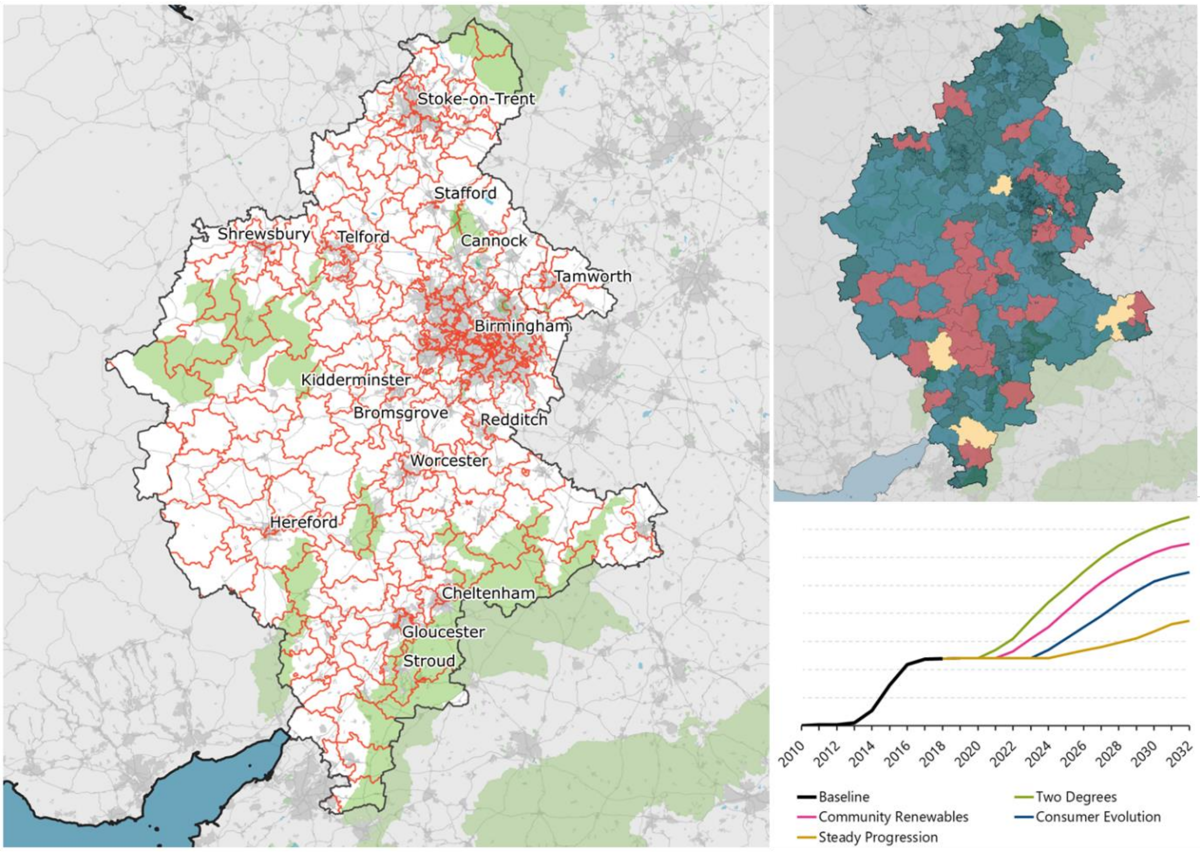
Distribution Future Energy Scenarios

Generation and demand technology growth scenarios to 2032



West Midlands licence area

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Acronym	Definition
AD	Anaerobic Digestion
ACT	Advanced Conversion Technology
BEIS	Department for Business Energy and Industrial Strategy
BEV	Battery Electric Vehicle
CAZ	Clean Air Zone
CCC	Committee on Climate Change
CCGT	Combined Cycle Gas Turbine
CfD	Contracts for Difference
CHP	Combined Heat and Power
DNO	Distribution Network Operator
DSR	Demand Side Response
DSO	Distribution System Operator
DUoS	Distribution Use of System
EFR	Enhanced Frequency Response
EfW	Energy from Waste
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 Systems
Ha	Hectares
kWh	Kilowatt-hour
MW	Megawatt
PHEV	Plug-in Hybrid Electric Vehicle
PPA	Power Purchase Agreement
PV	Photovoltaics
REPD	Renewable Energy Planning Database
RHI	Renewable Heat Incentive
RIIO	Revenue=Incentives+Innovation+Outputs
RO	Renewables Obligation
RTFO	Renewable Transport Fuel Obligation
STOR	Short Term Operating Reserve
ULEV	Ultra-Low Emission Vehicle
WPD	Western Power Distribution

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Introduction

This report sets out a range of credible Distribution Future Energy Scenarios (DFES) for how much generation, electricity storage and new demand technologies might be connected to Western Power Distribution's (WPD's) West Midlands licence area over the next 13 years to 2032. The report updates Regen's scenario analysis for licence area produced in 2017.

Rapid changes in the UK electricity system have taken place in the past decade. The growth of distributed forms of generation, such as solar PV, has already caused network constraints in the licence area. Seismic technological changes, including electricity storage, smart technologies and electric vehicles (EVs), will drive further changes in how electricity networks are used and how networks need to develop over the next decade.

Using the framework of National Grid Future Energy Scenarios (FES), these scenarios cover the growth of distributed generation and electricity storage, as well as low carbon demand technologies such as electric vehicles and heat pumps.

Role of Distribution Future Energy Scenarios

The findings of the DFES studies are the first stage of a process of strategic network assessment and options appraisal that WPD undertake as part of their network strategy work, as they transition to becoming a Distribution System Operator (DSO). The DFES studies are used in WPD's "Strategic Investment Options: Shaping Subtransmission" studies and their analysis of potential flexibility options to address network constraints.

