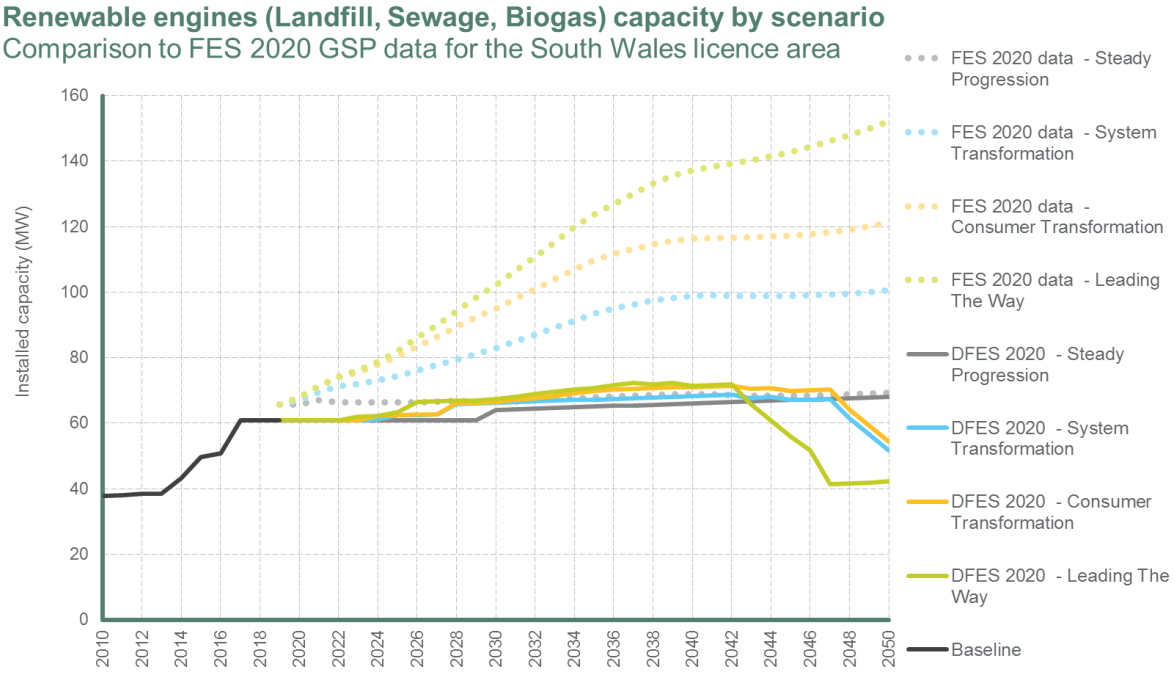
Summary of anaerobic digestion, landfill gas and sewage gas compared to the FES 2020 'Renewable engines (landfill, sewage, biogas)' building block technology

Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for Building Block ID number Gen_BB004.

- The growth in renewable engines capacity comes primarily from anaerobic digestion as landfill gas capacity decreases over time and sewage gas used to generate electricity sees limited growth.
- The scenarios to 2050 are lower than FES 2020. Calculations of the estimated long term maximum capacity of renewable engines is based both on 2050 population and assumptions about declining levels of waste production, which impact the feedstocks available. Additional deployment is however expected in sites which focus on biomethane injection rather than electrical capacity. This capacity is not included in this analysis.
- It is assumed in Steady Progression that no sites decommission in order to model the worst-case scenario on the distribution network and therefore it remains with the highest capacity in 2050 of 69 MW, similar to the baseline capacity.

Figure 25



Relevant assumptions from National Grid FES 2020:

Assumption number	1.1.5
Steady Progression	Support is focused on areas with greater potential volumes (UKCS/shale).
System Transformation	Bigger push for renewable gas as required to meet longer term decarbonisation targets.
Consumer Transformation	Bigger push for renewable gas as required to meet longer term decarbonisation targets.
Leading the Way	All sources of renewable fuels encouraged and biomethane used in niche areas in transport/industry.

References:

WPD connection offer data, Local Authority food waste collection status, UK cattle statistics, Land grade statistics, Climate Emergency declaration data, Regen consultation with local stakeholders and discussion with developers.

Biomass in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Biomass generation – including biomass for power generation and biomass CHP. Excludes biomass used solely for heat, and bioenergy with carbon capture and storage.

Data summary for biomass power (including CHP) in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	68	88	88	88	88	88	88
System Transformation	68	68	68	49	0	0	0
Consumer Transformation	68	68	68	49	0	0	0
Leading the Way	68	68	49	0	0	0	0

Summary:

- No new biomass power only plants are assumed to connect in this licence area except in a Steady Progression scenario.
- In all scenarios there is significant capacity reductions in biomass used for power generation in the medium term, as existing large scale sites come offline and are not replaced due to competition for sustainable feedstocks. Biomass power generation with carbon capture is assumed to connect at transmission level.
- In all net zero compliant scenarios there is an increase in biomass CHP providing low carbon heat and power in the 2040s.

Results and assumptions:

Baseline

- There are three biomass power sites in the South Wales licence area baseline, making up a total of 68 MW of power generation capacity. Two sites are situated in Margam, Neath Port Talbot, and burn waste wood and timber fuel, and a third site in Newport alongside Liberty Steel Works.

Near term (2020 – 2025)

- There are no sites with an accepted connection offer in the South Wales licence area. In Steady Progression one site which has planning permission but has not yet accepted a connection offer, is assumed to proceed.
- There have also been 10 unsuccessful projects, one of which was refused in planning. The nine other sites either withdrew or abandoned their planning application.

Medium term (2025 – 2035)

- Capacity of biomass for generation falls in the medium and long term under all scenarios. Plants reach the end of their operational life, assumed to range from 20 to 30 years, and are not replaced. However as WPD currently would have no mechanism to reclaim the capacity held in existing connection agreements, there is no modelled capacity reduction from existing sites before 2030 to capture reasonable worst case conditions on the distribution network.
- Some smaller scale dispatchable biomass power generation is assumed to continue generating throughout the projection period.
- In the net zero compliant scenarios, biomass fuel sources are assumed to be prioritised for other uses such as in increased carbon sinks and for use in construction. This reflects the recommendations from the Committee on Climate Change in their report 'Biomass in a low-carbon economy'.

