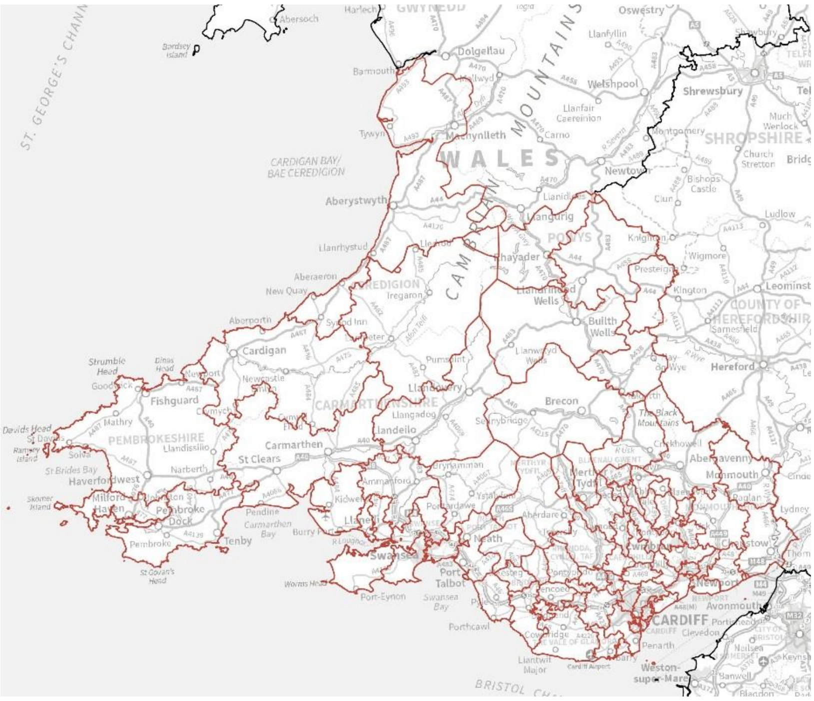
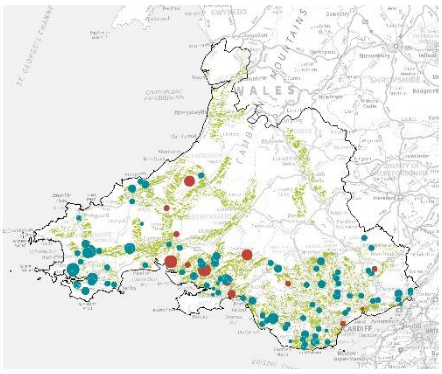
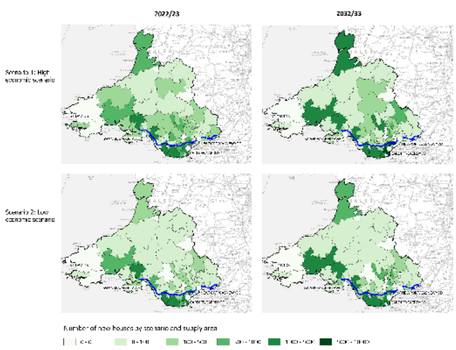
# Distribution Future Energy Scenarios

## A generation and demand study

## Technology growth scenarios to 2032






South Wales licence area

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| Acronym | Definition |
|---|---|
| AD | Anaerobic Digestion |
| ASHP | Air Source Heat Pump |
| ATT | Advance Thermal Treatment |
| BEIS | Department for Business Energy and Industrial Strategy |
| CCC | Committee on Climate Change |
| CfD | Contract for Difference |
| CHP | Combined Heat and Power |
| DNO | Distribution Network Operator |
| DNS | Developments of National Significance |
| DSR | Demand Side Response |
| DSO | Distribution System Operator |
| Duos | Distribution Use of System |
| EFR | Enhanced Frequency Response |
| EfW | Energy from Waste |
| ERF | Energy Recovery Facility |
| ESA | Electricity Supply Area |
| EPC | Energy Performance Certificate |
| EV | Electric Vehicle |
| FES | Future Energy Scenarios |
| FFR | Firm Frequency Response |
| FIT | Feed in Tariff |
| GIS | Geographic Information System |
| ha | Hectares |
| kW(h) | Kilowatt (hour) |
| LCOE | Levelised cost of electricity |
| LDP | Local Development Plan |
| MW | Megawatt |
| PEV | Pure Electric Vehicle |
| PHEV | Plug-in Hybrid Electric Vehicle |
| PPA | Power Purchase Agreement |
| PV | Photovoltaics |
| RHI | Renewable Heat Incentive |
| RO | Renewables Obligation |
| RTFO | Renewable Transport Fuel Obligation |
| STOR | Short Term Operating Reserve |
| SSA | Strategic Search Areas for onshore wind |
| ULEV | Ultra-Low Emission Vehicle |
| WPD | Western Power Distribution |

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## Introduction

This report is the second future scenario report for Western Power Distribution's (WPD's) South Wales licence area. With over 1 million households, the licence area is home to over 80 per cent of the Welsh population and the three biggest urban areas in Cardiff, Newport and Swansea.

The licence area has experienced unprecedented growth in distributed generation in the last six years and, although growth in new generation capacity has slowed, significant changes in the demands on the distribution networks are continuing.

Seismic shifts in technology including battery storage, smart technologies and disruptive demand technologies, such as electric vehicles, are expected to lead to further change in how our electricity networks are used and dictate how they need to develop.

South Wales has significant further potential in growth in many renewable technologies. The Welsh Government has set ambitious growth targets, there is a positive planning framework and the area has significant renewable energy resource. However, the area is facing significant network constraints including an embargo until 2026 on certain technologies connecting to the network due to a transmission constraint.

Currently the cost of network reinforcement to remove constraints is currently borne directly by the generators causing a constraint. Generators not able, or willing, to pay for the upgrade can also accept 'Active Network Management' that allows them to connect but with the condition that they stop generating when network limits require it. Currently there two Active Network Management zones in the South Wales licence area Swansea North and Pembroke.[1]

### Regulatory developments

In response to the growth of decentralised generation and the need to actively manage the electricity distribution system, Department for Business Energy and Industrial Strategy (BEIS) and Ofgem have set out a goal for Distribution Network Operators (DNOs) to become Distribution System Operators (DSOs) and to actively manage capacity and usage on their networks. WPD published the latest version of their DSO strategy in December 2017. [2]

Ofgem and BEIS are also currently developing proposals and consulting on how both transmission and distribution networks should be funded in the future. This is to ensure that existing network capacity is used efficiently and that networks receive appropriate value signals to fund network upgrades when needed. [3]

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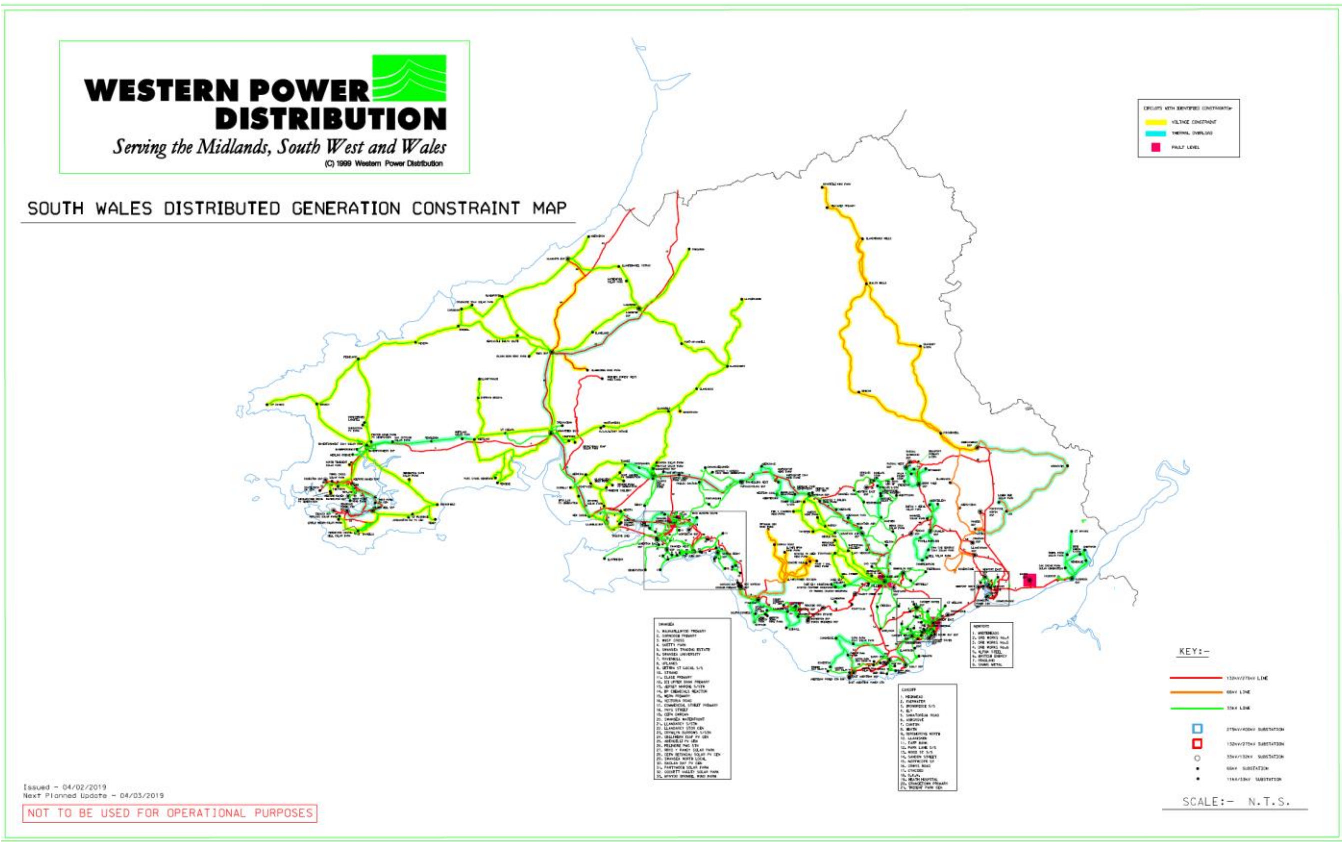
[1] https://www.westernpower.co.uk/Connections/Generation/Alternative-Connections/ANM-Further-Info.aspx

[2] https://www.westernpower.co.uk/About-us/Our-Business/Our-network/Strategic-network-investment/DSO-Strategy.aspx

[3] See Charging Futures Forum: https://www.ofgem.gov.uk/publications-and-updates/charging-futures-forum

Figure 0-1: South Wales licence area distribution network constraints[4]




4 https://www.westernpower.co.uk/docs/connections/Generation/Generation-capacity-map/Distributed-Generation-EHV-Constraint-Maps/South-Wales-Thermal-Map.aspx

## Strategic Network Reinforcement

DNOs can undertake a very limited amount of strategic network reinforcement that isn't directly funded by generators or new demand customers.

Any strategic investment by WPD needs to be carefully assessed, with a strong business case to choose 'least risk of regret' investment proposals. Considerations include:

- Areas with low or no spare capacity
- High potential for growth of future distributed generation or disruptive demand
- A clear model for cost recovery

This report is part of the process to develop these investment options and responds to Ofgem request for "enhanced forecasting and planning" from DNOs[5]. It provides scenarios, at Electricity Supply Area (ESA) level, for the potential growth of distributed generation, electricity demand growth and electricity storage in the South Wales licence area.

WPD has set out a five-step methodology in Table 0-1 to develop a business case for strategic investment.

Table 0-1: Strategic investment methodology

| Strategic network investment business case development | |
|---|---|
| Step 1. Distributed generation, electricity growth and demand growth scenarios ***(this assessment)*** | Assessing the potential growth in distributed generation, electricity storage and demand by technology type, Electricity Supply Area (ESA) location and year, by scenario |
| Step 2. Network constraint modelling | Identifying thermal, voltage and fault level constraints that result from scenario modelling |
| Step 3. Identify and assess options<br>• Estimate the capacity provided by these solutions<br>• Assess cost/timescale of these solutions | Identify and cost a small number of potential network reinforcement strategic investments<br><br>Identify future network solutions (including required National Grid electricity transmission upgrades) |
| Step 4. Assess alternative options | Assess the potential for demand side response (DSR), energy storage or generation constraint take up, given the cost of network solutions |
| Step 5. Present business case and options | Present business case and recommended investment options |

[5] https://www.ofgem.gov.uk/system/files/docs/2017/02/unlocking-the-capacity-of-the-electricity-networks-associated-document.pdf

## 1.1. Methodology

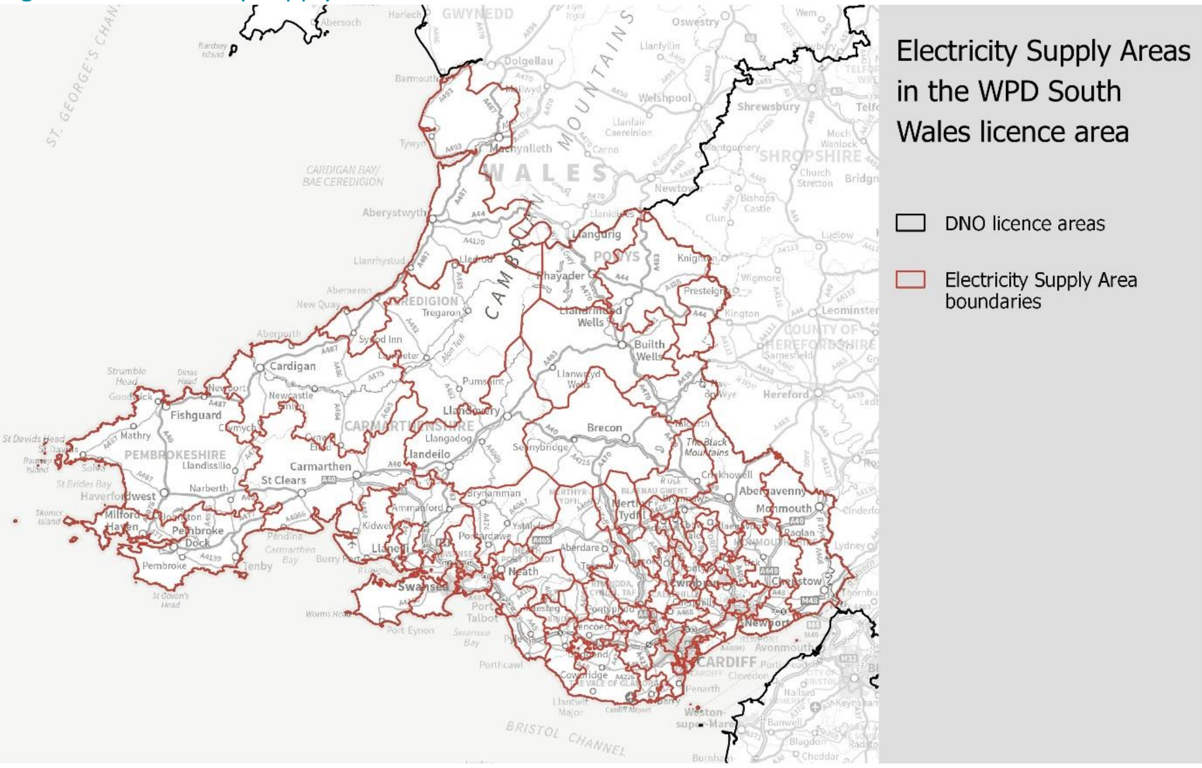
This report presents four scenarios for the potential growth from 2018 to 2032 in WPD's South Wales licence area of: disruptive demand technologies (electric vehicles, heat pumps and air conditioning); demand from new housing and commercial developments; new distributed generation (both renewable and small scale fossil fuel), and storage.

This report accompanies a dataset and documents the key market insights, assumptions and methodologies used in the scenario process.

### Electricity Supply Areas (ESAs)

The information is presented to WPD as a dataset by each of the 80 ESAs in the licence area (see Figure 0-2). ESAs are defined as geographic areas served by the same upstream network infrastructure. Regen and WPD have created these by mapping data on individual substations and the upstream network points using Geographic Information System (GIS) software.

Figure 0-2: Electricity supply areas in the South Wales licence area:



### Scenario process

The analysis undertaken for each technology in the report involves the following four stages:

**Stage 1 - A baseline assessment**. Technology baselines are calculated from WPD's network connection database as at the end March 2018. This information is then reconciled with Regen's project database and further desktop research is undertaken to address inconsistencies.

**Stage 2 - A pipeline assessment.** WPD's network connection agreement database is reconciled with the BEIS planning database, along with telephone and internet research and understanding of the current market conditions. This allows an assessment of which projects may go ahead and in what timescale. The domestic scale and demand technologies do not have a pipeline.

**Stage 3 – Resource assessment.** Locational data from various data sources and GIS analysis is used to understand the geographical distribution, local attributes, constraints and potential for technologies to develop within the region and each ESA.

**Stage 4 - A scenario projection to 2032.** The scenarios are based on National Grid's Future Energy Scenarios (FES) 2017 and interpreted for specific local resources, constraints and market conditions. The findings from a local consultation event along with interviews with developers, investors and analysis of current market reports is used. In addition to using Regen's existing analysis and knowledge.

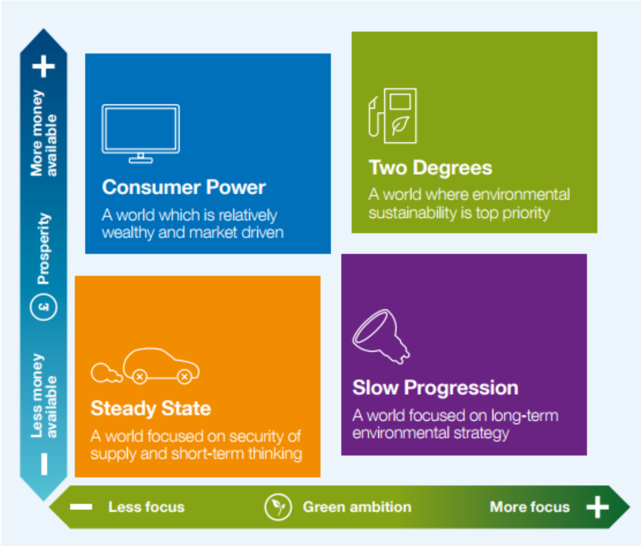
To build the baseline and scenarios for demand from new development, we undertook a different methodology which is detailed in section 5.

### Interpretation of FES

The framework 2017 Future Energy Scenarios[6] developed by the National Grid is used as a starting point for this assessment.

In some cases scenarios for South Wales will differ from the rest of the UK. Where this is the case the differences are explained in the relevant separate technology sections.

To note that the 2018 FES has significantly changed their FES scenario model to include an axis of centralised versus decentralised generation including a scenario called 'community renewables'. This new structure is not considered in this report.




## 1.2. Scenario descriptions

| Two Degrees – a world where environmental sustainability is top priority for government and consumers. |
|---|
| Under the Two Degrees scenario, it is assumed that future government policies take a strategic approach to decarbonising the energy system, consistent with the decarbonisation targets set for 2030 and 2050, and reinforced by the commitments made at the Paris Conference of Parties UN Agreement. Market conditions, financial support and technology development are also conducive to the strategic growth of distributed generation.<br><br>We also assume a high consumer engagement allied to the growth of electricity storage solutions and electricity demand technologies, such as electric vehicles and heat pumps. As a result, overall renewable energy and disruptive demand growth is in most cases strongest under this scenario.<br><br>Under this scenario it is assumed that the network is able to integrate all sources of generation and demand without constraints. |
| **Consumer Power – a world which is relatively wealthy, and market driven** |
| The Consumer Power scenario has features that lead to an emphasis on deployment of smaller scale generation and local supply through individuals, communities and other organisations, including technology development and consumers interested in green technologies.<br><br>Government intervention is limited under this scenario, with policies supporting deployment mainly where there is demand from consumers and communities.<br><br>The result is widespread, dispersed growth of small and medium scale renewable energy and demand technologies but some developments that run contrary to carbon reduction goals.<br>Under this scenario it is assumed that the network is able to integrate all sources of generation and demand without constraints. |

[6] http://fes.nationalgrid.com/fes-document/

| Slow Progression – a world focused on long-term environmental strategy |
| --- |
| The Slow Progression scenario features a strategic approach to renewable energy by government, but in a poor economic environment which means there is a lower government budget for support, less investment capital available and fewer technological innovations.<br><br>Government policy is focussed on the lowest cost actions, unlocking regulation and barriers where it is cost-effective to do so. Fewer larger-scale projects are likely to get support (as opposed to smaller distributed technologies). Consumers have lower and slower take-up of technologies than the two degrees scenario.<br><br>The result is a medium growth scenario, with a focus on the lowest cost technologies.<br>Under this scenario it is assumed that the network is constrained in the short-term but is able to integrate all sources of generation and demand without constraints following investment in the mid-2020s. |
| **Steady State – a world focused on security of supply and short-term thinking** |
| Under the Steady State scenario there is a poor economic environment and little green ambition in government or society.<br><br>There is a continued dependence on fossil fuels into 2020s and 2030s that would not be consistent with the UK’s stated decarbonisation and climate change commitments.<br><br>Low-carbon trends are significantly slowed, and growth only occurs when economics become extremely favourable. Growth of all technologies are lowest for all scales and technologies under this scenario.<br>Under this scenario it is assumed that the network remains constrained in the short to medium term and that it acts to reduce demand and generation accessing the network. |

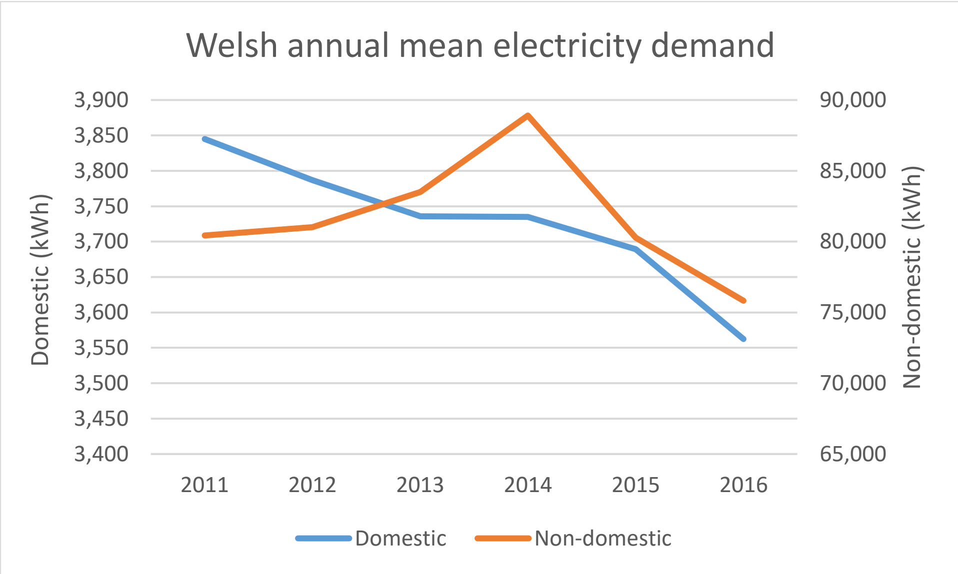
## 1.3. South Wales baseline demand

Understanding the future changes to trends in electricity usage in the South Wales licence area is important for WPD to develop a robust investment strategy.

Wales as a whole has the second lowest average household use of electricity in the UK (3,223 kWh in 2016) the lowest being Inner London at 2,888 kWh.[7] Since 2011, Welsh consumers have consistently used around 5.5 per cent less electricity per year than the UK average, and domestic demand has fallen by over 5 per cent. Commercial and industrial demand has reduced by less than 2 per cent compared to the fall in the South West of 6 per cent.

However, Wales also has relatively high average non-domestic energy use with use over 10 per cent, nearly 10,000 kWh per year, above the UK average. Neath Port Talbot is second only to the city of London for average commercial and industrial electricity use in a local authority. This is likely to be a result of the Port Talbot steel works which is primarily connected to the transmission network.

Figure A-1: Mean electricity use in Wales since 2011, domestic and non-domestic. [8]




This section sets out Regen's analysis, assumptions and market insights behind the future growth of disruptive demand technologies and new developments in the South Wales licence area. The areas analysed are:

- Electric vehicles
- Heat pumps
- Air- conditioning
- New commercial and domestic developments

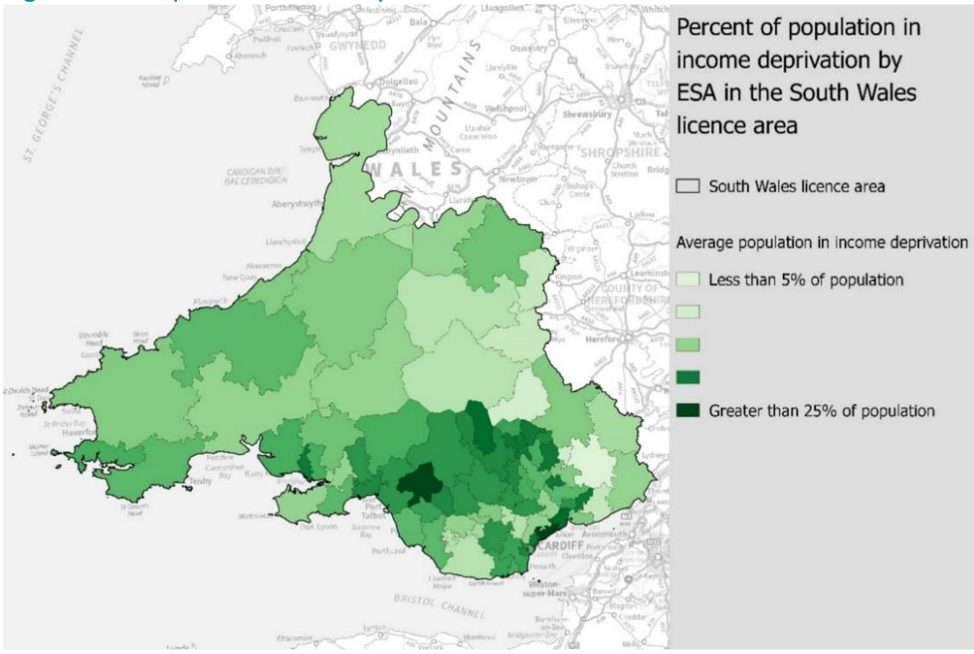
[7] https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics
[8] Source: BEIS, sub-national electricity sales and numbers of customers 2005 – 2016.

## 1.4. Demand growth factors

Despite the current trend being towards decreasing electricity demand year-on-year, there is an expectation that demand will start to increase again over the medium and longer term, due to more new housing and increasing electrification of heat, cooling and transport.

For South Wales, a key factor for new technology demand is affluence. Wales has consistently lower affluence, as measured by wages or by disposable income, than the UK average. The latest report by the Office of National Statistics has disposal income in Wales as £15,835, 20 per cent lower than the UK average of nearly £20,000.[9] As a result, new technologies such as electric vehicles and investments in homes such as heat pumps or air conditioning are likely to remain significantly lower than the national average during this analysis period.

Figure A-2: Deprivation levels by ESA in South Wales licence area.




The future trend in demand for electricity and the impact of that on the distribution network will be determined by several key variables. This section sets out the variables and uncertainties that impact across demand technologies in these scenarios. Some of these will be expanded in the demand sections where particular assumptions have been made.

### Uncertainty 1: Network charging and commercial peak demand

The electricity network is currently sized for peak demand periods that usually occur between 5:30 and 6 pm on a cold winter's day. Commercial customers on half hourly meters are incentivised to reduce their peak demand at these times by a variety of incentives and network charges.

To avoid some of these charges, large commercial customers have started to generate their own electricity and, as a result, the peak demand of electricity has been falling for several years.[10] Significant changes to

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9 https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/bulletins/regionalgrossdisposablehouseholdincomegdhi/1997to2016#analysis-of-nuts1-regions

10 https://www.auroraer.com/wp-content/uploads/2017/03/Ofgem-Embedded-Benefits-Reform-summary-and-Auroras-commentary.pdf

network charging are expected in the next few years that may start to erode the signals to avoid peak, such as higher fixed charges.  Depending on these charges, peak demand may start to rise once again.

### Uncertainty 2: Behaviour change through time of use tariffs

Domestic customers without smart metering are not currently incentivised to use electricity at different time periods in the day. [11]

For households, the roll-out of smart-meters to all electricity customers by 2020 means that they will start to have access to new tariffs and the ability to reduce their electricity costs by shifting demand to cheaper time periods. It is expected this may work to flatten domestic peak demand, but questions remain over how many people will respond to price incentives. Current evidence suggests that up to a third of consumers would respond to tariff signals.[12]

### Uncertainty 3: Automation and smart systems

Smart and flexible control systems will be a key factor in future markets. Electric vehicles, heat pumps and air conditioning units in households all have the potential to significantly increase a household's energy demand. If there is wide-spread uptake of these technologies, the impact on local networks could be significant and simultaneous usage or charging of EVs in a small area may well start to overload local sub-stations.

Time of use tariffs are unlikely to fully manage these impacts and upgrading all domestic substations to cope with higher peak demand could be very costly.  The technologies will depend on smart systems and automation that can stagger demand in a local area or switch off demand when the local network or system is becoming overloaded.

### Uncertainty 4: Government action on energy efficiency and building regulations

Energy efficiency of homes is a key driver of household demand for both electricity and gas. The Welsh Government Warm Homes Programme through Nest and Arbed[13] provides support and funding for energy efficiency improvements to low-income households and deprived areas in Wales.  However, the Arbed funding relies on the European Regional Development Fund and therefore continuation is uncertain following Brexit, as is the progress on reducing energy usage of household appliances. [14]

Currently there are few UK policies in place to drive energy efficiency. The UK government has however stated an intention in the Clean Growth Strategy to bring all homes in England and Wales to an Energy Performance Certificate (EPC) 'C' rating by 2035,[15] a significant task.  Building regulations are another important policy lever. If summer temperatures increase significantly then passive ventilation and cooling will need to be built into building regulations to avoid high take up of air conditioning technology in homes.

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[11] The only exception to this is economy 7 and 10 tariffs where consumers are metered differently and charged less for electricity used overnight. This is usually the choice in properties that have electric heating on overnight.

[12] https://www.citizensadvice.org.uk/about-us/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-policy-research/the-value-of-time-of-use-tariffs-in-great-britain/

[13] https://gov.wales/topics/environmentcountryside/energy/efficiency/warm-homes/?lang=en

[14] https://ec.europa.eu/energy/en/topics/energy-efficiency

[15] https://www.wwf.org.uk/updates/win-home-energy-efficiency-clean-growth-strategy

## 1.5. South Wales scenario summary

Given the level of uncertainty in the factors that drive demand there is also high uncertainty about growth in all the disruptive demand technologies. As a result, there are large differences in the highest and lowest scenarios.

Table A-1: Percentage of domestic households with disruptive demand technology in 2032 by scenario presents some of the potential level of growth of disruptive demand technologies. In the Two Degrees scenario electric vehicles could account for over 26 per cent of vehicles in 2032 and with heat pumps in 9 per cent of properties. In Steady State these numbers are 5.7 per cent and 1.7 per cent respectively.

Table A-1: Percentage of domestic households with disruptive demand technology in 2032 by scenario

| | **Electric vehicles (% of all cars)** | **Heat pumps** | **Air conditioning** |
|---|---|---|---|
| **Two Degrees** | 26.2% | 9.1% | 0.97% |
| **Consumer Power** | 19.4% | 3.1% | 5.34% |
| **Slow Progression** | 10.6% | 5.6% | 1.90% |
| **Steady State** | 5.7% | 1.7% | 3.92% |

# 2. Electric vehicles

With only around 2,200 electric vehicles (EVs) in the licence area, EV usage in South Wales is around 73 per cent lower than the rest of the UK. Government policy, commitment by manufacturers and new investment in charging infrastructure is expected to significantly increase EV usage over the scenario period in all scenarios. However, the licence area is expected to remain below the UK average during the scenario period due to its rural nature and levels of affluence.

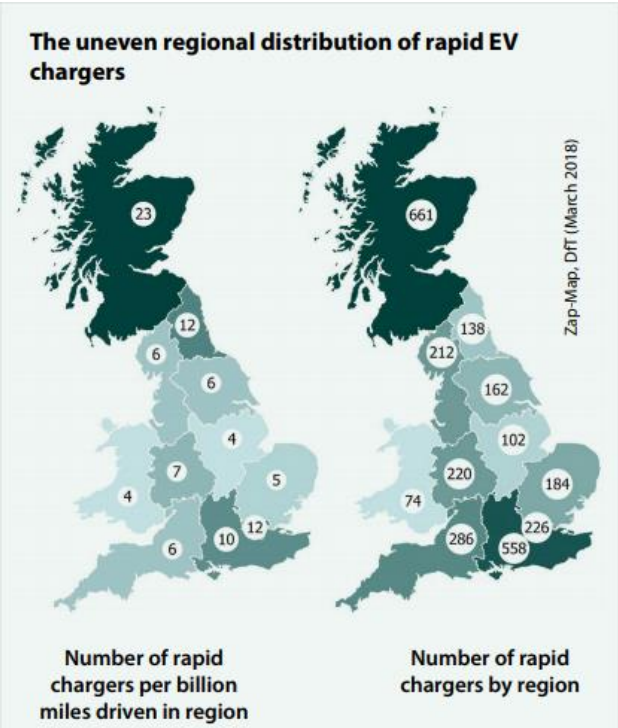
**Electric vehicle uptake is increasing in South Wales but remains behind the UK average.**

Table 2-1: Summary of growth in capacity of electric vehicles in WPD South Wales licence area.

| Numbers of electric vehicles in licence area | 2017 | 2020 | 2025 | 2032 | Proportion of all cars in 2032 (%) |
|---|---|---|---|---|---|
| Two Degrees | 2,233 | 8,878 | 61,349 | 397,784 | 26.2 |
| Consumer Power | | 7,881 | 39,426 | 295,353 | 19.4 |
| Slow Progression | | 5,749 | 28,587 | 161,910 | 10.6 |
| Steady State | | 5,234 | 20,133 | 86,565 | 5.7 |

## 2.1. Baseline

Figure 2-1: Charging infrastructure in the UK




Currently, the South Wales licence area take up of electric vehicles is significantly below the UK average, around 73 per cent lower with only 2,233 registered in the area. Less than one per cent of new vehicles registered were electric in 2017 against a UK average of 2.7 per cent. There was an acceleration of growth in electric vehicles in Wales in 2017 with new registrations increasing 35 per cent, ahead of the UK average growth. However, this was starting from a low base.

The low level of electric vehicles in South Wales can be explained by a number of factors. There is a lack of charging infrastructure in the area and Figure 2-1 illustrates Wales has one of the lowest provisions of rapid chargers in the UK. Furthermore, the rural areas and gradients in the licence area would also have made the earlier lower range models of electric vehicles unsuitable for many. And finally, the lower than average wages in the licence area would also have meant the high cost of earlier EV models were less affordable than elsewhere in the UK.