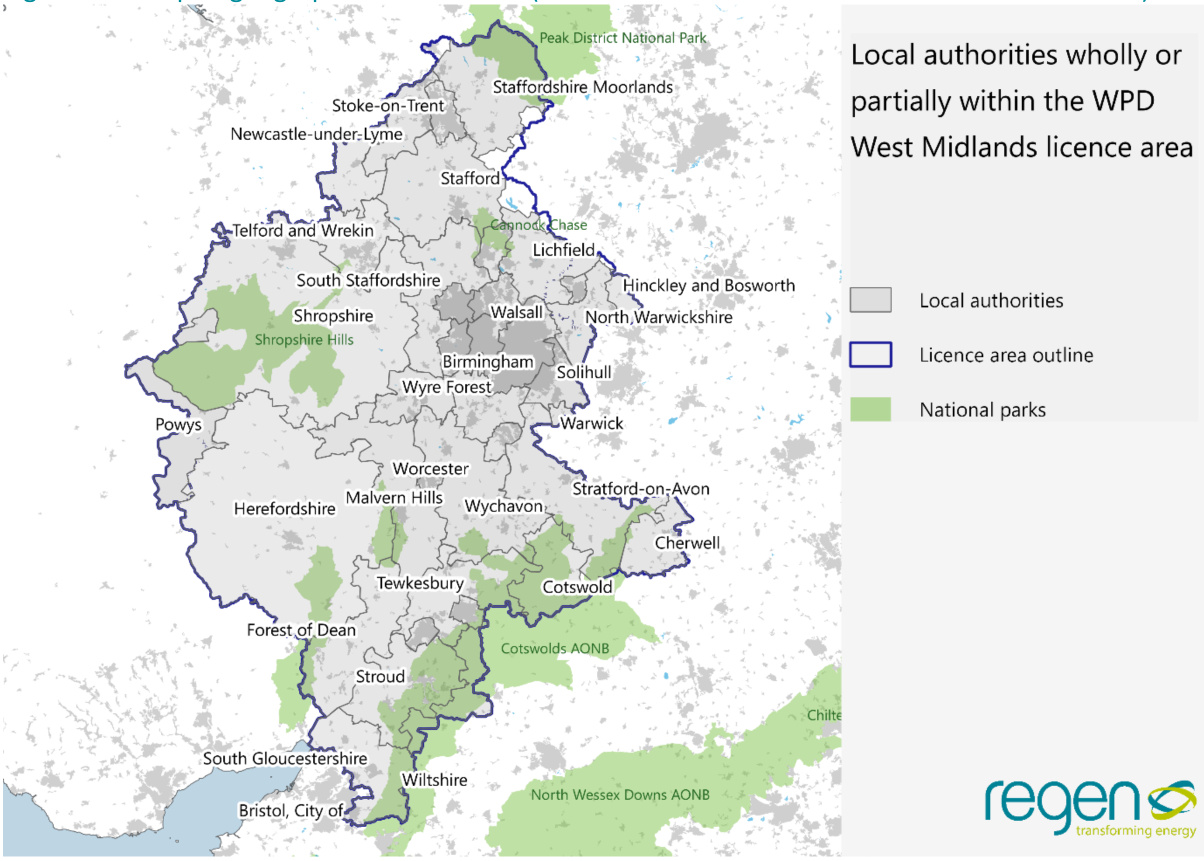
The DFES studies also contribute to WPD's business plan for the RIIO-2 price control framework[1] that comes in to force for electricity distribution on 1 April 2023, dictating how the networks are run and investment is managed up to 2028.

The West Midlands licence area

The West Midlands licence area runs from Stroud in the south, to Stoke-on-Trent in the north, covering 13,846 square kilometres (Figure 0-1). The licence area is characterised by a large urban and industrial conurbation in the centre, including Birmingham (the UK's second most-populous city), Wolverhampton and Solihull. The M5 motorway is a key feature which navigates through small cities such as Worcester, Gloucester and Stoke-on-Trent. The west of the licence area is more rural, bordering Wales and crossing the border in a few areas. The Malvern and Shropshire Hills, as well as some of the Cotswolds, are designated Areas of Outstanding Natural Beauty (AONBs).

[1] Revenue=Incentives+Innovation+Outputs or RIIO. More details available from Ofgem: https://www.ofgem.gov.uk/network-regulation-riio-model/network-price-controls-2021-riio-2/what-riio-2-price-control

Figure 0-1: Map of geographical boundaries (local authorities in the West Midlands licence area)



Report methodology

This analysis presents four scenarios for the potential changes in the use of the electricity distribution network from 2018 to 2032 in the licence area, covering:

- 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)
- electricity storage.

The main output of the analysis is a dataset that WPD uses for network planning. This report accompanies that dataset and records the key market insights, assumptions and methodologies used in the scenarios process.

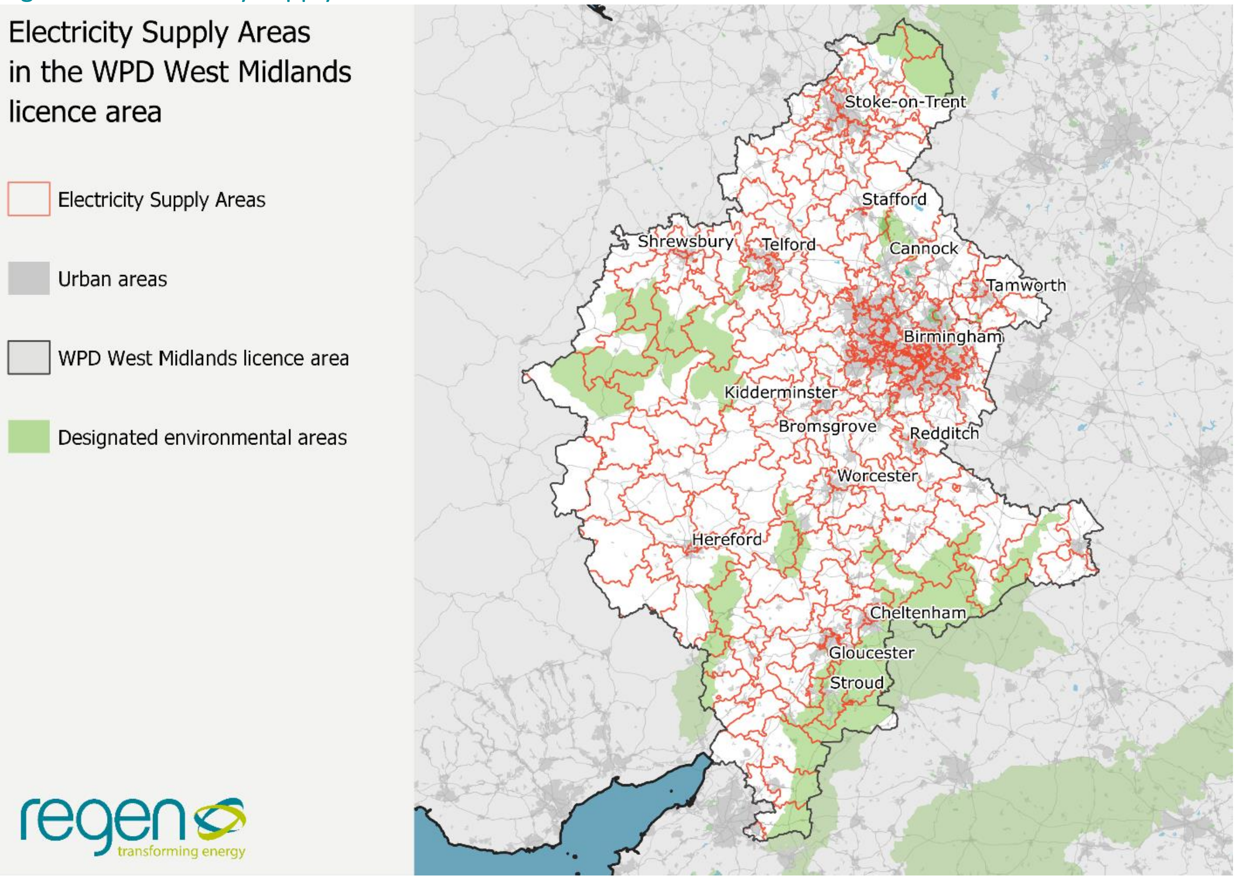
Projections of changes to underlying household and business demand through energy efficiency are not part of the analysis, as these are already included in existing network projections.