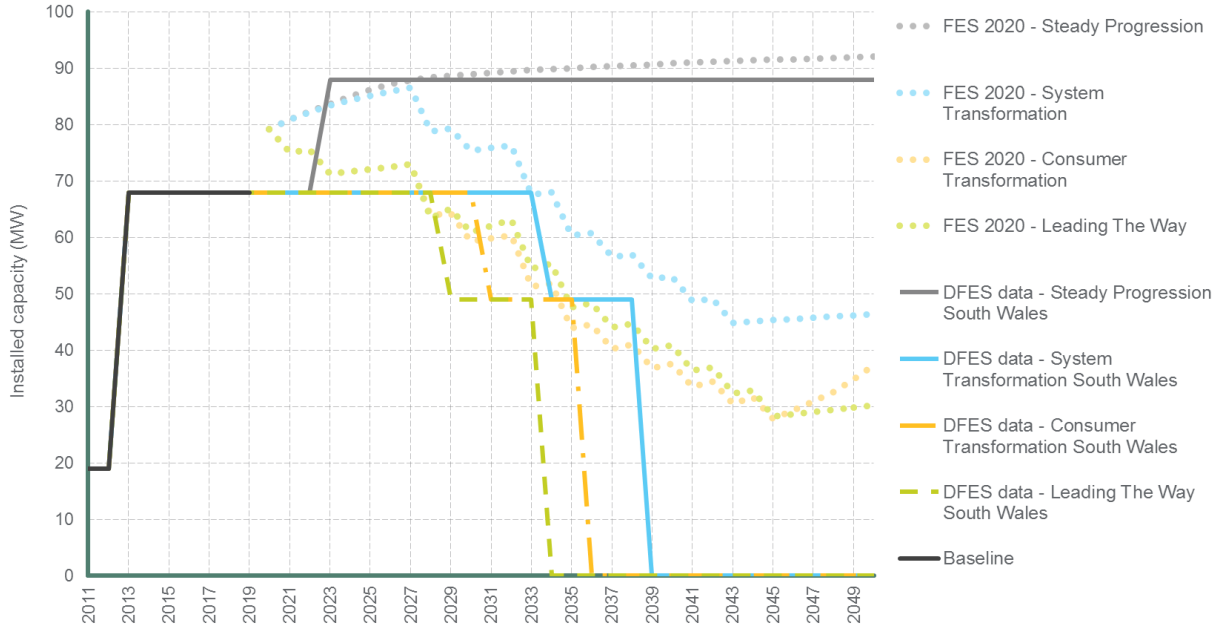
Long term (2035 – 2050)

- It is assumed that there is no biomass with carbon capture and storage used in power generation at the distribution level, instead these sites are installed at much larger capacities at the transmission level.
- The spatial distribution of new sites is based on the location of existing sites either currently connected or identified by developers through planning applications.

Figure 26

Installed biomass power capacity by scenario

Comparison to FES GSP data for the South Wales licence area



Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for the Building Block ID number Gen_BB010.

- The WPD DFES 2020 projections show a similar trajectory to the FES 2020 projections for the licence area, but to a lower level. This results from the assumptions as to the lifetime of the current sites in the baseline.
- The limited number of sites in the baseline mean that there are larger 'step' changes in the WPD DFES projections as single sites connect or reach the end of their operational life, than compared to the FES 2020 projection.

Relevant assumptions from National Grid FES 2020:

Assumption number	4.1.13
Steady Progression	Limited support for biomass due to less of a drive to decarbonise and lack of CCUS. Some growth in decentralised biomass without CCUS.
System Transformation	Uptake in biomass generation linked to CCUS driven by the decarbonisation agenda.
Consumer Transformation	Uptake in biomass generation linked to CCUS driven by the decarbonisation agenda.
Leading the Way	High growth driven by the decarbonisation agenda. Linked to CCUS as this results in negative emissions.

References:

WPD connection offer data, Committee on Climate Change, the Renewable Energy Planning Database, Regen consultation with local stakeholders and discussion with developers.

Waste (incineration) in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

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

Data summary for waste (incineration) in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	62	97	97	97	97	97	97
System Transformation	62	62	62	57	51	12	12
Consumer Transformation	62	62	62	62	62	62	57
Leading the Way	62	62	62	57	51	12	12

Summary:

- The carbon emissions from unabated EfW incineration plants are not consistent with a net zero goal. As a result, it is assumed in the scenarios that EfW capacity reduces after 2026 in the South Wales licence area as sites reach the end of their lifetime and existing capacity is not replaced.
- ACT gasification plants are expected to have lower associated carbon emissions and are part of a net zero 2050 scenario assuming that residual emissions are abated. All ACT sites on WPD's network connected in the last decade and do not disconnect before 2050.

Results:

Baseline

- There are three EfW sites in the baseline totalling 51 MW, the largest of which is a 40 MW incinerator at Trident Park, Cardiff, and connected in 2014
- There is one ACT facility in the baseline, a site in Barry Docks which gasifies waste wood. It is not projected to decommission by 2050 in any scenario.

Near term

- There are three pipeline sites which have accepted a network connection offer, with a total combined capacity of 70 MW.
- Only one of these, the 35 MW facility at Trident Park Cardiff, is assumed to connect. It is projected to commission in 2022 under a Steady Progression scenario.