## 2.2. Pipeline

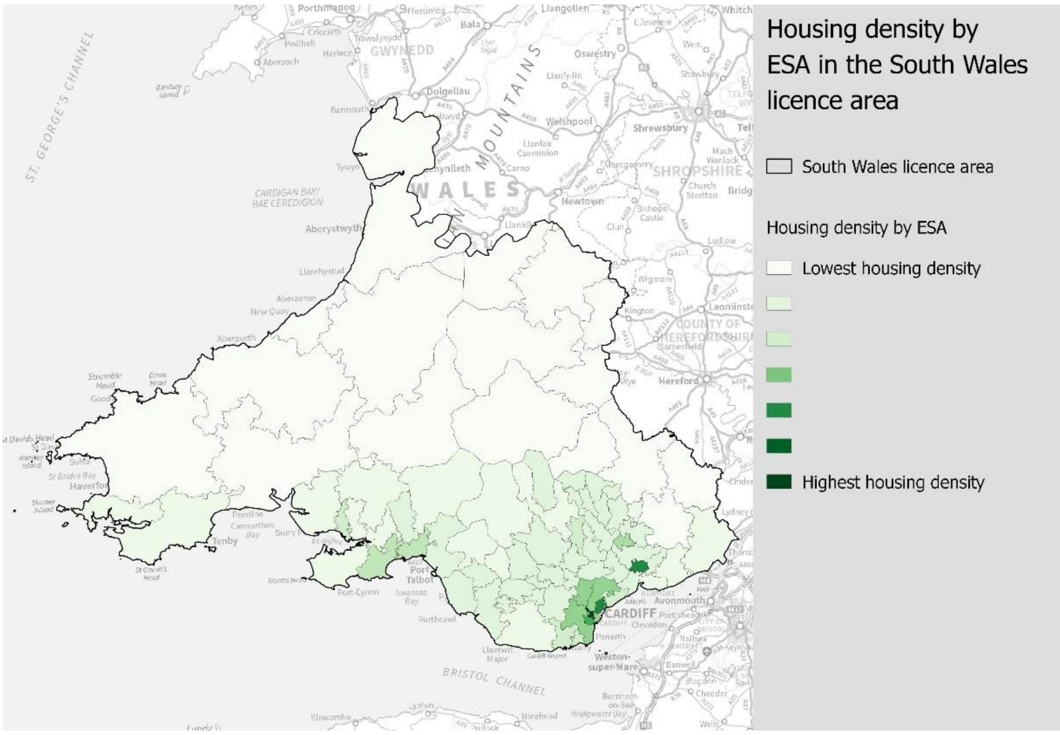
There is now strong political backing in the UK for the roll-out of alternative and electric vehicles with the ban on all new petrol and diesel cars by 2040. Phase-outs have been announced on even tighter timescales in Scotland (by 2032), and Paris streets will be fossil-free by 2030, with diesel gone by 2024.[16]

The UK government has also started to develop a multi-stranded funding and policy programme to enable the anticipated shift from fossil fuel to electricity. £1bn of funding was announced in the Clean Growth Plan mainly to support EV infrastructure with publicity and purchase subsidies extended to 2020. In November 2017 the Welsh Government also announced a £2m investment in charging infrastructure and, as a result, it is hoped that the charging provision will significantly improve.[17]

The number of electric vehicles in the licence is are expected to increase in the short-term as lower cost and higher range electric vehicles come onto the market and make an EV more viable. The 2018 Nissan Leaf has a range of 235 miles, 81 miles longer than the previous model. [18]

However, we anticipate that the proportion of EVs sold in the South Wales licence area compared to diesel and petrol vehicles is likely to remain consistently lower than the UK national average by 15-30 per cent by 2032 (depending on the growth scenario) due to the rural nature and the on average 10 per cent lower wages in Wales compared to the UK.[19]

Figure 2-2: Housing density by ESA in South Wales licence area




[16] http://www.telegraph.co.uk/news/2017/10/12/paris-ban-petrol-cars-city-2030-pollution-crackdown/
[17] https://businessnewswales.com/welsh-government-invest-2m-additional-electric-vehicle-charging-points/
[18] https://www.whatcar.com/news/2018-nissan-leaf-review/
[19] http://www.bbc.co.uk/news/uk-wales-41767830

## 2.3. Technology growth prospects

National and local legislation will be key drivers of future electric vehicle growth in the licence area. As well as the UK ban on new petrol and diesel sales in 2040, local measures will be important. Cardiff Council have announced they are considering a congestion charge[20] amongst options to reduce air pollution in the city. Congestion charges often include incentives for low-carbon and electric vehicles.

From a consumer perspective the key hurdle will be price. Lower running costs are not yet balancing out the up-front costs, even with the subsidy currently provided to reduce the cost of purchasing. Unless drivers have a high mileage, such as use for fleet applications, and there is limited evidence as to the actual whole life savings and resale value. Increased investment and competition is needed between manufacturers to drive down costs.

As a result, though growth of electric vehicles is certain, the trajectory of that growth is less clear. Regen's 2018 paper on electric vehicles 'Harnessing the Electric Vehicle Revolution' identified possible growth profiles for electric vehicles (Figure 2-3). The first, exponential growth is broadly equivalent to a Two Degrees scenario where growth starts accelerating in the near time. The explosive growth is equivalent to the Consumer Power scenario where growth increases once a price point is achieved in the 2020s. Given the slow rate of growth to date there is also a real potential for growth stagnating which is equivalent to a Steady State profile.

Key to the potential impact on the distribution network of electric vehicles is the split between the Plug in Hybrid Electric Vehicle (PHEV) which combines electric with a diesel or petrol engine and the Pure Electric Vehicle (PEV) which runs purely on electricity.

In 2017 only 38 per cent of new electric vehicles sold nationally were PEV. This has dropped from 57 per cent in 2014. FES 2017 predicts that the percentage of electric vehicles that are PEVs will grow again as subsidies and other incentives are removed from PHEV as an interim technology which still has associated emissions and air pollution impacts.

These scenarios have broadly followed FES in the split between the two types of EVs over the analysis period. The percentages are summarised in Table 2-2.

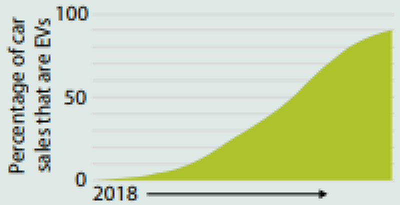
Table 2-2: Percentage of PEV as a proportion of total electric vehicles by scenario.

| Proportion of PEV in new electric cars | | 2017 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| Two Degrees | PEV | 38% | 44% | 54% | 68% |
| Consumer Power | PEV | | 32% | 38% | 52% |
| Slow Progression | PEV | | 35% | 38% | 45% |
| Steady State | PEV | | 35% | 32% | 39% |

[20] http://www.bbc.co.uk/news/uk-wales-43529029

Figure 2-3: High growth scenarios for electric vehicles from Regen's paper 'Harnessing the electric vehicle revolution' 2018

**Exponential growth**

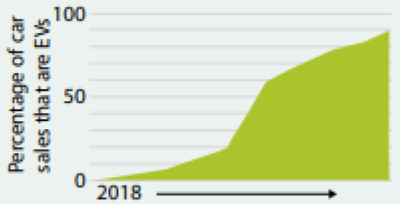



**From a slow start exponential growth kicks in around 2020. By 2030 70% of new car sales are EVs.**

EVs become the vehicle of choice towards the mid 2020s and dominate the market as the end date for petrol and diesels approaches due to:

- Manufacturers bringing out new models with greater range and efficiency
- Cost falling as manufacturing reaches scale
- Consumer acceptance of EVs driven by concerns over pollution and low running costs
- China continuing to set the international pace in market demand and supply

**Explosive growth**

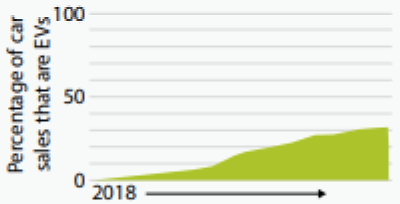



**The EV market reaches a tipping point where an overwhelming consumer demand for EVs leads to a rapid and disruptive market expansion.**

The EV market explodes as a tipping point is reached in the early 2020s driven by massive increase in consumer demand because of:

- Low running costs and price reductions
- Pollution and environmental concerns e.g. cities penalising petrol/diesels
- New models and marketing driving lifestyle choices
- New technology solving range and degradation issues
- Resale market for diesel/petrol collapsing

**Stagnated growth**




**Initial growth is curtailed as the market fails to develop. EVs remain a relatively small part of the overall car market until the mid 2030s.**

Initial growth is curtailed due to:

- Consumers remaining wary – perhaps driven by performance not living up to promise
- Incumbent manufacturers' opposition
- Running cost and price efficiency remain uncompetitive
- Battery degradation and poor second-hand market for EVs
- Support mechanisms are reduced as policy makers do not follow through on climate and pollution commitments

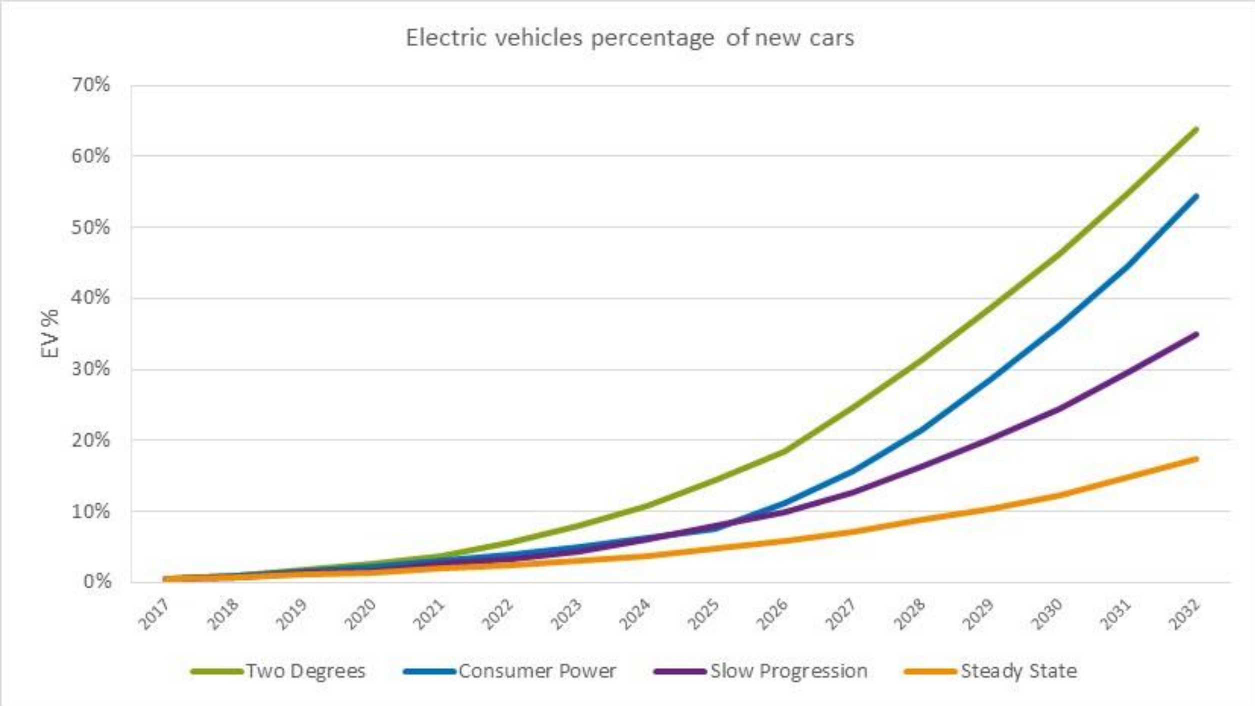
The factors associated with growth of electric vehicles in the licence area and how they relate to the scenarios have been summarised in Table 2-3.

Table 2-3: Assumptions for factors influencing capacity growth for electric vehicles

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and government support** | | | | |
| Ban on new fossil fuel vehicles | Ban moved forward to 2035 | Ban in 2040 | Ban in 2040 | Ban date not met/delayed |
| Local restrictions on petrol and diesel/air quality legislation | Restrictions in Welsh urban areas from early 2020s | No local restrictions | Some urban restrictions later in 2020s | No local restrictions |
| Charging infrastructure provision | Investment increased in all areas to match UK average provision by 2020 | Low investment with charging points mainly in urban areas | Investment improves towards end 2020s | Wales remains behind UK in charging infrastructure |
| Grants and exemptions for ULEV | Continued until price parity achieved | Subsidies halted in early 2020s | Continued into 2020s but reduced | No subsidies past 2020 |
| **Technology cost and performance** | | | | |
| Cost of purchasing EV versus petrol and diesel | Reaching parity early 2020s | Parity mid-2020s | Parity towards end of 2020s | Slower cost reduction means remains more expensive |
| Range and battery life reach petrol and diesel equivalent | Early 2020s (inc. subsidy) – mid 2020s without | Mid 2020s | Late 2020s | Remain lower restricting market |
| **Consumer factors** | | | | |
| Manufacturer models and promotion | Model choice increases and are heavily promoted | High end model choice increases and heavily promoted | Choice increases but remains under promoted | Continue with limited range and low promotion |
| Smart charging / flexibility business models | Smart charging and flexibility actively taken up by EV owners | Limited smart charging leading to higher peaks in urban areas | Some smart charging but lagging behind market growth | Less demand and disruption – few controls introduced |
| Affluence and economic growth | Capital available to invest in new vehicles | Capital available to invest in new vehicles | Low economic growth restrains EV demand | Low economic growth restrains EV demand |
| **Resource factors** | | | | |
| Licence area take up as a proportion of UK average (currently 25%) | Catches up to 85% by 2032 | Catches up to 85% by 2032 | 70% of UK average by 2032 | 70% of UK average by 2032 |
| Geography of uptake | Evenly spread amongst population | Concentrated in urban areas | Evenly spread amongst population | Concentrated in urban areas |

## 2.4. Scenario results

Figure 2-4: WPD South Wales licence area electric vehicle growth scenarios.




### Relationship to FES 2017 and 2016 Scenario report

As a result of the 2040 new fossil car ban and other policy measures that were announced subsequent to our previous report, the scenario numbers of electric vehicles are around double that of our previous report.

The scenarios differ from FES 2017 in that they assume later and faster growth of electric vehicles, reflecting the stagnated growth in the sector that continued after the publication of FES 2017. As a result, these scenarios model that over 60 per cent of new cars purchased in 2032 are electric vehicles compared to FES's 33 per cent. This reflects the market adjusting rapidly on approaching the date of the ban. This later growth means that the numbers of EVs as a proportion of total cars in the licence area for Two Degrees and Slow Progression are around 10 per cent lower than FES by 2032. Consumer Power and Steady State have numbers similar to FES.

### Distribution of technology across ESAs

The previous scenarios report in 2016 projected EV growth correlated with installations of domestic rooftop PV. This corresponded highly to factors which relate to EV uptake; specifically, customer affluence, and the early adopters or green engaged consumers. As EVs become more mainstream, as projected over the study period, these factors will be superseded by different demographic factors such as population and housing density. Growth in this scenario is therefore distributed by:

- Adoption of rooftop solar PV in the near term
- A weighting towards urban and semi-urban areas, measured by housing density that indicates detached or semi-detached housing. These housing types are expected to dominate EV uptake in the near term, but to give way to more even distribution towards the end of the period.
- High income ESA areas as measured by ESA averages by levels of deprivation data
- The population in each ESA

# 3. Heat pumps

**Legislation for heating in off-gas homes could drive up numbers of heat pumps in the South Wales licence area.**

The South Wales licence area has relatively low numbers of heat pumps currently installed.

However, with higher subsidies available there may start to be an increase in the short-term. In the medium term, the UK government continues to signal their intention to decarbonise heating in 2020s, particularly in the 12 per cent of the licence areas' off-gas homes.

Table 3-1: Total number of properties with heat pump by scenario

| Total domestic properties with a heat pump | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 2,533 | 5,352 | 37,770 | 101,989 |
| Consumer Power | | 3,501 | 11,465 | 34,449 |
| Slow Progression | | 3,755 | 15,393 | 61,338 |
| Steady State | | 3,437 | 7,390 | 18,735 |

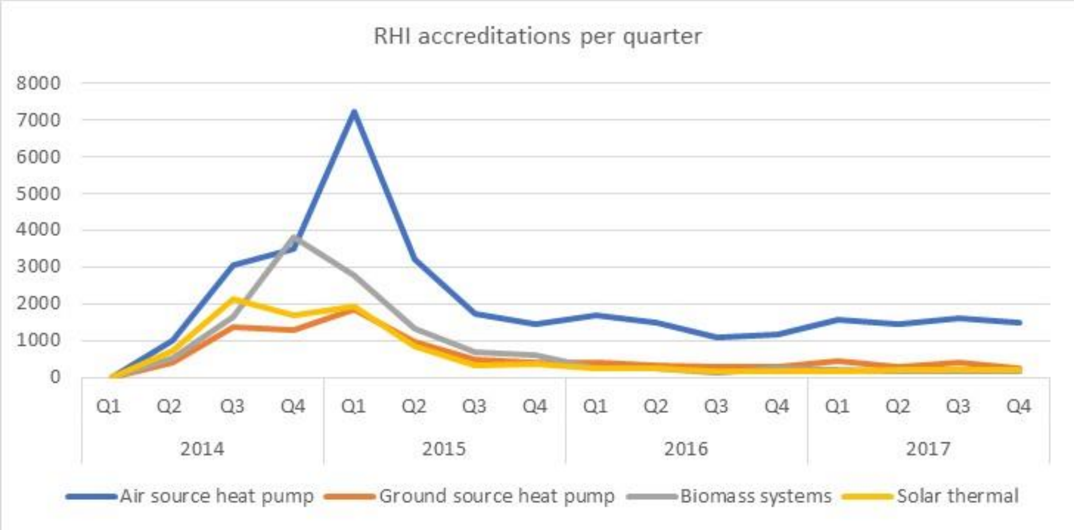
## 3.1. Baseline

The South Wales licence area has relatively low numbers of heat pumps compared to the national average with only around 2,533 installed through the domestic Renewable Heat Incentive (RHI) in 2017. Just one per cent of the 136,000 off-grid houses (around 12 per cent of the housing stock) in the licence area have a heat pump (assuming 80 per cent of heat pumps are installed in off-gas grid houses).

Figure 3-1 shows the relative stagnation in RHI accredited installations since the 2015 peak. However, it is possible that more heat pumps may have been installed in new homes built by developers  These are not able to access the RHI and, therefore, are not currently recorded in government data or covered in this analysis. Figures from BSRIA[21] suggest that 22,000 heat pumps both commercial and domestic were sold in 2017 compared to under 7,000 total domestic RHI accreditations.

[21] https://www.openaccessgovernment.org/uk-heat-pump-market-is-growing-again/44301/

Figure 3-1: Accreditations under RHI scheme 2014-2017 (GB data BEIS Jan 2018)




## 3.2. Pipeline

There is no data on the pipeline of heat pumps, however in the short-term growth is likely to improve due to the impact of new higher RHI subsidies.

Figure 3-2: RHI Tariff uplift rates from BEIS

| Technology Type | Current tariff (p/kWh) | Uplifted tariff (p/kWh) |
|---|---|---|
| Biomass plant | 3.85 | 6.54 |
| Air source heat pump | 7.63 | 10.18 |
| Ground source heat pump | 19.64 | 19.86 |

***Fig 1:** Tariff uplift rates*

These tariff increases were introduced in September 2017 and run to April 2021 (see Figure 3-2). There was around a 30 per cent increase for air source heat pumps (ASHP) and a marginal increase for ground source systems. These changes are expected to modestly increase the rate of installations.

The new tariffs also introduced a ‘heat demand limit’ which make subsidies only available to small systems making them less attractive for larger properties. The scenarios do not currently project commercial heat pumps as this market is expected to continue to be small.

## 3.3. Future growth scenarios

Recent developments in hybrid heat pump systems, where heat pumps are installed along with a backup technology (primarily gas) have started to reduce some of the barriers, and raise potential for higher growth, particularly in on-gas properties.

**Recent hybrid system trials found up to 55 per cent reduction in carbon emissions were possible in retrofit properties.**

Table 3-2: Number of properties and predicted type of heat pumps with percentages from Two Degrees scenario.

| Types of property | No. of properties | % in 2032 (Two Degrees) | Type of heat pumps assumed in the model |
|---|---|---|---|
| **On-gas existing** | 823,459 | 6% | Assumed that by 2032 half of those fitted in retrofit properties will be hybrid heat pump systems based on Air Source Heat Pumps with gas back-up. |

| | | | |
|---|---|---|---|
| **Off-gas existing** | 196,947 | 18% | Assumes that 100 per cent are single heat pump systems with higher proportion of larger ground-source heat pumps due to space available. A proportion by 2032 may also be hybrid systems with oil back-up. |
| **New build properties** | 97,916 (high growth) | 70% | The building standards of new homes mean that it is assumed 80 per cent are likely to be single system Air Source Heat Pumps with 20 per cent as hybrid systems. |

A study into the potential of heat pumps for BEIS by Element Energy found that the carbon savings the achieved could be significant but depended on well-managed and well-sized systems for the housing they served. The study found savings as high as 55 per cent of annual emissions. However, in poorly managed systems this saving dropped to 18 per cent. The report identified the cost compared with traditional boilers as the key barrier for both single and hybrid heat systems but concluded that for "typical existing buildings, hybrid heat pumps offer substantially more cost-effective heat decarbonisation option than standard heat pumps."[22] For thermally efficient buildings, those that have been extensively retrofitted, or new builds, then a single heat pump system remains the most cost effective.

**Hybrid heat pump systems could mitigate the high impact of electrified heating on local electricity networks**

A further benefit not costed in the BEIS study is the impact of high levels of electric heating installed on a local distribution network. High numbers of heat pumps with electrical back up could cause a significant network stress during winter peaks. Hybrid systems would significantly lessen this impact if smart systems could revert to back-up systems during peaks. The concept is being explored by the Wales and West Utilities and Western Power Distribution Freedom Project[23].

**Policy focus on off-gas grid housing**

Ambitious intentions for off-gas properties were announced by the UK government in the Clean Growth Strategy "*Beyond the RHI, our ambition is to phase out the installation of high carbon fossil fuel heating in new and existing off gas grid residential buildings (which are mostly in rural areas) during the 2020s*".[24] A 'Call for Evidence' reaffirmed these ambitions in March 2018 and noted that action would be taking place during 2020s.[25]

With affluence levels in Wales below the UK average, it is likely that the higher costs associated with heat pumps will continue to limit uptake of heat pumps. Higher installation levels will need further incentives or regulations, such as those used for condensing boilers in 2005. If all new heating systems were required to be heat pumps, or include a hybrid system, there could be an increase in uptake of heat pumps as much as 6.6 per cent of properties per year, assuming a boiler life of 15 years.

The factors associated with growth of heat pumps in the licence area and how the relate to the scenarios have been summarised in Table 3-3.

Table 3-3: Assumptions for factors influencing capacity growth for Heat Pumps

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|

22 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700572/Hybrid_heat_pumps_Final_report-.pdf

23 https://www.westernpower.co.uk/Innovation/Projects/Current-Projects/FREEDOM.aspx

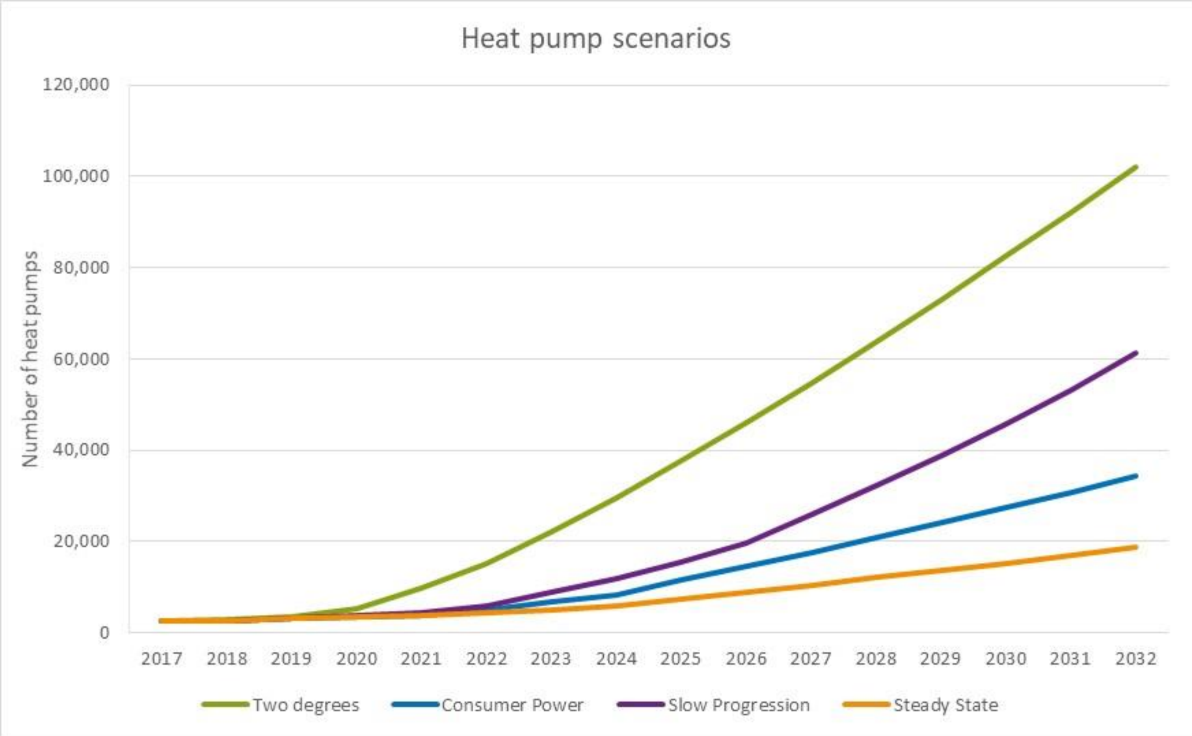
24 P.79, Clean Growth Strategy, 2017 https://www.gov.uk/government/publications/clean-growth-strategy

25 https://www.gov.uk/government/consultations/a-future-framework-for-heat-in-buildings-call-for-evidence

| | | | | |
|---|---|---|---|---|
| **Infrastructure and Government support** | | | | |
| Regulations on new boilers – off gas | **Introduced in early 2020s** | **No regulation** | **Introduced later 2020s** | **No regulation** |
| Regulations on new boilers – on gas | **Introduced towards end 2020s** | **No regulation** | **Introduced late in scenario period** | **No regulation** |
| New build regulations | **Early 2020s new builds required to install HP** | **No change to existing** | **Mid 2020s new builds required to install** | **No change to existing** |
| Subsidy for installations | **Subsidies available to lower income** | **No subsidies** | **Subsidies available to lower income** | **No subsidies** |
| **Technology cost and performance** | | | | |
| Hybrid technology reaches cost/payback parity | **Mid 2020s** | **Late 2020s** | **Late 2020s** | **End of period** |
| Smart controls maximise seasonal performance factor | **Come online mid-2020s** | **Mid 2020s** | **Late 2020s** | **End of period** |
| **Consumer factors** | | | | |
| Consumer understanding/awareness | **Heavy promotion around regulation** | **High end model choice increases and heavily promoted** | **Choice increases but remains under promoted** | **No promotion** |
| Affluence and economic growth | **Capital available to invest** | **Capital available to invest** | **Low economic growth restrains demand** | **Low economic growth restrains demand** |
| **Resource factors** | | | | |
| Proportion in off-gas /gas properties | **Split between off-gas with hybrids in on gas properties** | **Mostly off-gas with some hybrids in affluent on-gas** | **Focused on off-gas properties** | **Focused on off-gas properties** |

## 3.4. Heat pump scenario

Figure 3-3: WPD South Wales licence area heat pump growth scenarios.




### Relationship to other scenarios

The expected level of heat pump installations has been increased significantly from the scenario projections in the 2016 report. This reflects the governments Clean Growth Strategy plan on phasing out high carbon heating for off-gas grid properties in 2020's. With 12 per cent of properties off-gas this policy would particularly impact rural parts in the licence area.

However, the scenarios remain below the FES 2017. Slow Progression and Consumer Power are around 40 per cent lower than the FES with Steady State around half. The Two Degrees scenario has nine per cent of properties with heat pumps by 2032, in FES this is around 24 per cent. This is due to the low baseline in the licence area compared with FES growth projections and lower affluence in the region.

### Distribution by ESA

The scenarios have projected heat pumps growth separately for hybrid and single heat pump systems in new home developments, and in on-gas and off-gas properties. The geographic distribution is based on the total number of homes in an ESA, as well as the number of properties which are on or off-gas grid.

# 4. Air conditioning

Though domestic air conditioning has low uptake at present, mechanical cooling has potential to be a large new source of demand for local electricity networks, growing significantly towards the end of the scenario period.

Table 4-1: Number of properties in South Wales licence area that have one air conditioning unit installed.

| Number of domestic properties with air con | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 8,600 | 9,085 | 9,870 | 10,823 |
| Consumer Power | | 12,503 | 24,328 | 59,697 |
| Slow Progression | | 9,023 | 9,990 | 20,753 |
| Steady State | | 11,175 | 20,319 | 42,727 |

## 4.1. Baseline

The UK's mild climate means that demand for domestic cooling is currently low. The FES 2017 estimates that air conditioning is currently installed in around 1 per cent of homes.[26] However, as summer peak temperatures rise due to climate change, demand for cooling is expected to increase, particularly in dense urban areas that act as 'heat islands'.

In contrast, air conditioning in commercial properties has been steadily rising since 1990s and often is part of upgrades to system integrated heating and cooling. The Carbon Trust expects that 40 per cent of commercial floor space will be air-conditioned by 2020 compared to 10 per cent at the end of 1994.[27] BRE assume that this historic growth is likely to continue to 2040 but at slightly lower levels. [28] However, there is no data on which to make assumptions currently on the growth of commercial air conditioning, so it is not included in the scenarios projections.

We have used the FES 2017 assumptions on air conditioning for baseline and projections but adjusted for lower relative affluence of the South Wales licence area.

## 4.2. Scenario

**FES 2017 predicts that in Consumer Power scenario by 2050 up to 60 per cent of homes could have air conditioning.**

National Grid's 2017 FES predicts that temperatures after 2040 could rise to levels that would drive exponential growth in homes with up to 60 per cent adoption by 2050.[29] The impact of the extra demand would potentially double the summer evening electricity peak and account for around 2.5 per cent of the total UK electricity demand. Air conditioning installations are expected to be weighted towards both dense urban housing and affluence.

[26] Assuming one unit per household
[27] https://www.carbontrust.com/media/17824/j7906_ctg005_air_conditioning_aw_interactive.pdf
[28] https://www.bre.co.uk/filelibrary/pdf/projects/aircon-energy-use/StudyOnEnergyUseByAirConditioningFinalReport.pdf
[29] http://fes.nationalgrid.com/media/1290/ac-2050-v212.pdf

**Building regulations are adjusted in Two Degrees to facilitate passive cooling, particularly in new homes.**

Building standards have traditionally focused on heat retention in buildings, some of which may ultimately increase the need for mechanical cooling and ventilation in the summer. If summer temperatures rise significantly in the UK, standards would need to be adjusted to encourage passive cooling.

A further driver may be the uptake of heat pumps as many have the potential to also work as cooling units. If policies are successful in driving the uptake of heat pumps, some units may be adjusted to offer cooling to domestic properties as a secondary benefit. This impact is not modelled in these scenarios.

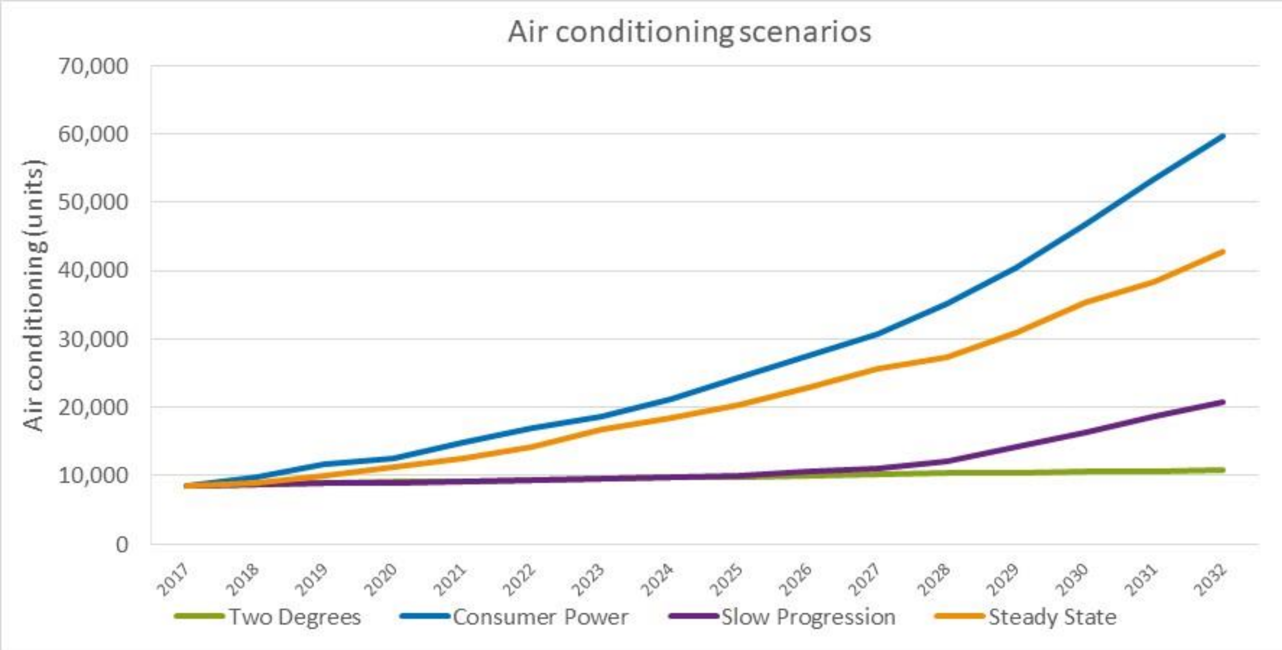
Table 4-2 outlines the key factors that are anticipated to be the key drivers of air conditioning uptake.