Electricity Supply Areas

The information is presented to WPD as a dataset broken down into 230 Electricity Supply Areas (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.

There are 36 local authorities in WPD's West Midlands licence area and 38 in the extended licence area used in this analysis (which includes a few additional ESAs from East Midlands and South Wales).

Figure 0-2: Electricity supply areas in the West Midlands licence area



Scenarios process

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

Stage 1: A baseline assessment. Technology baselines for installed capacity are calculated from WPD's network connection database. 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 database of accepted connection offers 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 on 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: Scenario projections to 2032. Using National Grid's FES 2019 as a framework, a bottom-up assessment of local resources, constraints and market conditions is carried out to develop the scenarios for each technology. A consultation event is carried out to enable stakeholder input to be gathered, and research is undertaken with specific developers and investors active in the licence area.

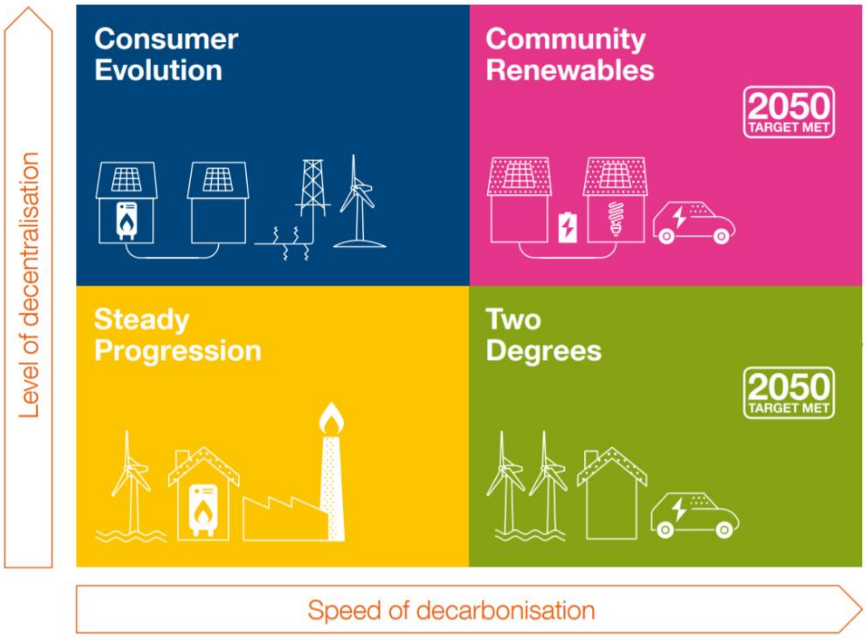
To build the baseline and scenarios for demand from new developments, we undertook a different methodology which is detailed in section 4.

Future Energy Scenarios 2019

This study uses the FES 2019[2], developed by National Grid Electricity System Operator, as a starting point.

The FES 2019 framework aligns future scenarios to two key axes: speed of decarbonisation and level of decentralisation. Two scenario pathways meet the UK's previous emissions reduction target of 80% by 2050 – Two Degrees and Community Renewables. There is an added Net Zero sensitivity analysis that examines how net zero carbon emissions can be met by 2050.

Figure 0-3: National Grid Electricity System Operator Future Energy Scenarios Framework (2019).



Along with the FES 2019 growth pathways, the Regen study used specific local attributes, characteristics and resources along with geographical and social factors to determine likely growth. This means that each licence area will differ in specific ways from the rest of the UK.

For example, there may be particularly good resource for a certain technology which means proportional growth will be higher than the FES projection. Others may already have high levels of deployment, which may limit the potential for future growth in cases where the feedstock is limited or where there are cumulative impact issues.

The four scenarios, in summary, are:

- **Two Degrees** explores how the 2050 decarbonisation target can be achieved with a focus on larger-scale and more centralised technologies. This scenario features changes to the energy landscape such as hydrogen heating and large-scale, transmission-connected generation technologies such as offshore wind.
- **Community Renewables** explores how the 2050 decarbonisation target can be achieved through a more decentralised energy landscape with high levels of smaller-scale, local and domestic activity.
- **Consumer Evolution** is a decentralised scenario which makes progress towards the decarbonisation target but fails to achieve the 80% reduction by 2050. Deployment is focused on smaller-scale, local and domestic projects with a lack of strong policy support.
- **Steady Progression** is a centralised scenario that makes progress towards, but does not meet, the 2050 decarbonisation target. In the timescale of this study, the scenario sees very low deployment of renewable technologies, with gas-fuelled power generation and heating continuing to play a dominant role.

[2] http://fes.nationalgrid.com/fes-document/ the assumptions underpinning the FES 2018 scenarios are published by National Grid in a workbook.

A. Introduction to disruptive demand technologies

Factors impacting electricity demand

Electricity demand from households and businesses has been decreasing in the UK year-on-year[3]. However, FES 2019 projects that demand will start to increase again, particularly from the 2030s onwards, due to increasing electrification of heating, cooling and transport.

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

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

Demand scenario summary

Although each technology has particular drivers and barriers, the key factors that will determine the level of deployment for heat pumps and EVs are:

- **Technology costs:** The potential for future falls in technology price and running costs versus the incumbent technologies, such as petrol and diesel vehicles or gas central heating.
- **Government policy:** The likely level of government support for take-up of technologies, such as revenue support, and where they might be focused.
- **Building regulations:** New build or other regulations which will influence the take-up of air conditioning or electrification of heat and transport in new homes.
- **Smart and flexible technologies:** Smart and connected technologies will allow households to minimise energy usage. They can also help manage the growth in domestic demand by providing flexibility to the network.