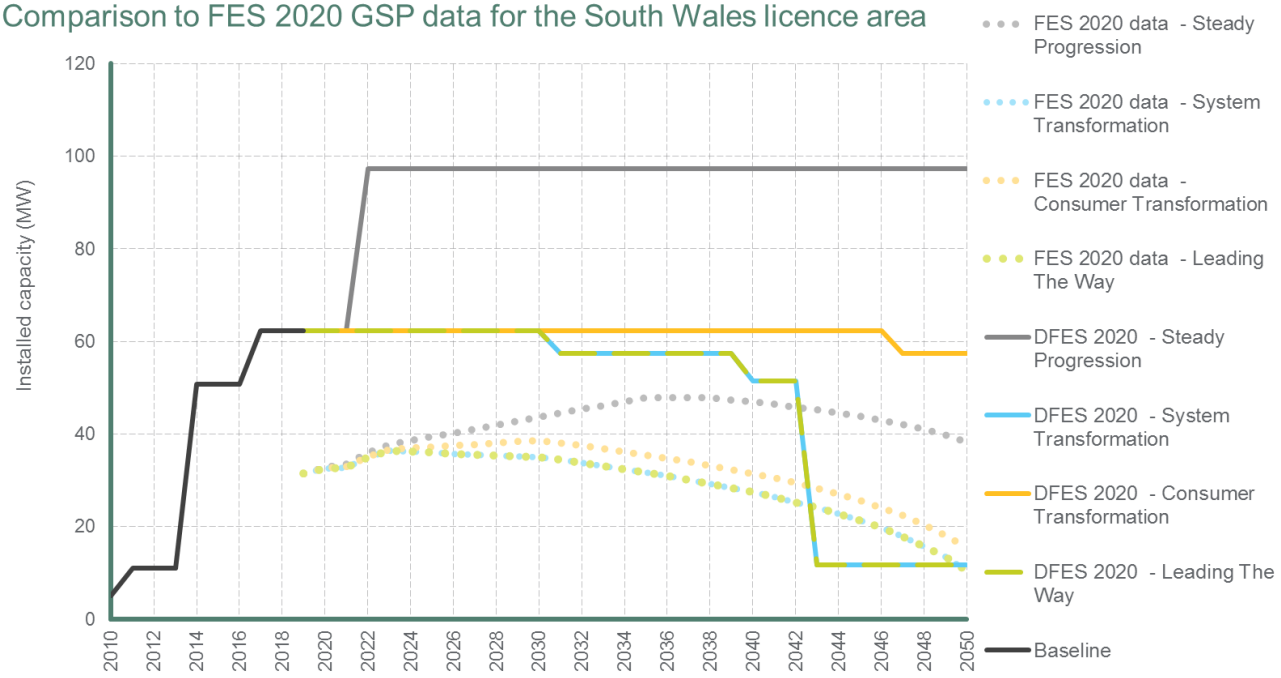
Medium term and long term

- No additional sites have been projected beyond the pipeline site. The medium and long term projection is determined by the decommissioning of sites based on an assumed lifetime of the EfW facilities of between 20 years and 30 years depending on the scenario. However as WPD would currently have no mechanism to reclaim the capacity held in existing connection agreements, there is no modelled capacity reduction from existing sites before 2030 to capture reasonable worst case conditions on the distribution network.

Figure 27

Waste (incineration) capacity by scenario

Comparison to FES 2020 GSP data for the South Wales licence area



Reconciliation with National Grid FES 2020:

- WPD connections data suggest a baseline capacity which is significantly higher than FES 2020 baseline for the South Wales licence area.
- There is no near term growth in the net zero compliant scenarios. One pipeline site connects in Steady Progression in 2022.
- The decommissioning of specific sites in the medium and long term means that the WPD DFES 2020 projections show large step changes in capacity, when compared with FES 2020.
- While modelling credible pathways to net zero, the DFES must also capture the near term worst case conditions that the distribution network could see, which is important for strategic investment modelling. While National Grid ESO may discount generators without a supply contract, WPD DFES includes all generators with valid connection agreements regardless of absent supply contracts, this may lead to some discrepancies in the baseline totals.

Relevant assumptions from National Grid FES 2020:

Assumption number	4.1.11
Steady Progression	No great change in waste management from society; leaving waste available as a fuel source.
System Transformation	Less waste to burn in general due to a highly conscious society adapting to low waste living.
Consumer Transformation	Limited societal change in waste management; less waste than current produced, limiting waste to burn generation.
Leading the Way	Less waste to burn in general due to a highly conscious society adapting to low waste living.

References:

WPD connection offer data, Renewable Energy Planning Database, Climate Emergency declaration data, Regen consultation with local stakeholders and discussion with developers.

Fossil gas power generation in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Fossil gas fired power generation covering four technology types – OCGT, CCGT, reciprocating engines and CHP sites.

Data summary for fossil gas in the South Wales licence area:

Installed capacity (MW)		Baseline	2025	2030	2035	2040	2045	2050
OCGT (non-CHP)	Steady Progression	21	21	21	21	21	21	21
	System Transformation	21	21	21	13	13	1	1
	Consumer Transformation	21	21	21	13	13	1	1
	Leading the Way	21	21	21	1	1	1	1
CCGT (non-CHP)	Steady Progression	10	10	10	10	10	10	10
	System Transformation	10	10	10	10	10	10	0
	Consumer Transformation	10	10	10	10	10	10	0
	Leading the Way	10	10	10	10	0	0	0
Reciprocating engines (non-CHP)	Steady Progression	324	364	448	514	538	568	580
	System Transformation	324	324	324	324	312	297	287
	Consumer Transformation	324	324	324	324	312	297	287
	Leading the Way	324	324	312	223	110	0	0
Gas CHP	Steady Progression	107	126	126	126	126	126	107
	System Transformation	107	126	126	126	126	107	107
	Consumer Transformation	107	126	126	126	126	107	107
	Leading the Way	107	126	126	126	126	19	0

Summary:

- Fossil gas-fired power generation decreases in all net zero compliant scenarios, whereas for some generator types capacity increases significantly under a Steady Progression scenario.
- In all scenarios, the primary role of fossil-gas is to provide flexibility and back-up services. Therefore, although the installed capacity may remain stable over some years, the annual running time, and energy output, decreases.
- At a national level, after 2030 hydrogen generation becomes a more economical source of supply-side flexibility in System Transformation, whereas in Leading the Way and Consumer Transformation this flexibility is provided by higher levels of energy storage and residential thermal stores.

Results and assumptions:

Baseline

- There is a total of 462 MW of fossil gas fired power generation connected in the South Wales licence area. Most of the current installed capacity comes from reciprocating engines and gas CHP, with two OCGT and a single CCGT site forming the remainder of capacity.

Near term (2020 – 2025)

- A National Grid Electricity Transmission Statement of Works currently in force prevents the deployment of new thermal generation and battery storage projects until c.2028, significantly hampering the deployment of new fossil gas projects in the licence area.
- As a result there is a limited pipeline in this licence area with only three pipeline sites which have accepted a network connection offer, all of which accepted their offer in 2016 or earlier.
- The pipeline sites are all around 20 MW in size and are identified as proposals for reciprocating engines.
- Evidence of Capacity Market activity has only been identified for one of the three pipeline sites, which applied but did not prequalify for the T-4 2019 and 2020 auctions. No planning applications have been identified for the pipeline sites.
- Lack of activity in the Capacity Market or evidence of planning applications means that these projects are projected to go ahead only in a Steady Progression scenario in 2021.
- No increase in capacity outside of the current pipeline of projects is projected in any of the scenarios in the near term.

Medium term (2025 – 2035)

- There is no new capacity projected for fossil gas CHP, CCGT or OCGT in the medium term across all scenarios. In the net zero compliant scenarios, it is assumed that sites come offline as they reach the end of their operational life – 25 to 30 years by scenario.
- OCGT and CCGT operational hours are projected to reduce in the medium term based on the age of the current baseline of projects, whereas there is no reduction in capacity for relatively newer gas CHP sites. However as WPD would currently have no mechanism to reclaim the capacity held in existing connection agreements, there is no modelled capacity reduction from existing sites before 2030 to capture reasonable worst case conditions on the distribution network.
- Some fossil gas reciprocating engines are assumed to come offline at the end of their operational life in the net zero compliant scenarios, leading to a small reduction in the medium term after 2030. In all scenarios the effects of the National Grid Electricity Transmission Statement of Works are assumed to cease in 2028. From 2028 onwards there is a consistent increase in reciprocating engine capacity in Steady Progression.