Table 4-2: Assumptions for factors influencing growth in the number of air conditioning units

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and Government support** | | | | |
| Building regulations on cooling | **Strong regulations driving passive cooling** | **No regulation** | **Some regulation on standards** | **No regulation** |
| **Technology cost and performance** | | | | |
| Unit and running costs | **High unit and running costs** | **Low unit and low running costs** | **High unit and running costs** | **Low unit cost and high running cost** |
| **Consumer factors** | | | | |
| Affluence | **Capital available to invest in passive systems** | **Capital available to buy air con** | **Low economic growth restrains demand** | **Low economic growth restrains demand** |
| **Resource factors** | | | | |
| Climate and temperature rise | **Temperature rise minimised** | **Temperature increases significantly** | **Temperature increases moderately** | **Temperature increases significantly** |
| Installation in urban areas | **Use concentrated in urban areas** | **Use concentrated in urban areas** | **Use concentrated in urban areas** | **Use concentrated in urban areas** |

## 4.3. Air conditioning scenario

Figure 4-1: WPD South Wales licence area air conditioning growth scenarios.




## 4.4. Relationship to other scenarios

The scenarios for air conditioning are taken directly from FES growth scenarios but adjusted 20 per cent lower to reflect affluence levels in the licence area. These scenarios also assume an increase in Slow Progression. This differs from FES which assumes zero growth for both Two Degrees and Slow Progression. Given the delay in action to slow climate change in Slow Progression these scenarios assume that that higher temperature rises occur towards the end of the period and this is reflected in the increase in levels of air conditioning.

## 4.5. Distribution by ESA

The distribution of air conditioning in the South Wales licence area has been weighted by affluence and housing density to reflect the impact of heat islands in high density urban areas.

# 5. New development growth

The impact of new housing and commercial developments on demand at an ESA level requires a detailed assessment of local authority plans and is therefore a different methodology than the technology growth scenarios.

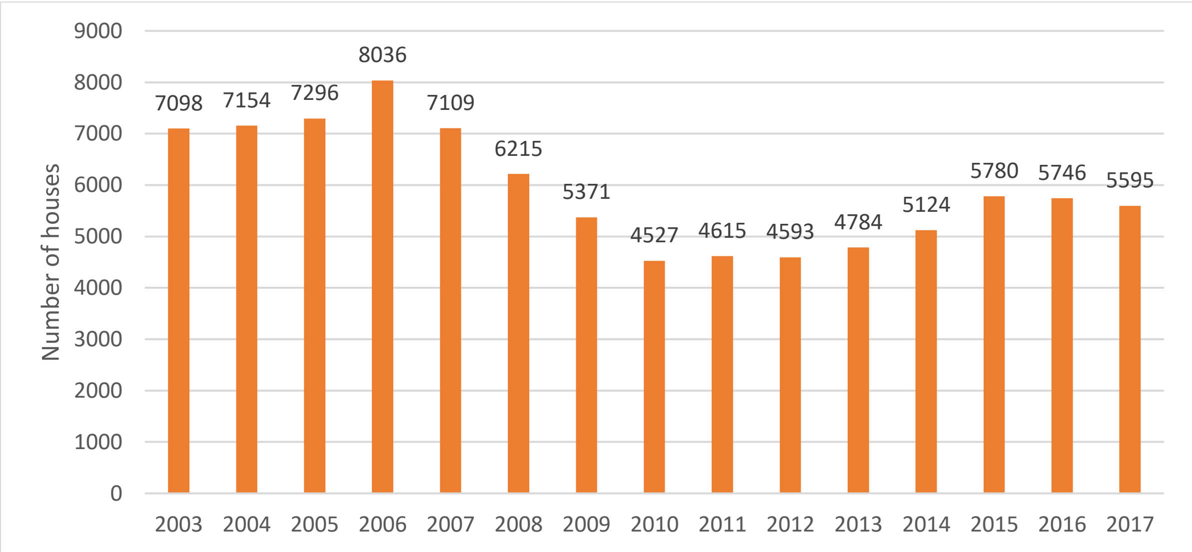
The data presented in the scenarios only considers developments currently in local plans. As a result, the scenario numbers reduce towards 2025 as local plans tend to be focussed on developments planned for between 2018 and the mid-2020s – in practice new developments would be expected to come forward towards the end of the scenario period.

The Welsh Government have been encouraging local authorities to cooperate and combine resources to produce joint Local Development Plans (LDPs), but at present local authorities are continuing separate LDP reviews. Following the analysis in this report, the Welsh Government published updated housing projections into 2020s which are significantly lower than previous projections on which the LDPs analysed for this report have been based.[30] Therefore, adjustments were made to the high and low-growth scenarios to reflect those changes. These adjustments are described in the 'growth factors' sections.

## 5.1. Baseline

Total numbers of new build houses in the South Wales licence area have seen a decrease in the two years since 2015. Overall annual build out rates tend to fall short of the requirements set out in the LDPs and it is expected that the numbers set out in the plans will fall to reflect this when they are updated.

Figure 5-1: Annual totals for new houses in the South Wales licence area, 2003-2017[31]




[30] https://statswales.gov.wales/Catalogue/Housing/Households/Projections/National/2014-Based/householdprojections-by-variant-year

[31] Source: BEIS sub-national electricity consumption data, 'LSOA domestic electricity 2016', based on number of new MPANS annually.

## 5.2. Methodology

New development sites can have a significant impact on local electricity demand. To understand what sites are expected within the licence area and to produce growth scenarios, the plans from the 19 local authorities in the South Wales licence area were reviewed to collect data on location, size and type of planned future developments.

The methodology for this analysis is set out in Figure 5-2. The information collected is reviewed with local authorities to ensure information is up-to-date and local insight is captured.

Figure 5-2: Summary of data collection methodology for residential and non-residential sites


### Data sources

Local authority Local Plans are the primary data source for this analysis. The plan contains a core strategy and additional supporting documents, policies and maps identifying potential sites with varying levels of detail on the building type and end use.

If the documents were not available, outdated or too vague due to the stage of the local plan process, additional documents were used such as the Joint Housing Land Availability Study and annual monitoring reports which are often updated more regularly than the Local Plans.

### Types of development - Development sites

Development sites are categorised into two main types of development sites: strategic sites and general allocation sites. Numbers of homes that currently do not have a site associated with them are called unallocated homes.

- **Strategic sites:** These are highlighted in local plans as areas of development with significant growth potential. Each site is given a specific location within the policies map. There is no established single definition for what constitutes a strategic site; however, generally these are large developments, either housing led or mixed-use regeneration projects.

- **General allocation sites:** These cover additional housing or non-residential developments that will be built outside of the strategic sites. These developments tend to be smaller sites with less specific location details.

- **Unallocated homes:** Local plans often contain targets for new homes to be achieved during the plan period. Additional homes above those in planned development are called 'unallocated' homes. They can be built across the local authority and not earmarked for any specific sites. Where unallocated housing was identified, the quota was distributed across the local authority's ESAs, based on geographic area and any additional information in the plan as to where it might be focused.

### Information gathered about development sites

The available data for each development site was reviewed to obtain, where possible:

- An estimate of the number of residential units to be built.
- The site area ($m^2$) of non-residential property to be built.
- Any indication of phasing, amount of property to be built per year etc.
- The site's location and the relevant ESA/ESAs it would connect to.
- Status of the local plan.
- The category of planned end-use for non-residential sites/areas of sites. The non-residential categories provided by WPD are listed in Table 5-1 and cover 15 different electricity profiles.

Table 5-1: Non-domestic profile categories

| Non-domestic demand profile categories | Equivalent General-Use Classes Order |
|---|---|
| **Factory and Warehouse** | B8, B2 |
| **Government** | D1 |
| **Hospital** | C2 |
| **Hotel** | C1 |
| **Hypermarket** | A1 |
| **Medical** | D1 |
| **Office** | B1 |
| **Other** | |
| **Police** | D1 |
| **Restaurant** | A3 |
| **Retail** | A1 |
| **School and College** | D1 |
| **Shop** | A1 |
| **Sport and Leisure** | D2 |
| **University** | C2 |

### Review with local authorities

To ensure the most up to date information on future developments, data collected was sent to planning and economic development officers in the 19 local authorities across the South Wales licence area for review and comment.

Contacting the local authorities individually highlighted how in some areas the local plan core strategy can be out of date quite quickly, due to the lengthy examinations process. Although the current local plans remain useful for identifying large strategic sites, more up to date documents, such as the annual monitoring report. are often necessary to capture the full picture. These documents often include details on the smaller 'off plan' sites, which are not part of the larger allocations.

A stakeholder engagement event was also held in Cardiff and all 19 local authorities were invited. This allowed local authorities to feedback any further information on the process.

Although any review has the limitation of being a snap-shot, the combination of local plans and local authority engagement provided a good level of detail on which to base future development projections.

## 5.3. Housing growth factors

### Factors affecting the scenarios: housing and non-domestic demand

The key factor affecting the growth rate of new developments is the economic environment. The level of green ambition will have little relevance to the number of developments – although it may change the energy demand of a property (the demand profile of housing and non-domestic properties is outside the scope of this report). Two Degrees and Consumer Power are, therefore, considered as one scenario that assumes high growth rates due to a better economic environment and Slow Progression and Steady State as a second scenario with a lower growth rate.

With the new development numbers from the Welsh Government released in June 2018 being significantly below earlier rates used for Local Development Plans, in these scenarios both high and low growth projections have been adjusted to reflect these changes.

### Consumer Power and Two Degrees

- **Strategic sites:** it is assumed that strategic sites are likely to go ahead, regardless of economic climate, but to reflect the new numbers from the Welsh Government strategic site build out rates have been delayed between 2 and 10 years.

Figure 5-3: Details of assumptions made in development of strategic sites in the high growth scenarios

| Year | Description of reductions - domestic |
|---|---|
| First two years (2018-2020) | 70 per cent of the build out rate has been assumed. Then:<br>• 10 per cent is delayed 2 years<br>• 10 per cent is delayed 3 years<br>• 10 per cent is delayed 4 years |
| From 2021 | 40 per cent of annual build out rate is built to schedule, the remaining 60 per cent delayed by the periods below.<br>• 10 per cent is delayed 3 years<br>• 10 per cent is delayed 4 years<br>• 10 per cent is delayed 5 years<br>• 10 per cent is delayed 6 years<br>• 10 per cent is delayed 7 years<br>• 10 per cent is delayed 9 years |

- **General allocation:** the planned target figure has been multiplied by 65 per cent, to reduce the total housing built in the slow economic growth scenario.

- **Unallocated houses:** as with general allocation, the planned target figure has been multiplied by 50 per cent.

### Slow Progression and Steady State

For the lower economic growth scenarios, we assume that there are delays to the current plans and fewer houses and commercial buildings are delivered than planned. The different types of development were treated as following:

- **Strategic sites:** it is assumed that strategic sites are likely to go ahead, regardless of economic climate, but are likely to suffer more delays than high growth due to the poorer economic environment. Table 5-2 shows the assumptions that have been made to delay a proportion of the development between 2 and 10 years.

Table 5-2: Details of assumptions made in development of strategic sites in the low growth scenarios

| Year | Description of reductions - domestic | Description of reductions - non - domestic |
|---|---|---|
| First two years (2018-2020) | 80 per cent of the build out rate has been assumed. Then:<br>• 10 per cent is delayed 2 years<br>• 10 per cent is delayed 3 years | 60 per cent of the build out rate has been assumed. Then:<br>• 20 per cent is delayed 3 years<br>• 20 per cent is not completed |
| From 2021 | 30 per cent of annual build out rate is built to schedule, the remaining 60 per cent delayed by the periods below.<br>• 10 per cent is delayed 4 years<br>• 10 per cent is delayed 5 years<br>• 10 per cent is delayed 6 years<br>• 10 per cent is delayed 7 years<br>• 10 per cent is delayed 8 years<br>• 10 per cent is delayed 9 years<br>• 10 per cent is delayed 10 years | 40 per cent of annual build out rate is built to schedule, the remaining 60 per cent delayed by the periods below.<br>• 20 per cent is delayed 3 years<br>• 20 per cent is delayed 4 years<br>• 20 per cent is not completed |

- **General allocation:** the planned target figure has been multiplied by 34 per cent, to reduce the total housing built in the slow economic growth scenario. 66 per cent is not completed.

- **Unallocated houses:** as with general allocation, the planned target figure has been multiplied by 10 per cent. 90 per cent is not completed.

## 5.4. Scenario results

### Overall development

The Two Degrees and Consumer Power scenarios see 62,003 houses developed by 2025 in the licence area. An additional 1,705 hectares of non-domestic development is also developed.

Steady State and Slow Progression scenarios result in 38,063 houses and a further 1,175 ha of non-domestic development by 2025.

As the information below shows, nearly 90 per cent of non-domestic development is occurring in the next three years. There is very little currently in local plans past this time horizon.

Table 5-3: Total figures for domestic and non-domestic development up to 2025

| | High economic scenario | | Low economic scenario | |
|---|---|---|---|---|
| | Domestic (number of houses) | Non-domestic (ha) | Domestic (number of houses) | Non-domestic (ha) |
| **2020/21** | 29,983 | 1,552 | 19,607 | 909 |
| **2025/26** | 62,003 | 1,704 | 38,063 | 1,175 |

Across the licence area 203 strategic mixed-use developments were identified with over 60,000 houses. A further 166 strategic sites have been identified for office or industrial use only. General allocation and unallocated had a further 50,000 and nearly 18,000 houses respectively. There is up to 670 ha for general allocation non-domestic development. The largest strategic sites identified include Coed Darcy Urban Village in Neath Port Talbot with up to 3,490 houses and Plasdwr in North West Cardiff with 2,677 houses.

### Domestic developments

Table 5-4 shows total number of new houses in the South Wales licence area to 2025. The largest number of new homes is to be built in Cardiff which is expecting 10,807 by 2025. Swansea, Carmarthenshire and Rhondda Cynon Taf have the next three highest numbers of new houses.

Table 5-4: 2025 totals for planned new houses by local authority in the South Wales licence area

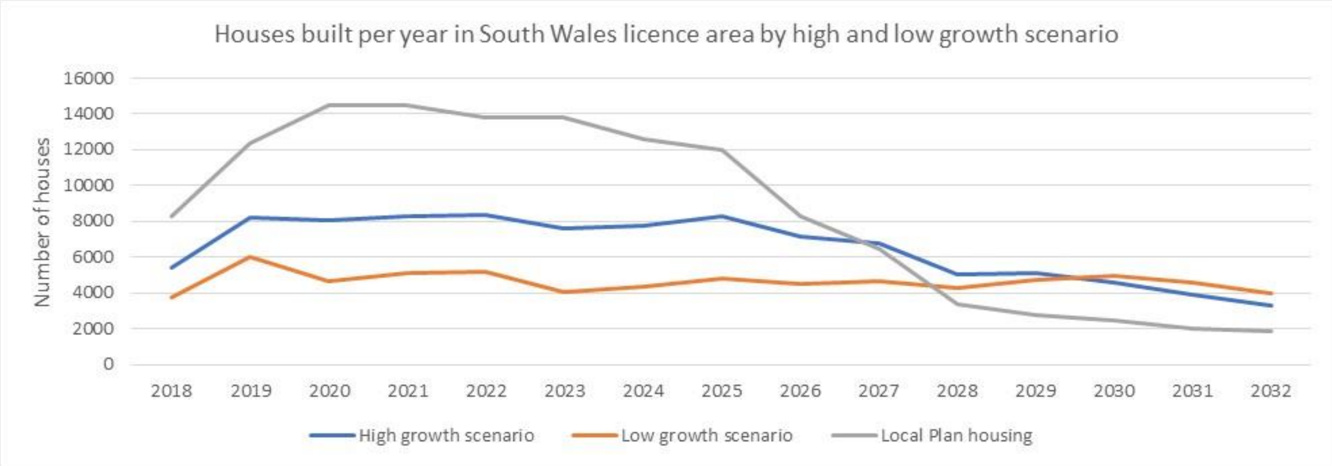
| Local authority | High Growth – Two Degrees and Consumer Power (Total number of houses) | Low Growth – Slow Progression and Steady State (Total number of houses) |
|---|---|---|
| Blaenau Gwent | 1,542 | 870 |
| Bridgend | 3,702 | 2,532 |
| Caerphilly | 2,982 | 1,761 |
| Cardiff | 10,807 | 7,585 |
| Carmarthenshire | 6,377 | 3,558 |
| Ceredigion | 1,718 | 876 |
| Forest of Dean | 232 | 227 |
| Gwynedd | 79 | 40 |
| Herefordshire | 27 | 8 |
| Merthyr Tydfil | 1,179 | 671 |
| Monmouthshire | 2,342 | 1,376 |
| Neath Port Talbot | 3,940 | 2,338 |
| Newport | 3,835 | 2,105 |
| Pembrokeshire | 3,599 | 1,972 |
| Powys | 1,549 | 656 |
| Rhondda Cynon Taf | 4,116 | 2,389 |
| Swansea | 7,306 | 4,474 |
| The Vale of Glamorgan | 4,442 | 3,130 |
| Torfaen | 2,229 | 1,495 |
| **Total** | **62,003** | **38,063** |

Figure 5-4 shows a peak early-on in the high growth scenario as strategic sites with more certainty of going ahead are often focussed in the initial stages of the plan period. The high-growth average over the period is just over 6,500 a year. In a high growth scenario, further development sites could be expected to come forward towards 2020 – however, assumptions about development that is not yet identified have not been included.

As the data collected from local authorities often only covers a five-year trajectory, these scenarios are more certain in the near term. The amount of robust data available reduces towards the end of the scenario period, particularly for monitoring reports based on planning applications, hence the decline towards 2032.

The low growth scenario shows the decreased level of growth once we have applied the percentage reduction figures to annual build out rates in a slower economic climate. The average annual growth rate for slow growth over the study period is 4,650. This is similar to the average growth since 2010.[32]

Figure 5-4: Local plan new house projections in the South Wales licence area




[32] Based on historic year average (2010-2016) for number of new houses by LSOA in the south wales licence area. Source: BEIS sub-national electricity consumption data, 'LSOA domestic electricity 2016', based on number of new MPANS annually.

### Non-domestic development

Table 5-5 shows that the local authority of The Vale of Glamorgan has the highest amount of planned non-domestic development. This includes 384 ha at the Cardiff Airport Enterprise Zone. The next highest is Pembrokeshire with six strategic sites including 22 ha at Pembrokeshire Science and Technology Park. Newport is the third highest with nearly 80 ha between the Solutia and Duffryn strategic sites.

The majority of the developments are classified as either Factory and Warehouse or Office with only 12 per cent outside that category. There are 41 sites (6 per cent of the allocation) which are categorised as School or College.

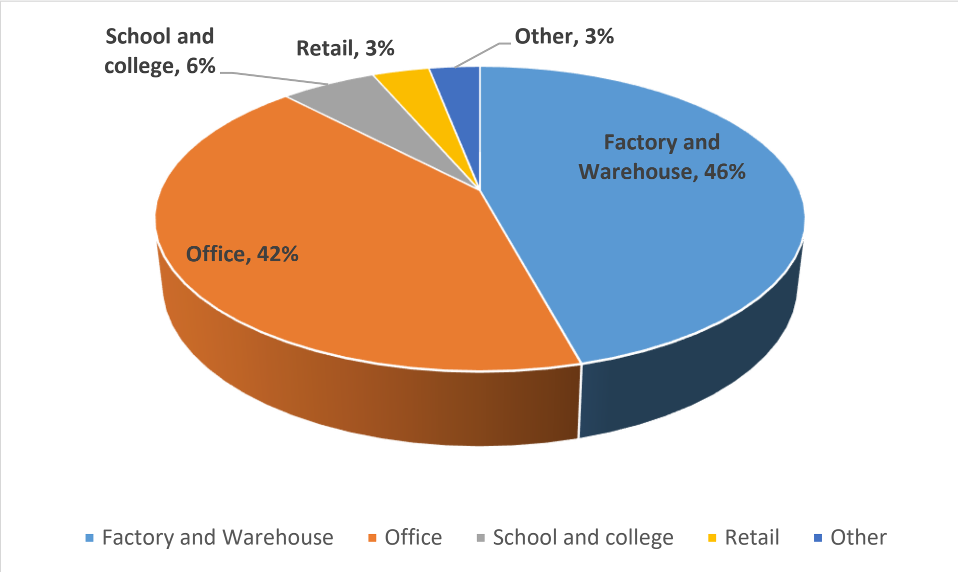



Table 5-5: 2025 totals for planned non-domestic developments by local authority

| Local Authority - total non-domestic developments (ha) | High Growth – Two Degrees and Consumer Power | Low Growth – Slow Progression and Steady State |
|---|---|---|
| Blaenau Gwent | 56 | 36 |
| Bridgend | 72 | 48 |
| Caerphilly | 123 | 89 |
| Cardiff | 81 | 51 |
| Carmarthenshire | 107 | 69 |
| Ceredigion | 41 | 26 |
| Merthyr Tydfil | 32 | 23 |
| Monmouthshire | 65 | 42 |
| Neath Port Talbot | 21 | 11 |
| Newport | 142 | 91 |
| Pembrokeshire | 232 | 159 |
| Powys | 10 | 7 |
| Rhondda Cynon Taf | 92 | 64 |
| Swansea | 37 | 24 |
| The Vale of Glamorgan | 527 | 386 |
| Torfaen | 67 | 49 |
| **Total** | **1,705** | **1,175** |

## 5.5. Geographic distribution by ESA

Figure 5-5 shows the distribution of total housing figures by 2025 for each ESA in the licence area. As would be expected, the largest growth is focused around areas with high population density or in the local authorities surrounding Cardiff and the M4 corridor.

Figure 5-5. 2022 and 2032 new housing distribution by supply area in the high and low economic growth scenarios

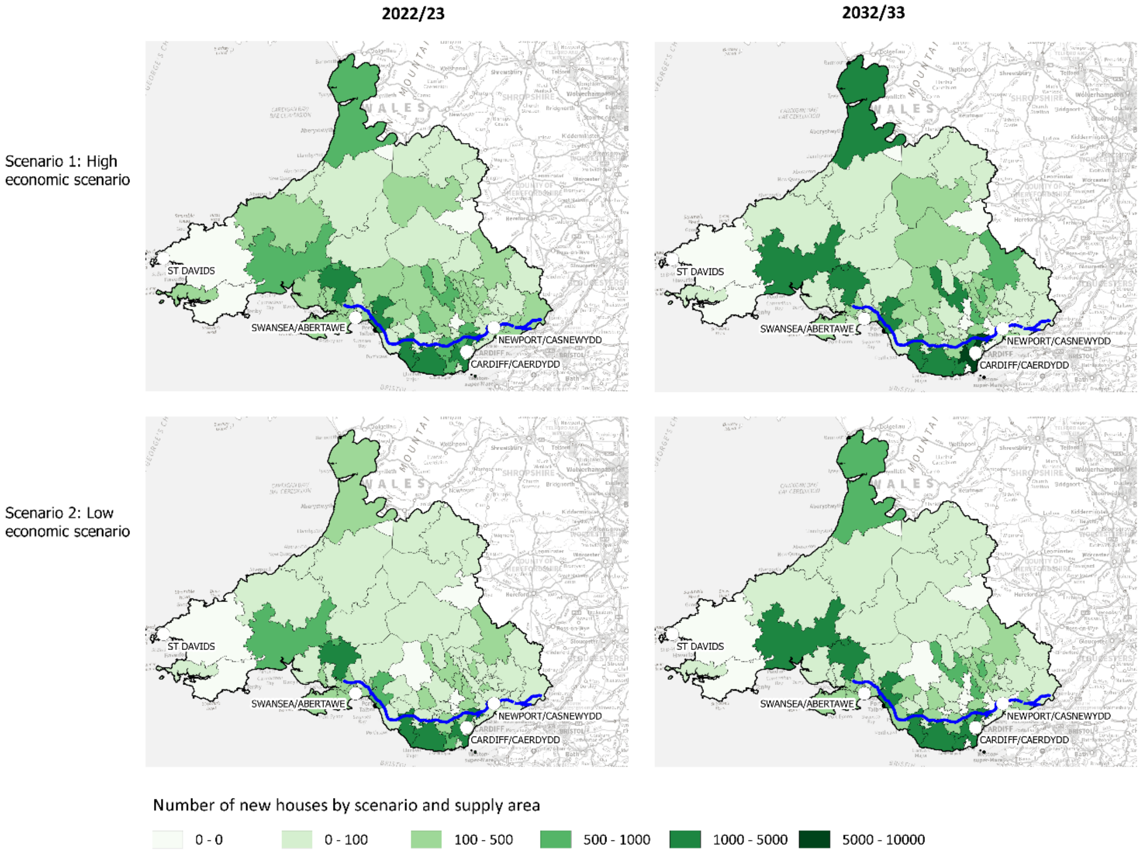


Figure 5-6. 20 Ten largest domestic development sites in the South Wales licence area

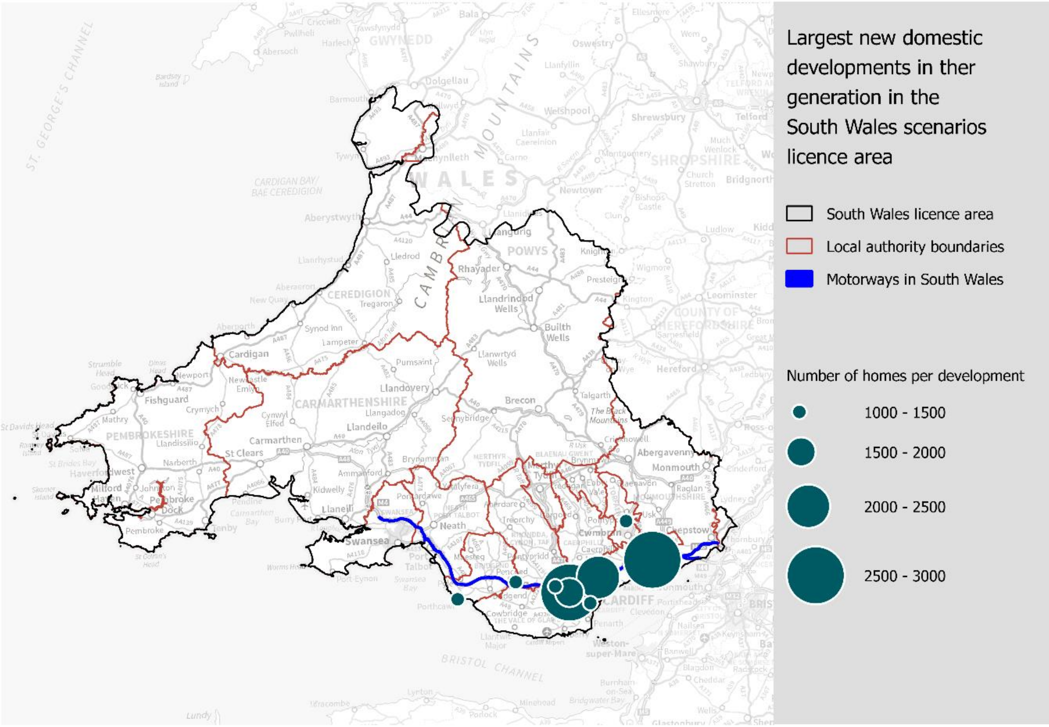


Figure 5-7 2022/23 and 2032/33 non-domestic development distribution by supply area in high and low economic scenarios

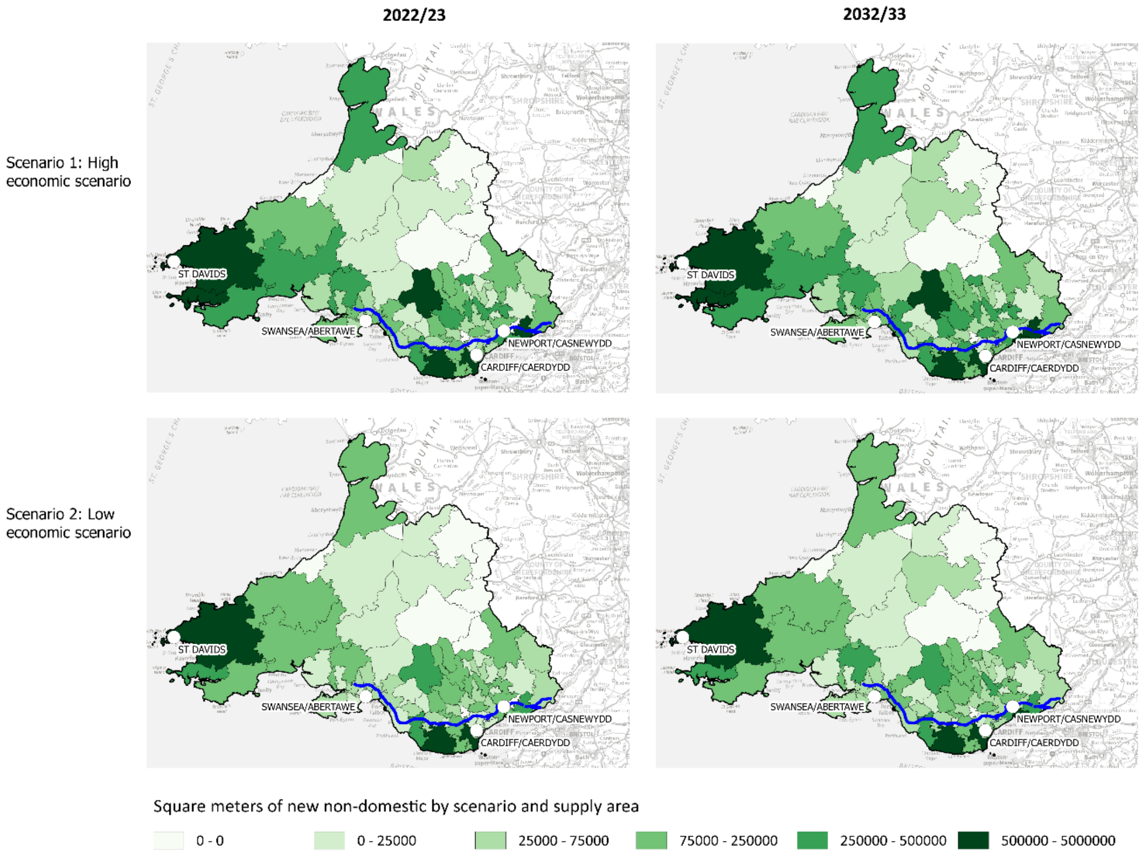
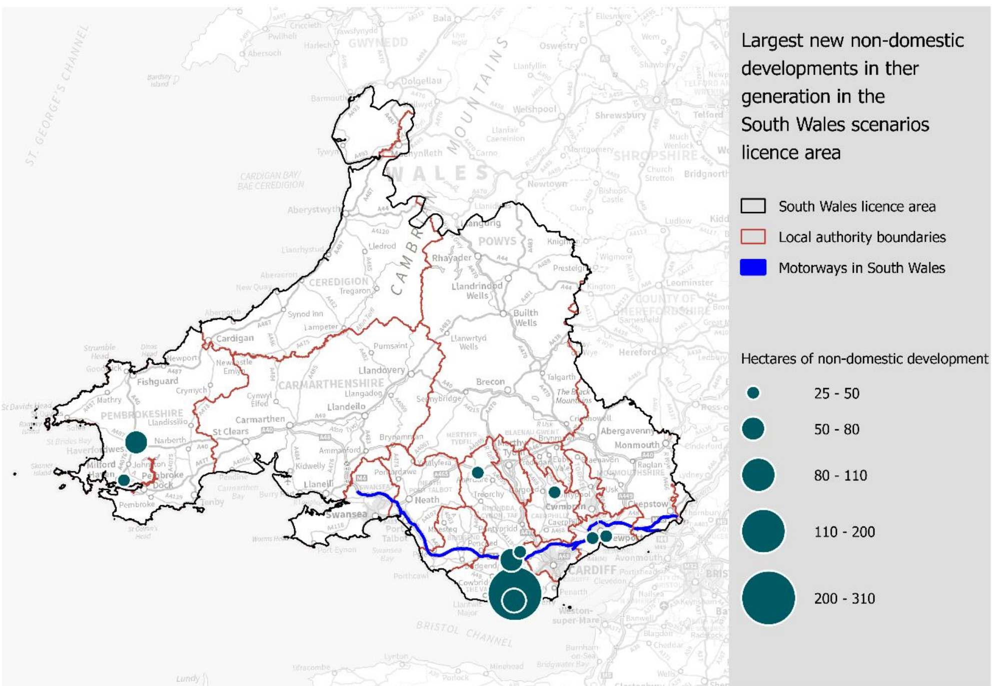



Figure 5-8. 20 Ten largest non-domestic development sites in the South Wales licence area



# B. Introduction to generation

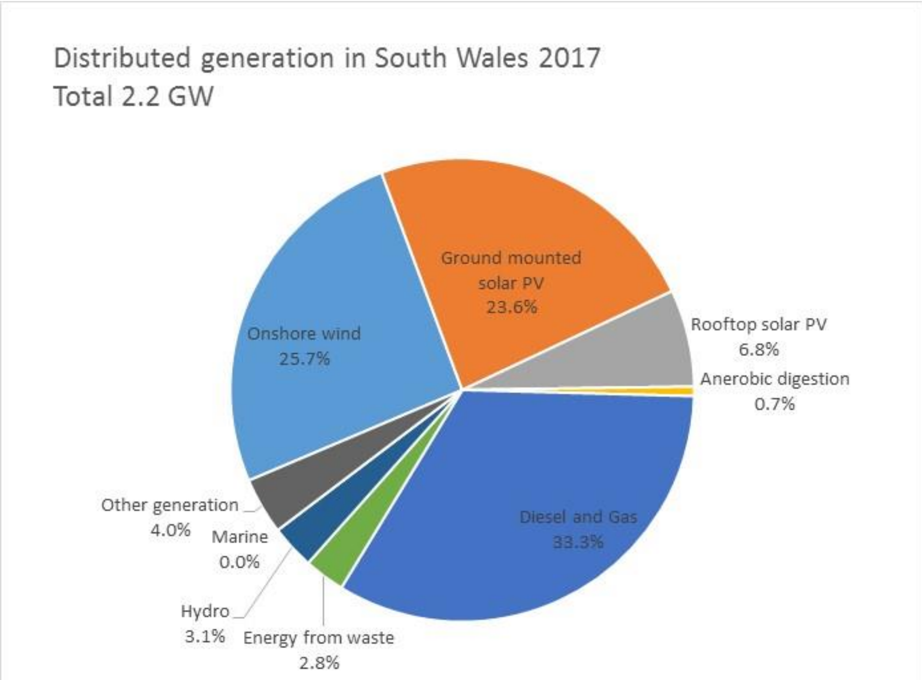
## South Wales baseline generation

At the end of September 2017, the UK's renewable electricity capacity totalled 38.9 GW, an increase of 13 per cent (4.4 GW) from 2016.  Solar and onshore wind have 32 per cent of the capacity with offshore wind at 16 per cent. [33]

In South Wales, there is currently around 2.2 GW of distributed generation on the network of which 1.4 GW is renewable energy generation. 3.6 per cent of the UK the total.

Onshore wind is over a quarter of the generation though fossil generation from diesel and gas in the largest current technology in the licence area.