Although low carbon technology costs are expected to fall in the next decade, questions remain over how far these costs may have fallen by 2032. In addition, government policy remains vague about future direction or commitment to maintain existing policies such as subsidies for new EVs. The result of these uncertainties is that there are large differences in the deployment of different technologies in the highest and lowest scenarios.

Table A-1 presents the findings for the level of growth of disruptive demand technologies in the licence area under the four scenarios. In the Community Renewables scenario EVs could account for over 62% of vehicles by 2032, and heat pumps in 22% of properties. In Steady Progression these numbers are 13% and 4% respectively.

[3] https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics

Table A-1: West Midlands licence area, percentage of domestic households with each disruptive demand technology in 2032 by scenario

	Electric Vehicles (% of all vehicles)	Heat pumps	Air conditioning
Two Degrees	85.3%	15.8%	1.1%
Community Renewables	61.5%	22.1%	3.1%
Consumer Evolution	12.4%	7.3%	6.0%
Steady Progression	12.7%	4.1%	6.0%

1. Electric vehicles

The WPD West Midlands licence area has 10% of all vehicles registered in GB and the total annual mileage driven in the licence area is 9.3% of the GB total. At the end of 2018 the area had above average numbers of electric vehicles registered, with 14.8% of GB total[4].

In this report 'EVs'[5] refers to Plug in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (BEVs).

Electric vehicle uptake in the West Midlands is ahead of the GB average by close to 50%.

National and local policy support and investment by vehicle manufacturers, along with improvement in charging infrastructure, is projected to drive significantly increased EV numbers in all scenarios. The licence area is expected to remain above the UK average for uptake of EVs until towards the end of the scenario period due to its relative affluence and large urban and industrial areas.

Electric vehicle baseline

Table 1-1 summarises the current baseline of mileage, vehicles registered and type of EV in the licence area. There were 31,289 EVs registered in the licence area as of 2018[6].

Table 1-1: Baseline of vehicles and electric vehicles registered in the West Midlands licence area (December 2018)

Vehicles in the West Midlands licence area	All Vehicles	Cars	LGVs	HGVs	Buses & Coaches	Motor-cycles
All vehicles in licence area	3,783,991	3,132,747	474,964	56,849	13,330	106,100
% of all GB vehicles in licence area	9.9%	9.9%	11.8%	11.3%	8.3%	7.9%
Electric vehicles in West Midlands	31,289	30,045	1,023	39	17	164
West Midlands % of GB electric vehicles	14.8%	15.0%	14.9%	77.6%	5.6%	4.8%

[4] Source Department for Transport (DfT) 2018

[5] The term EVs is used here to refer to Battery Electric Vehicles and Plug-in Hybrid Electric Vehicles, sometimes collectively known as Plug-in Vehicles (PIVs) as they interact with the electricity network. Hybrid vehicles that do not plug-in or vehicles that have some other electric efficiency features are not included.

[6] Note: the definition of an EV in the DfT dataset corresponds to "plug-in" vehicles and is not split out in the same way as the FES 2019 vehicle types.

Electric vehicle growth factors

The growth in EV uptake will be driven by a mix of local and national policies. The UK government has already announced a ban on new petrol and diesel vehicle sales in 2040[7]. Further policies, such as Clean Air Zones and purchase price support, will be key factors for future EV uptake in the licence area.

Clean Air Zones

The development of Clean Air Zones (CAZs) to tackle air quality in this relatively urban and industrial licence area will be an important local growth factor. Birmingham is developing a CAZ that is due to be operational in 2020[8]. This will charge older models of petrol and diesel vehicles to enter central Birmingham and is expected to increase the uptake of EVs. Scrappage schemes, alongside CAZs, are planned to help small businesses and low-income households make the transition to EVs. Other urban areas such as Stoke-on-Trent and Solihull are also discussing CAZ implementation, and these would be expected to be introduced in the more ambitious scenarios.

Purchase price support

Targeted government support to help with the upfront costs of EVs is expected to continue until the early 2020s. The scenarios vary in the timescales of when purchase prices are projected to reduce enough for subsidies to not be needed. In the more ambitious scenarios, there will be more BEVs than PHEVs. The removal of the purchase price support for PHEV car models in November 2018 has had a considerable impact. In 2018, 75% of EV sales were for PHEV cars and 25% were BEVs, whereas in 2019, BEV car sales are ahead of PHEV car sales and this trend is likely to continue[9]. Changes to the company car tax "Benefit-in-Kind" arrangements will come into effect in 2020/2021[10] and will be another strong incentive for consumers to shift towards BEVs.

Vehicle manufacturer response

Significant investments, strategic partnerships and more competition between manufacturers are starting to drive down costs to the consumer. This cost reduction accelerates in the more ambitious scenarios. New, custom-built EV platforms are starting to come to market that are likely to improve manufacturer capability and profitability. New EU CO_2 reduction regulations for cars, vans and lorries[11] are forcing manufacturers to transition faster to avoid substantial fines. As a result, a significant increase in the number of EV models available on the market, across all the vehicle categories, is expected in the early 2020s. Regen's market insight paper 'Harnessing the EV Revolution'[12] discussed these factors and their expected impact on EV uptake.

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[7] E.g. Road to Zero Strategy 2018

[8] https://www.birmingham.gov.uk/info/20076/pollution/1763/a_clean_air_zone_for_birmingham

[9] https://www.smmt.co.uk/category/news/registrations/evs-afvs/

[10] https://www.goultralow.com/fleets-and-businesses/tax-benefits/

[11] https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en

[12] Harnessing the Electric Vehicle Revolution, https://www.regen.co.uk/publications/harnessing-the-electric-vehicle-revolution/ Regen, 2018.