Long term (2035 – 2050)

- In the long term, under all net zero compliant scenarios, the annual running hours of all unabated fossil-gas plant are expected to fall to almost zero, as other providers of flexibility are more economical, and baseload demand is met by other sources. This leads to a reduction of total installed capacity down to near zero by 2050 in Leading the Way. As WPD would have no mechanism to reclaim the capacity held in existing connection agreements, under Consumer Transformation and System Transformation sites come offline 45 years after the connection date to capture reasonable worst case conditions.

Figure 28

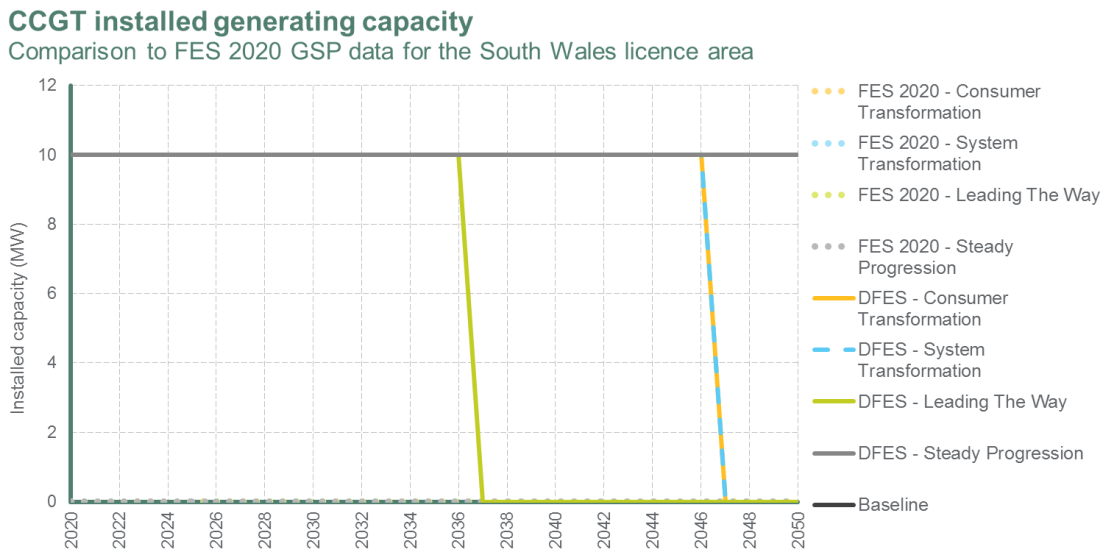


Figure 29

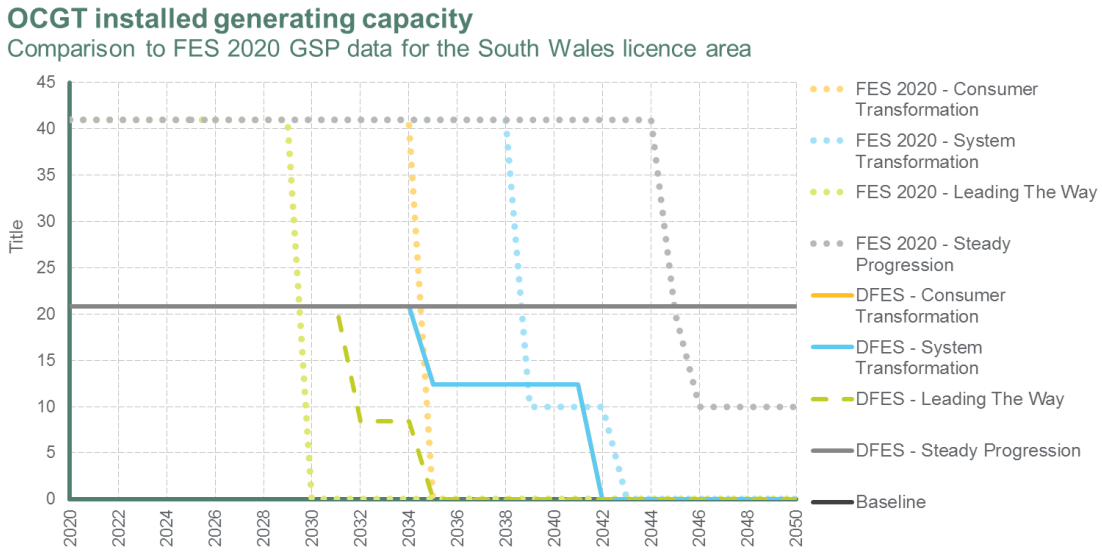


Figure 31

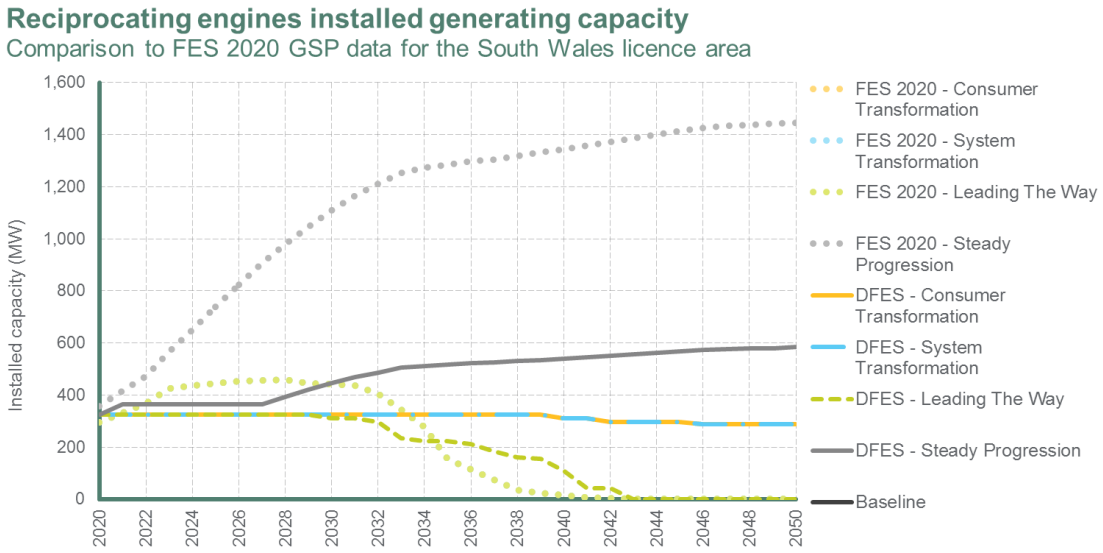
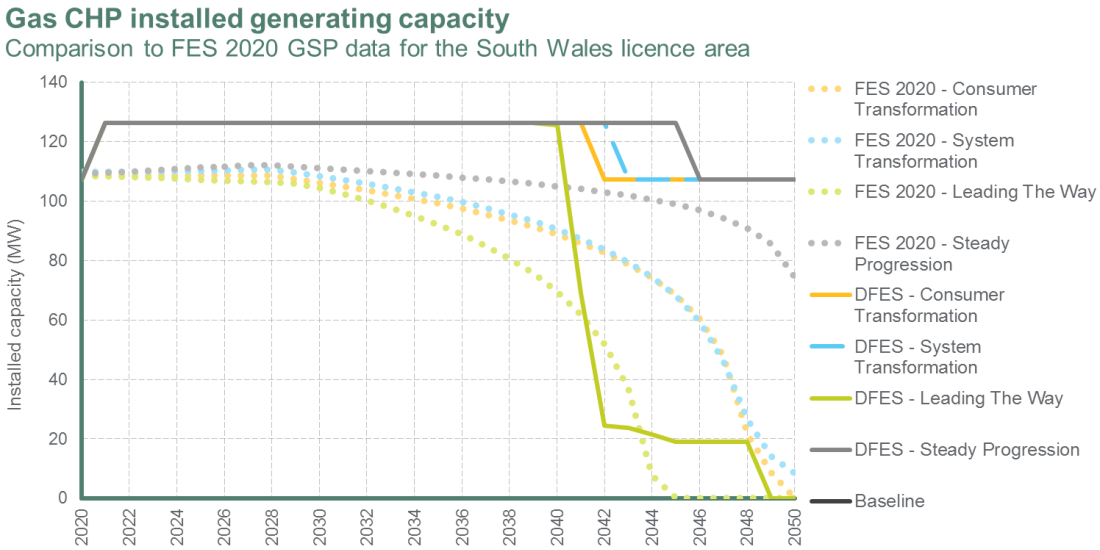