Figure B-1: Baseline distribution generation in South Wales licence area




This section sets out Regen's analysis, assumptions and market insights behind the future growth scenarios of electricity generation technologies in South Wales. The generation technologies analysed are:

- Onshore wind
- Ground mounted solar PV
- Rooftop solar PV
- Anaerobic digestion
- Energy from waste
- Hydropower
- Marine
- Diesel and gas
- Other generation (note not scenarios)

[33] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/669723/Renewables.pdf. P.58 (12 March 2018)

## Generation growth factors

The future growth of distributed and renewable energy depends on both UK, Welsh national and local factors. This section sets out the variables and uncertainties that impact across distributed supply technologies. Some of these will be expanded in the technology sections where issues are most relevant.

### Welsh Government renewable support and strategy

Political support for renewables and distributed generation in Wales is high. Continued commitment from the Welsh Government will be a key driver of sustained growth.

Currently 43 per cent of electricity demand in Wales is met by Welsh renewable energy [34] and in 2017, the Welsh Government announced a target of meeting 70 per cent of electricity demand from Welsh renewable sources by 2030. They also announced an additional target to have one GW of renewable electricity capacity to be locally owned by 2030.[35]

On request from the Welsh Government in December 2017, the Committee on Climate Change recommended national targets for Wales in line with the UK's 2050 targets. It includes a recommendation to set a 2030 target for an emissions reduction of 45 per cent on 1990 levels, though the report also recognises that the industrial emissions in Wales are higher than UK average and therefore reductions will be more challenging. [36]

In addition, there are also targets and aspirations that have an influence at a local level in the licence area. The Swansea Bay City Region Deal for £1.3bn of investment up to 2030 was signed in 2017 with 2 of the 11 projects covering energy specifically, 'homes as power stations' project and marine energy demonstrator in Pembrokeshire. [37]

With energy and planning amongst other powers now devolved to the Welsh Government through the Wales Act 2017, the development of renewable and distributed generation in Wales is expected to follow a different and potentially higher path than the rest of the UK. Unlike UK regions, Wales has a much larger number of levers under local control to 'affect change'. For example, in contrast to the English position, the Welsh Government has signalled continued support for onshore wind, as well as marine power including the Swansea Bay Tidal Lagoon which recently failed to obtain CfD price support from the UK government.[38]

The Welsh Government also have a significantly different approach to planning stating that renewable projects are appropriate in all parts of Wales.

The recent draft planning guidance in Wales, Edition 10, [39]has stated that Local Authorities must take an active, leadership approach at the local level by identifying targets for renewable energy in their development plans – specifically based on resource rather than energy consumption.

[34] https://gov.wales/docs/desh/publications/171207-energy-generation-in-wales-en.pdf
[35] https://gov.wales/about/cabinet/cabinetstatements/2017/unfcc/?lang=en
[36] https://www.theccc.org.uk/wp-content/uploads/2017/12/CCC-Infographic-Building-a-low-carbon-economy-in-Wales2.jpg
[37] http://www.swanseabaycitydeal.wales/about/
[38] https://gov.wales/about/cabinet/cabinetstatements/2017/onshorewindandsolardevelopment/?lang=en
[39] https://beta.gov.wales/planning-policy-wales-edition-10

Applications for onshore generating projects above 10 MW being made directly to the Welsh Ministers under the Developments of National Significance (DNS) process.[40] The recent decision in North Wales at Pant-y-Maen[41] has indicated the Welsh Government's willingness to overrule local objections if it is felt the benefits outweigh the impacts.

### UK government technology preferences and subsidies.

Despite having control over energy planning, the level of direct energy subsidies and financial support for technologies continue to be decided by the UK government.

Subsidies have been used effectively to establish and reduce the costs of some renewable energy technologies. The Feed-In-Tariff (FIT) and the Renewables Obligation offered subsidy support to a range of renewables. The closure of both for large scale renewables in 2016 and 2017 respectively has had a dramatic effect on deployment rates. The remaining FIT for domestic renewables will be removed in 2019.

The key remaining UK policy is Contract for Difference (CfD) which provides a level of price certainty where generators bid into a periodic auction to receive support at a specified price level. However, it is not available for all technology types and less developed technologies such as geothermal and marine are, in reality, unable to compete on a cost basis for the available support.

As the price of power on the electricity market becomes more variable, in part due to intermittent renewables, a price guarantee mechanism is increasingly important to enable construction of all new generation as it provides a level of guaranteed income. Without this certainty, risk and cost of capital become prohibitive for any new project being constructed to sell electricity into the market.

Although the Welsh Government remains committed to renewables and onshore wind in particular, the impact of support, or lack of, will for the time being remain the same in Wales as the rest of the UK. With politics rather than cost-effectiveness determining UK policy at present both wind and solar currently have received no government support since early 2017. The removal has had a dramatic effect on deployment.

The Welsh Government has urged a rethink[42] in particular to open the Contract for Difference to onshore wind and solar, but if and when this change might be made is uncertain.

### Network constraints on distribution and transmission

The South Wales licence area is experiencing significant network constraints at a transmission level as the quote from the letter mentions below.

*"The South Wales region has seen unprecedented growth in levels of embedded generation of all types, and specifically plant that is to be used for supplying energy at peak demand times. Unlike other areas of the Transmission Network, which have recently seen significant closures large thermal generation, there have been none in South Wales. These factors, together with small reductions in levels of demand in the area, has in the short term, reduced the capacity available for some types of generation connections in the South Wales Group" (National Grid Letter to WPD, 19 May 2016)*

Pending upgrades to the transmission system, expected sometime between 2026 – 2028, controllable generation types that can run at peak times will not be able to connect to the network in the licence area. This does not include onshore wind or solar, or technologies under 1 MW. However, it does have an impact

40 https://beta.gov.wales/sites/default/files/consultations/2018-02/ppw-restructure-draft-ppw_en.pdf (p.82)
41 https://www.realwire.com/releases/Consent-for-Pant-y-Maen-Wind-Farm
42 https://www.businessgreen.com/bg/news-analysis/3022144/wales-urges-uk-government-to-think-again-on-onshore-wind-ban

on the short and medium term development of battery storage, along with gas generation and technologies such as energy from waste or bio-energy that generate electricity.

Whether this constraint continues until the anticipated upgrade date or continues past that date is uncertain. It is possible that a system of Active Network Management on the distribution system could manage the constraint with a non-investment solution or equally the constraint may worsen and continue the embargo beyond 2026.

Details of how this embargo has been dealt with is covered in the sections of those technologies impacted. As the objective of the study to identify and anticipate areas that will require network investment to avoid constraints. As a result, it would not be correct to restrict growth of these technologies in all scenarios. In higher growth scenarios, this embargo is not projected to have an impact in the medium term (post 2021) except to delay pipeline projects. In lower growth scenarios the embargo continues but at varying timescales.

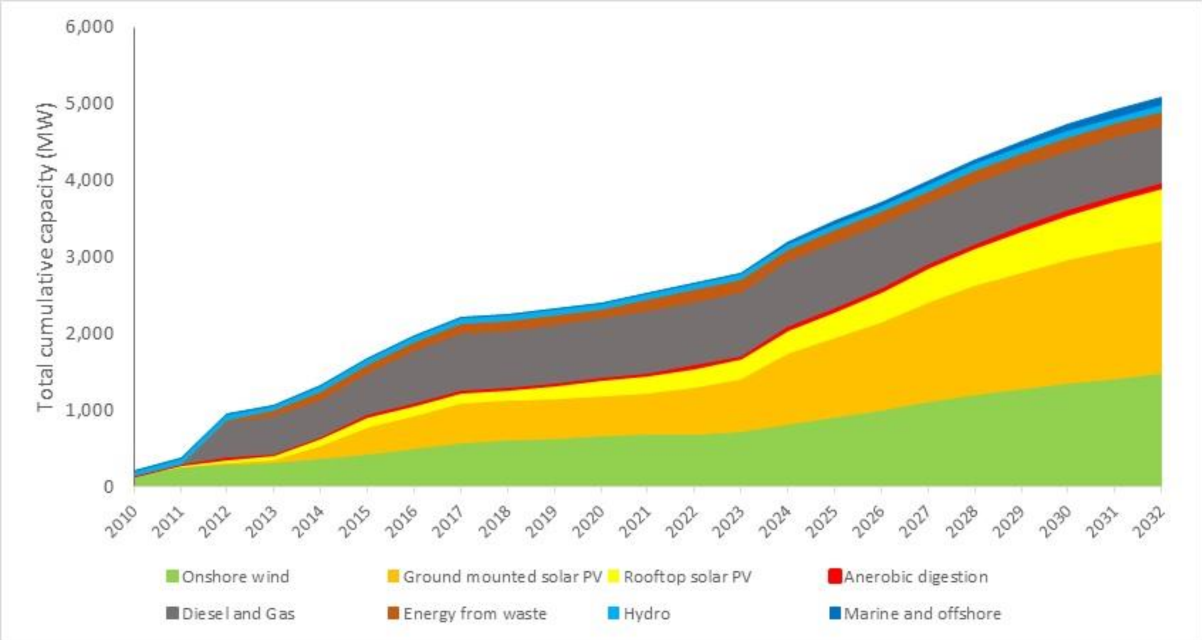
## South Wales scenario summary

Under a Two Degrees scenario, distributed electricity capacity in the licence area could more than double installed capacity from 2.4 GW to 5.3 GW in 2032. In Steady State capacity increases only 28 per cent from 2017 to 3.0 GW.

Table B-1: Summary table of growth in distributed generation 2017-2032

| All distributed generation (MW) | 2017 | 2025 | 2032 | Additional capacity 2017-32 (%) |
|---|---|---|---|---|
| **Two Degrees** | 2,377 | 3,661 | 5,284 | 122 |
| **Consumer Power** | | 2,953 | 4,230 | 78 |
| **Slow Progression** | | 2,617 | 3,908 | 64 |
| **Steady State** | | 2,438 | 2,992 | 26 |

Figure B-2: Cumulative growth (MW) for Two Degrees scenario distributed generation




In Two Degrees capacity growth improves significantly from mid-2020s.

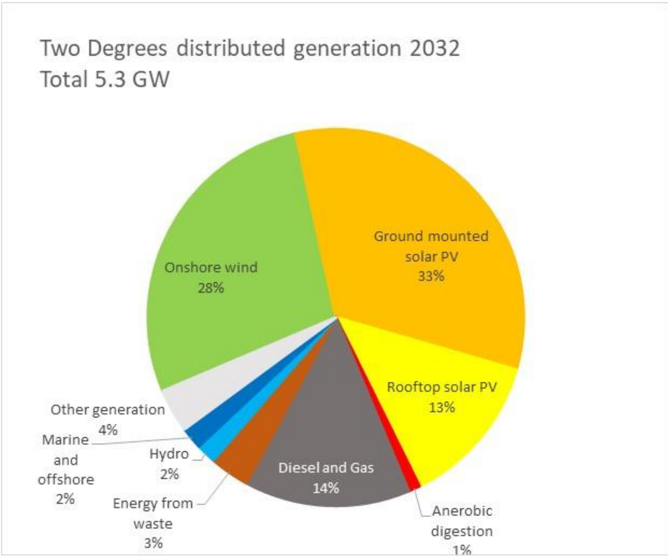
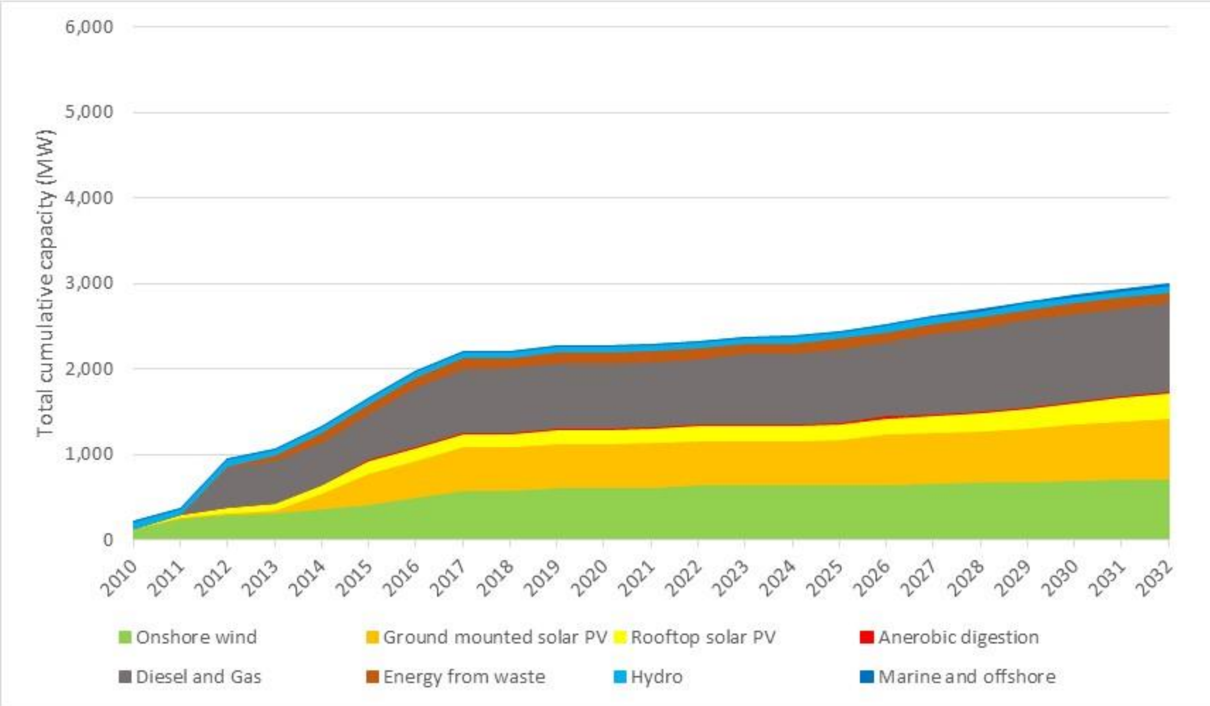
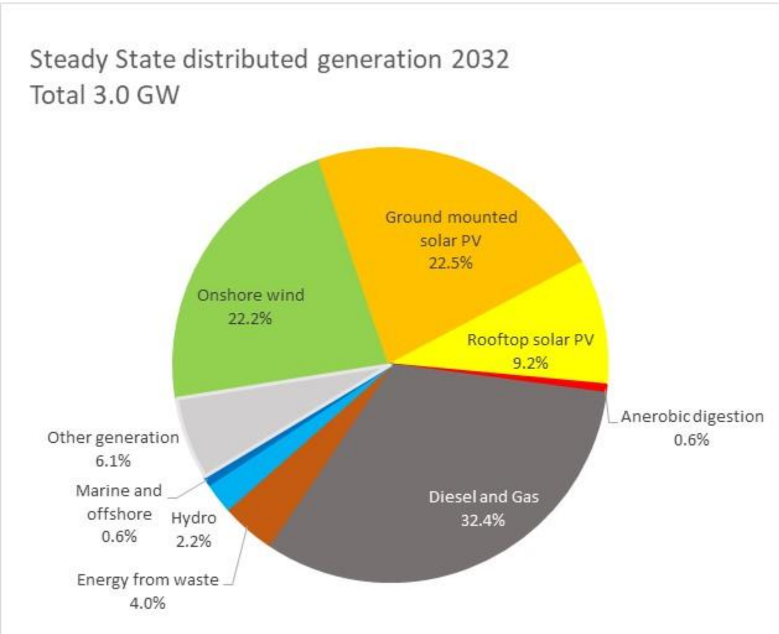


Figure B-3: Cumulative growth (MW) for Steady State scenario distributed generation




In Steady State, growth remains is slow and there are significantly more fossil fuels. Growth improves slowly towards the end of 2020s.



# 6. Onshore wind

Wales has a unique planning environment for onshore wind, with a largely positive approach. As subsidy free projects begin to become viable, UK developers are likely to focus their efforts in Scotland and across Wales due to the planning regimes and resource availability.

In the absence of network issues, South Wales is likely to see relatively high capacity increase in the onshore wind sector once project economics are unlocked.

**With its positive planning policy and strong wind resource, South Wales has significant potential for growth in its onshore wind capacity.**

Table 6-1: Summary of growth in capacity of onshore wind in WPD South Wales licence area.

| (MW) | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 577 | 670 | 844 | 1,457 |
| Consumer Power | | 610 | 697 | 941 |
| Slow Progression | | 622 | 713 | 1,032 |
| Steady State | | 610 | 647 | 709 |

## 6.1. Baseline

There is 577 MW of onshore wind capacity connected to the distribution network in the South Wales licence area, comprising 176 individual projects. 94 of these projects are below 500 kW, totalling 10 MW, two per cent of the total capacity.

In the two years since the 2016 study, nine new projects have been installed, totalling 134 MW. The largest of these (and the largest in the licence area) is Brechfa Forest West wind farm with a connection agreement of 57.4 MW. Projects installed in this period, such as Brechfa Forest West, benefitted from the grace periods for the Renewables Obligation. The final grace period is due to conclude in January 2019, after which no further projects will be able to access the RO.

TAN 8[43], the renewable energy planning policy framework for Wales, has created a unique planning policy environment, which clearly directs large wind developments (over 25 MW) to Strategic Search Areas. Strategic Search Areas C and D partially fall within the South Wales licence area and E, F, and G are wholly within the area.

E, F, and G were assigned an indicative capacity of 480 MW altogether. The total capacity of sites within these areas is 351 MW, however when projects within 2 km of an SSA boundary are included, this total increases to 501 MW. 228 MW of this installed capacity is a single site, Pen Y Comoedd, which is connected to the transmission grid and, therefore, not included in the baseline. Network issues around C and D appear to have limited deployment in these Strategic Search Areas.

## 6.2. Pipeline

There is 291 MW of onshore wind capacity in the accepted connections database, made up of 32 projects. 18 of these projects are over 1 MW in scale, representing 285 MW of the total potential pipeline. The remaining 14 potential projects are smaller scale, totalling 6 MW.

[43] http://gov.wales/topics/planning/policy/tans/tan8/?lang=en

Previously in the 2016 study, there were 119 projects in the pipeline. Just six of these have been built out in the intervening two year period. 10 new projects totalling 23 MW have accepted connection agreements since 2016 and 91 projects have dropped out of the pipeline.

This significant reduction in the pipeline is a result of subsidy cuts. Large scale onshore wind currently has no financial support from the UK government. The CfD process, which provides price certainty for new generation, is not currently available to onshore wind. Wind was eligible under previous rounds of the CfD and projects such as Mynydd Y Gwair in South Wales have qualified to receive a contract. However, new projects entering the pipeline must be viable without subsidy.

The developers of large scale projects with connection agreements in South Wales have been contacted, and the projected commissioning year and connection capacity for these projects under each scenario has been included in the analysis. In the near term, due to the curtailment of the ROs and disqualification from CfD auctions for onshore wind, it is assumed that only developments with an accepted network connection are in the pipeline.

Table 6-2 identifies the approach followed for sites with an accepted network connection and planning permission identified. Pipeline projects currently under construction or sites with other specific circumstances, such as those currently in the appeal process, have been considered individually.

Table 6-2: Detail of approach taken in scenarios to pipeline projects

| | Total MW | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|---|
| Pipeline projects with planning permission identified | 58 | From 2020 | From 2021 | From 2021 | From 2022 |

## 6.3. Technology growth prospects

**Price support**

The Welsh Government has called for the UK government to do more to support the development of onshore wind, particularly by including it within Round three of the CfD[44]. Analysis by Arup shows that if onshore wind were to be included in the CfD, it would offer the cheapest form of electricity generation for the UK[45]. A form of price support for onshore wind is included under Two Degrees and Slow Progression.

**Cost reductions leading to subsidy free viability**

**Large scale wind projects with the right site conditions are starting to apply for planning permission in the UK.**

Even without access to price support, falling costs have increased the potential for subsidy free projects.[46] Onshore wind costs have fallen consistently in recent years, with IRENA estimating a 30 per cent decrease in UK installed costs between 1983 and 2016[47]. Turbine efficiencies have improved with the UK average capacity factors increasing from 20 per cent to 30 per cent over a 20 year period to 2018. Costs are expected to continue to fall due to savings from larger turbines and lower maintenance costs, with Bloomberg predicting a further 47 per cent decrease in the levelised cost of energy from onshore wind by 2040[48].

Subsidy free projects are starting to appear in the pipeline for other areas. For example, planning permission was recently provided to a seven turbine project in North Wales that is not eligible for any subsidy.[49]

Other than network connection costs, scale is the key factor in determining whether a site could currently be viable; the larger the turbines tip height and rotor diameter, the more likely the project economics are to work. Sites need to be able to accommodate these large turbines from both a landscape planning and access point of view. As costs fall, the scale required will reduce.

If network issues are put aside, the rate at which costs continue to fall will be a dominant factor in determining the rate of widespread deployment in South Wales.

**Planning for large scale wind in Strategic Site Areas**

The current E, F and G Strategic Site Areas having approached their indicative capacity is likely to limit further large-scale development in South Wales. However, there remains scope for expansion and there has been relatively less development in C and D where there is less grid access. Under the scenarios, the development of new Strategic Search Areas in South Wales is considered as well as strategic action to unlock remaining capacity in the current areas.

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[44] https://gov.wales/docs/desh/news/171129-position-on-support-for-onshore-wind-and-solar-developments-en.pdf
[45] https://www.arup.com/news-and-events/news/inclusion-of-onshore-wind-in-cfd-mechanism-key-to-reducing-cost-of-uk-decarbonisation
[46] https://www.agora-energiewende.de/fileadmin/Projekte/2017/Future_Cost_of_Wind/Agora_Future-Cost-of-Wind_WEB.pdf
[47] http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf
[48] https://about.bnef.com/new-energy-outlook/
[49] https://www.naturalpower.com/consent-pant-y-maen/

**Planning for other scales**

Overall the planning environment in Wales for onshore wind is favourable. In particular, the latest Draft Planning Policy Wales: Edition 10, consulted on in spring 2018[50], is positive about the role of wind in Wales' future energy mix: "Wales has an abundant wind resource and, as a result, wind energy forms a key part of meeting the Welsh Government's vision for future renewable energy production."

**The Welsh Government's positive stance on onshore wind is likely to attract development once subsidy free sites are viable.**

This positive national policy context is then backed up by the fact that planning applications for onshore wind farms in Wales with an installed generating capacity above 10 MW are determined directly by Welsh Ministers, under the DNS process[51]. Applications for wind energy developments under 10 MW are determined, in the first instance, by Local Planning Authorities.

However, TAN 8 also serves to limit the development of wind energy above 5MW outside SSAs, creating an unfavourable policy environment for medium scale wind energy development in Wales in any location other than brownfield sites. The majority of local authorities in the South Wales licence area have adopted this Welsh national planning policy quite literally; with policy encouragement for only small scale wind, under 5MW, with some limiting development to community owned or projects connected to electricity demand through a direct wire rather than the public network.

How local authorities interpret and enact Welsh Government planning policy in the development of their local plans will have an impact on the future deployment of onshore wind and is a key factor within the scenarios.

**Small scale wind**

The poor economics of smaller turbines (under 500 kW) and planning obstacles in England means this part of the sector has almost entirely disappeared in England. However, the Welsh Government's positive approach to planning for wind, along with its targets for local ownership of generation capacity, mean that South Wales is a relatively favourable environment for smaller turbines. Growth in the deployment of smaller scale wind projects is expected under a Consumer Power scenario in particular.

**Repowering**

Repowering of projects is likely to be affected in England by the current negative planning environment. In South Wales, with an overall positive planning environment, projects are considered to be able to achieve planning for repowering under all scenarios. Projects repower earlier under the scenarios with a stronger economic environment due to the availability of capital.

**Split blade technology development**

Access to sites for large scale wind turbine blades is a significant limiting factor; many otherwise suitable sites do not have road access that permits a lorry carrying a blade to access the site. Split blade technology is under development and potentially could open up access to currently constrained sites.

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[50] https://beta.gov.wales/sites/default/files/consultations/2018-02/ppw-restructure-draft-ppw_en.pdf
[51] https://gov.wales/topics/environmentcountryside/energy/renewable/wind/?lang=en

## 6.4. Scenario results

Figure 6-1: WPD South Wales licence area onshore wind growth scenarios.

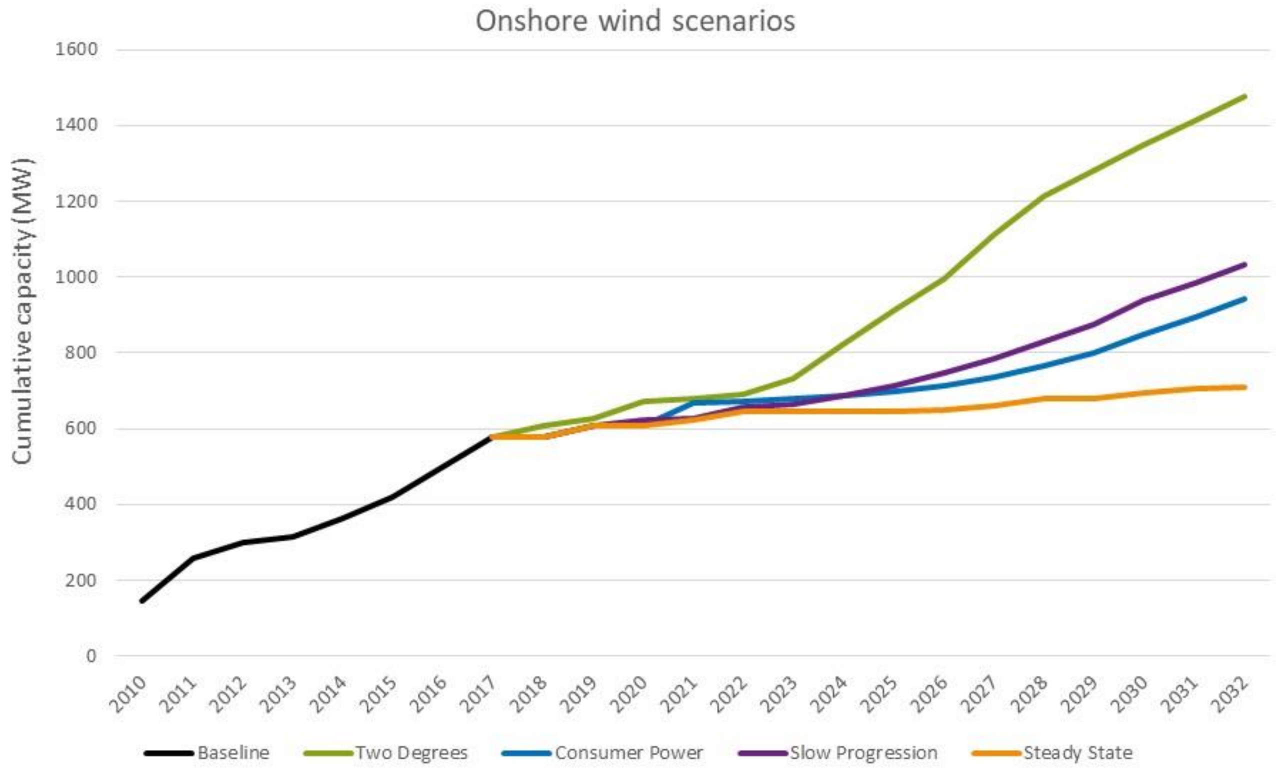



Table 6-3: Assumptions for factors influencing capacity growth for onshore wind in South Wales

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and government support** | | | | |
| CfD or price support mechanism opened to onshore wind | **Price support available from early 2020s** | **No price support** | **Price support available from mid-2020s** | **No price support** |
| Planning environment for projects outside SSAs | **Local authorities take a strategic approach to wind: allocating areas for wind up to 25 MW and setting local targets in early 2020s. All scales benefit.** | **Overall supportive local planning environment with prioritisation of sub-5 MW farm and community scale projects – but no area allocations for 5 to 25 MW scale.** | **Local authorities take a strategic approach to wind: allocating areas for wind up to 25 MW and setting local targets in mid-2020s. Market conditions mean larger scale projects benefit** | **Relatively positive planning environment but no pro-active approach to drive 5 to 25 MW development in South Wales.** |

| | | | | |
|---|---|---|---|---|
| New SSAs are developed | **Welsh Government develops new SSAs for large scale wind in early 2020s and unlocks strategic grid issues for current SSAs that are not at capacity.** | **No new SSAs** | **Welsh Government develops new SSAs for large scale wind in mid 2020s.** | **No new SSAs** |
| Repowering | **Projects repower from early 2020s** | **Projects repower from early 2020s** | **Projects repower from mid-2020s** | **Projects repower from mid-2020s** |
| **Technology cost and performance** | | | | |
| Cost reductions and technology improvements | **Global market drives significant cost reductions in early 2020s, alongside some improvements to efficiency.** | **Global market drives significant cost reductions in early 2020s, alongside some improvements to efficiency.** | **Cost reductions impact in mid-2020s with focus on largest scale projects.** | **Cost reductions impact in mid-2020s with focus on largest scale projects.** |
| Split blade technology development | The development of split blade turbines opens up access to more remote sites in the mid 2020s. | The development of split blade turbines opens up access to more remote sites in the mid 2020s. | The development of split blade turbines opens up access to more remote sites in the early 2030s. | The development of split blade turbines opens up access to more remote sites in the early 2030s. |

### Relationship to FES 2017 and 2016 Scenario report

The scenarios project higher growth than the FES 2017 under all scenarios, with significantly higher growth under Two Degrees. This reflects the fact that the positive and proactive planning environment and strong resource in Wales have the potential for development to be far higher in this licence area than in English areas.

The scenarios are roughly in line with the 2016 study, as the factors affecting the market have not changed greatly in the intervening years. Steady State also grows more quickly than previously due to large pipeline projects that will be installed; following this, growth is expected to drop back down in line with previous projections.

### Distribution of technology across ESAs

The scenario projections are distributed based upon a resource assessment to identify the potential for wind development of unconstrained areas. This includes high wind speed areas within proximity to the distribution network, and outside of landscape and land use constraint areas such as Areas of Outstanding Natural Beauty, National Parks, and woodlands areas.

Due to the specific characteristics of the planning environment in Wales, the distribution has been treated differently for different scales of development. The SSAs dominate the current distribution of onshore wind capacity, and the remaining SSA capacity and land area has been considered in the scenarios for the development of large scale wind. Under Two Degrees and Slow Progression, there is also the potential for the development of new SSAs within the licence area towards the end of the study period.

In general, areas with the best resource and network availability are expected to see developments earlier in the study period.  Under higher development scenarios, the potential for currently underfilled SSAs is realised. The highest development of distributed small scale wind is expected under the Two Degrees and Consumer Power scenarios.

# 7. Ground mounted solar PV

South Wales has significantly lower ground mounted solar PV installed capacity than other licence areas. The highest growth rate was in 2015: a total of 196 MW was commissioned which approximately doubled the baseline from the previous year. The ending of subsidies led to growth stalling in 2016 and 2017, with 150 MW commissioned in the two year period as projects built out under Renewables Obligation grace periods. No new projects were commissioned in quarter one 2018.

**South Wales' hilly topography means deployment is likely to be lower than other licence areas under all scenarios.**

HM Treasury has explicitly ruled out further subsidy support until 2025[52].
The focus of the market is therefore on subsidy-free business models such as private wires or co-location with storage. The viability of the sector in the medium term depends on continued cost reduction.

Table 7-1: Summary of growth in capacity of ground mounted solar PV in WPD South Wales licence area.

| MW | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 530 | 540 | 1042 | 1752 |
| Consumer Power | | 530 | 872 | 1456 |
| Slow Progression | | 530 | 659 | 1257 |
| Steady State | | 530 | 540 | 731 |

## 7.1. Baseline

There is 530 MW of ground mounted solar connected to the network in the South Wales licence area, according to the WPD connected database. This is a 152 MW increase on the previous South Wales study baseline of 378 MW in 2016.

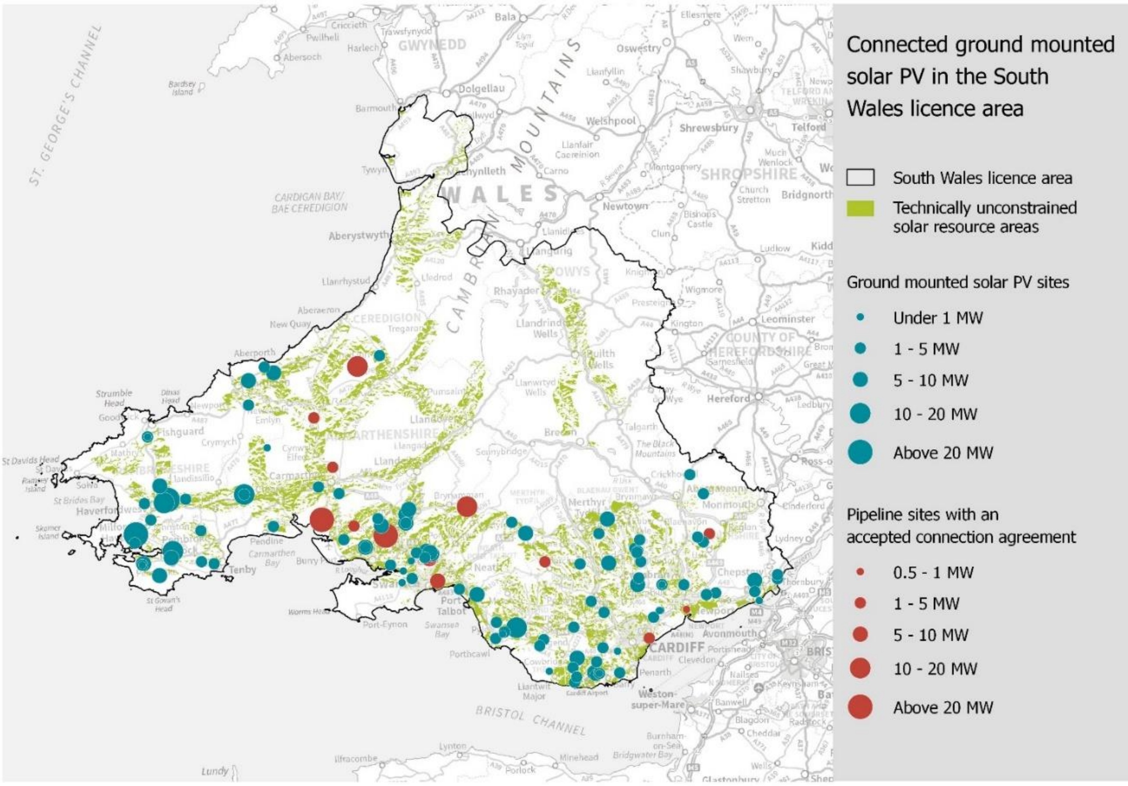
The majority of capacity growth in the licence area has occurred in the last five years; 93 per cent of the baseline capacity commissioned since 2013.