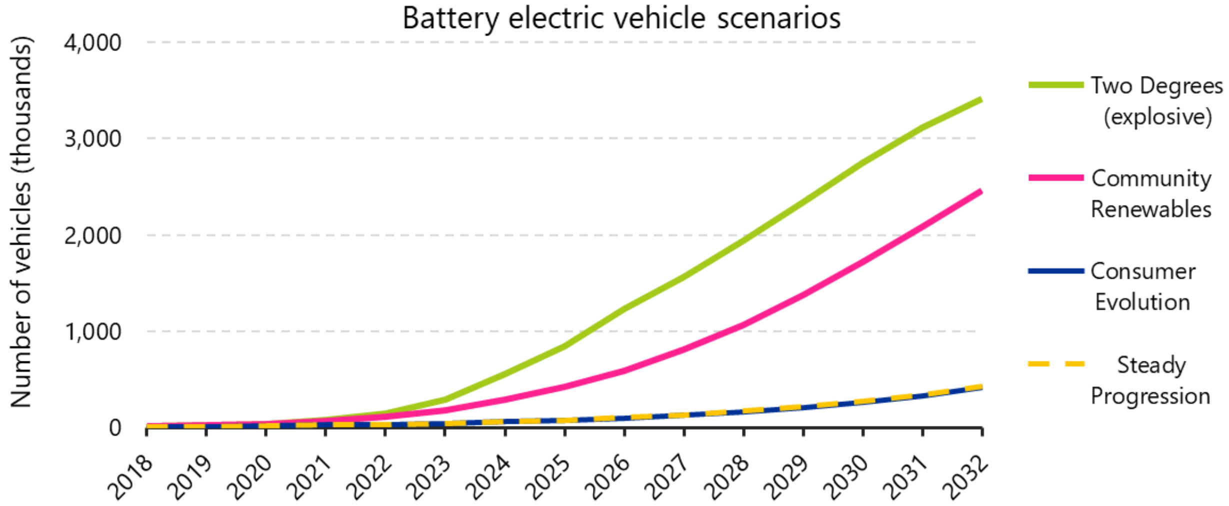
The key factors influencing future electric vehicle deployment in the licence area and how they relate to the scenarios are summarised in Table 1-2.

Table 1-2: Assumptions for factors influencing capacity growth for electric vehicles

Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government policy and support				
Ban on new fossil fuel vehicles	Ban moved forward to 2030	Ban moved forward to 2035	Ban in 2040	Ban in 2040
Local restrictions on petrol and diesel / air quality legislation	Restrictions in urban areas from early 2020s	Restrictions in urban areas from mid 2020s	Some urban restrictions later in 2020s	No further local restrictions
EV charging provision	Focused on public charging in strategic sites e.g. motorway service areas	Focus on home and workplace charging	Slow increase in home and workplace charging	Slow increase in public charging infrastructure
Targeted support for purchase of ULEV	Starting to reduce after 2020	Continued until price parity achieved	Continued into 2020s but substantially reduced	No subsidies past 2020
Technology cost and performance				
Cost of purchasing EV versus petrol and diesel	Parity by early 2020s	Parity by mid 2020s	Parity towards end of 2020s	Parity towards end of 2020s
Range and battery life reach petrol and diesel equivalent	Early 2020s	Mid 2020s	Late 2020s	Late 2020s
Consumer factors				
Smart charging / flexibility business models	Some smart charging and flexibility provided by EV owners	Smart charging and flexibility actively taken up by EV owners	Some smart charging but lagging behind market growth	Less demand and disruption – fewer smart controls introduced
EV supply	Restriction on supply resolved early 2020s	Restriction on supply resolved early 2020s	Restriction on supply resolved mid 2020s	Restriction on supply resolved in late 2020s
Affluence and economic growth	Capital available to invest in new vehicles	Capital available to invest in new vehicles	Lower economic growth restricts EV demand	Lower economic growth restricts EV demand

Electric vehicle scenarios

Figure 1-1: WPD West Midlands licence area battery electric vehicle scenarios



Scenario summary

The results summarised in Table 1-3 show that in a high-growth scenario, the licence area could have almost 3.5 million electric vehicles by 2032. The vast majority of these would be BEV cars[13], with other vehicle types making up a small but potentially significant contribution.

Regen's EV growth model also assumes that EV uptake in the licence area stays ahead of the national average in the short and medium term but will align to national average by the end of the scenario period. This assumption reflects key factors driving early adoption such as affluence levels, off-street parking and second car ownership along with CAZs in and around urban centres.

Table 1-3: EV deployment in the West Midlands licence area - all vehicle types

EV registrations - All Vehicles	2018	2020	2025	2032
Two Degrees (explosive)	31,289	65,269	899,363	3,479,803
Community Renewables		60,727	454,568	2,509,500
Consumer Evolution		51,842	131,724	504,121
Steady Progression		52,013	133,279	518,649

Table 1-4: EV deployment in the West Midlands licence area by vehicle type in 2032

EV registrations by 2032	All Vehicles	BEV Cars	BEV LGVs	HGVs	Buses/ Coaches	Motor-cycles	PHEV Cars	PHEV LGVs
Two Degrees (explosive)	3,457,865	3,303,107	72,187	3,389	792	29,836	48,291	263
Community Renewables	2,509,500	2,363,746	71,410	4,595	831	21,387	47,385	146
Consumer Evolution	504,121	397,365	12,949	714	187	6,237	86,299	370
Steady Progression	518,649	411,868	12,949	715	188	6,237	86,322	370

[13] The proportion of PHEV vehicles, which has been high, is projected to fall significantly as consumers adopt BEVs.

Relationship to other scenarios

The scenarios use baseline vehicle registration data and the FES 2019 projection rates allocated proportionally to the licence area, alongside other local considerations. The Two Degrees (explosive) projection has modelled a faster growth profile, with quicker uptake in the near term (2020s), in comparison to FES 2019. The high baseline, which is around 50% ahead of the rest of GB, is a trend that continues and then reduces over time to a align with the FES 2019 projections towards the end of the report period.