Figure 30



While modelling credible pathways to net zero, the DFES must also capture the near term worst case conditions that the distribution network could see, which is important for strategic investment modelling. While National Grid ESO may discount generators without a supply contract, WPD DFES includes all generators with valid connection agreements regardless of absent supply contracts, this may lead to some discrepancies in the baseline totals.

Reconciliation with National Grid FES 2020:

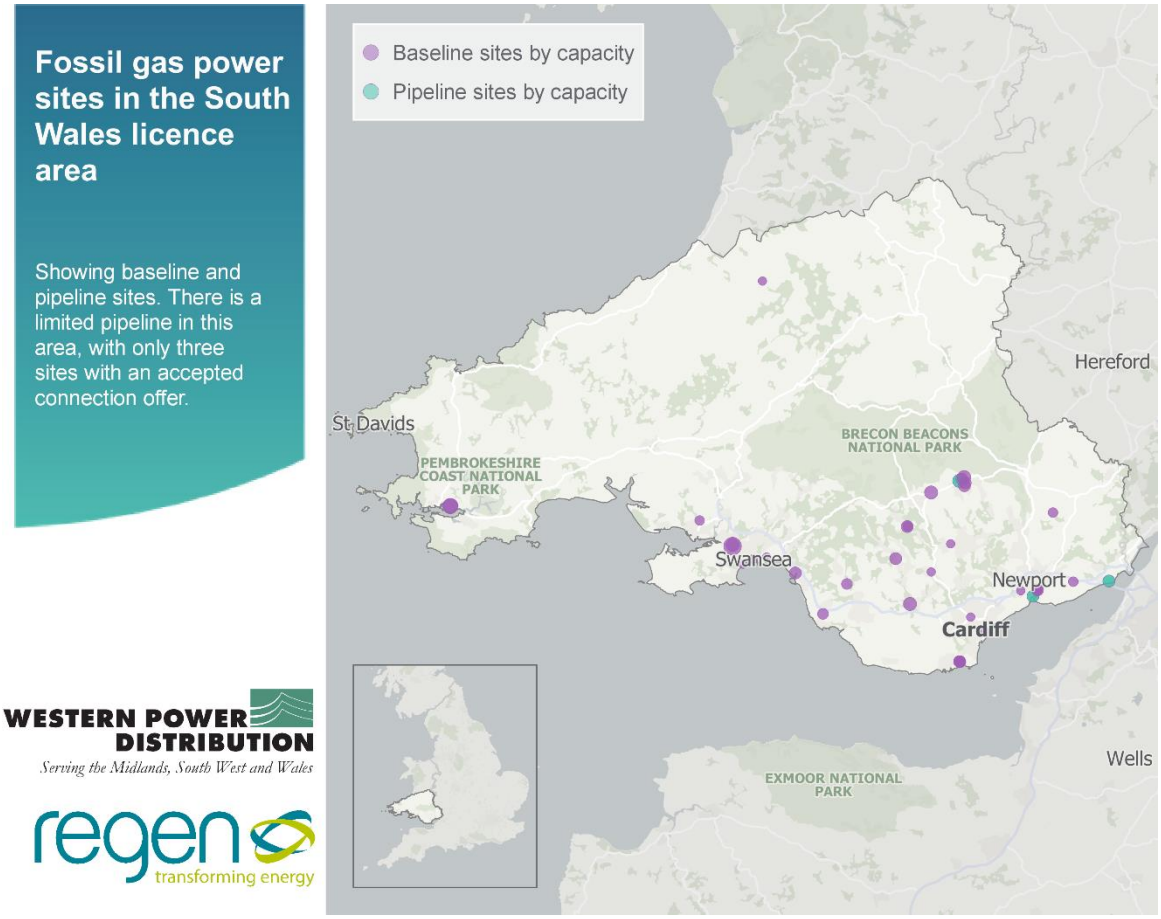
Results in this section relate to the FES 2020 data as reported for Building Block ID numbers Gen_BB001, Gen_BB002, Gen_BB006, Gen_BB008, Gen_BB009.

- The WPD DFES 2020 projections are broadly in line with FES 2020 for all fossil gas technology types.
- The WPD DFES projections are below those in FES 2020 for reciprocating engines due to the limited pipeline and a period of low activity based on the assumption that the National Grid Electricity Transmission Statement of Works affects deployment until 2028. After this period, capacity increases in line with FES 2020, but remains well below due to the lack of deployment in the near term and due to the treatment of the sites in the pipeline.
- In the medium and long term, deployment is in line with the FES, but remains lower due to the lower near term deployment of pipeline sites
- There is a baseline capacity discrepancy for all sub-technologies, though most pronounced for reciprocating engine sites. The WPD DFES baseline for reciprocating engine sites is 36 MW above FES 2020 and 20 MW below FES 2020 for OCGT sites. The baseline difference for CCGT and gas CHP is 10 MW and 1 MW, respectively. Though the trajectories are in line with the FES 2020 data, the WPD DFES projections show large 'step' changes as specific sites come offline, reflecting the limited number of sites for some technology types.

Factors that will affect deployment at a local level:

- The spatial distribution of new gas sites is based on proximity to the electricity network and reflects activity in the pipeline and Capacity Markets.