The baseline is significantly lower than other licence areas. For example, South Wales has less than half the ground mounted solar of the South West, which is only slightly larger in total land area. Factors that have resulted in this lower baseline include:

- Network availability is relatively limited in South Wales – solar farms tend to be within 2 km of a network connection so the potential corridors for development are limited in South Wales by the limited reach of the network.
- The hilly topography of South Wales limits the available resource space – solar farms tend to be built in open landscapes with larger, flatter fields.
- The lower affluence of the area means that fewer farmers have capital to invest in smaller scale on farm projects.

[52] https://www.theguardian.com/environment/2017/nov/22/no-subsidies-for-green-power-projects-before-2025-says-uk-treasury

Figure 7-1: Ground mounted solar PV sites with resource areas in the South Wales licence area




## 7.2. Pipeline

There are 21 projects in the ground mounted solar pipeline, with a total of 281 MW of accepted-not-yet-connected capacity[53]. The largest of these is Gwent Farmers' Community Solar Scheme, with an accepted capacity of 49 MW, which submitted a planning application in March 2018.

The removal of subsidies for ground mounted solar projects over 5 MW and drastic cuts to the FIT for sub-5 MW projects have had a significant impact on the pipeline. The pipeline has reduced significantly since the 2016 study, which had 749 MW of solar capacity with connection agreements, 2.5 times greater than the current pipeline. 15 of the 21 current pipeline projects were present in the 2016 study pipeline and are yet to be developed.

Without subsidies, solar developers are now focussed on new business models that could provide a higher and more certain price for the electricity they generate such as selling to corporates directly, either with a private wire or through a power purchase agreement (PPA). However, these arrangements have proven slow and difficult to agree. There are only 6 new projects that have been added to the South Wales pipeline since 2016. These range in scale from 720kW to 24 MW. They include a project co-located with wind project and some projects that appear to be linked to corporates.

The following assumptions have been applied to projects in the pipeline.

Table 7-2: Assumptions made on the ground mounted solar PV pipeline by scenario

| | Total MW | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|---|

[53] PV sites with a connection agreement below 500 kW are not considered in the ground mounted model; they are included in the rooftop solar projections.

| | | | | | |
|---|---|---|---|---|---|
| Pipeline projects with planning permission identified | 70 | From 2022 | From 2023 | From 2024 | From 2026 |
| Pipeline projects without planning identified | 210 | From 2024 | From 2025 | From 2026 | Projects fail |

## 7.3. Technology growth prospects

**Achieving price parity through falling costs**

The installed cost of large scale ground mounted solar PV in the UK fell by 76 per cent between 2010 and 2017 according to the International Renewable Energy Agency's 2017 market report. The cost of electricity from solar PV fell by almost three-quarters in 2010-2017 and continues to decline, albeit at a slower rate than at the start of the decade[54].

Competitive auctions in overseas power markets, global competition amongst experienced solar developers, production volumes and technology development are all contributing to continuing falling global costs. By 2020, IRENA expects solar PV (and other mainstream renewables) to have average costs that are competitive with fossil fuel power stations in the global market[55]. According to Bloomberg, the global levelized cost of electricity from solar is set to drop another 66 per cent by 2040. By 2021, Bloomberg consider ground mounted solar will be cheaper than coal in the UK[56].

Module price reductions are largely driven by international markets; however, individual market specifics such as the number of experienced developers, import tariffs and the planning policy environment produce installed cost variations for the UK from the global average. For example, as skills and installation volumes have been lost from the UK sector due to the current deployment hiatus, installed cost reductions may not continue apace with the global market.

Under the higher economic growth scenarios, reduced module costs, R&D investment and reinvigorated supply chains allow for strong solar development. Under scenarios constrained by low economic growth, reduced and slower deployment rates mean that cost reductions are more limited.

**Price support**

The close of the RO and removal of eligibility for the CfD mean that large scale ground mounted solar projects are currently without a subsidy[57]. The UK government has explicitly ruled out further subsidies for solar until at least 2025. However, the Welsh Government, in conjunction with several energy and environmental organisations has called for the UK government to do more to support the development of solar PV, particularly by including it within Round three of the CfD[58]. Whilst falling costs mean that a subsidy may not be necessary in the near future, volatility in the electricity market price means that a price support mechanism would reduce the risk for new projects and, therefore, the cost of capital.

Under scenarios with green ambition, a CfD or another price support mechanism is introduced to reduce risks in the short term.

[54] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf
[55] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf
[56] https://about.bnef.com/new-energy-outlook/#toc-download
[57] Sub-5 MW ground mounted plants are eligible for the FIT until March 2019 but this has been significantly reduced.
[58] https://gov.wales/docs/desh/news/171129-position-on-support-for-onshore-wind-and-solar-developments-en.pdf

**High solar load**

**Price parity is the key growth factor for ground mounted solar with Two Degrees seeing this early in 2020s due to price support**

A key challenge for the future deployment of solar is that, at peak times of high solar generation, excess electricity generation is likely to depress the wholesale price or to have an impact that causes regulators to change network charges. Research from Aurora suggests that by the 2020s, there will be considerable decreases in wholesale electricity prices at times of high solar load[59]. Co-locating with storage will mitigate this effect to an extent. This factor is relevant only in those scenarios with high solar development. It is a limiting factor to growth under Two Degrees and Consumer Power in the late 2020s but its impact is limited by the high rates of storage co-location under these scenarios.

**Development of new business models**

The challenge for developers of solar PV in South Wales is to develop profitable sites post-subsidy. UK sites currently being developed in the post-subsidy environment are focussed on: very large projects, such as a 350 MW project proposed in Kent[60] and sites with sunk costs (e.g. planning permission in place) such as Clay Hill[61], Anesco's 10 MW solar PV project near Milton Keynes co-located with energy storage, which opened in September 2017. Sites added to the pipeline since 2016 in South Wales will have post-subsidy business models underpinning them.

Co-location with energy storage is a key business model for post-subsidy renewable development. Combining solar and storage may facilitate increased renewable energy development by reducing output intermittency and reducing peak generation. It could also help mitigate the electricity market price risk either through flexibility services or through arbitrage by storing and selling low cost solar power during higher priced evening peaks. This has the potential to transform the sector but Regen analysis indicates that co-location currently remains a very challenging business model[62]. In South Wales, National Grid's embargo on new dispatchable generation is affecting the deployment of battery storage (Section 15), which will have an impact on the date when co-location models are viable.

**Positive planning environment in Wales**

The Welsh Government is supportive of renewables deployment in general and has committed to a target of 70% of its electricity consumption coming from renewables by 2030. The recently consulted on Draft Planning Policy Wales: Edition 10 sets a positive framework, with requirements for local authorities to take a positive approach to planning for renewables, including allocating areas and setting local targets. The Welsh Government has also set a target for 1 GW of renewable electricity capacity in Wales to be locally owned by 2030, and that all renewable energy projects have at least an element of local ownership by 2020. This is expected to encourage a beneficial environment for solar PV, which has previously been favoured by community energy groups. According to a Welsh Government review of its community renewable energy support programme, community solar PV has previously been a quicker technology for community energy groups to develop, as they are less affected by the barriers that affect wind and hydropower.

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[59] http://www.auroraer.com/wp-content/uploads/2017/11/Aurora-Battery-Conference-31-Oct-2017.pdf (2017)
[60] https://www.theguardian.com/environment/2017/nov/09/giant-solar-power-plant-uk-biggest-north-kent-coast-subsidy-free-power-station-faversham
[61] http://anesco.co.uk/clayhill-uks-first-subsidy-free-solar-farm/
[62] https://www.regensw.co.uk/Handlers/Download.ashx?IDMF=9d010979-7cc4-4515-b900-a65a4a4765b7

## 7.4. Scenario results

Figure 7-2: WPD South Wales licence area ground mounted solar PV by scenario.

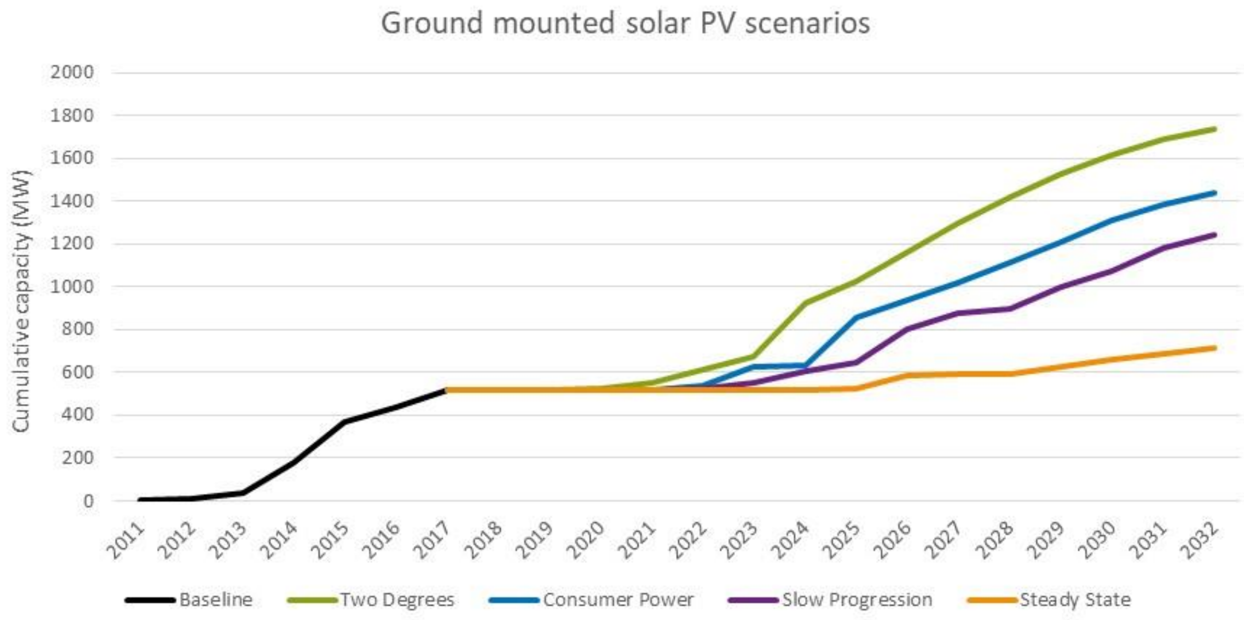



Table 7-3: Assumptions for factors influencing capacity growth for ground mounted solar

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and government support** | | | | |
| CfD or price support mechanism opened to ground mounted solar | **Price support available from early 2020s** | **No price support** | **Price support available from mid-2020s** | **No price support** |
| Planning environment | **Proactive approach to planning for solar through local area allocations and targets, alongside strategic network investment** | **Positive planning environment but no local action or strategic approach.** | **Proactive approach to planning for solar through local area allocations and targets, alongside strategic network investment** | **Relatively positive planning environment but no local action or strategic approach.** |
| **Technology cost and performance** | | | | |
| Solar reaches price parity | **Parity reached in early 2020s due to rapid cost reductions, positive planning and price support.** | **Parity reached in mid 2020s due to rapid cost reductions.** | **Parity reached in mid 2020s due to price support and slower cost reductions/supply chain development.** | **Price parity reached in late 2020s, delayed by lack of price support and slower cost reductions/** |

| | | | | |
|---|---|---|---|---|
| | | | | **development of supply chain.** |
| Co-location with storage potential | **Widely viable co-location model from early 2020s** | **Widely viable co-location model from mid- 2020s** | **Widely viable co-location model from late- 2020s** | **Widely viable co-location model from early 2030s** |
| High solar load | Towards the late 2020s, high levels of solar depresses wholesale price/affects network charges | In early 2030s, high levels of solar depresses wholesale price/affects network charges | Lower level of deployment not affected by high solar load issues | Lower level of deployment not affected by high solar load issues |

### Relationship to FES 2017 and 2016 Scenario report

The projections in this report are significantly higher than those in the FES 2017, except for in the Steady State scenario[63]. This is based on Regen's view that the solar market could come back strongly without subsidy in the near term.

The projections are roughly in line with the 2016 study, with lower maximum deployment predicted under Two Degrees than previously. This reflects the latest thinking on the impact of high solar load on price cannibalisation at times of peak solar generation, which is likely to limit maximum deployment levels. In addition, this study has assessed the impact of slope and orientation on the available resource in South Wales and, as a result, has decreased the maximum potential.

### Distribution of technology across ESAs

Assessment of the potential for ground mounted solar PV focussed on the available land for development, including an analysis of the topography of the area, and proximity to the network in the South Wales licence area. Additional considerations for developers may include visibility of the site, as well as nearby housing density and vehicular access. The developable land area for solar has been estimated with regards to the following constraints:

- Designated land areas – Ancient Woodlands, Areas of Outstanding Natural Beauty, Country Parks, National Parks, Special areas of Conservation, Sites of Special Scientific Interest etc.
- Physical constraints – roads, woodlands, waterbodies, 50m buffers around houses etc.
- That developable land is within 1.5 km of the 33 kV (or higher) network.
- The orientation and gradient of the ground within the licence area – excluding those sites on particularly steep or north facing ground.

The scenario generation growth projections are distributed according to both the results of the developable land resource assessment and the existing baseline distribution across the ESAs. Figure 7-1 shows the developable solar resource corridors and the existing baseline of ground mounted solar PV sites. The commissioned solar project baseline and the resource areas identified show a strong concurrence across the licence area.

[63] The FES 2017 does not explicitly split out roof-mounted and ground mounted PV. Assumptions have been applied to the FES 2017 to extract a ground mounted figure from the FES projections.

# 8. Rooftop solar PV

**Rooftop solar photovoltaic market has dropped 95 per cent between 2015 and 2017.**

Deployment of rooftop solar photovoltaic (PV) installations in South Wales has dropped 95 per cent from 37 MW in 2015 to only 1.7 MW added in 2017.

This drop is larger than in other areas and reflects the significant reduction in subsidies available through the Feed-in-Tariff. However, the ambition of the Welsh Government to boost renewable generation and programmes such as 'housing as power stations' in South Wales along with expected reductions in cost, mean that growth is potentially still high in the medium and long-term.

Table 8-1: Summary of growth in capacity of rooftop solar photovoltaic in WPD South Wales licence area.

| Total cumulative capacity (MW) | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 152 | 208 | 363 | 697 |
| Consumer Power | | 174 | 263 | 538 |
| Slow Progression | | 169 | 257 | 445 |
| Steady State | | 164 | 187 | 294 |

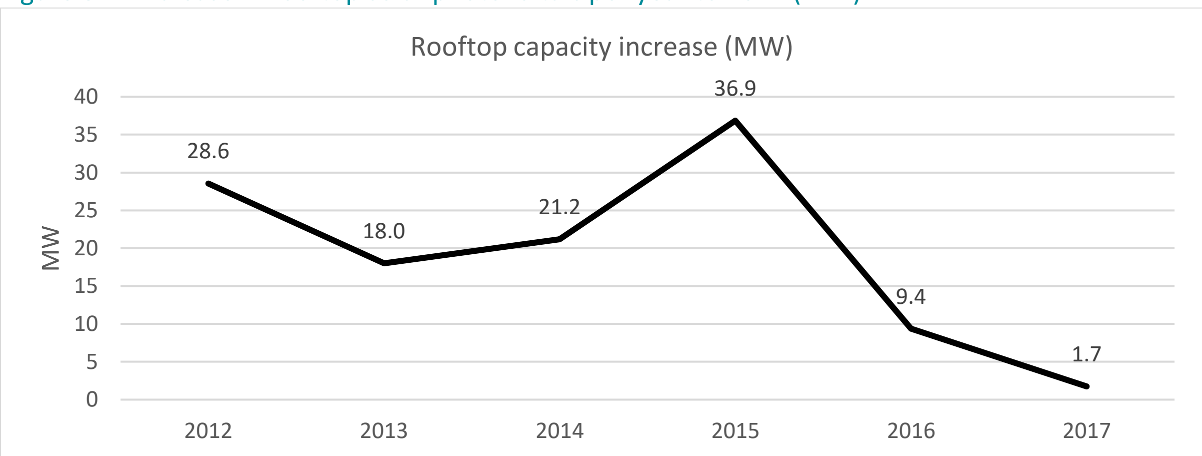
## 8.1. Baseline

Currently there is rooftop solar PV installed in 34,300 or 3.1 per cent of homes in the licence area, contributing a total of 152 MW of capacity. The average size of installations has been increasing. The average of the total baseline is 3.5 kW but the average size for 2017 only was 4kW.

The baseline of commercial rooftop solar PV is 31 MW capacity from around 1300 installations. The average size of a commercial system is significantly larger 23 kW.

Despite significant increases in the first half of the decade, Figure 8-1 illustrates that South Wales licence area has seen a very significant drop in rooftop solar installations since 2015, with under 2 MW added in 2017 from only 363 installations.

Figure 8-1: Increase in rooftop solar photovoltaic per year to 2017 (MW)




The significant reduction in the FIT for roof-top and small-scale PV from 2016 were intended to reflect the falling cost of technology which, since 2009 has reduced the cost of small systems by around two thirds.

Upfront costs however remain significant. It costs between £4,000-£6,000 for a 3 kW system.[64] Payback periods are currently too high for many companies and households to invest.

## 8.2. Pipeline

There is a small 1.8 MW pipeline of rooftop solar PV from 29 projects taken from WPD's accepted but not yet connected database. It is assumed that all the pipeline is from commercial projects as all of the projects are above 3kW. The average size is 62.5 kW.  In all scenarios these are expected to be connected in 2018.

The biggest factor in short-term growth remains the FIT. Despite falling technology costs the payback for residential rooftop solar PV is currently around 10 years and the FIT makes a significant contribution. The 2017 Autumn budget announced that the remaining low level of FIT subsidies will stop after March 2019 and as a result the scenarios are predicting a small pick-up in installations ahead of that date. Once the FIT ceases in 2019, the residential market is likely to drop further as the payback period increases significantly to up to around 18 years.[65]

However social housing projects with longer-term investments, economies of scale and policy drivers such as reducing fuel poverty, could retain a business case. Social housing provider Optivo recently launched tender for up to 5 MW of solar rooftop across their housing portfolio.[66]

The Government is expected to consult in summer 2018 on whether there will be any new policy on encouraging small scale renewables. New subsidies similar to the FIT are not expected, but there is potential the government will continue to encourage further rooftop solar PV installations on social housing, which make up around 15 per cent of housing in the South Wales licence area.

The Welsh Government targets around renewable energy (70 per cent by 2020) and 'houses as power station'[67] aspirations of Local Authorities such as in the Swansea Bay City Region could also drive significant installations in the medium term.

For commercial properties, the FIT is less significant for new projects where the power can be used on site and offset the retail price of power. This has already reached a point where the right properties and usage profile can have payback periods of five to six years[68].

However, barriers remain. The increases in business rates for properties with PV and potentially also storage means there is now a penalty for commercial properties installing their own PV. Furthermore, only a limited number of companies have the capacity and ability to make a strategic long-term investment in energy management that PV requires.

[64] https://www.theecoexperts.co.uk/solar-panels/1kw-pv-systems
[65] Regen market insight
[66] https://www.solarpowerportal.co.uk/news/optivo_launches_100_million_solar_tender_to_roll_out_social_housing_solar
[67]http://www.swansea.ac.uk/press-office/latest-research/turninghomesintopowerstationscouldcuthouseholdfuelbillsby600ormore-report.php
[68] Industry sources February 2018

## 8.3. Technology growth prospects

Increases in global demand, supply and innovation have driven down the installed cost of solar PV by 77 per cent since 2009 according to Bloomberg New Energy finance[69]. Though reductions are slowing, continued fall in costs is expected. With other disruptive solar technologies such as thin-film perovskite solar having the potential for even bigger cost reductions. [70]

**There is high potential growth in the installation of rooftop PV with the Welsh Government's support for renewables and initiatives such as 'homes as power stations'.**

**Social housing a driver of growth in South Wales**

Although price falls may encourage private households to invest in the medium term, key areas of domestic growth are likely to be in social housing where longer term investment horizons and economies of scale make a stronger investment case for retrofit. This could be boosted further with government subsidy support or policies such as requiring higher energy efficiency bandings for social lettings.

**New housing rates potentially high**

Rooftop solar PV is also likely to feature more in new build housing where the installation is cheaper and benefits again from economies of scale. Furthermore, building regulations or planning policies could be used to encourage developers to install. In the Two Degrees scenarios over 50 per cent of new homes built in 2032 are likely to include solar and with nearly 30 per cent of existing social housing being retrofitted with rooftop solar PV.

**Co-location business models**

Co-location of residential rooftop solar with storage from batteries also has the potential to provide an additional income stream, bringing down payback periods for domestic and commercial installations. Aggregation of small solar with storage (batteries or an electric vehicle in households) along with smart technology could soon offer flexibility services to the grid.

The extra income commercial or domestic systems could receive from an integrated system of generation and storage is expected to start providing attractive returns and result in an uptick in domestic and commercial rooftop PV installations during 2020s. Technology costs of the combined systems, coupled with the price of energy, will determine growth towards the mid-2020s.

[69] https://about.bnef.com/blog/tumbling-costs-wind-solar-batteries-squeezing-fossil-fuels/
[70] https://www.oxfordpv.com/Research

## 8.4. Scenario results

Figure 8-2: WPD South Wales licence area rooftop solar PV growth scenario.

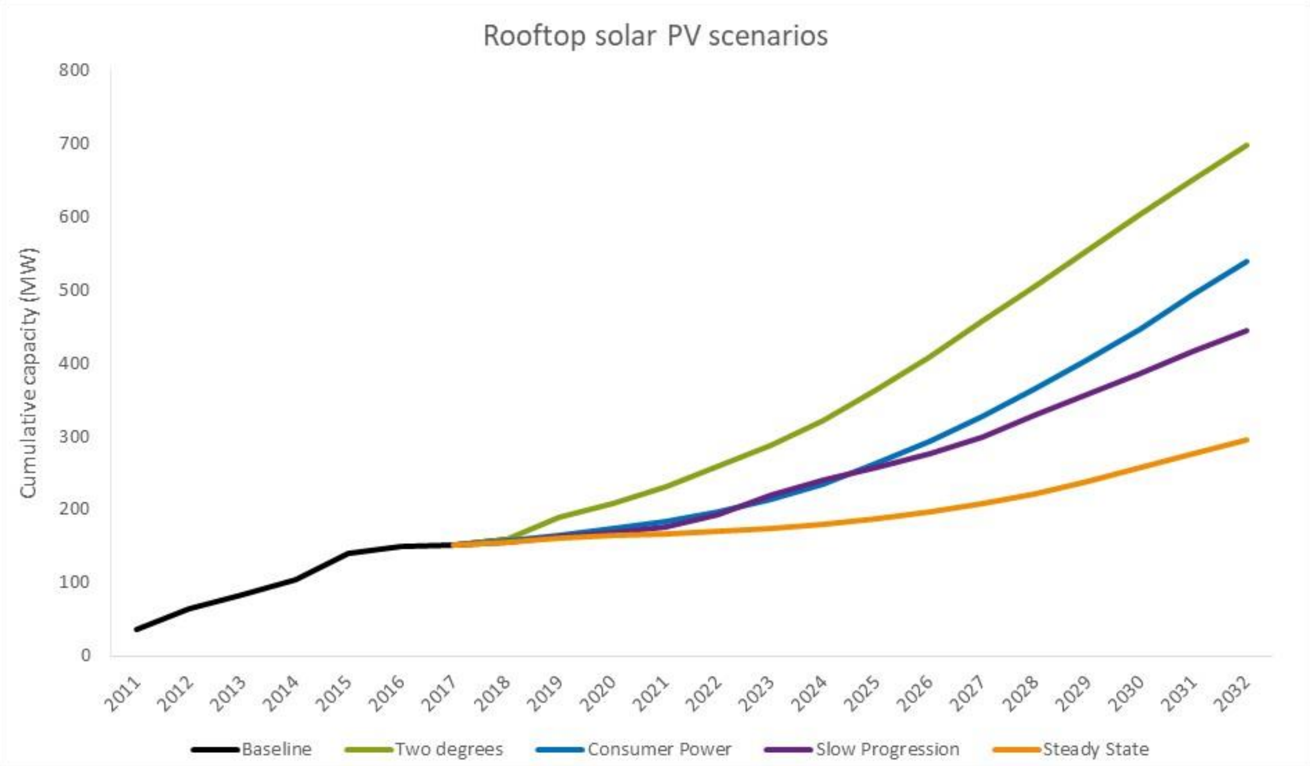



Table 8-2: Assumptions for factors influencing capacity growth for solar rooftop PV

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Government support** | | | | |
| Domestic retrofit support | **Small incentive offered post 2019** | **No subsidy past 2019** | **No subsidy past 2019** | **No subsidy past 2019** |
| Social housing PV support | **Incentive/subsidy offered post 2019** | **No subsidy past 2019** | **Incentive/subsidy offered post 2023** | **No subsidy past 2019** |
| New housing/retrofit regulations (Welsh Government) | **EPC and regulation incentives from early 2020s** | **No incentives** | **EPC and regulation incentives later in period** | **No incentives** |
| **Technology cost and payback** | | | | |
| Technology cost reductions | **Continued falls through scenario period** | **Continued falls through scenario period** | **Cost reductions slow down** | **No further cost reduction** |
| Payback periods for domestic installs | **Reach under 5 years in 2022** | **Reach under 5 years in 2025** | **Reach under 5 years in 2026** | **Reach under 5 years in 2032** |
| **Consumer factors** | | | | |
| PV with EV and battery improves investment | **Flexibility revenue /savings available from 2022** | **Flexibility revenue /savings available from 2028** | **Flexibility revenue /savings for commercial from 2028** | **No flexibility market developed – low EV take up** |

| | | | | |
|---|---|---|---|---|
| Affluence and economic growth | **Capital available to invest in PV** | **Capital available to invest in PV** | **Low growth with less money for investment** | **Low growth with less money for investment** |
| **Resource factors** | | | | |
| Licence area potential (high irradiance area) | **Continues to increase ahead of UK average** | **Stays ahead of UK average** | **Stays ahead of UK average** | **At UK average** |
| Geography of uptake | **Evenly spread amongst population** | **Concentrated more affluent areas** | **Evenly spread amongst population** | **Concentrated more affluent areas** |

### Relationship to FES 2017 and 2016 Scenario report

The scenarios are as a whole slightly lower than the Gone Green scenario in 2016 South Wales scenario, this is as a result of the unexpectedly long hiatus in new installations over the last two years. The Slow Progression projection is significantly lower than the other scenarios as it does not assume higher levels of social housing retrofit that have compensated for the hiatus in Two Degrees and Slow Progression.

Compared to FES, the Two Degrees scenario has greater levels of rooftop solar PV and Consumer Power is slightly lower than FES. In Two Degrees small-scale PV is expected to experience growth at the same time as subsidised support in areas such as social housing. FES assumes lower levels and strategic investment elsewhere, reflecting that rooftop is a relatively small contribution to achieving carbon targets. Slow Progression and Steady State scenarios are also slightly higher than FES reflecting the high solar irradiance of the area as well as the Welsh Government and local authority targets for renewables at a household level.

### Distribution of technology across ESAs

Unlike in the south west of England, there is a weaker correlation between the concentration of rooftop solar PV and affluence. In Wales, the impact of proactive investment by social landlords and community housing schemes has had a significant impact on distribution patterns.

The future capacity of rooftop solar PV has been projected separately by social housing, retrofit housing, new housing and commercial. These separate projections for capacity were distributed differently according to ESA levels of: social housing, new housing, existing housing and affluence, and commercial and industrial units respectively.

# 9. Anaerobic digestion

**The overall deployment potential of AD in South Wales will be limited by the available food waste resource and a lack of manure feedstocks.**

Anaerobic digestion (AD) deployment has been lower in South Wales than other WPD licence areas. In particular, the small number of cattle farms has meant fewer projects that use manure as a feedstock. There was a significant increase in AD projects commissioning in 2015 and 2016 thanks to sufficient FIT and RHI tariffs being available. However, growth stalled again in 2016 as a result of subsidy cuts.

The 2018 RHI reset and increases to RTFO (Renewable Transport Fuel Obligation) rates may revitalise the AD market with a focus on plants producing biomethane. However, the Welsh Government has strong policies to reduce food waste, which are already having an impact, reducing the available feedstock.

Table 9-1: Summary of growth in capacity of anaerobic digestion in WPD South Wales licence area

| MW | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 14.8 | 21.2 | 32.9 | 52.9 |
| Consumer Power | | 18.3 | 25.8 | 38.8 |
| Slow Progression | | 18.3 | 24.9 | 27.9 |
| Steady State | | 16.6 | 17.7 | 20.4 |

## 9.1. Baseline

This section excludes sewage sludge AD, which tends to operate to supply water treatment works with little direct impact on the electricity network.

There is 14.8 MW of installed AD capacity in South Wales from 25 projects.

2015 and 2016 were significant growth years for AD in the area, with over 80 per cent of the current total of AD capacity commissioned in this period. During this period, both the FIT and RHI tariffs were sufficient to incentivise new projects to develop.

The largest AD plant in Wales commissioned in January 2016 in Bridgend, a 3.2 MW AD plant, which processes municipal and commercial food waste. The vast majority of plants in South Wales are on farms and the average plant size for South Wales is just under 600 kW. The AD Portal Biogas Map shows there are fewer AD plants in South Wales than other regions[71] and there is a stronger bias towards plants that process waste[72]. This reflects the lower proportion of dairy/beef farms in the region and therefore the lower availability of cattle manure as a feedstock.

RHI and FIT tariff digressions in 2016 have stalled the market and no further projects have been commissioned since 2016 in the licence area.

AD deployment has been slower in the South Wales licence area than other areas such as the South West and West Midlands with developers citing the following factors:

- Fewer cattle farms

[71] AD biogas portal map shows fewer AD plants overall in the UK – the baseline for this study is more complete.

[72] https://www.google.com/maps/d/viewer?mid=1Qf92NTQfp73mglljO7i9YdoOMKk&ll=52.0926620793365%2C-3.6634978460913317&z=7

- Less affluent farmers: The current low return on investment that is available is only sufficient to attract project owners with available capital i.e. it is not high enough to allow for the cost of borrowing, reducing the pool of potential farmers able to develop schemes.
- High network connection costs

**Note on the baseline**

The baseline in the previous 2016 study was just 2.5 MW, as many of the 2015 and 2016 projects were yet to appear in the subsidy datasets due to time lags and errors in dataset publications. Some of the projects installed in 2015 and 2016 were not present in the 2016 study's pipeline either, which had 7.7 MW of accepted capacity.

The connections agreement database does not appear to give an accurate forecast for the AD deployment pipeline, perhaps because AD projects tend to be incorrectly categorised or not to appear at all in the data. As a result, the current installed capacity exceeds previous expectations for 2018 AD deployment in the 2016 study.

## 9.2. Pipeline

There are three projects in WPD's accepted-not-yet-connected database, a total of 2.1 MW of accepted capacity.

The increase in the RHI in 2018 for both biogas combustion and biomethane production is expected to have a limited but positive impact on the AD market.

Table 9-2: Anaerobic digestion assumptions on pipeline projects commissioning dates

| | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| Commissioning dates of pipeline projects | All go ahead after 2019 | All go ahead after 2021 | All go ahead after 2023 | Only some go ahead after 2026 |

## 9.3. Technology growth prospects

Anaerobic digestion can use a range of feedstocks to produce energy including:

- Food and drink waste from households
- Processing residues from food production
- Agricultural residues including manure and crop residues
- Energy crops grown such as maize
- Sewage sludge (not considered further here)

AD is suitable for a variety of different uses at different scales: processing food waste and manure; producing biomethane for the gas grid and transport; producing onsite electricity and heat; and generating electricity for export. There are different market drivers depending on the type of AD being considered.

**Limited potential for agricultural residue AD**

South Wales has a lower number of cattle farms than other regions, with roughly 1 million fewer cows than the south west of England for example73. As a result, there is lower potential for on farm plants that process manure in South Wales. The baseline data shows that where plants are developed on farms in South Wales they tend to use other feedstocks, such as processing, abattoir or food wastes.

Manure processing plants tend to be smaller in scale and are less likely to be suitable for biomethane production. The development of this type of plant across the UK has been negatively impacted by cuts to the FIT in 2016.

The government has introduced a requirement for at least 50 per cent of AD feedstock to be from waste (or residues) to receive RHI support, limiting the potential for using energy crops.74 This requirement further limits the potential for AD projects that do not have access to waste streams.

The growth potential of manure processing on farm projects is limited under all scenarios in the South Wales licence area.

**Subsidies for electrical generation**

Current low tariffs and deployment caps under the FIT are limiting deployment. However, if the FIT were to be increased again to previous higher levels, it could be a driver for further deployment of electricity generating plants.

**Subsidies and incentives focused on biomethane may drive sector towards gas production.**

[73] Figures analysed from south west data https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697021/regionalstatistics_southwest_04apr18.pdf and by estimating South Wales licence area data from https://gov.wales/statistics-and-research/welsh-agricultural-statistics/?lang=en

[74] https://www.legislation.gov.uk/ukdsi/2018/9780111166734/pdfs/ukdsiem_9780111166734_en.pdf

**Development of the biomethane market**

RHI tariffs for heat and biomethane production from AD were reset to 2016 levels in spring 2018. This is expected to provide a boost for the industry.75 In September 2017 the Department for Transport announced a doubling of the supplier obligation on renewable fuels to 9.75 per cent by 2020, along with increased Renewable Transport Fuel Obligation rates.76 They also declared that biomethane and AD are 'perfectly positioned' to meet the targets.77

To access these revenues, it is likely that a proportion of new AD plants will skew towards biomethane injection to the gas network or for transport fuels rather than biogas for electricity production. This means new plants may have less impact on the electricity network and face fewer network constraints.

As a relatively mature technology, opportunities for cost reduction are low, and price parity is unlikely to be achieved in the near or mid-term. The continuation of government subsidies for heat and biomethane is a key factor considered in the scenarios.

**Waste feedstocks availability**

A key barrier for AD is feedstock availability. Cadent's report on the potential future sources of biogas (bioSNG and biomethane) suggests a limited role for AD technologies compared to gasification, based on the low availability of both food waste and manures[78].

**Availability of fuel sources will limit future size of market. Welsh Government has ambitious food waste reduction targets.**

Food waste collections are important for improving fuel supply and improving gate fees for AD. Wales already has one of the highest rates of food waste collection in the world with 89 per cent of local authorities in Wales having separate food waste collections[79]. This is significantly higher than England where 45 per cent of councils offer no food collection at all. Wales' ambition is to cut food waste by 50 per cent by 2025 against a 2006-07 baseline and Wales' household waste in 2017 was already lower than the rest of the UK by around 9 per cent. The resource availability of municipal food waste is therefore scheduled to decrease significantly over the scenario period, reducing the potential for further municipal food waste plant development. The scenarios consider food waste availability as a key factor.

**Scenario summary**

Growth remains muted in the licence area across the lower growth scenarios as a result of the lack of FIT, low availability of residue feedstocks and high waste reduction targets, coupled with lower levels of affluence than other licence areas.