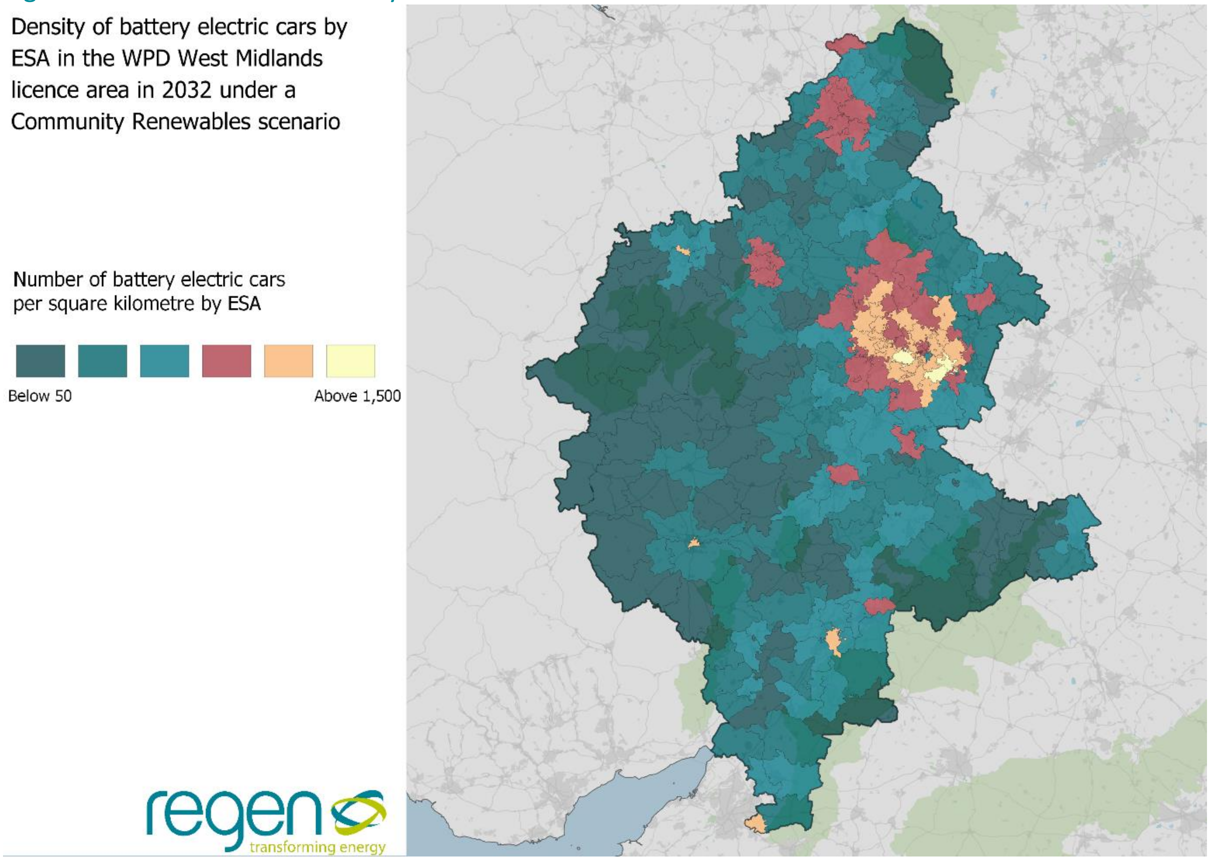
The FES 2019 scenarios present a higher growth projection for electric vehicles than FES 2018. The key question is now about the speed of uptake in the short and medium term and how many of those will be BEV. The two highest scenarios in FES 2019 (Two Degrees and Community Renewables) show the same growth profile. Near-term growth in this analysis has been reduced in line with the latest EV sales figures.

The most ambitious projections for total electric vehicle numbers in the West Midlands are over double the projections in the 2017 report, reflecting the progression of the market, increased policy support and the 2040 ban date for petrol and diesel vehicles, which has been introduced since the initial projections were made. The lowest growth scenario is now projecting more than double the number of EVs as in the 'No Progression' scenario in 2017.

Distribution of technology across ESAs

The distribution of EVs largely reflects the current distribution of vehicle types, with a strong weighting towards urban areas, affluent areas and those with higher level of commercial and industrial activity. Figure 1-2 represents the spatial distribution of the EVs in 2032 under Community Renewables. Data on the property types and the estimated number of cars per household are also taken into account.

Figure 1-2 Electric vehicle density in the West Midlands licence area



2. Heat pumps

The West Midlands licence area has around 11,030 heat pumps and a total of 114 MWth capacity.

There is an increase in heat pumps under all scenarios in this analysis period. Under the most ambitious scenario, Community Renewables, a total of 573,208 heat pumps will be installed in the licence area by 2032. In comparison, Steady Progression has 103,674 heat pumps by 2032.

Of the over half a million heat pumps in Community Renewables, it is projected that nearly 40% will be on-gas hybrid heat pumps by 2032.

Table 2-1: Total number of properties with a heat pump by scenario in West Midlands licence area

Total domestic properties with a heat pump	2018	2020	2025	2032
Two Degrees	11,030	14,462	50,694	401,338
Community Renewables		15,079	64,934	573,208
Consumer Evolution		14,862	31,202	183,884
Steady Progression		14,151	26,876	103,674

Baseline

The licence area is estimated to have had around 11,030 heat pumps installed by the end of 2018, equivalent to 0.48% of houses. This is ahead of the GB average of 0.3%, despite having proportionally more on-gas homes; 88% of homes in the licence area are on the gas grid, compared to the GB average of 85%. The higher uptake may be explained by the fact that 44% (4,842) of the heat pumps are installed in new build properties not supported by the Renewable Heat Incentive (RHI). RHI deployment data shows an increase in installations for the retrofit and self-build market in the licence area over the last two years, due to the tariffs available.

Pipeline

There are no data on the pipeline of heat pumps; as a result, the scenario projections start in 2019.

Heat pump growth factors

This scenario assessment breaks down heat pumps into three categories: retrofit on-gas, retrofit off-gas, and new build. There are also two types of heat pump projected – electric heat pumps and gas back-up hybrid heat pumps[14]. A summary of the assumptions is outlined below. The scenarios do not currently include commercial heat pumps.

[14] Hybrid heat pumps partner an air source heat pump with a back-up boiler (gas, oil or LPG) with smart controls to optimise the efficiencies of both technologies. This can be a lower cost solution in comparison with full electrification via an electric heat pump alone.

Table 2-2: Number of properties and type of heat pumps under a Community Renewables scenario for the West Midlands licence area

Types of property	Number of properties	% with a heat pump in 2032	Type of heat pumps assumed in the model
On-gas existing	2,035,358	20.8%	Assumes that by 2032 half of those fitted in retrofit properties will be hybrid heat pump systems based on air source heat pumps with gas boiler back-up.
Off-gas existing	275,408	18%	Assumes that 100% are fully electric heat pump systems with higher proportion of larger ground-source heat pumps due to space available.
New build properties	285,173	35.5%	Fossil fuel heating being phased out means that all heat pumps are assumed to be fully electric heat pump systems with no gas back-up.

Subsidy support

The key subsidy support is the Renewable Heat Incentive. There were 5,272 accreditations for air source heat pumps under domestic RHI scheme in the GB in 2018. Air source heat pumps represent 56% of the successful accreditations that have been deployed under the domestic RHI[15], whereas ground source heat pumps correspond to 14.3% of the total installations. In September 2017 the RHI tariff rates were increased for domestic air source and ground source heat pumps. The new tariffs also set a heat demand limit to avoid focusing support on larger properties. There has been a resultant increase in air source heat pump deployment rates, rising to an average of 760 per month in 2019, up from an average of 440 per month in 2018[16]. Uptake of the domestic RHI has been high among registered social landlords, representing 22.5% of the total accreditations under the scheme[17]. Heat pumps in new build properties (other than self-build) are not able to access the domestic RHI. All scenarios, with the exception of Steady Progression, anticipate continuation of the subsidy post-2021 with a focus on low income households.