Figure 32



Relevant assumptions from National Grid FES 2020:

Assumption	Assumption number
Unabated large scale gas generation	**4.1.6**
Steady Progression	Low gas price and lower focus on decarbonisation promotes gas as the source of flexible generation.
System Transformation	High levels of decarbonisation, plus other sources of flexibility reduce the need for unabated gas.
Consumer Transformation	High levels of decarbonisation, plus other sources of flexibility reduce the need for unabated gas.
Leading the Way	Highest level of decarbonisation significantly reduces the amount of unabated gas.
CHP gas generation	**4.1.14**
Steady Progression	Low gas price supports growth however there is less emphasis on small scale generation that could be considered societal disruptive.
System Transformation	Renewable technologies are preferred due to the ambition to decarbonise.
Consumer Transformation	Renewable technologies are preferred due to the ambition to decarbonise.
Leading the Way	Gas generation not favoured in an accelerated net zero world; renewable technologies are favoured earlier.

References:

WPD connection offer data, Capacity Market auction results and data, System Wide Resource Registers (GB), the TEC register, the Renewable Energy Planning Database, Climate Emergency declaration data, Regen consultation with local stakeholders and the results from the WPD DFES consultation events.

Diesel generation in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Distributed diesel generation.

Data summary for diesel generation in the South Wales licence area:

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	131	131	131	131	131	131	131
System Transformation	131	131	131	1	1	0	0
Consumer Transformation	131	131	131	1	1	0	0
Leading the Way	131	131	131	1	1	0	0

Summary:

- Increasingly stringent air quality limits mean there is no increase in diesel generation capacity in the net zero compliant scenarios for the South Wales. The EU's Medium Combustion Plant Directive (MCPD) adoption into UK law enforces air quality limits in 2025 that impact the viability of diesel generators in WPD's licence areas (except those used solely for back up).
- All existing plants not used solely for back up are therefore decommissioned by 2025 in the net zero compliant scenarios. In Steady Progression it is assumed that there is a delay and capacity reduces to zero by 2032.

Results and assumptions:

Baseline

- There are eight sites in the baseline totalling 131 MW. This is the largest baseline in WPD’s four network areas.
- There are six 20 MW diesel plants, and one back up generator in the South Wales licence area.

Near term (2020 – 2025)

- With stringent air quality standards under the MCPD, diesel plants will no longer be able to operate from 2025 without abatement technologies which are unlikely to be financially viable in the near term. However, as WPD currently would have no mechanism to reclaim the capacity held in existing connection agreements, there is no modelled capacity reduction from existing sites before 2030, to capture reasonable worst case conditions on the distribution network.
- The seven standalone diesel sites in the baseline have been modelled to reduce operational hours to zero 10 years after their connection year, or by 2025, whichever comes first, but stay online until at least 2030 to capture reasonable worst case conditions on the distribution network.
- Back-up generators are assumed to have a lifetime of 15 years and are unaffected by the MCPD.
- There are two pipeline diesel sites in South Wales totalling 60 MW. Neither have planning permission or have won a capacity market auction and therefore do not connect in any scenario.

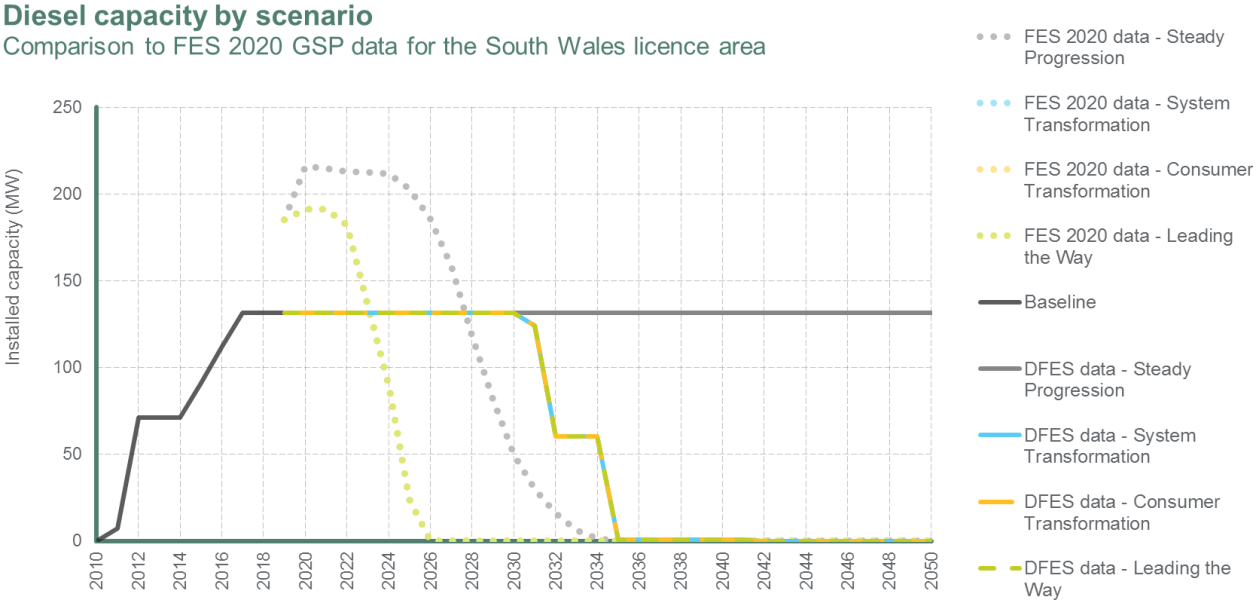
Medium to long term (2025 – 2050)

- No further deployment of distributed diesel has been modelled beyond 2025.
- It should be noted that non-synchronous diesel generation (e.g. only operating as back up when mains failure occurs) is not subject to the MCPD and therefore remain connected until the end of their lifetime when they are assumed to be replaced with a different technology.

Figure 33

Diesel capacity by scenario

Comparison to FES 2020 GSP data for the South Wales licence area



Reconciliation with National Grid FES 2020:

Results in this section relate to the FES 2020 data as reported for the Building Block ID number Gen_BB005.

- The assumptions underpinning this work are in line with the FES 2020 results, however there is a discrepancy in the total capacity currently installed. WPD connections data suggest a baseline capacity which is lower than the FES 2020 baseline for the South Wales licence area.
- While modelling credible pathways to net zero, the DFES must also capture the near term worst case conditions that the distribution network could see, which is important for strategic investment modelling. While National Grid ESO may discount generators without a supply contract, WPD DFES includes all generators with valid connection agreements regardless of absent supply contracts, this may lead to some discrepancies in the baseline totals.
- In the three net zero compliant scenarios, diesel sites decommission at the same rate by 2025, and by 2032 in Steady Progression, which is in line with FES 2020.