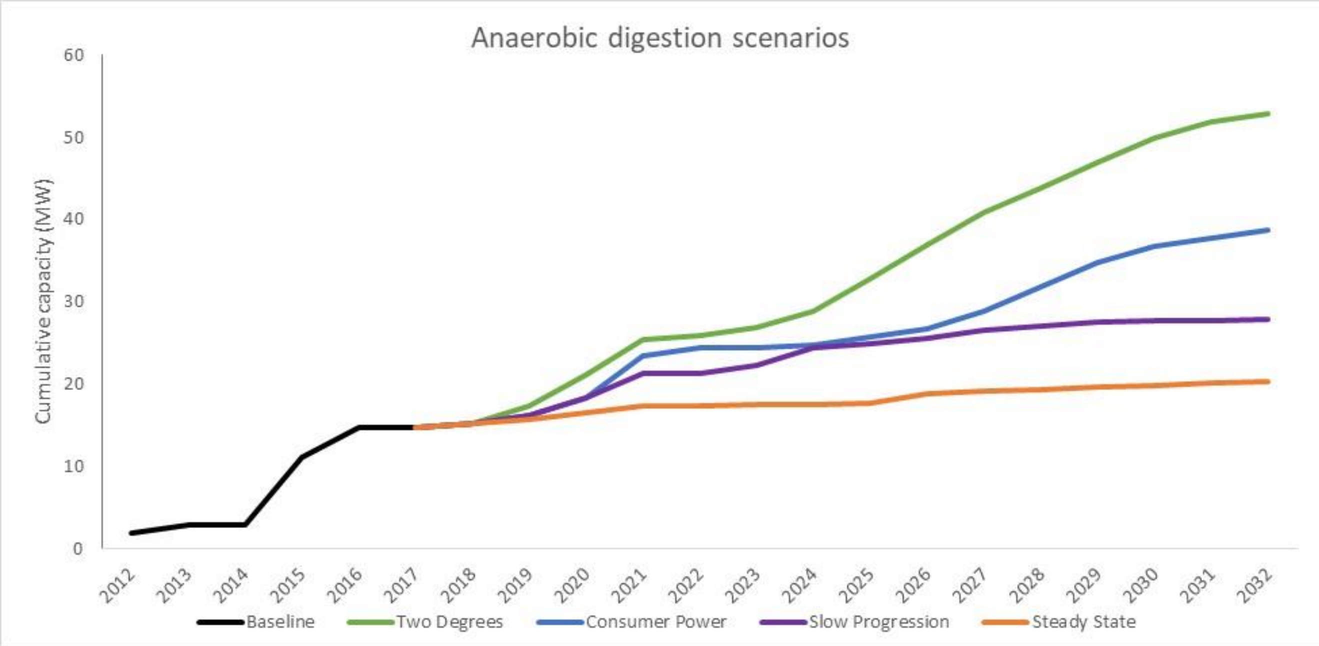
Two Degrees has higher growth with a replacement for the FIT post-2019 increasing the number of electricity generating plants, as well as a high number of new plants focusing on biomethane production.

Consumer Power sees a larger number of small plants focussed on electricity production. Slow Progression sees a slow pace of development due to a lack of investment capital and lack of FIT. Steady State sees deployment continuing at a low rate to take advantage of the available resource where possible.

[75] http://adbioresources.org/news/press-release-anaerobic-digestion-industry-welcomes-laying-of-rhi-legislati
[76] https://www.gov.uk/government/consultations/renewable-transport-fuel-obligation-proposed-changes-for-2017
[77] http://adbioresources.org/news/press-release-biomethane-perfectly-positioned-to-meet-new-renewable-fuel-ta
[78] https://cadentgas.com/getattachment/About-us/The-future-role-of-gas/Renewable-gas-potential/Promo-Downloads/Cadent-Bioenergy-Market-Review-SUMMARY-Report-FINAL-amended.pdf
[79] http://adbioresources.org/news/how-are-we-doing-on-separate-food-waste-collections

## 9.4. Scenario results

Figure 9-1: WPD South Wales licence area AD growth scenarios




### Relationship to FES 2017 and 2015 Scenario report

The FES 2017 data does not include details of AD potential as a separate category; it may be contained within "other renewable generation". As a result, a comparison cannot be made between these scenarios and the FES 2017.

The 2018 baseline is significantly higher than the 2016 baseline for South Wales, due to a significant spike in installations in 2015 and 2016. As a result of this and the additional emphasis the UK government has placed on the role of AD in biomethane production, the 2018 scenarios are considerably higher and different in shape to those produced in 2016.

### Distribution of technology across ESAs

The scenario projects are distributed based on several spatial factors including total availability of higher grade agriculatural land within each ESA. Peri-urban ESAs were also weighted for higher AD deployment, as these locations are close to both potential food waste and agricultural resources and contain brownfield development locations. Under those scenarios with the most available food waste (Consumer Power and Steady State), these peri-urban ESAs see higher levels of connected AD.

Table 9-3: Assumptions for factors influencing capacity growth for anaerobic digestion

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| | | | | |
| Subsidy available for electricity generation from AD | **FIT is continued post-2019 at viable level** | **No subsidy for electricity** | **No subsidy for electricity** | **No subsidy for electricity** |
| RHI incentive for biomethane plants | **Remains high, with support extended after 2021 (which is the current cut-off date). Focus is on biomethane plants.** | **Remains high, with no further support after 2021. Greater focus on electricity and heat production.** | **Remains high, but with very limited support after 2021. Focus is on biomethane plants.** | **Remains high, with no further support after 2021. Greater focus on electricity and heat production.** |
| RTFO | **Strict transport emissions regulation incentivises production of biomethane, rather than electricity generation from AD** | **Limited incentive to use AD to produce road fuels, focus remains on electricity generation** | **Delayed transport emissions regulation incentivises production of biomethane later in the period** | **Limited incentive to use AD for road fuels, focus remains on electricity generation** |
| Availability of food waste | **Low resource availability: High levels of food waste collection offset by achievement of 50% waste reduction target mid-decade** | **Medium resource availability: High levels of food waste collection continue and waste reduction target is achieved later in decade.** | **Low resource availability: High levels of food waste collection offset by achievement of 50% waste reduction target mid-decade** | **High resource availability: High levels of food waste collection continue and waste reduction target is missed.** |
| Availability of finance and R&D improves efficiencies | **Capital is available to develop and expand sites** | **Large numbers of small scale plants are developed** | **Low availability of capital dampens deployment rates despite subsidy schemes** | **Low availability of capital dampens deployment rates** |

# 10. Energy from waste

There is limited scope for new energy from waste (EfW) incineration plants in the South Wales licence area as the Cardiff energy recovery facility is set to expand, processing domestic waste from across southern Wales.

In the long term, new capacity growth will depend on largely unproven ATT (Advance Thermal Treatment) plants, which aim to produce synthetic gas from municipal waste for combusting to generate electricity, for injection to the gas grid or for road transport fuels.

**Growth of the EfW market in South Wales will depend on the successful development and incentivisation of ATT technologies.**

Table 10-1: Summary of growth in capacity of EfW in WPD South Wales licence area.

| Energy from Waste (MW) | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 124 | 124 | 162 | 180 |
| Consumer Power | | 124 | 162 | 191 |
| Slow Progression | | 124 | 128 | 180 |
| Steady State | | 124 | 128 | 128 |

## 10.1. Baseline

Current EfW capacity in South Wales totals 124 MW from 4 projects:

- Trident Park EfW is a Cardiff energy recovery facility with a 39.7 MW connection agreement. It was commissioned in 2014. The facility produces energy from waste from nine local authorities; originally Cardiff, Newport, Monmouthshire, Vale of Glamorgan, and Caerphilly, now expanded to also include waste from Rhondda Cynon Taf, Merthyr Tydfil, Blaenau Gwent and Torfaen councils. It diverts 95 per cent of South Wales' residual waste away from landfill.
- Crymlyn Burrows Materials Recovery and Energy Centre, in Neath Port Talbot, is a 5 MW incineration plant commissioned in 2002. Despite issues with its operation and holding business, it appears to still be operational and processing municipal waste from Neath Port Talbot[80]. This project was previously mis-categorised in the baseline data as "other generation."
- A waste wood gasification plant in Barry Docks began generating in 2018 and is in the baseline with a connection agreement for 11.7 MW.
- Magram Green Energy Plant in Port Talbot, a waste wood power station with a 49 MW connection agreement which will import waste wood chips from across the UK. The plant is under construction and due to fully commission in 2018.

[80] https://orca.cf.ac.uk/87466/2/1-s2.0-S0305900615300015-main.pdf

## 10.2. Pipeline

The pipeline of projects from the WPD accepted-not-yet-connected database is limited to three sites.

One is an incineration project:

- An extension to Trident Park in Cardiff. The site operator has secured a planning amendment to increase the volume of waste processed by the facility by 21 per cent and to increase the power output by 3.6 MW.

The other two projects with an accepted grid connection plan to use gasification technology, instead of conventional incineration. These plants are:

- An 18.75 MW ATT plant in Hirwaun, which appeared in the pipeline in the 2016 South Wales scenario. The project was due to commission in March 2018 under the terms of its CfD. Its construction has been delayed and the developer is currently considering a revised construction schedule and is seeking changes to its CfD[81].
- A 15 MW ATT plant in Cardiff, which does not have a CfD in place and is yet to submit a planning application[82].

Table 10-2: Pipeline assumptions for Advanced Thermal Treatment plants

| ATT pipeline capacity (MW) | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| 33.75 | Projects go ahead from 2022 | Projects go ahead from 2024 | Projects go ahead from 2026 | Projects do not go ahead |

[81] https://lowcarboncontracts.uk/cfds/enviroparks-hirwaun-generation-site
[82] http://www.cogenuk.com/featured/lockheed-martin-cogen-build-energy-waste-plant-wales/

## 10.3. Technology growth prospects

**Availability of resource**

**The EfW sector is ultimately limited in growth by the availability of waste resource, with the Welsh Government setting a zero waste target.**

The key variable for the future development of EfW is the availability of the waste resource. Industry sources differ on when they believe EfW capacity will exceed supply as it will depend on variables such as the level of export or import of waste to the EU post Brexit, the setting and achievement of recycling targets and the availability of untapped resources such as commercial and industrial waste. The Welsh Government has set a target for Wales to become a zero waste nation by 2050 and its waste strategy sets out that "there will be far less need for residual waste treatment facilities such as 'energy from waste' plants with the number and/or capacity required progressively reducing from 2025 to 2050[83]."

**Subsidy availability**

The UK government no longer offers subsidy support for new mass burn EfW facilities; the business models for new incineration EfW facilities are built on a combination of gate fees and energy generation.

**As the biogas market takes off, there is potentially a significant role for ATT technologies.**

ATT projects were eligible for Round 2 of the CfD, with six contracts awarded to projects in 2017 totalling 64 MW.[84] Round 3 of the CfD is due to take place in 2019 and ATT projects are currently eligible.

ATT projects can also produce biogas for direct injection into the gas grid or use in transport, with subsidy support available through the RHI and the RTFO. If the market for biogas accelerates, there is likely to be an upsurge of interest in ATT[85] [86]. In particular, there may be opportunities for small scale ATT plants to develop processing commercial waste streams, such as medical waste for example.

**National Grid embargo on dispatchable plant**

The South Wales licence area is experiencing significant network constraints at a transmission level. Pending upgrades to the transmission system expected sometime between 2026 – 2028, new controllable generation that can run at peak times including energy from waste will not be able to connect to the network in the licence area. This embargo is considered in the scenario factors, but the expected slow development of projects means that it is unlikely to have a significant impact.

**ATT development**

There are few ATT plants successfully operating in the UK, with issues around the reliability of the technology and projects failing to commission as a result. Further investment is needed in ATT to develop a reliable technology.

There is an active network of opposition to proposed EfW facilities, including ACT plants despite their lower local impacts. Opposition focuses on not reclaiming the valuable resources in residual waste as well as local

[83] https://gov.wales/docs/desh/publications/100621wastetowardssummaryen.pdf
[84] https://www.mrw.co.uk/latest/act-and-biomass-schemes-backed-in-cfd-auction/10023285.article
[85] https://www.endswasteandbioenergy.com/article/1464257/cadent-highlights-biosng-potential
[86] http://www.barrowgreengas.co.uk/industry-news/2016/5/4/biogas-comes-of-age

pollution concerns[87]. Based on the UKWIN[88] interactive map of sites, around 50 per cent of proposed EfW and ACT sites have been effectively opposed or have otherwise failed to progress.

**Potential sites in the South Wales licence area**

There are five further projects that have seen some development activity in South Wales and could potentially be brought forward by 2032. These sites do not have a grid connection offer and have either been refused planning or failed to progress.

- Biffa's 0.4 MW incineration plant at Swansea Enterprise Park. An initial proposal was rejected by planning committee in March 2018.[89]
- A pilot small scale ATT plant on the Severn Bridge Industrial Estate. The developer went into administration in March 2018 and Monmouthshire County Council dismissed the planning application based on the developer's insolvency in April 2018.[90]
- An 18 MW pyrolysis plant at Cwmgwili to process commercial waste. The plant was refused planning permission in February 2016[91] but still appears on the developer's website as a project.[92]
- A gasification plant at Newport Docks which was granted planning in 2009 but has failed to progress.[93]
- A potential site proposed by the Central Wales Waste Partnership near Swansea that was opened to the market in 2013 but no further developments have been announced.[94]

### Scenario summary

Since 2016, the Trident Park extension has been consented and this plant is due to incinerate the vast majority of the residual waste resource in South Wales. A further small scale municipal waste plant is under development in Swansea but was recently refused planning. Under the scenarios with green ambition, no further incineration plants are developed in the licence area. Under Consumer Power and Steady State, the larger resource availability means a Swansea EfW is developed with a larger capacity than currently proposed.

Based on the factors considered, ATT is treated as follows under each scenario:

- Two Degrees: 3 ATT plants with focus on biogas post-2024 due to subsidies driving this market
- Consumer Power: ATT plants at 4 main locations due to resource availability with focus on electricity generation until 2030
- Slow Progression: 2 ATT with focus on biogas in late 2020s/early 2030s due to slow technology development.
- Steady State: lack of investment in ATT technology means that ATT projects fail to progress and the remainder of the resource is exported.

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[87] http://ukwin.org.uk/
[88] UK Without Incineration Network
[89] https://www.swansea.gov.uk/media/25514/Decisions-for-week-ending-9-March-2018/pdf/Decisions_for_week_ending_9_March_2018.pdf
[90] https://www.endswasteandbioenergy.com/article/1463177/pilot-gasification-plant-refused-planning-consent
[91] https://www.bbc.co.uk/news/uk-wales-south-west-wales-35491806
[92] http://www.cleanpowerproperties.com/projects.html#
[93] http://ukwin.org.uk/map/
[94] http://ukwin.org.uk/map/

## 10.4. Scenario results

Figure 10-1: WPD South Wales licence area EfW growth scenarios

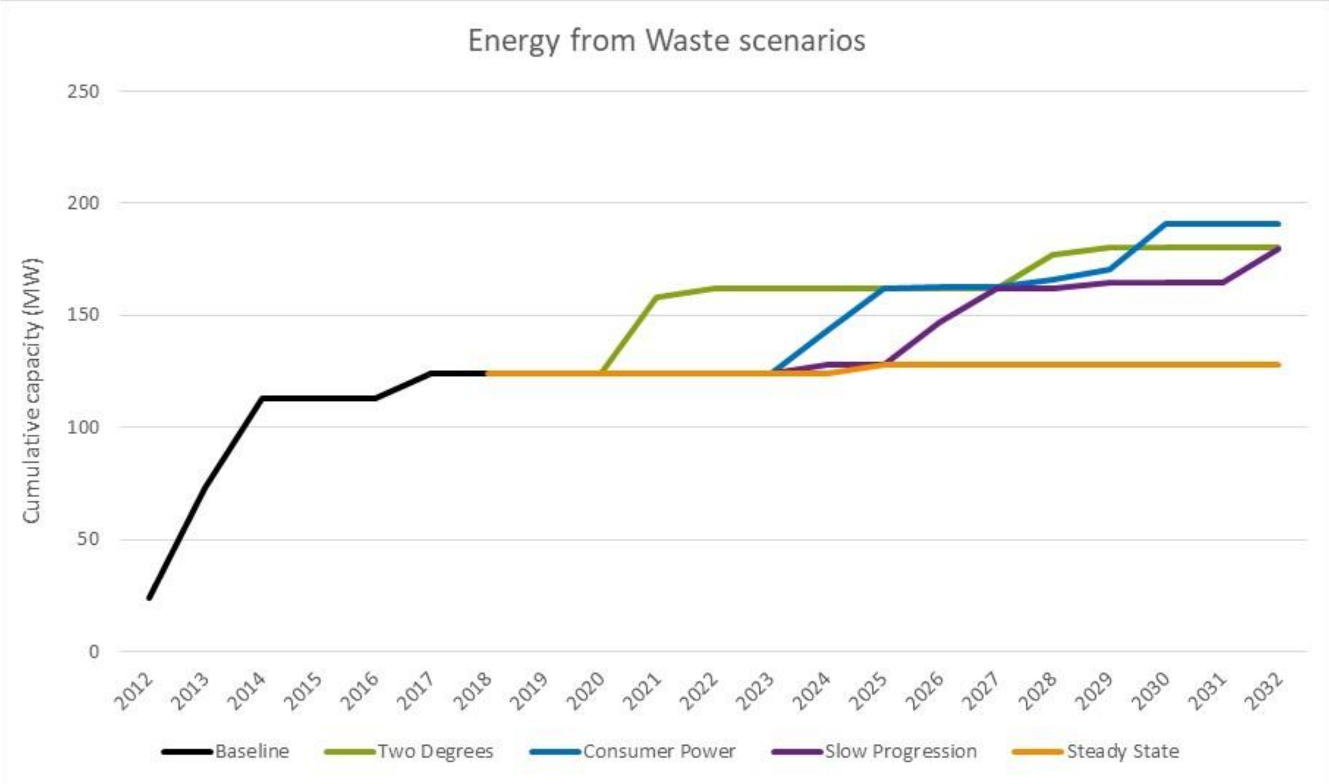



Table 10-3: Assumptions for factors influencing capacity growth for EfW

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and government support** | | | | |
| Subsidy for biogas production and government regulation of market affecting whether ATT plants focus on biogas or electricity production | **Market regulation and subsidy support for biogas production from early 2020s** | **No market regulation or subsidy available leads to focus on electricity generation until early 2030s** | **Market regulation and subsidy support for biogas production from mid 2020s** | **No market regulation or subsidy available** |
| Resource availability | **Low waste resource availability: High recycling rates and lower waste production** | **Medium waste resource availability: engaged consumers lead to higher recycling rates but lack of strong government policy** | **Low waste resource availability: High recycling rates and lower waste production** | **Highest waste resource availability: Lower recycling rates and lack of government policy** |
| Available network capacity in South Wales | **South Wales network constraint preventing new** | **South Wales network constraints preventing** | **South Wales network constraints** | **South Wales network constraints** |

| | | | | |
|---|---|---|---|---|
| | **EfW capacity is mitigated by 2020/2021** | **new EfW capacity is mitigated in 2022** | **remain in force until 2026** | **remain in force until 2026 and limited capacity is available thereafter, causing a slow uptake in new EfW projects in the region** |
| **Technology cost and performance** | | | | |
| ATT development | **Investment in R&D leads to development of reliable ATT biogas technology, including small scale plants** | **Investment in R&D leads to development of reliable ATT electricity generation technology, including small scale plants** | **Lack of investment leads to slow progress in developing ATT** | **Lack of investment leads to slow progress in developing ATT** |

### Relationship to FES 2017 and 2016 Scenario report

The FES 2017 data does not include details of EfW potential as a separate category; it may be contained within "other renewable generation". As a result, a comparison cannot be made between these scenarios and the FES 2017.

This study's scenarios differ significantly from the 2016 study. The 2016 study hypothesised one further large scale incineration plant in the Swansea area under all the scenarios except Steady State where no development occurred. With the extension of Trident Park in Cardiff now agreed, there is little scope for additional municipal waste plants (which tend to be incineration) and so there are no additional incineration plants in the scenarios for this study.

The 2016 study did not consider the potential for further ATT plants in the licence area as few plants had been successfully developed in the UK at that point and high profile failures were dominating the market. Since then a number of ATT plants have successfully commissioned and there has been an uplift in projects reaching the construction phase as a result this study sees a number of ATT plants potentially being developed under different scenarios.

### Distribution of technology across ESAs

Energy from waste is a large scale technology likely to be concentrated in a small number of sites, rather than distributed across the licence area. EfW plants take a significant time to develop and require both a suitable industrial site with good transport links and an identified resource. There are potential sites which have been progressed to some extent at Cwmgwili, Swansea, Newport and Portskewett.

As a result, the methodology for this chapter is focussed on existing sites with some development potential and whether or not they progress under different scenarios. The sequence of development for these projections under the scenarios has been considered with an understanding of the local planning environment and the distribution of previous developments. Other sites could come forwards during the scenario period, but it is difficult to predict the location of new potential sites. Existing sites have been used as a proxy to indicate the potential scale, timing and location of development.

# 11. Hydropower

Hydropower capacity in South Wales is dominated by a small number of large projects. 95 per cent of projects in the area are small scale, low head schemes. Whilst there remains a significant number of low head opportunities in the area, the current low subsidy and high hydro costs mean that deployment is likely to be limited under all scenarios.

**Hydropower is a mature technology with cost reductions unlikely to have an impact on deployment rates in the near term.**

Table 11-1: Summary of growth in capacity of hydropower in WPD South Wales licence area.

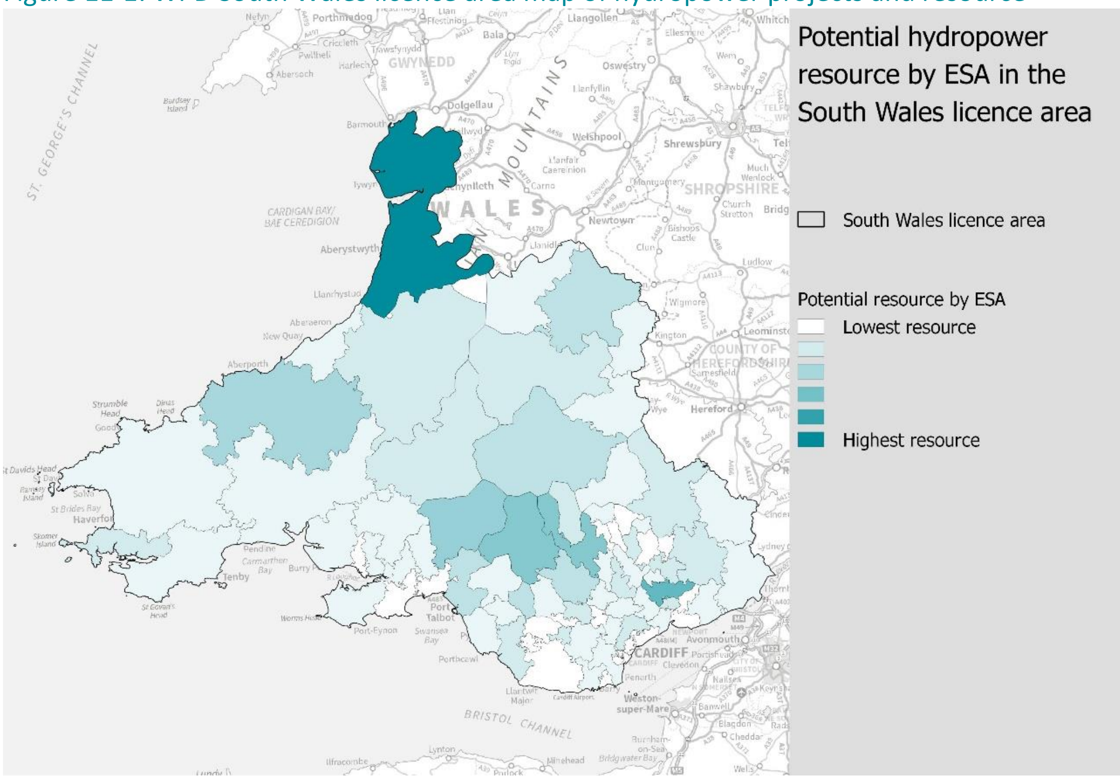
| Hydropower capacity growth MW) | 2017 | 2020 | 2025 | 2032 |
|---|---|---|---|---|
| Two Degrees | 69 | 71 | 77 | 90 |
| Consumer Power | | 71 | 72 | 79 |
| Slow Progression | | 71 | 71 | 73 |
| Steady State | | 71 | 71 | 72 |

## 11.1. Baseline

There is just over 69 MW of hydro projects in the South Wales licence area, from 101 projects. One large project dominates this total, the 56 MW Rheidol hydropower station commissioned in 1962. There are five further projects with a capacity of 1 MW or more. Excluding these six large scale projects, the total capacity of the remaining 95 projects is just 3.5 MW.

Capacity growth peaked in 2015, with 912 kW installed from 21 projects. Since 2015, FIT subsidies have been cut and as a result, growth fell to 242 kW from eight projects in 2016 and 119 kW in 2017 from three projects.

Figure 11-1: WPD South Wales licence area map of hydropower projects and resource



## 11.2. Pipeline

There are two projects in the pipeline: one 1.8 MW project and one 7 kW project. One other project featured in the 2016 pipeline, a 1.68 MW project, but this has since been dropped.

The 1.8 MW pipeline project, Ystradffin Hydro Power Station[95], was present in the 2016 South Wales pipeline. It has now received planning permission and is expected to commence construction in 2018. It is assumed that the project commissions in 2019 under all scenarios except Steady State where it is delayed to 2020.

There are no details available to enable identification of the 7 kW project. It is assumed that the project commissions in 2019 under all scenarios, except Steady State where the project fails.

## 11.3. Technology growth prospects

Hydropower developers are currently focused on high head sites in North Wales and Scotland – and under current market conditions this is likely to continue. In the South Wales licence area, the hydropower resource tends to be low head. Many sites with optimal conditions and larger sites have already been developed. Although there are potentially numerous feasible smaller sites in South Wales, these will have relatively higher costs.[96] As a result, the growth potential is limited under all the scenarios.

**Subsidy availability**

Hydropower is a predictable and reliable renewable energy resource. However, it is relatively expensive to deploy, limiting its growth potential. Each project requires detailed technical feasibility studies and permitting, as well as being subject to high upfront capital costs. Civil engineering costs make up a large proportion of installation costs.

**Hydro technology installation costs remain high and much lower subsidies means few projects are economically viable.**

The technology is relatively mature, with limited market scale, and so unlikely to see the type of cost reductions that other renewable technologies are expected to achieve; it is unlikely that hydropower will be widely viable without further subsidies in the near or mid-term. The current level of the FIT is below what is needed to incentivise high levels of hydropower deployment. The FIT is due to end in April 2019, with no current proposals to replace it.

**Business rates**

Increases to business rates in 2017 were set to negatively affect the viability of hydropower in Wales. However, the Welsh Government subsequently capped the increase at 10 per cent or £1,000 for projects with an annual rateable value up to £50,000, as well as offering 100 per cent relief to community owned hydropower projects.[97]

[95] http://www.envsys.co.uk/projects/ystradffin-hydropower-project/
[96] http://www.renewablesfirst.co.uk/hydropower/hydropower-learning-centre/how-much-do-hydropower-systems-cost-to-build/
[97] http://www.british-hydro.org/good-news-at-last-for-business-rates-and-hydropower-in-wales/

**Environmental permitting**

Environmental requirements increase the cost of installing even the smallest scale hydro projects. Eel regulations were introduced in 2009 and can cause major difficulties for some low head schemes. In March 2016, the UK government proposed new legislation requiring the removal of river obstructions or the building of fish passes to provide a route around or through these hurdles.[98] The legislation is yet to be passed. There are opportunities for hydropower projects to benefit river ecosystems offering win-wins, e.g. by installing fish passes around existing barriers.

**New business models**

**Hydropower has the potential to underpin new local supply models.**

Small-scale hydropower traditionally has high public approval and is appealing to community energy groups and landowners who are attracted to generating energy from this very visible resource in their area. The Welsh Government is particularly supportive of locally owned projects, with its target of 1 GW of locally owned electricity generation by 2030[99].

Hydropower has the potential to play a role in the development of local energy markets. For example, the Energy Local project in Bethesda, North Wales, is trialling a local energy club that uses the electricity generated from a local hydropower project[100]. In addition, the predictable nature of hydropower generation, alongside its potential to store energy, make it a suitable technology to potentially provide flexibility and balancing services

Growth in the numbers of installations will depend on improving the level of government subsidy and keeping business rates low, on recognition of its potential ecological benefits and on business models being available for local communities to develop projects.

[98] http://www.renewablesfirst.co.uk/hydropower/hydropower-consenting/hydropower-environmental-consenting/
[99] https://gov.wales/newsroom/environmentandcountryside/2018/180112-share-your-story-on-locally-owned-renewable-energy/?lang=en
[100] http://www.energylocal.co.uk/cyd-ynni/

## 11.4. Scenario results

Figure 11-2: WPD South Wales licence area large and small scale hydropower growth scenarios.

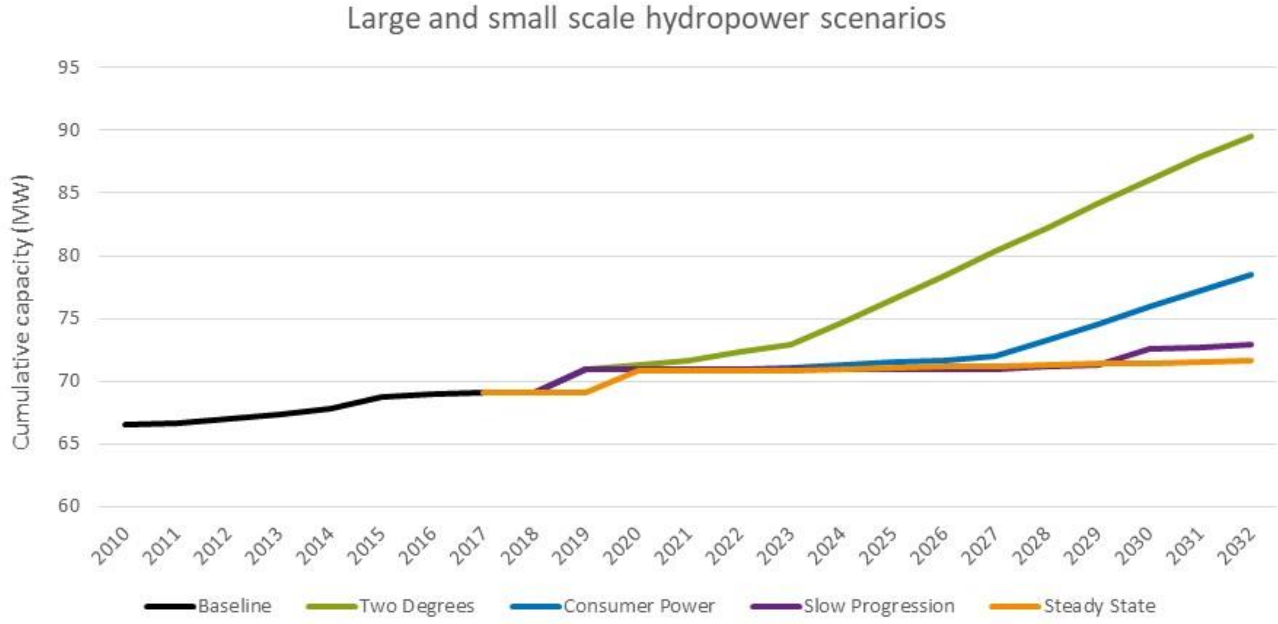



Table 11-2: Assumptions for factors influencing capacity growth for hydropower in South Wales

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and Government support** | | | | |
| Subsidy availability | **Replacement for FIT for hydro post-2019 with higher tariffs** | **Subsidy available for community projects post-2019** | **No subsidy** | **No subsidy** |
| Business rates | **Welsh Government continues to grant business rates relief to all scales of hydropower** | **Welsh Government grants business rates relief to community hydropower projects only** | **Welsh Government grants limited business rates relief** | **No business rates relief** |
| Environmental permitting | **Environmental improvement opportunities from hydropower recognised, facilitated and incentivised** | **Fishing groups successfully lobby for more extant environmental permitting for hydropower projects.** | **Environmental improvement opportunities from hydropower recognised but not incentivised.** | **Current environmental permitting requirements are sustained** |
| **Technology cost and performance** | | | | |
| New business models | **Business models that enable hydropower to play a role in flexibility and balancing markets are developed** | **Local supply models are rolled out more widely** | **New business models are slower to develop** | **Hydropower projects remain focussed on standard business models.** |

### Relationship to FES 2017 and 2016 Scenario report

The scenarios are broadly in line with those proposed in the 2016 study. The Two Degrees scenario is marginally higher than the previous study as a result of Welsh Government introducing the business rates exemption for hydropower in 2017; it is assumed under Two Degrees that this positive stance on hydropower is continued, along with higher subsidies and a positive proactive approach to permitting. Similarly, Consumer Power sees business rate relief and a subsidy for community hydropower projects, unlocking this sub-sector in South Wales. Slow Progression and Steady State have been marginally reduced compared to the 2016 study, reflecting current very low deployment rates and no further FIT.

Predicted growth rates under all the scenarios are far lower than those used for the whole of Great Britain in the FES 2017. This is due to the low head resource in the area; higher growth rates that skew the national average upwards are likely to be seen in North Wales and the Scottish Highlands. It is assumed that there will be no further large scale hydropower projects in the licence area under any of the scenarios.

### Distribution of technology across ESAs

The scenario projections are distributed across the licence area based upon the baseline trends – where growth has previously been – as well as the technical potential for hydropower within the ESA. The baseline trends have been analysed for different capacity scales to reflect the impact of scale on distribution.

# 12. Marine and offshore energy

Despite significant potential and Welsh Government support for the marine energy sector (wave, tidal and floating wind), there are no live projects in the licence area. There is however, the Pembrokeshire demonstration zone with backing from European Structural Investment Funding (ESIF) and a Marine Energy Test Area (META) in Milford Haven, with backing from ERDF.

With tidal and wave experiencing a prolonged development and demonstration phase, the lack of UK government subsidy support means that in the short and medium term any projects are likely to remain small scale. However, in green scenarios, deployment is expected to accelerate towards the end of the period.

| Marine capacity (MW) | 2025 | 2032 |
|---|---|---|
| Two Degrees | 40 | 100 |
| Consumer Power | 0 | 60 |
| Slow Progression | 0 | 20 |
| Steady State | 0 | 20 |

## 12.1. Baseline

The current baseline covers one tidal demonstration project of 15 kW. The DeltaStream tidal technology was installed in Ramsey Sound the Haverfordwest Grid ESA in 2016 but operated for only three months until a failure in the sonar meant it needed to be shut down. The project is no longer operating and has been decommissioned.