The non-domestic RHI is available for heat pumps, but represents a small proportion of the total accreditations, with ground source heat pumps at 5.15%, water source heat pumps at 0.45% and air source heat pumps at 2.61%. Shared ground loops for domestic properties using individual ground source heat pumps are starting to see increased deployment under the scheme. This is due to a policy change that means that this type of installation can be eligible for the more generous non-domestic RHI tariff rates.

New policies focusing on off-gas areas will drive uptake in 2020s

Deployment of heat pumps has been below initial expectations. The higher upfront cost of the technology is the key barrier, with the domestic RHI designed to cover this cost for the consumer in existing homes and self-build properties. Heat pumps can cost £5,000 to £7,500 more than a conventional gas boiler for a typical semi-detached house[18]. This may include changes to the building that may be needed, such as larger radiators or better insulation/glazing, to allow the heat pump to work efficiently.

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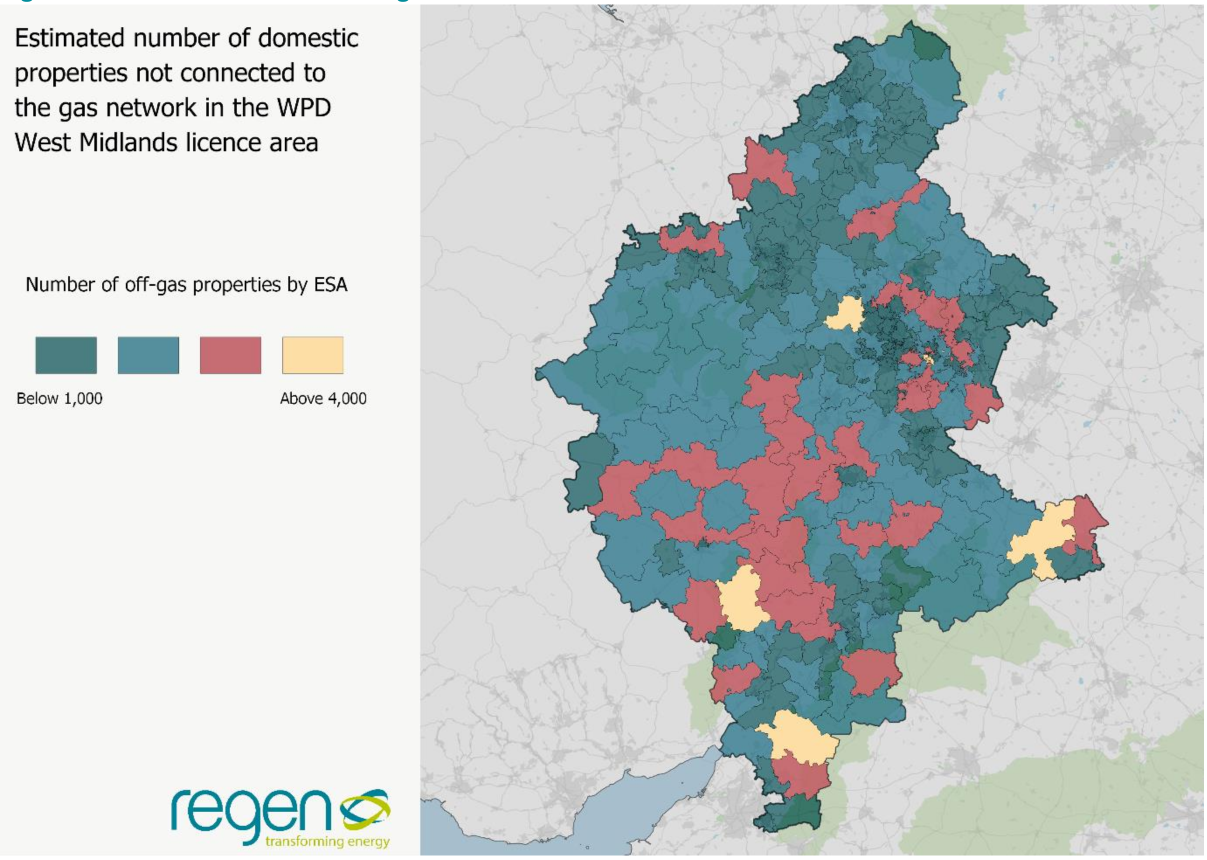
15 https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi/contacts-guidance-and-resources/public-reports-and-data-domestic-rhi
16 https://www.gov.uk/government/collections/renewable-heat-incentive-statistics
17 https://www.ofgem.gov.uk/system/files/docs/2019/07/domestic_rhi_annual_report_18-19_sy5_0.pdf
18 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700572/Hybrid_heat_pumps_Final_report-.pdf

There is likely to be further regulation focused on off-gas properties over the scenarios period, which will be key to driving growth in heat pump deployment. The Clean Growth Strategy from government states that "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 or currently electrically heated) during the 2020s"[19]. Figure 2-1 shows the distribution of off-gas homes in the licence area.

Figure 2-1 The distribution of off-gas homes in the West Midlands licence area



New building regulations

The Future Homes Standard[20] was announced in 2019 and included the intention that from 2025, new homes will be required to have greater energy efficiency and low-carbon heating systems. As a result, all scenarios anticipate that from 2025 there will be a restriction on new gas connections, with heat pumps and heat networks prioritised in new properties.

Related energy efficiency and ventilation standards are due to come in late in 2020, including installing heating systems that are sized to run at lower temperatures with larger radiator systems. This is to ensure that these buildings are future proofed for heat pump deployment.

A key driver of increased uptake will be the updated Standard Assessment Procedure (SAP) regulations (version 10.1)[21], used for assessing building performance for homes, which uses a carbon emissions factor for electricity from the network that is 74% lower than the previous figure. This is consistent

[19] P.79, Clean Growth Strategy, (2017) https://www.gov.uk/government/publications/clean-growth-strategy
[20] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843757/Future_Homes_Standard_Consultation_Oct_2019.pdf
[21] https://www.bregroup.com/wp-content/uploads/2019/11/SAP-10.1-08-11-2019_1.pdf

with lower coal and higher renewable energy generation on the network. There is also provision for monthly carbon factors to take into account the variance in grid electricity carbon intensity across the year[22]. The result is that heat pumps are more likely to be technology of choice to meet building regulations on energy performance. SAP changes will come into effect when national building regulations are updated, which is likely to be in 2020.