Relevant assumptions from National Grid FES 2020:

Assumption number	4.1.31
Steady Progression	Less focus on decarbonisation compared to other scenarios. Diesel plant retired later than other scenarios.
System Transformation	Initial growth in gas peaking plant as renewables grow (instead of high growth in storage technologies), later switching to Hydrogen.
Consumer Transformation	Initial growth in gas peaking plant as renewables grow (instead of high growth in storage technologies), later switching to alternate sources of flexibility such as storage and V2G.
Leading the Way	Low use as scenario sees greater use of other technologies (e.g. storage). Earliest closure of diesel reciprocating engines.

References:

WPD connection offer data, Regen consultation with local stakeholders.

Other generation in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

All generation connection agreements and accepted offers that are either unidentified as one of the basic technology types.

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

Installed capacity (MW)	Baseline	2025	2030	2035	2040	2045	2050
Steady Progression	50	50	50	50	50	50	50
System Transformation	50	50	50	50	50	50	50
Consumer Transformation	50	50	50	50	50	50	50
Leading the Way	50	50	50	50	50	50	50

Summary:

- There is 50 MW of connected ‘other generation’ sites that have no identified technology type. In some cases this is because of a lack of available data means that connected site cannot be found, in other cases it is because the fuel source of likely backup generators cannot be confidently identified. All baseline ‘other generation’ sites are under 6 MW.
- There is only a single ‘other generation’ pipeline site but with 0 MW export capacity, the baseline total does not change over the projection period.

Reconciliation with National Grid FES 2020:

There is no equivalent technology type in National Grid FES 2020 to compare to.

References:

WPD connection agreement and offer data.

Results and assumptions

Energy storage technologies

Battery storage in the South Wales licence area

Summary of modelling assumptions and results.

Technology specification:

Battery storage, comprising four business models:

- **Standalone network services** – typically multiple MW scale projects that provide balancing, flexibility and support services to the electricity network.
- **Generation co-location** – typically multiple MW scale projects, sited alongside renewable energy (or occasionally fossil fuel) generation projects.
- **Behind-the-meter high energy user** – single MW or 'hundreds of kW' scale projects, sited at large energy user operational sites to support onsite energy management or to avoid high electricity cost periods.
- **Domestic batteries** – typically 10-20kW 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 Wales licence area:

Installed power capacity (MW)		Baseline	2025	2030	2035	2040	2045	2050
Standalone network services	Steady Progression	0	0	20	20	34	35	37
	System Transformation	0	0	5	5	7	8	8
	Consumer Transformation	0	0	20	29	39	41	42
	Leading the Way	0	0	20	20	34	35	35
Generation co-location	Steady Progression	4	24	29	32	36	38	39
	System Transformation	4	24	28	28	30	31	32
	Consumer Transformation	4	34	43	52	62	72	80
	Leading the Way	4	24	43	47	60	68	76
Behind-the-meter high energy user	Steady Progression	0	1	18	20	24	24	24
	System Transformation	0	1	5	6	7	7	7
	Consumer Transformation	0	5	32	35	42	42	42
	Leading the Way	0	6	39	41	47	47	51
Domestic batteries	Steady Progression	0	0	3	4	5	25	28
	System Transformation	0	0	1	1	1	3	3
	Consumer Transformation	0	0	19	29	64	137	226
	Leading the Way	0	1	17	43	205	277	351

Summary:

- The South Wales licence area has the lowest level of existing operational battery storage projects in the WPD network and a similarly low pipeline of near-term sites.
- This is as a result of the National Grid Electricity Transmission Statement of Works currently in force which prevents the deployment of new thermal generation and battery storage projects until c.2028, significantly hampering the deployment of new battery projects in the licence area.
- By 2050, the overall battery capacity in the South Wales licence area is by far the lowest of WPD's four licence areas, ranging from 53 MW in System Transformation to 575 MW in Leading the Way in 2050.

Results and assumptions:

Baseline

- There are only 3 battery storage projects totalling 4.3 MW currently connected in the South Wales licence area. Two of these are generation co-location projects.
- The National Grid Electricity Transmission Statement of Works has likely been a significant factor in this low deployment.

Near term (2020 – 2025)

- The South Wales licence area has a low pipeline of accepted battery storage connection offers, with 11 projects totalling 35 MW having an accepted network connection offers in the licence area. These are a mixture of generation co-location, behind-the-meter and domestic battery storage business models, with an average capacity of c.3 MW.
- Of these projects, 20 MW (2 sites) have planning approval and one of these sites also secured a contract in the Capacity Market.
- The largest (20 MW) pipeline site secured a connection offer despite the Statement of Works restriction in-place and thus has been modelled to connect in the 2020s, otherwise deployment is assumed to be very low in the near term.
- By 2025, connected battery storage capacity in the South Wales licence area is highest (48 MW) in the Leading the Way scenario and lowest (27 MW) in the System Transformation scenario.

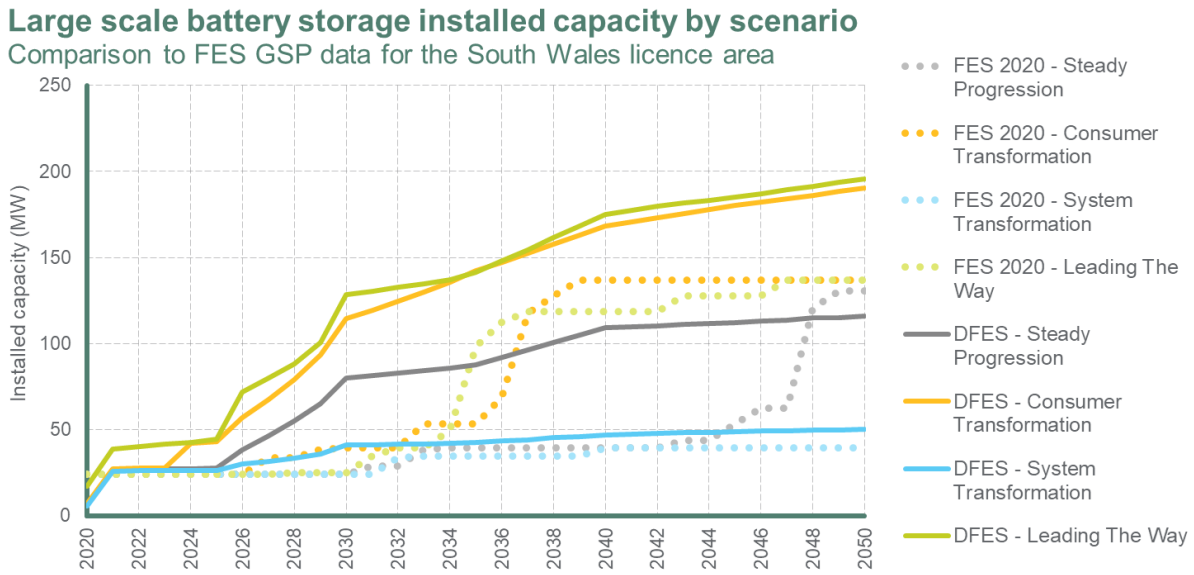
Medium term (2025 – 2035)