## 12.2. Pipeline

There are no currently no marine technology projects in the pipeline in the licence area, however, testing and demonstrators remain active in the area. Marine Power Systems WaveSub prototype is currently undergoing sea testing (non-moored) in Milford Haven and the developer remains optimistic for a 2020 commercialisation and ultimately targeting a 30 MW wave farm. [101]

Wales has a significant amount of wave and tidal stream resource, both off the coast of Pembrokeshire, into the Celtic Sea and off the coast of Anglesey. The development of marine energy is also seen as a strategic priority by the Welsh Government. This is supported by the Marine Energy Wales partnership and an active marine energy sector, particularly around the port of Pembroke and the Haven Enterprise Zone. Tidal demonstration projects have been deployed in Ramsey Sound and there is now a designated wave energy demonstration zone off the coast of Pembrokeshire.

The Welsh National Marine Plan has also identified Strategic Resource Areas for marine energy, providing clear policy support from a planning perspective. The Swansea Bay City Region Deal includes proposals for the development of a major marine energy centre at Pembroke Dock.

[101] http://marinepowersystems.co.uk/unchartered-territories-building-the-uk-into-a-21st-century-maritime-nation/

## 12.3. Technology growth prospects

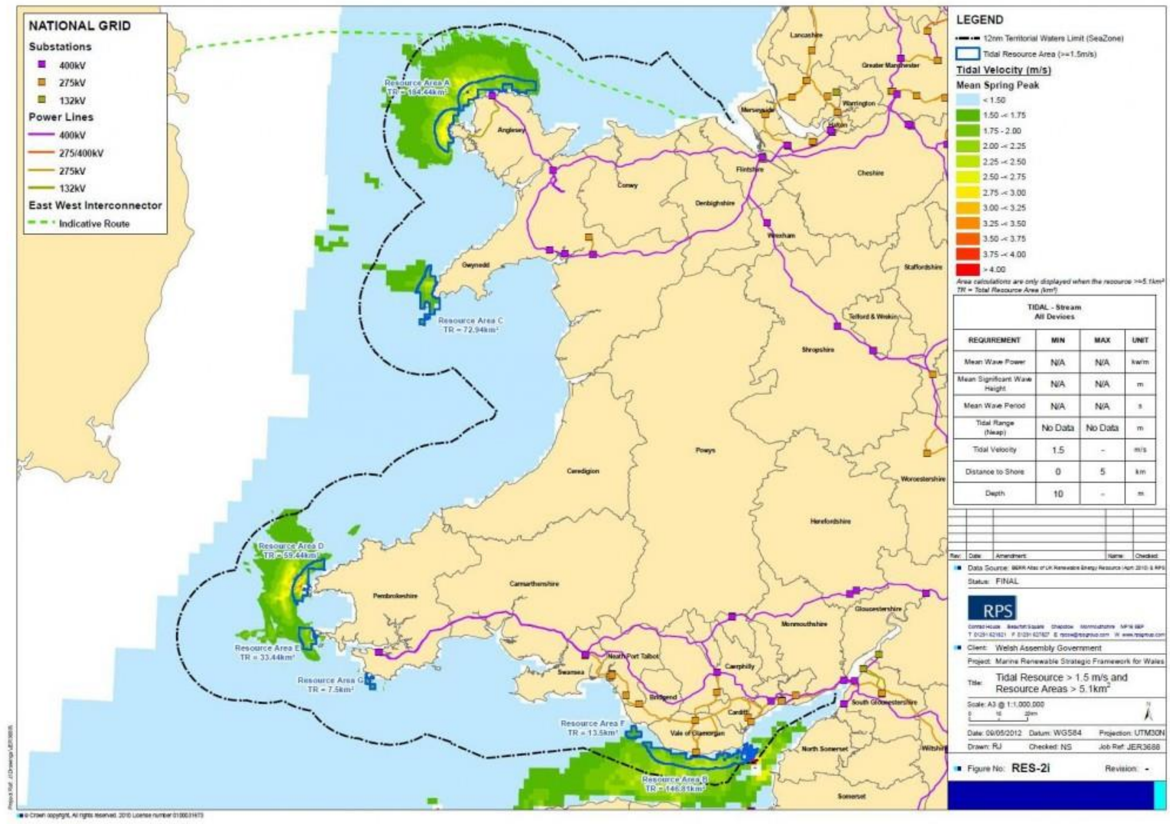
The development of marine energy, wave, tidal and offshore wind is a strategic priority for Wales. Marine Energy Wales was set up in 2016, building a pan-Wales platform from the Pembrokeshire Coasting Forum and formally linking existing demonstration zones in Pembrokeshire and Anglesey.

UK government financial support however is currently heavily weighted to offshore wind following the success of the technology in reducing costs. The less developed marine technologies such as tidal stream and wave energy are currently unable to compete with the more mature offshore wind technology for access to government support.

In 2006, PMSS carried out a high-level study of tidal and wave resource in Wales, which provides an estimate of the available resource surrounding the South Wales coastline.[102] The breakdown of potential capacity can be seen in the map below and potential by technology type was calculated as:

- 5.6 GW wave energy
- 910 MW shallow water tidal stream resource
- 640 MW deeper water tidal stream resource

Figure 12-1: Wave and tidal in Wales. Image courtesy of Marine Energy Pembrokeshire[103].




[102] http://www.marineenergywales.co.uk/wp-content/uploads/2016/01/Marine-Renewables-in-Pembrokeshire-Marine-Energy-Task-Group-for-Wales.pdf

[103] http://www.marineenergypembrokeshire.co.uk/wp-content/uploads/2010/04/Tidal-resource-for-Wales-MRESF-1024x718.jpg

Whilst the energy potential of marine renewables in South Wales is large, with both tidal stream and wave energy technologies remaining in a prolonged period of technology development and demonstration, most of this resource will be developed after 2032. Without new sources of financial support from the UK government, projects are likely to remain relatively small scale and focused at the existing sites in Pembrokeshire Demonstration Zone and Ramsey Sound/St David's Head. Once the technology matures the demonstration zone has a full potential of 180 MW.

For the scenarios it is assumed that if any potential large-scale tidal range or offshore wind project are constructed in the period to 2030 they will connect directly to the National Grid Transmission network and so would not be considered as distributed generation. In June 2018, the UK government made the decision not to support the planned Swansea Bay Tidal Lagoon, which has delayed the project further.

In order to develop successfully, the marine technologies need to achieve the following milestones.

1. Technology development – proving the reliability and performance of new technology
2. Success of a series of pilot and demonstration projects
3. Access to resources including the planning and consenting process
4. Access to finance – which will initially require collaboration between public and private sector investment
5. Policy and political support for the sector – both regionally and UK

Tidal stream and wave energy technologies are still in stage 1, a period of technology development and demonstration. Floating wind however has moved to stage 2 with number of successful demonstration projects deployed in 2017. The projects have turbines that generate between 5-6 MW.

**Floating wind is expected to be the next technology to commercialise successfully. Wave and tidal remain in technology development phases for the medium-term.**

As a result, the Pembrokeshire Demonstration Zone recently announced plans for floating wind and speculated that the first floating wind project could be operational by 2024.[104] It is hoped that having floating wind closer to successful commercialisation would also help the development of wave power on the site.

[104] https://www.walesonline.co.uk/business/business-news/plans-floating-wind-farm-pembrokeshire-14326983

## 12.4. Scenario results

Figure 12-2: WPD South Wales licence area marine and offshore growth scenarios.

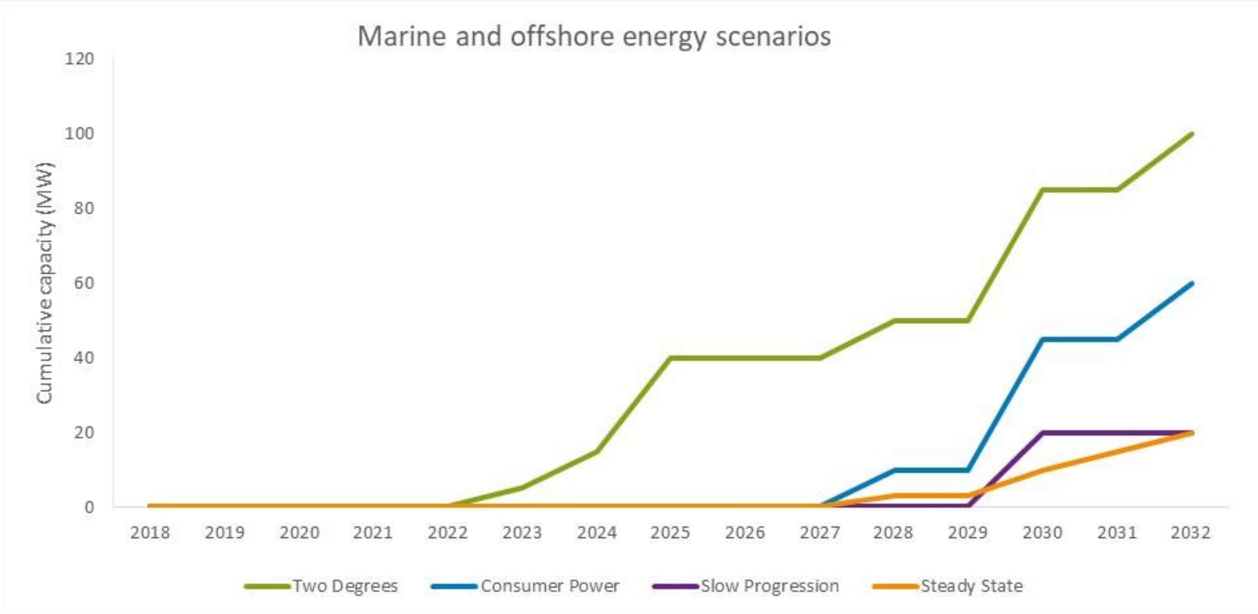



Table 12-1: Assumptions for factors influencing capacity growth for marine energy in South Wales

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Government support** | | | | |
| Welsh Government and planning | **Continues strategic support for marine energy with supportive planning** | **Continues strategic support for marine energy but some planning obstacles** | **Continues strategic support for marine energy with supportive planning** | **Marine energy gets lower priority in Wales with planning obstacles** |
| UK Government subsidy support | **Improved subsidy for less-developed technologies in early 2020s** | **Marine unable to compete for subsidies** | **Improved subsidy for less-developed technologies in late 2020s** | **Marine unable to compete for subsidies** |
| **Technology development and innovation** | | | | |
| R&D funding and demonstration. | **R&D funding leading to successful demonstrators in early 2020s** | **R&D funding leading to successful demonstrators in early 2020s** | **R&D funding low and successful demonstration not until late 2020s** | **R&D funding low and successful demonstration not until late 2020s** |
| Commercial projects | **Starting from mid-2020s** | **Towards end of the scenario period** | **Towards end of the scenario period** | **Not in scenario period** |
| **Resource factors** | | | | |
| Licence area potential | **High marine energy potential** | **High marine energy potential** | **High marine energy potential** | **High marine energy potential** |
| Geography of take-up | **Projects in demonstrator and other zones** | **Focused in demonstrator areas** | **Focused in demonstrator areas** | **Focused in demonstrator areas** |

### Relationship to other scenarios

Despite the inclusion of floating wind in the scenarios, the growth predictions for the marine energy sector, particularly for the highest growth scenarios have been reduced significantly since the scenarios in 2016. The absence of any meaningful government support or access to finance means that tidal and wave sectors in particular have not developed as expected.

In FES 2017 there is no separate marine category as the technologies except for offshore wind are covered in 'other renewables' category.

### Distribution by ESA

Projects have been distributed by ESAs located closest to the best off-shore resource sites as well as expected project development areas.

# 13. Diesel and gas

After a period of very significant investment in a handful of diesel and gas peaking plants, the market has softened, with a decrease in the rate of connecting new fossil fuelled capacity.

**South Wales has seen strong capacity growth for diesel and gas peaking plant in recent years.**

The South Wales embargo on new connections above 1 MW, the recent adoption of new regulations on emissions from medium combustion plant and rising fossil fuel costs are likely to encourage investors to look more closely at DSR and gas-fired plants, with diesel being actively squeezed out of the Capacity Market.

Figure 13-1: Installed capacity from diesel and gas in the South Wales licence area

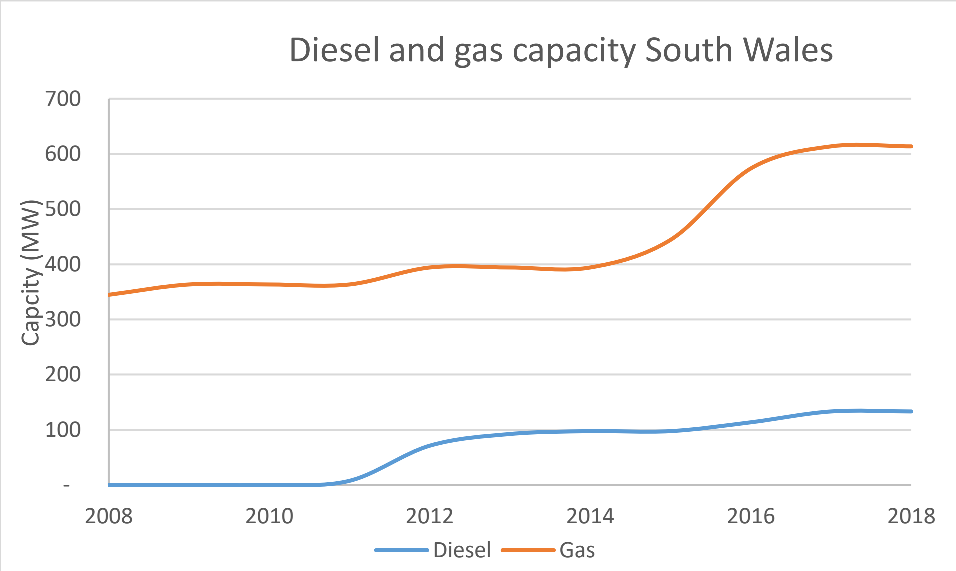



Table 13-1: Summary of growth in capacity of diesel and gas in WPD South Wales licence area.

| | Gas (MW) | | | Diesel (MW) | | |
|---|---|---|---|---|---|---|
| | **2018** | **2025** | **2032** | **2018** | **2025** | **2032** |
| **Two Degrees** | 614 | 728 | 706 | 133 | 122 | 47 |
| **Consumer Power** | | 722 | 813 | | 154 | 128 |
| **Slow Progression** | | 635 | 790 | | 118 | 98 |
| **Steady State** | | 635 | 839 | | 133 | 189 |

## 13.1. Baseline

**Diesel generation.**

South Wales has just over 133 MW of diesel engines generating electricity and diesel plant make up a quarter of both the existing and pipeline projects in South Wales.

This capacity comes from just eight sites, with five of them having capacities of around 20 MW each (four at 21,216 kW, and one at 19,040 kW). All of these are connected at the 33kV level.

Prior to 2011, just 7.5 MW of diesel generating plant was connected to the network. In the following year, this increased nearly tenfold to over 71 MW with four 21 MW plants being connected within 6 months over winter 2012, all owned by Green Frog Power. This surge in plant construction was in response to Green Frog

Power winning Short Term Operating Reserve (STOR) contracts for 14 sites in October 2010, across South Wales and the North East of England.

All these sites are typically expected to run for less than 50 hours a year and designed to start and reach full output within 45 seconds. This has traditionally been faster than gas peaking plant can respond, but new gas plants are delivering much faster start-up cycles and performing equally as well as diesel.

**Gas generation.**

The South Wales licence area has just over 618.6 MW of gas engines generating electricity from 26 sites, dominated by the Centrica power station at Barry, which accounts for nearly 250 MW.

Small scale fossil fuel generation has seen a fall in costs, with both gas and diesel plant becoming more economically viable in the 5 – 20 MW range. Primary uses for either type of generator are for businesses to provide backup, avoid Triads, reduce electricity consumption at peak price points and participate in balancing service markets.

Since 2016 National Grid have imposed an embargo on new generation that is likely to run at peak times, meaning no sites over 1 MW will be able to connect. In addition the last 12 months has seen pressure on the businesses cases for small scale fossil fuel generators (both developers of new plant, and those with contracts already in place), with the Medium Combustion Plant Directive resulting in costs rising for some existing and most new plant operators, and natural gas wholesale costs creeping back up to around 45p/ therm for the period out to 2022.

## 13.2. Pipeline

Due to the embargo on new projects, the pipeline of new gas and diesel generation projects consists of eight projects and no new connection agreements have been made or offered since August 2016. However 165 MW of diesel and gas capacity has been connected since the embargo was imposed, resulting from existing project applications.

Of the eight pipeline sites that currently have live connection agreements agreed prior to the embargo, half have not made applications to participate in the Capacity Market. For the four that did, only one project has been successful in securing a contract:  a 21MW gas driven generator operated by Beaufort Power Ltd at Ebbw Vale, participating from 2019 for a 15 year term.

**Large scale gas**

There are some large scale ‘rapid response’ projects still making their way through planning looking perhaps to connect once the embargo is lifted. The Abergilli Farm 299 MW gas-fired power plant near Swansea currently has an application lodged with the Planning Inspectorate to deliver rapid and flexible support to the National Grid at transmission level. It is expected to produce power for up to a maximum of 2,250 hours per year. This project is over 50 MW, so classed as a nationally significant infrastructure project and requires a Development Consent Order, submitted to the Secretary of State for Business Energy and Industrial Strategy.

**Medium Combustion Plant Directive (MCPD)**

The UK government has passed legislation that will introduce new emission limits for mid-sized generators from December 2018. The legislation, aimed at transposing the European Union Medium Combustion Plant

Directive into UK law, will establish a ceiling on nitrogen oxide emissions, primarily aimed at curbing the participation of diesel engines in the Capacity Market.

The new limits will come into effect for new plant from 20 December 2018, whilst existing generators have until 1 January 2025 if they have a thermal input of more than 5 MW, or 1 January 2030 if their thermal input is less than 5 MW.

Backup generation is not classed as participating in 'balancing services' such as the Capacity Market, and therefore is exempted from meeting these new emission limits. These plants can operate for 'testing purposes' up to 50 hours a year and this is allowed to form part of an organisations attempt to lower consumption during Triad periods.

Industry has been aware of the planned changes since early 2016, with a strong expectation that this would direct emission abatement investment in new plant, almost certainly for diesel but potential cheaper gas engines too. Following the success of diesel-fired reciprocating engines in the T-4 auctions of 2014 and 2015, the Department for Environment, Food and Rural Affairs promised to introduce new emissions limits for diesel as part of MCPD to prevent 'dirty diesel' accessing further subsidy.

Seven of the eight pipeline sites that have planning permission and a connection offer or agreement would be impacted by the new MCPD, as they do not currently provide balancing services. However, as most of these sites are gas they are likely to be able to satisfy the new requirements. The regulations stipulate that any new or existing generators that enter into *new* balancing services contracts would be subject to the new emissions limits from December 2018.

The one project with a Capacity Market contract is expected to connect in all scenarios by 2020.

Under a Two Degrees or Consumer Power scenario, where it is assumed that policies are in place to manage the thermal constraints ahead of the 2026 embargo date, projects are expected to progress through to operation in the short term.

Under Slow Progression and Steady State scenarios however, it is assumed that the pipeline will only connect after the planned transmission network reinforcement.

- Pipeline projects that have won Capacity Market contracts are expected to go ahead in all scenarios
- Pipeline projects that have applied to the Capacity Market and been unsuccessful are modelled as having a lower likelihood of going ahead
- Pipeline projects that have not applied to the Capacity Market are investigated to ascertain what other income streams they may be targeting

Table 13-2: Diesel and gas pipeline under each scenario for the WPD South Wales licence area

| Pipeline projects | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| With Capacity Market contracts | 2019 | 2019 | 2019 | 2019 |
| Applied to CM but unsuccessful | 2020 at 10% capacity | 2021 at 50% capacity | 2023 at 35% capacity | 2025 at 70% capacity |
| Other projects | Not going ahead | 2022 at 50% capacity | Not going ahead | 2023 at 70% capacity |

## 13.3. Technology growth prospects

**New emissions limits are likely to see most diesel-fired generating assets dropping out of new balancing services contracts from 2022 onwards**

In our considerations of the prospects for diesel and gas projects being developed in the South Wales licence area out to 2035, we have considered three main factors:

- Impact of tightening air quality standards and emission limits
- The attractiveness of the business case for network connected gas and diesel
- The extent to which peaking plant are needed for the UK energy system

As diesel and gas technologies will experience different impacts from the factors above, we have addressed the scenarios of growth separately.

**MCPD**

Undoubtedly, the most significant change to the legislative landscape for gas and diesel plants has been the translation of the MCPD into UK law, to be implemented from December 2018. Sub 50 MW projects wishing to win new balancing service contracts must meet new emissions limits, this will increase capital costs, and in all likelihood prevent new diesel projects from being cost effective. Modern gas plants are, by and large, able to meet the emission limits set out in the MCPD.

**Market conditions**

Increased air quality standards, and rising diesel costs are likely to see connection requests for new diesel plants to contract substantially in the coming decades. Gas driven generation will continue to be a central technology, with viable business models in our energy mix, but will be sensitive to the different scenarios of demand growth.

**Balancing services revenues**

Capacity Market clearing prices have been falling sharply as auctions roll around, with the February 2018 clearing price a record low of £8.40 per kW, well below expectations and the previous T-4 auction in 2017 which cleared at £22.50. Whilst this is good for energy bill payers in the short term, there are question over whether the 'race to the bottom' is hampering the prime focus of the mechanism: to encourage new capacity to be built. The building of new generation is critical to achieving the government aim of enabling a legislative moratorium on coal fired power by the mid 20-20s.

**Competition with storage**

Gas continues to compete with battery storage for some balancing services contracts. As demand for balancing services increases (along with confidence in the markets to deliver them) so do opportunities for gas projects to play a role, at a range of scales.

**Role of peaking plant / DSR**

The extent to which the UK energy system relies on distributed, network connected plants to deliver power at peak times is a key feature of our scenario analysis. Gas currently plays a commanding role in the fleet of UK peaking plants and we examine how this may change in the scenarios, given policy or market shifts in support.

Changes to the UK's Triad arrangements and embedded benefits received by network-connected generators will have an impact on the shape of UK capacity at peak times. As of April 2018, Ofgem have implemented a new charging regime for small scale generators that reduces the level of income such plants can receive for generating at peak times. This new regime is currently the subject of a judicial review.

Opinion about the role of smaller peaking plants remains divided. Despite lower system efficiencies, smaller gas reciprocating engines and Open Cycle Gas Turbines may deliver significant network benefits and have shorter investment cycles than larger plant.

Green Frog Power, one of the biggest developers of gas driven peaking plant in the UK expects flexible capacity to "…increase by nearly 340% over the next 20 years and around half of this will be reciprocating engines with an estimated 11GW operational by 2030…"[105]

The growth in deployment of peaking plant, by nature medium in scale and distributed, has had a significant impact on the UK market since 2011, helping drive down reserve costs and rekindling investment in diesel 'farms' and new smaller gas power plants. However, the most recent T-1 and T-4 Capacity Market auctions (for 2018-2019 and 2021-2022 respectively) saw significantly fewer diesel projects applying and being awarded contracts, compared with new build gas plants. Over the last five Capacity Market auctions (since 2014) 80% of the contracts have been awarded to either gas or battery storage projects, with only a handful of diesel projects being successful.

This trend is reflected in South Wales, with most of the fossil fuelled network connections identified as gas. However, South Wales has relatively few fossil fuelled network connections when compared to other licence areas, and all scenarios reflect only moderate changes to the overall capacity, given the low starting level.

[105] http://www.greenfrogpower.co.uk/generation

Figure 13-2: WPD South Wales licence area diesel growth scenarios.

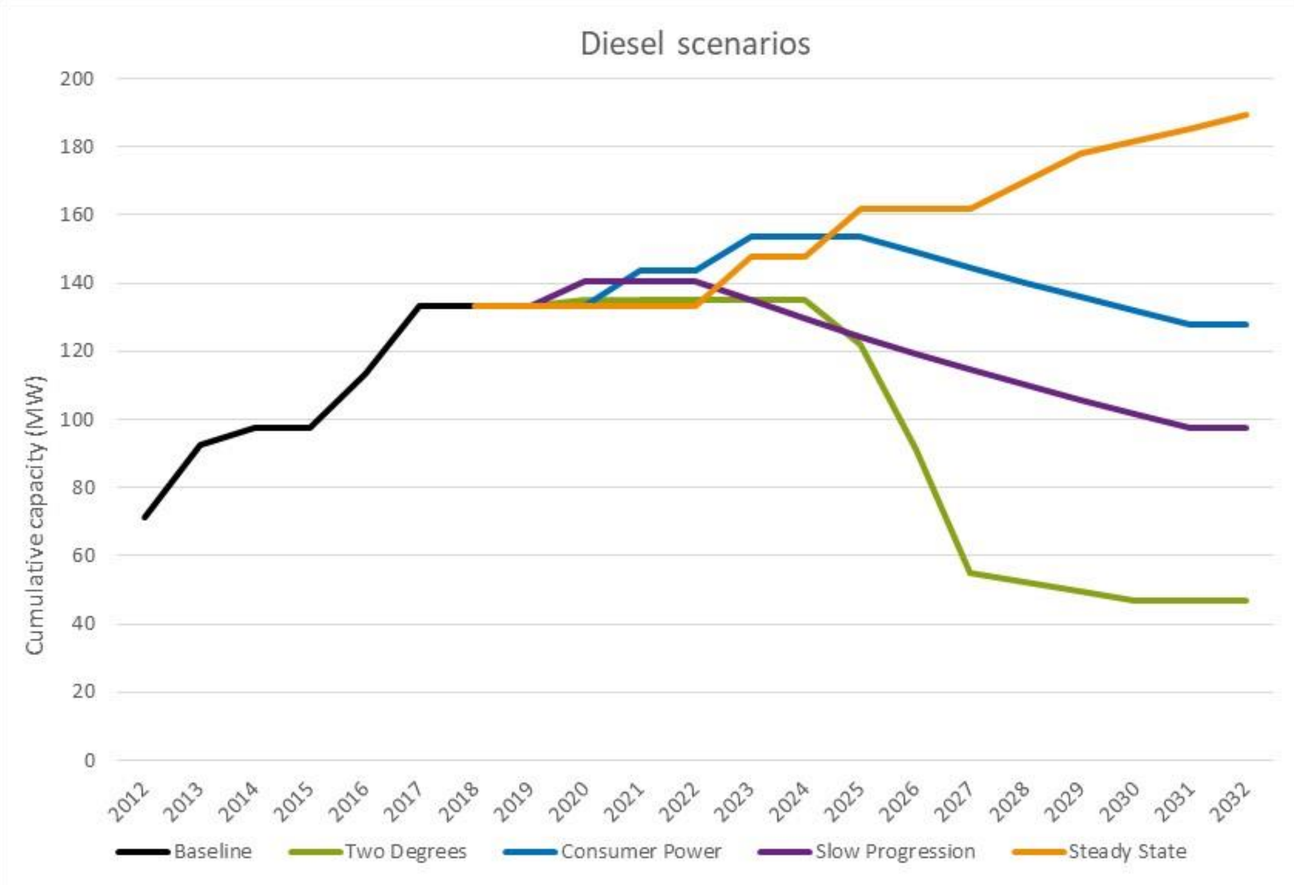



Table 13-3: Assumptions for factors influencing capacity growth for diesel

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and Government support** | | | | |
| Tightening air quality standards and emission limits | **Diesel to meet same MCPD limits as gas** | **50% increase on MCPD emission limits for Diesel** | **MCPD only** | **MCPD only** |
| Market conditions | **No further growth of diesel plant. Capacity reduces steadily as costs increase and plant is replaced** | **No further growth of diesel plant. Capacity reduces steadily as costs increase and plant is replaced** | **No further growth of diesel plant. Capacity reduces steadily as costs increase and plant is replaced** | **Limited growth** |
| Role of flexible, distributed diesel peaking plant in the UK | **Large increase in demand for flexible generation, but most projects are battery storage or EV-led** | **Large increase in demand for flexible generation, with limited demand for fossil fuelled plants** | **Moderate increase in demand for flexible generation, with fossil fuelled generation delivering most of it** | **Continued demand for flexible generation, with significant reliance on fossil fuelled technologies, although a large proportion will be at transmission level** |

Figure 13-3: WPD South Wales licence area gas growth scenarios.

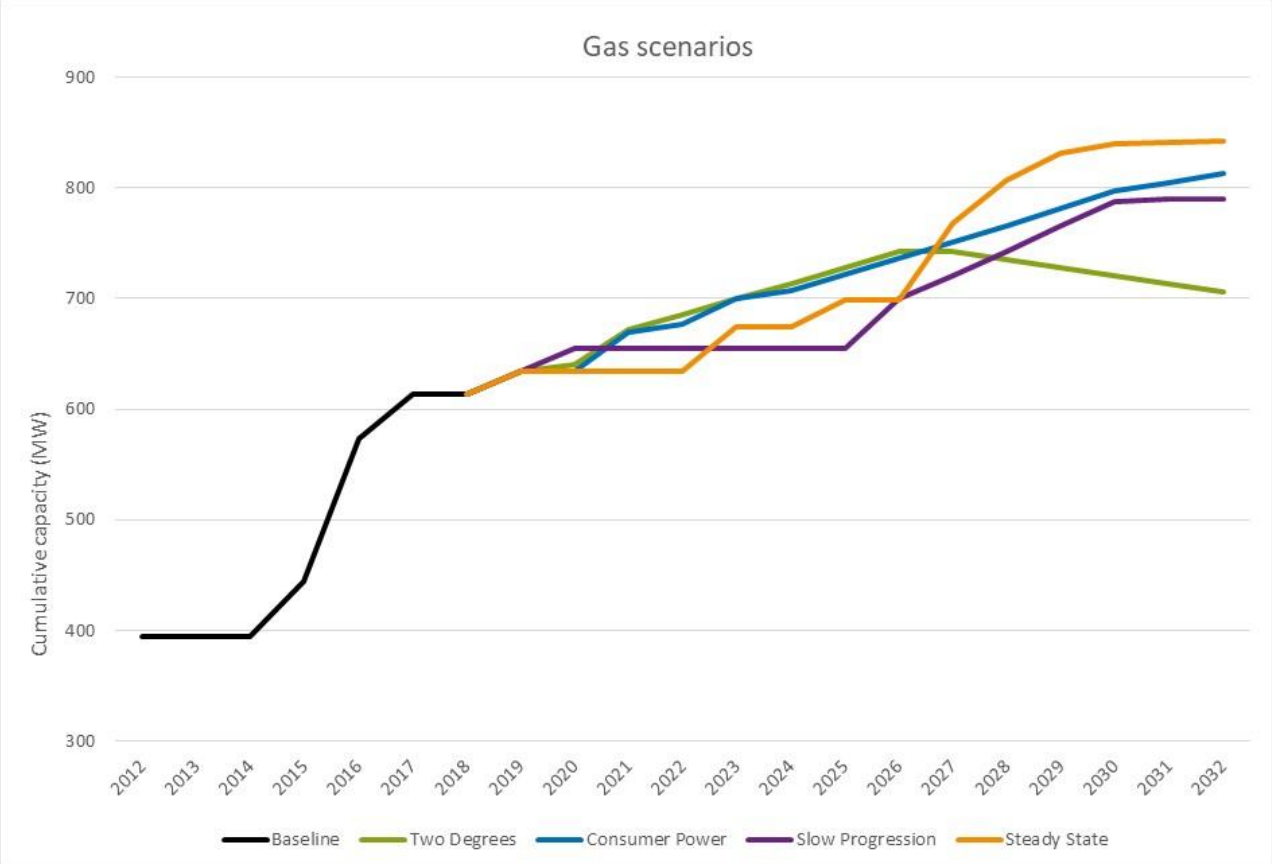



Table 13-4: Assumptions for factors influencing capacity growth for gas

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and Government support** | | | | |
| Tightening air quality standards and emission limits | **Gas emission limits decreased substantially by 2035** | **MCPD emission limits tightened regularly** | **MCPD emission limits tightened slowly** | **MCPD only** |
| Market conditions | **Gas plant project starts to become more expensive** | **New gas technology projects steadily lose market share to battery storage** | **Gas is the most cost-effective peaking plant, but battery storage steadily gains market share** | **Gas remains the most cost effective peaking plant technology** |
| Role of flexible, distributed gas peaking plant in the UK | **Large increase in demand for flexible generation, but most projects are battery storage or EV-led** | **Large increase in demand for flexible generation, with limited demand for fossil fuelled plants** | **Moderate increase in demand for flexible generation, with fossil fuelled generation delivering most of it** | **Continued demand for flexible generation, with significant reliance on fossil fuelled technologies, although a large proportion will be at transmission level** |

### Relationship to FES 2017 and 2015 Scenario report

FES 2017 projected significant reductions in power generation from gas for all scenarios bar steady state. Even the steady state scenario only sees a net increase in gas consumption for power generation in the mid 2020’s due to replacing capacity from retiring nuclear power plants.

However, the FES 2017 analysis includes both transmission connected generation and network connected transmission. Whilst the overall consumption for gas fuelled power generation may decline, this is likely to be masking an increase in small scale gas peaking plant capacity.

### Distribution of technology across ESAs

Factors that affect the distribution of gas and diesel engine sites include proximity to the gas and high voltage electricity network, as well as the availability of industrial, and brownfield sites. The number of market bids in each ESA is representative of the resource and network connection potential in that area and is therefore used as one of the factors effecting distribution for gas sites. For diesel engines the ability to export power is less likely to be important given emissions regulations. Therefore the number of commercial and industrial sites has been used as a distribution factor.

# 14. Other generation

## 14.1. Baseline

The other generation category covers clean biomass generation, landfill gas, sewage gas CHP or AD, and micro and small CHP, as well as two projects on WPD's connection register that have not been identified as a particular energy source.

There is 88.6 MW of other generation capacity in WPD's connected data base in the South Wales licence area from 45 projects. The largest project is a 16 MW site in Aberdare. The average scale is around 2 MW.

## 14.2. Pipeline

There are a further 13 'other generation' projects in WPD's accepted-not-yet-connected database. These have a total generation capacity of 106.7 MW. The majority of this is from four projects between 20 – 40 MW which are likely to be bioenergy plants.

# C. Introduction to energy storage

## Storage technology costs and capabilities

Energy storage technology comes in many forms and sizes, ranging from the large scale long duration technologies such as pumped hydro, to ultra-rapid response technologies like supercapacitors. Whilst there is evidence of market activity around other technologies, battery storage is by far the dominant technology, reflecting its flexible operational capabilities and modularisation and the emergence and growth of the EVs.

Within battery storage technology, the dominant variant is solid-state with Lithium-Ion (Li-Ion) chemistry. Reductions in the cost of Li-Ion battery storage projects, is one of the drivers for future growth in the short/medium term, potentially alongside flow-state batteries (such as Vanadium-Redox) and more established battery types such as Lead-Acid. Industry predictions for reduction Li-Ion costs vary, with Lazard suggesting a potential 36% reduction over the next five years and Bloomberg New Energy Finance's analysis showing a 24% reduction across 2017, with similar reductions set to continue in the near term.

Whilst cost reduction in battery cells is likely to continue out to 2032, the cells are only one component of overall system costs for energy storage systems. The costs of established hardware like inverters, power cabling, control systems and containerisation (often referred to as 'balance of system' or 'balance of plant', see Figure 2) are unlikely to fall rapidly.

Figure C-1: Energy storage system components

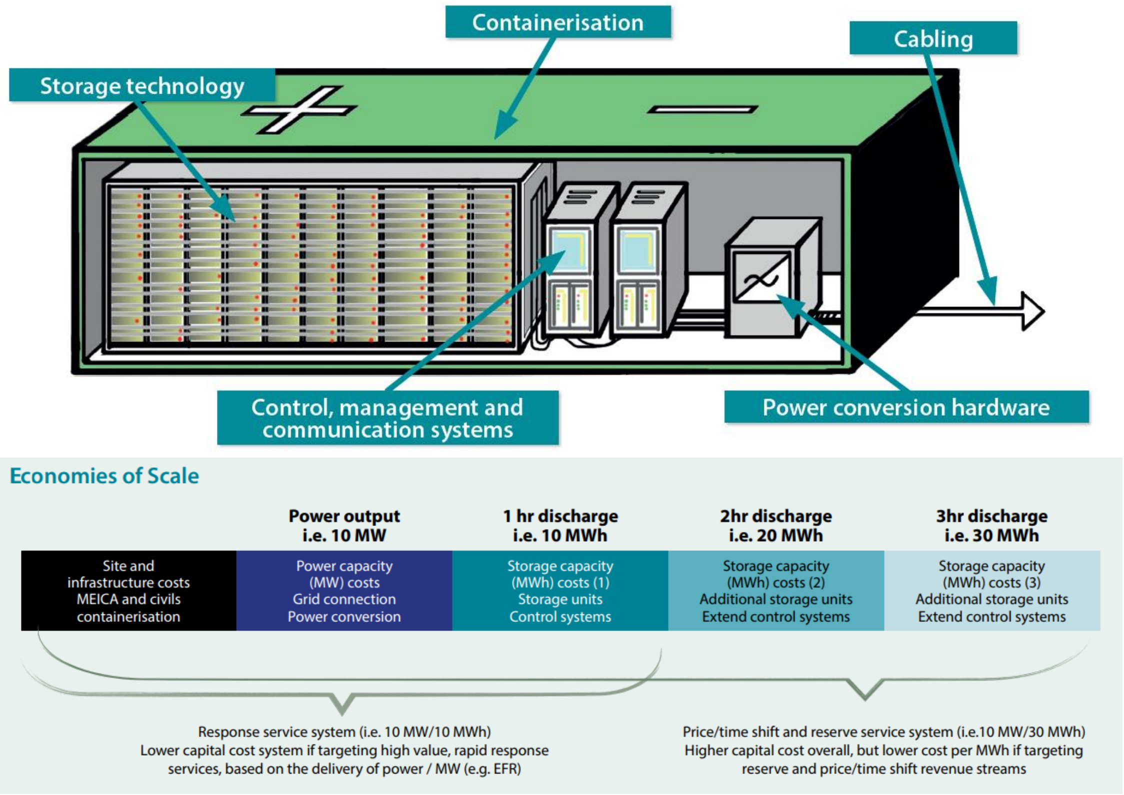
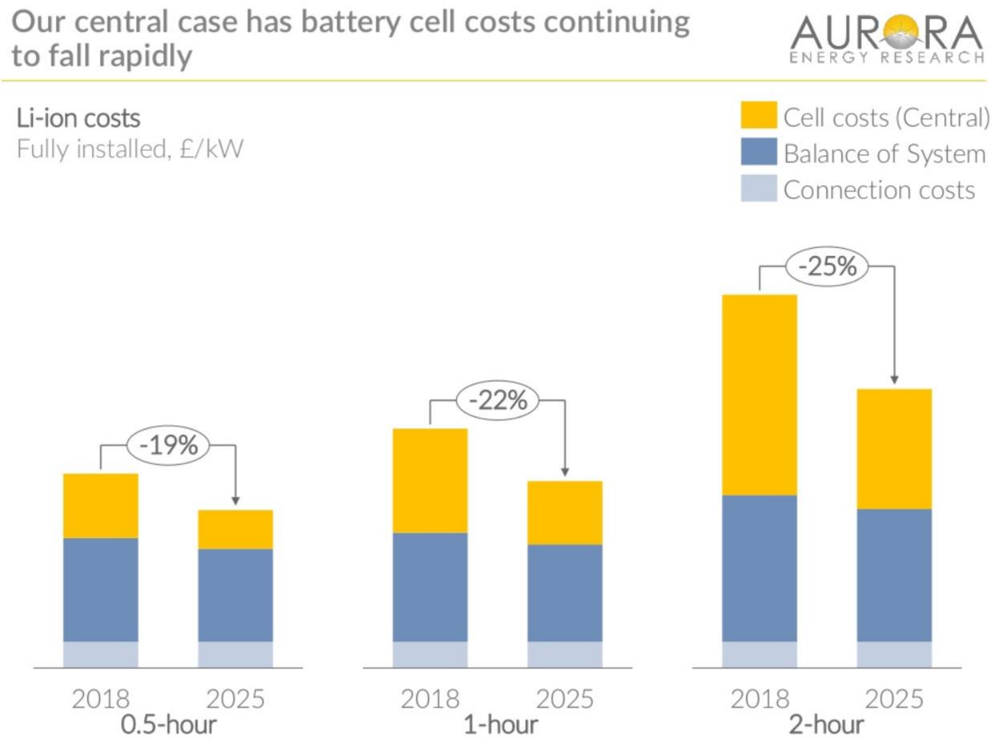



Figure C-2: Aurora energy storage system component cost projections (2018 + 2025)
*Source and credit: Aurora Energy Research, October 2017*




The development of storage control systems that enable assets to respond quickly, automatically and to target multiple programmes/revenue streams is another key area of development. The capability to be an adaptive flexible technology, is largely reflective of the sophistication of the control philosophy, with control concepts around 'partitioning' of banks of storage cells to target different income streams and charge/discharge thresholds changing on-the-fly based on prices, dispatch requests or event triggers. There is also the potential for storage asset owners to take advantage of reducing cell costs and the modularisation of battery systems, by adding more banks of cells in the future, to enable them to participate in longer duration markets without some of the upfront capital costs.

The development of Hybrid Energy Storage System (HESS) solutions that site two (or more) storage technology types behind the same connection point, could enable a project to participate in (and potentially optimise contributions) to both rapid-response and longer-duration markets. Research around hybrid systems is already emerging, with examples of Li-Ion battery + flywheels[106], Li-Ion battery + flow battery and Power-to-heat + Li-Ion battery (amongst others[107]).

The potential to co-locate energy storage with demand and generation, as well as the potential to install a hybrid-technology energy storage plant, opens the potential for highly flexible distributed energy resources. Whilst this creates complexity for network operators in seeking to understand the operating behaviour and network impact of a given connection point, this also paves the way for more adaptable and thus valuable actors in future local flexibility markets.

[106] See Sheffield University research: https://www.sheffield.ac.uk/news/nr/flywheel-europe-energy-1.704921
[107] See Energy Storage Forum article "Hybrid energy storage; are combined solutions gaining ground?": https://energystorageforum.com/news/energy-storage/hybrid-energy-storage-combined-solutions-gaining-ground

## Current business models

Despite considerable interest from financiers and developers in storage, the business model for energy storage at all scales is changing and projects are becoming more difficult to finance. Figure 15-1 on p.105. outlines the current six business models Regen identified in its 2016 report for WPD.

The first wave of storage projects were predominantly under the 'Response Services' and 'Reserve Services' business models, driven by contracts secured under frequency response (i.e. Enhanced Frequency Response (EFR) and Firm Frequency Response (FFR)) and Capacity Market programmes.

National Grid have only tendered one round of EFR to date and recent industry analysis[108] shows that there is oversubscription in the FFR market, driving prices down. It is evident that in the near term, frequency response markets have started to reach a saturation point, with a greater volume of planned storage projects than there are available FFR contracts.

In addition to this, the de-rating of shorter duration storage assets in the Capacity Market and a similar level of oversubscription, driving outturn prices down to their lowest to date, means that Capacity Market contracts are both low in value and uncertain for storage projects. For the sites that have successfully secured EFR, FFR or Capacity Market contracts (such as the Cenin battery project in the South Wales baseline), there is still the need for asset owners/operators/funders to secure addition revenue streams in the near term, as well as securing income streams for the non-contracted years that follow.

Commercial and industrial schemes that are located behind the meter are not immune to evolving revenue streams, with participation in FFR/Capacity Market being a key component of many projects' business cases. Other sources of benefit for a storage asset co-located with demand stem from the ability to minimise an energy using site's exposure to high cost periods, such as Triads and Red-band DUoS charges. Though the pending phased removal of embedded benefits[109] will reduce income for storage assets spilling energy to the grid during Triads, the savings to a demand customer avoiding Triad penalties is likely to still be of notable value. The size of a storage asset (i.e. its energy capacity/hours of discharge duration) is critical, to enable a demand customer to 'hit' the three Triad half hour periods.

Behind the meter energy storage may also provide a valuable energy resilience service. Whilst dominant storage technologies (i.e. solid-state batteries) are unlikely to be able provide long term back-up supply functions to buildings, Uninterruptible Power Supply (UPS) functionality is something that onsite battery storage has been successfully delivering to Data Centres and other critical SCADA/IT infrastructure in offices and operational sites for many years. The prospect of 'partitioning' storage asset capacity or deploying multiple smaller storage plants on a single site, to act in different operating modes for a demand site is of interest to industries that are sensitive to power interruptions or power quality issues (e.g. hospitals, data centres, manufacturing or water industry sites). The potential for multiple smaller scale storage assets to be deployed behind the meter should be considered, alongside (or potentially instead of) single commercial scale storage plants.

## New sources of benefit for storage assets

Whilst current business models for storage are challenging, other revenue streams are coming to the fore, with the development of the local flexibility services. Where National Grid has been procuring flexibility through balancing services (such as FFR and EFR described above), the location of these assets is largely

[108] See Cornwall Insight "Battery overload: Storage and the FFR market" (May 2018): https://www.cornwall-insight.com/publications/chart-of-the-week/chart-of-the-week/2018/battery-overload-storage-and-the-ffr-market
[109] See Ofgem Embedded Benefits: Impact Assessment (June 2017): https://www.ofgem.gov.uk/publications-and-updates/embedded-benefits-impact-assessment-and-decision-industry-proposals-cmp264-and-cmp265-change-electricity-transmission-charging-arrangements-embedded-generators

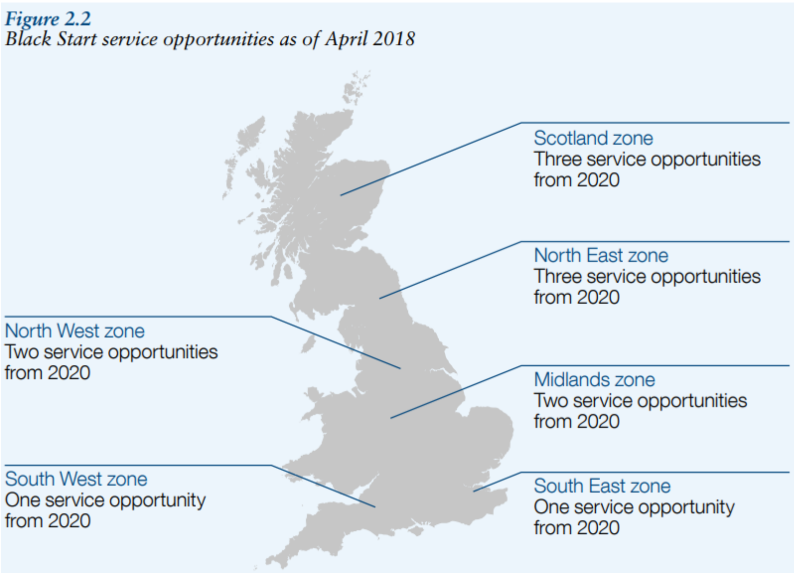
irrelevant and flexible response provides a net benefit to support National Grid to regulate the frequency of the system and keep national demand and supply in balance.

WPD, alongside other DNOs in their licence areas, are beginning to turn to distributed energy resources (or DERs) to provide local flexibility services to address local network challenges, as an alternative (or deferment) to investing in network reinforcement. Energy storage is potentially very well placed to participate, playing to the strengths of potentially being located near to constrained substations/within constrained areas and being sized to meet the specific needs of the DSO.

Another potential emerging revenue stream for storage assets, is through the recent announcement of the intention to widen the range of technologies that can participate in National Grid's system as 'Black Start' restoration planning. National Grid published a Product Roadmap[110] in May 2018, describing intentions to remove barriers for distributed energy resources and storage. Traditionally provided by large thermal plant, National Grid spent c.£55million on 18 Black Start contracts in 2017/18. The potential for new energy storage projects to secure even a modest share of this annual market, could be a notable source of new income for storage developers to target. The entry thresholds, operational requirements and the method by which the proposed market-based approach is to be trialled in 2020/21, will need to be understood in more detail before the true potential value to storage developers is known.

In addition to this, with Black Start being a more localised/zonal orientated service, National Grid have indicated that there will be a series of 12 service opportunities across 6 UK zones, see Figure C-3. The specific service opportunities that might fall within the South Wales licence area is therefore largely unknown at this stage.

Figure C-3: National Grid Black Start service opportunities, by zone (May 2018)
*Source and credit: National Grid*




[110] See National Grid Product Roadmap for Restoration (May 2018): https://www.nationalgrid.com/sites/default/files/documents/National%20Grid%20SO%20Product%20Roadmap%20for%20Restoration.pdf

# 15. Energy storage

The South Wales licence area has very low energy storage development to date.

There is an embargo by National Grid on new dispatchable generation[111] that is above 1 MW until 2026, preventing new commercial scale storage projects.

**National Grid embargo on new connections >1MW until 2026 is likely to continue to stifle the market in South Wales.**

The consultation event for these scenarios found strong interest in storage from industry[112], the agricultural sector and from developers for co-locating storage with operational solar farms in the region[113]. Under a more favourable policy and operational environment there is, therefore, potential for storage to grow strongly in South Wales.

Table 15-1: Summary of growth in capacity of energy storage in WPD South Wales licence area

| Battery storage capacity | MW | | | | MWh | | |
|---|---|---|---|---|---|---|---|
| | 2017 | 2020 | 2025 | 2030 | 2020 | 2025 | 2030 |
| Two Degrees | 4.3 | 30 | 218 | 417 | 53 | 760 | 1737 |
| Consumer Power | | 30 | 224 | 467 | 47 | 635 | 1422 |
| Slow Progression | | 11 | 70 | 354 | 28 | 192 | 1100 |
| Steady State | | 6 | 35 | 177 | 14 | 96 | 550 |

## 15.1. Baseline

To date there is only one active storage site[114] connected to the distribution network in the South Wales licence area, which comprises two separately registered Tesla Powerpack[115] battery storage systems, totalling **4.3 MW**, see Table 15-2.

Table 15-2: Summary of growth in capacity of energy storage in the WPD South Wales licence area

| Organisation | Location | Technology | Installed Capacity | ESA |
|---|---|---|---|---|
| Cenin Limited | Parc Stormy Bridgend | Battery storage | 2.34 MW | Pyle 132/33 |
| | | Battery storage | 1.95 MW | Pyle 132/33 |

Cenin's storage asset [116], (located at an old industrial cement site) is targeting National Grid balancing services, specifically the Firm Frequency Response (FFR) programme, securing a 2 year contract at £19/MW/hour. In addition to FFR however, the Cenin's published commercial aggregator partners Kiwi Power successfully secured a Capacity Market contract under the 2018 T1 auction for a 4 MW storage asset (de-rated to 1.6 MW).

There has been little development in energy storage in the region due predominantly to Statement of Works (SoW) correspondence received from National Grid in 2016. With the transmission network in the South

[111] Defined as dispatchable or non-intermittent generation technologies, such (but not limited to) thermal generation or market driven energy storage.
[112] Wales accounts for 5.7% of GB industrial demand, which we have assumed to almost wholly in
[113] Feedback from farmers and solar asset owners from consultation event held 6th June
[114] With no real visibility of domestic battery storage, the baseline only considers larger, commercial scale storage assets registered on WPD's generation capacity registers
[115] See Tesla Powerpack product range: https://www.tesla.com/en_GB/powerpack
[116] See Electrek article (March 2018): https://electrek.co/2018/03/15/tesla-powerpack-project-uk/

Wales reaching capacity under peak conditions, there is an embargo on any new storage projects (as well as thermal/other dispatchable generation) above 1 MW, until relevant reinforcement works has been completed between 2026-28.

National Electricity Transmission System (NETS) letter – May 2016

Statement of Works update statement – March 2017

This has impacted on both the volume and capacity of enquiries and connection offers for storage projects, which is notably lower in the South Wales licence area compared to others.

## 15.2. Pipeline

Despite the National Grid embargo, there is a single 20 MW storage asset with accepted-not-yet-connected status, see Table 15-3.

Table 15-3: Summary of energy storage pipeline in the WPD South Wales licence area

| Organisation | Location | Technology | Capacity | ESA |
|---|---|---|---|---|
| FPC Industrial & Enterprise 2 Ltd | Traston Road Newport | Battery storage | 20 MW | Newport South 132/33 |

Under a Two Degrees and Consumer Power scenario, where policies are in place to manage the thermal constraints, the 20 MW storage asset could feasibly progress through to operation in the short term.

Under Slow Progression and Steady State scenarios however, it is assumed that the planned SoW reinforcement in late 2026 is the only way that commercial scale energy storage can connect to the network again. A summary of this is shown in Table 15-4.

Table 15-4: Energy storage pipeline under each scenario for the WPD South Wales licence area

| Project name | Capacity | BSP location | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|---|---|
| FPC Industrial at Traston Road | 20 MW | Newport South BSP | 2019 | 2020 | 2026 | 2027 |

Analysis of distribution network connected storage assets participating in Capacity Market auctions, also shows that there is very little activity in Wales, see Table 15-5. Of this, only the Cenin project falls within the South Wales licence area.

Table 15-5: Welsh distribution connected energy storage projects in recent Capacity Market auctions

| Applicable Auctions | Delivery Year | Storage Projects in Wales – Prequalified | | Storage Projects in Wales – Winners | |
|---|---|---|---|---|---|
| | | No. Projects | Capacity (MW) *Derated (Act.)* | No. Projects | Capacity (MW) *Derated (Act.)* |
| T4 2016/17 | 2020/21 | 0 | 0 | 0 | 0 |
| T1 2017/18 | 2018/19 | 1 | 1.6 (4.2) | 1 | 1.6 (4.2) |
| T4 2017/18 | 2021/22 | 3 | 4 | 1* | 0.729* (1.6)* |

** 2018 T4 auction results are provisional only at time of writing*

## 15.3. Technology growth prospects

**Access to a good distributed grid capacity is key for siting storage. Even with an earlier resolution to the active SoW embargo, South Wales may still not be a hub of storage project development**

As discussed in Regen's 2017 paper[117], for the next wave of storage projects it is expected that access to a robust grid connection point will remain a key factor that determines the location of new storage projects.

The majority of the first wave of storage projects in the UK are distribution network connected[118] and concentrated in an arc that follows the main industrial centres of Great Britain and the main spine of the electricity network.

For South Wales, therefore, the embargo on controllable generation and storage connections until the transmission network reinforcement is fundamental to releasing capacity in the area and enabling a storage pipeline to flow again. The effect of unlocking capacity at any point is likely to cause a surge of storage connection enquiries, alongside thermal generation technologies also looking to connect.

**Storage project developers need to adapt to lower revenues coming from the saturated FFR and Capacity Market and to target new markets such as DSO led local flexibility services, co-location and**

Once the embargo is resolved there is good potential in the licence area to develop storage.

The scenarios project storage growth using the six key business models shown in Figure 15-1. In the near term, with the frequency response and reserve services markets reaching saturation point, projects in South Wales will likely look to access other revenues. With a high level of commercial and industrial demand in South Wales licence area there is likely to be potential for storage models located with high energy users, specifically 'commercial & industrial behind-the-meter prosumers' and potentially response or reserve storage business models, dependent on capacity and/or partnerships with commercial aggregators.

Those storage assets for high energy users below the 1 MW embargo threshold are more likely to be developed before the end of the embargo. Proximity to industrial energy demand (i.e. to off-set/mitigate high cost periods for large energy users) may become a prime locational factor for storage projects in the licence area in the short and medium term.

The high deployment of renewable generation in South Wales also means good potential for co-location battery and renewable generation that target price arbitrage, enabling time-shifting/price-shifting of exported volume to generate additional revenue for generation sites.

Where storage assets are co-located with both generation and demand, further benefits could be realised. Enabling the maximisation of self-consumption of onsite generation, further cost-optimised avoidance of Triads (with storage being charged by onsite generation) and the potential to access more lucrative energy price markets/mechanisms (i.e. sleeving/PPAs) are all sources of benefit that behind the meter storage developers are reviewing.

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[117] See *Energy Storage The Next Wave* (Nov 2017) https://www.regensw.co.uk/energy-storage-the-next-wave-2

[118] Echoed by response to WPD storage consultation, where respondents stated 96% of storage capacity would be connected on the distribution network

Figure 15-1: Six storage business models developed by Regen for WPD.

**1. Response service** - Providing higher value ancillary services to transmission and distribution network operators, including frequency response.

**2. Reserve service** - Specifically aiming to provide short/medium term reserve capacity for network balancing services.

**3. Commercial and industrial** - Located with a higher energy user (with or without on-site generation) to avoid peak energy costs and peak transmission and distribution network charges, while providing energy continuity

**4. Domestic and community** - Domestic, community or small commercial scale storage designed to maximise own use of generated electricity and avoid peak electricity costs

**5. Generation co-location** - Storage co-located with variable energy generation in order to a) price/time shift or b) peak shave to avoid network curtailment or reinforcement costs

**6. Energy trader** - The business model that references the potential for energy supply companies, local supply markets and/or generators using storage as a means of arbitrage between low and high price periods - likely aggregated - and peak shaving.

Distribution Network Operators are also beginning to turn to distributed energy resources (or DERs) to provide local flexibility services to address local network challenges, as an alternative (or deferment) to investing in network reinforcement.

Energy storage is potentially very well placed to participate, playing to the strengths of potentially being located near to constrained substations/within constrained areas and being sized to meet the specific needs of the DSO. Storage projects (either directly connected or operating behind the meter with a large energy user) could therefore become a dominant technology in local flexibility markets.

The relative value of these services is the relatively unknown factor at this stage, with these markets being fairly new and for many areas not yet up and running. However, a precedent has been set with WPD issuing calls for expressions of interest (EOI) for flexibility services through their 'Flexible Power' programme.

Flexible Power
By Western Power Distribution

Initially focussed around a trial in the Midlands in 2017, WPD's call for flexibility has been extended to include 18 new flexibility zones, within five constraint areas for both winter 2018 and summer 2019 (see Figure 15-2). The constraint areas in these calls are currently focussed on the Midlands and South West licence areas and are also predominantly targeting peak demand management, through three core flexibility services (see Table 15-6).

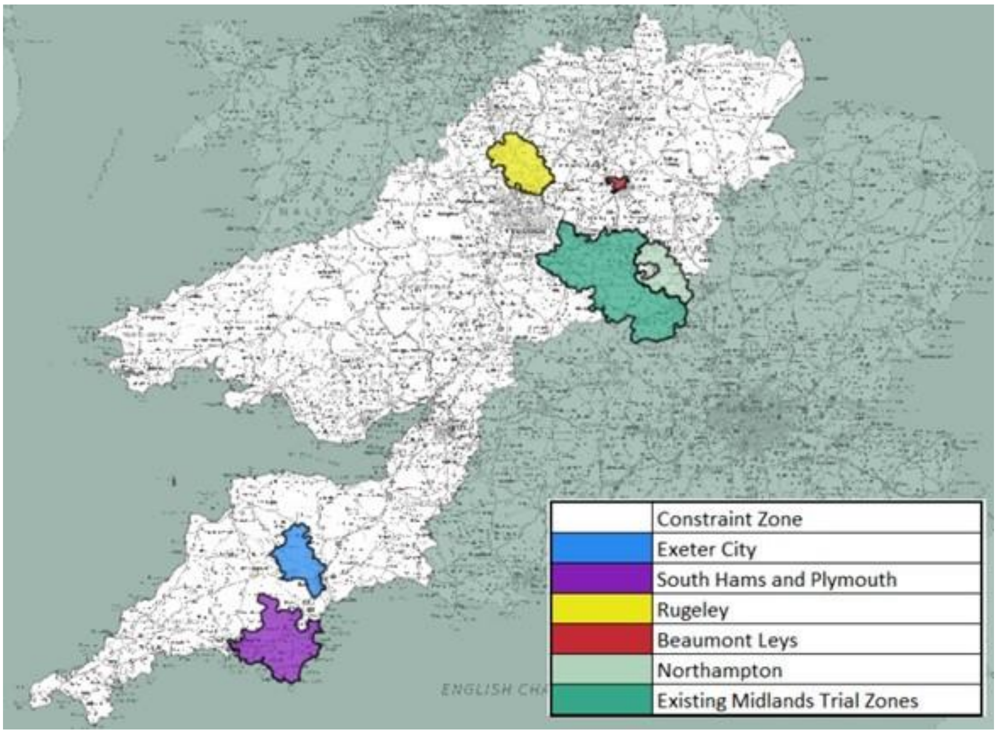
Table 15-6: Flexible Power Services for businesses (Source: WPD, Regen analysis)

| Service | Description | Requirement | Dispatch | Payment Structure |
|---|---|---|---|---|
| **Secure** | Used to manage peak demand loading on the network and pre-emptively reduce network loading. | Largely required on weekday evenings, all year round | **Declaration:**<br>Week ahead *(Thursday for the following week, commencing Monday)*<br>**Dispatch notice:**<br>Week ahead notification of need and 15min signal | **i) Arming Fee:**<br>Credited when the service is scheduled<br>**ii) Utilisation Fee:**<br>Awarded when flex service is delivered |

| | | | | |
|---|---|---|---|---|
| **Dynamic** | Used to support the network in the event of specific fault conditions | Largely required during maintenance periods, likely through British Summer Time | **Declaration:** Week ahead *(Thursday for the following week, commencing Monday)* **Dispatch notice:** 15 minutes | **i) Availability Fee:** Credited when availability is accepted **ii) Utilisation Fee:** Awarded when flex service is delivered |
| **Restore** | Used to help with restoration following rare fault conditions, reducing stress on the network | Unplanned fault conditions are rare and largely in the event of equipment failure | **Declaration:** Week ahead (Thursday for the following Monday) **Dispatch notice:** 15 minutes | **i) Utilisation Fee:** Premium reward for response that aids network restoration, awarded when flex service is delivered. |

So even though the procurement of flexibility could be seen as one potential option to mitigate the live connection constraint on storage and thermal generation in South Wales licence, the focus of current flexibility procurement is around demand peaks and network events, not distributed generation led constraints.

Figure 15-2: Map of WPD constraint areas (June 2018)




The value to providers of flexibility is both based on fixed and variable payments, the type of flexibility service and the constraint zone they fall within. Storage operators will no doubt be assessing the value of securing a local flexibility contract, but more as an additional revenue stream to stack on top of other sources of income, rather than being the single 'silver bullet' return on investment. Storage operators are very well placed to be able provide flexibility to the DNO and thus as these calls for EOI spread to other areas or diversity to seek other types of service, the potential for storage projects targeting specific constraint areas may become apparent.

## 15.4. Scenario results

Figure 15-3: WPD South Wales licence area battery storage growth scenarios.

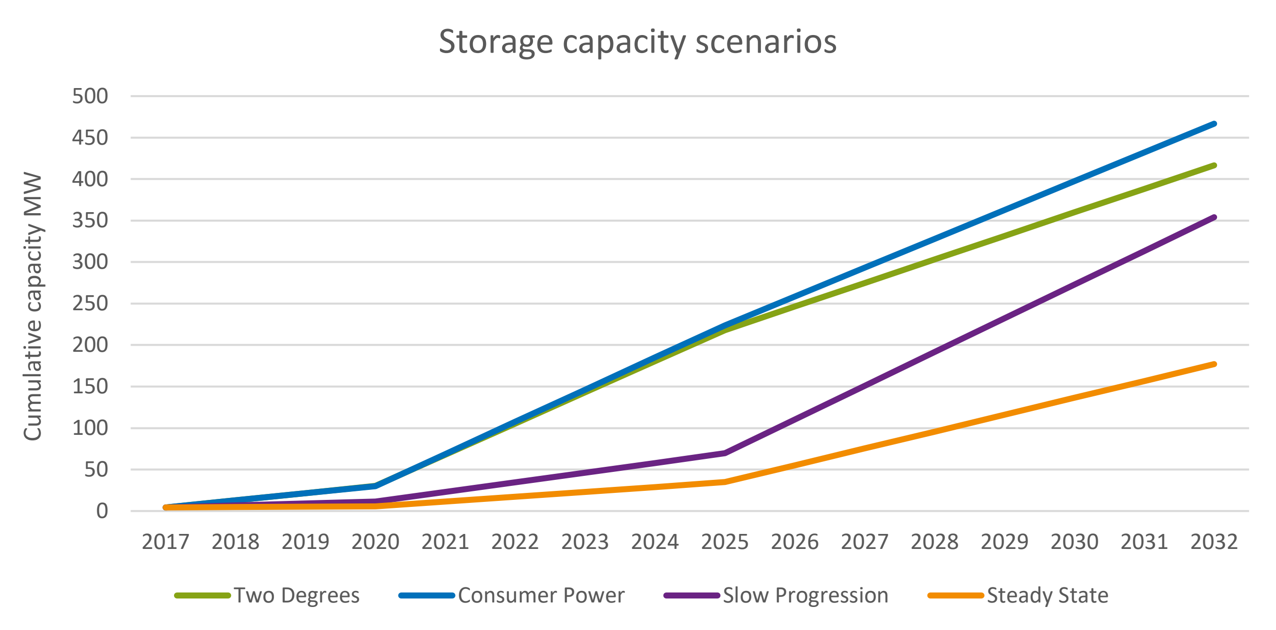



Table 15-7: Assumptions for factors influencing capacity growth for energy storage

| Growth factors | Two Degrees | Consumer Power | Slow Progression | Steady State |
|---|---|---|---|---|
| **Infrastructure and government support** | | | | |
| Storage technology development | **Enhanced capability and reduced cost within 2020s** | **Enhanced capability and reduced cost within 2020s** | **Enhanced capability and reduced cost later in 2020s** | **No significant improvement in capability or cost during scenario period.** |
| Specific policy support for storage | **Firm guidance on co-locating with renewables, co-location projects growing the 2020s** | **Storage able to support high energy users with high cost periods/tariffs, without adverse policy decisions targeting behind the meter assets. High energy user storage projects grow in the 2020s** | **Conflicting storage policy announcements continue, limiting all business models until late 2020s** | **Adverse storage policy decisions stifle growth of all business models out to 2032** |
| Available network capacity in South Wales | **South Wales network constraint preventing new storage is mitigated by 2020/2021** | **South Wales network constraints preventing new storage is mitigated in 2022** | **South Wales network constraints remain in force until 2026** | **South Wales network constraints remain in force until 2026 and limited capacity is available thereafter, causing a slow** |

| | | | | |
|---|---|---|---|---|
| | | | | **uptake in new storage projects in the region** |
| **Storage technology costs** | | | | |
| Battery storage technology and balance of plant cost improvements | **Battery storage costs continue to reduce notably out to 2030, driven by EV growth** | **Storage costs rapidly reduce, especially for behind the meter scale (C&I and potentially co-location)** | **Storage costs reduce less rapidly, due to market appetite being lower than projections** | **Storage costs reduce slowly, with low deployment and barriers to EV deployment** |
| **Evolving revenue streams and business models** | | | | |
| Development of local flexibility markets | **Local flexibility services are signposted and procured across the region, providing benefits to storage assets at all levels** | **Local flexibility services procured across the region, behind the meter projects most commonplace, enabling DSR and storage combined services** | **Local flexibility services uptake is moderate, with slow uptake and/or incumbent flexible assets dominating markets** | **Local flexibility services uptake is slow, with little/no uptake and incumbent flexible assets securing most of the contracted capacity** |

## Methodology

The methodology for the storage projections follows both a top down and bottom up methodology. The top down approach uses the Regen storage model predications for the size of the UK market adjusted for South Wales by accounting for local factors such as affluence, population and proportion of industrial demand. The bottom up methodology builds scenarios from pipelines and factors such as the level of distributed generation in the licence area.

## Relationship to FES 2017 and 2015 Scenario report

The 2017 FES shows there to be a range of 8.8 GW (TD) and 5.8 GW (SS) of storage capacity by 2032[119]. Regen's growth analysis shows notably higher storage uptake, with 12.5 GW by 2032. The proportion of storage capacity that connects to the distribution network varies by scenario, see Table 15-8.

Table 15-8: FES vs Regen capacity storage growth projections out to 2032 and proportion connecting to distribution network, by scenario

| Scenario | All GB storage Capacity by 2032 (MW) | | Proportion of storage on distribution network | |
|---|---|---|---|---|
| | FES 2017 | Regen | Percentage | Capacity (MW) |
| Two Degrees | 8,802 | 12,500 | 64% | 5,661 |
| Consumer Power | 9,224 | 12,000 | 76% | 7,049 |
| Slow Progression | 7,437 | 10,180 | 67% | 4,993 |
| Steady State | 5,807 | 6,440 | 53% | 3,081 |

[119] Note this and Regen's figures include 2.7 GW of legacy pumped hydro connected to the Transmission network in north Wales.

The high growth scenarios are slightly higher than the previous report for both Two Degrees and Consumer Power. The report is significantly higher for Slow Progression and Steady State, reflecting the growth of the market for battery storage and the reduction in technology cost which will impact across the scenarios. In particular this reflects the potential for co-location with renewables in South Wales, an area that has nine per cent of the UKs renewable capacity installed.

### Distribution of technology across ESAs

The capacity in the scenarios with the exception of the pipeline project have been distributed according to the following factors.

Table 15-9: Distribution factors for the storage operating models

| Storage Business Model | Distribution Factors |
|---|---|
| **1. Response service** | Distribution based upon existing distribution of connection applications |
| **2. Reserve service** | Distribution based upon existing distribution of connection applications |
| **3. Commercial and industrial** | Proportion of commercial and industrial land space |
| **4. Domestic and community** | Distribution of rooftop solar PV |
| **5. Generation co-location** | Distribution of ground mounted solar PV and wind |