- The four business models for battery storage are modelled separately and are driven by different factors.
- Except for the sites in the pipeline, no additional standalone battery storage capacity has been modelled to connect until after 2028, the end of the Statement of Works period.
- Except for the sites in the pipeline, generation co-location capacity in the South Wales licence area is limited until nearer to 2030. With a range of renewable generation deployment across the scenarios out to 2035, the capacity of co-located battery storage varies between 2030 and 2035, the largest being 60 MW in Consumer Transformation.
- Uptake of domestic batteries is assumed to be more limited, in line with the moderate uptake of rooftop PV projected in the South Wales licence area in the medium term. The scenarios with lower societal change (System Transformation and Steady Progression) see a particularly low (1 MW) uptake of domestic batteries, Leading the Way (76 MW) has a stronger uptake in the early 2030s.

Long term (2035 – 2050)

- In the long term, the biggest increase in projected battery storage capacity occurs in a Leading the Way scenario, where a significant increase in overall deployment of domestic batteries is seen by 2050, equating to batteries in c.6% of all homes in the licence area.
- In contrast there is very low deployment of storage the System Transformation scenario overall, as the high use of hydrogen for balancing and heat means there is a lesser need for distribution network flexibility deployment.
- Overall, installed battery storage capacity in the South Wales licence area is largest (575 MW) in Leading the Way and lowest (only 53 MW) in System Transformation by 2050.
- The South Wales licence area is by far the lowest of WPD's four licence areas for overall battery storage capacity in 2050, across all scenarios.

Figure 34



Reconciliation with National Grid FES 2020:

- A handful of pipeline sites that have accepted connection offers with WPD have been modelled to connect in the near-to-medium term, despite the Statement of Works restriction in the licence area. This results in a near term variance between the WPD DFES 2020 and the FES 2020.
- The WPD DFES 2020 has a higher installation of domestic batteries in System Transformation than the same scenario in FES 2020, reflecting the potential uptake in line with EV and rooftop solar PV deployment in the medium and long term.
- In Leading the Way, a substantial amount of domestic batteries is modelled to come online by 2050 in the FES 2020 projections. Following stakeholder feedback, the WPD DFES 2020 projections have allowed for moderately more larger scale batteries to come online by 2050 in this scenario and moderately fewer domestic batteries.

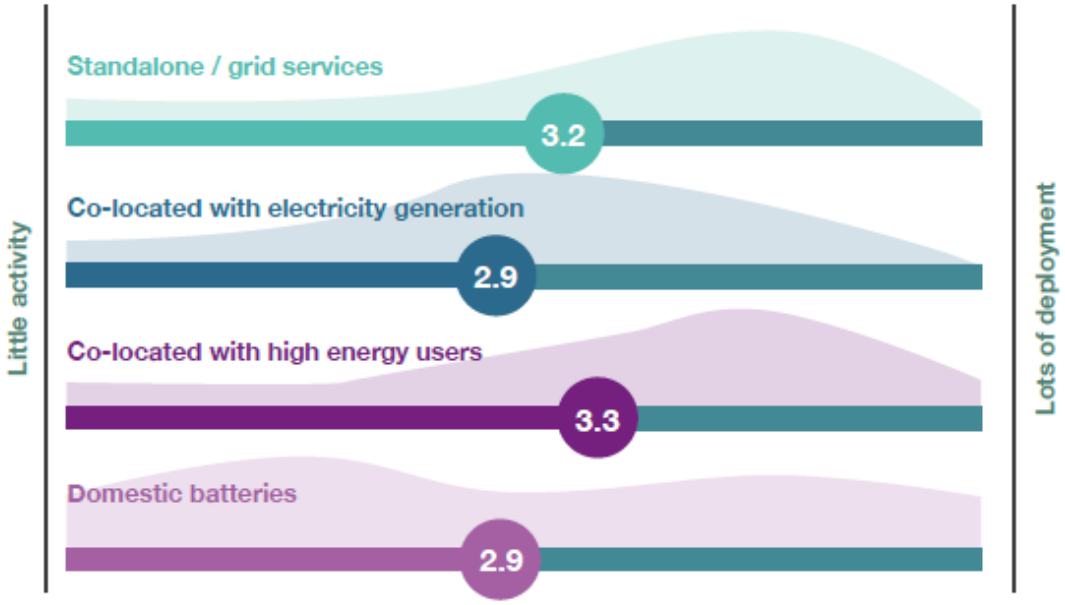
Factors that will affect deployment at a local level:

Results in this section relate to the FES 2020 data as reported for Building Block ID number Srg_BB001 and Srg_BB002.

- The spatial distribution of new battery storage projects in the near term is based on the location of the pipeline sites.
- In the longer term, spatial distribution varies according to the four battery storage business models used in the modelling.
- These local factors are:
    - **Standalone:** Proximity to 33kV and 132kV electricity network.
    - **Generation co-location:** Proximity to ground mount solar PV and onshore wind projects within the licence area.
    - **Behind-the-meter high energy user:** Proximity to industrial estates and commercial buildings.
    - **Domestic batteries:** Domestic dwellings with rooftop PV.

Stakeholder feedback from the consultation events:

Your comments to us	Our response
Theme: energy storage	
There was support from stakeholders for all energy storage business models presented. However, domestic batteries were rated the least likely to have high deployment in the near term.	We will continue to analyse energy storage deployment through the four business models, and we will update our projections for domestic batteries to reflect this feedback.
You told us that co-located energy storage facilities would be likely be at least 50% of the power capacity of the solar farm, with around a quarter of respondents suggesting the storage sites would be 100% of the renewable energy asset capacity or larger.	This is higher than the current national baseline average, according to data from the Department for Business, Energy, and Industrial Strategy. We will increase our projected proportional power size for co-located energy storage sites.
You told us that energy storage technologies other than lithium-ion and solid state batteries could be deployed in the future. This included liquid or compressed air storage, power-to-gas sites, and small-scale pumped hydro.	We will review this for the next round of DFES and incorporate stakeholder feedback for which technologies we could include.



References:

WPD connection offer data, the Renewable Energy Planning Database, various local authority online planning portals, EMR Delivery Body Capacity Market registers, Regen consultation with local stakeholders and discussion with developers.

Distribution Future Energy Scenarios 2020

Results and assumptions reports have been published for all four WPD licence areas and are available at the WPD DFES website, along with interactive maps and data download options.

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