Local authorities such as London and Bristol are setting planning requirements for new developments to reduce carbon emission beyond current standards, which may drive heat pump uptake higher in some areas. However, the Future Homes Standard consultation considers restricting local authorities' ability to set higher standards.

Hybrid heat pumps for retrofit

Hybrid heat pumps are becoming a more important technology for heat decarbonisation in existing homes and are a key feature in Community Renewables and Two Degrees. The use of the back-up boiler (usually gas) during low ambient temperatures and peak demand periods can help reduce the impact of heat pumps on the electricity network. The concept has been explored by the Wales & West Utilities and Western Power Distribution's Freedom Project[23].

New business models are starting to come to market for hybrid heat pump technologies combined with smart controls. Changes to the domestic RHI are encouraging new structures to help households cover the upfront costs of a change in heating system. RHI payments can now be taken by a third party over a seven-year term where heat pumps have been installed with smart controls alongside the existing boiler system. An example is the B-Snug offer, backed by Shell, which is focused on oil- and LPG-heated properties[24].

The factors associated with growth of heat pump installations in the licence area, and how they relate to the scenarios, are summarised in Table 2-3.

Table 2-3: Assumptions for factors influencing capacity growth for heat pumps

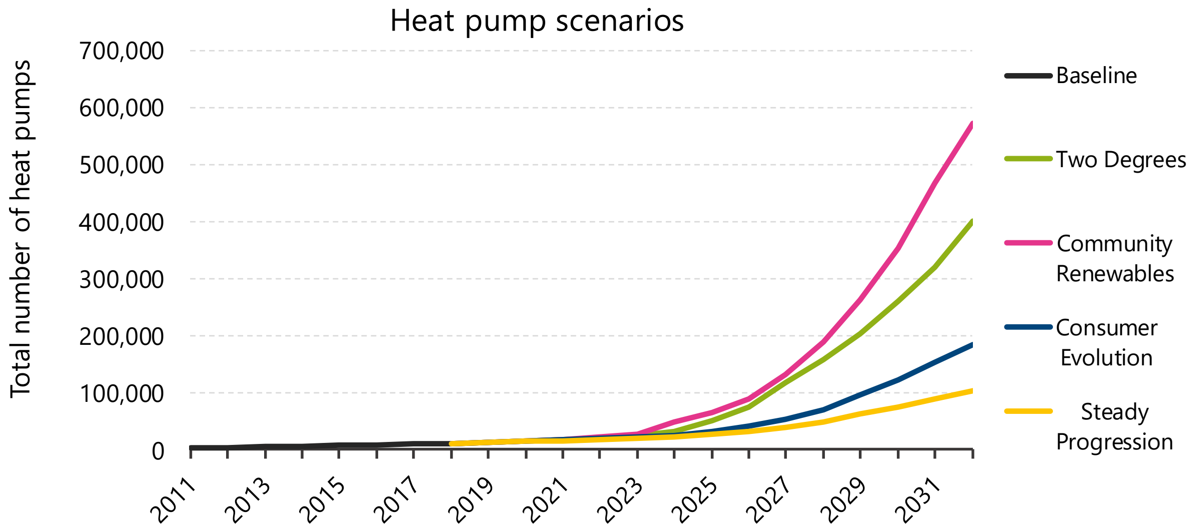
Growth factors	**Two Degrees**	**Community Renewables**	**Consumer Evolution**	**Steady Progression**
Government policy and support				
Regulations/incentives encouraging heat pumps for heating in **off-gas properties**	Introduced in early 2020s	Introduced in early 2020s	Introduced later in the 2020s	None in scenario period
Regulations/incentives encouraging heat pumps for heating in **on-gas properties**	No specific incentives for heat pump installation	Introduced mid 2020s	Introduced late in scenario period	None in scenario period
National building regulation changes and local planning policies support the roll out of heat pumps in **new developments**	From early 2020s, policy leads to widespread use of heat pumps in new builds	From early 2020s, policy leads to widespread use of heat pumps in new builds	From late 2020s, policy leads to widespread use of heat pumps in new builds	From late 2020s, policy leads to widespread use of heat pumps in new builds

22 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/836925/REQUEST.pdf
23 https://www.westernpower.co.uk/projects/freedom
24 https://www.b-snug.com/

Subsidy for installations	Limited subsidies for lower income households	Subsidies available to lower income households	Subsidies available to lower income households	No subsidies
Market and technology factors				
Hybrid technology reaches cost/payback parity	Mid 2020s	Mid 2020s	Late 2020s	End of period
Smart controls maximise/flexibility and efficiency of usage	Come online in mid 2020s	Come online in mid 2020s	Late 2020s	End of period
Affluence and economic growth	Capital available to invest	Capital available to invest	Low economic growth restrains demand	Low economic growth restrains demand

Heat pump scenarios

Figure 2-2: WPD West Midlands licence area heat pump scenarios.



Scenario summary

Community Renewables and Two Degrees show significant growth in heat pumps installed, ramping up from rapidly from 2023. This occurs in both on- and off-gas homes. In new builds, a ban on fossil fuel-based heating occurs post-2025 in both Two Degrees and Community Renewables, with a more limited requirement under Consumer Evolution. The high level of on-gas properties in the licence area drives deployment of hybrid heat pumps, with 220,438 projected to be installed under Community Renewables by 2032. In Two Degrees, the increase in the number of heat pumps is lower at 401,338 heat pumps by 2032, with more of a focus in off-gas areas. This is due to less subsidy support, a lack of regulations incentivising on-gas heat pump deployment and more hydrogen-based networks in urban and industrial areas.

Consumer Evolution and Steady Progression have much lower level of deployment and by 2032, heat pumps are installed in 7.3% and 4.1% of homes respectively.

Relationship to other scenarios

The results of this scenario analysis show that the overall proportion of homes with heat pumps is slightly above FES 2019 estimates by 2032 for Community Renewables and Two Degrees due to a high number of new-builds in the licence area. Growth in deployment is higher in the late 2020s, as on-gas properties take advantage of hybrid heat pumps. Higher deployment in the late 2020s, albeit to a lesser extent than in the greener scenarios, is also projected in Consumer Evolution and Steady Progression in this analysis.

In comparison with our 2017 analysis of the West Midlands, the growth projected for heat pump installations is higher in all scenarios due to more ambition coming from government for phasing out fossil fuel heating by 2025, stricter building regulations, lower carbon factors from grid electricity and the Future Homes Standard.

Distribution by ESA

The scenarios estimate the heat pumps installed in the licence area for new developments, on-gas and off-gas properties. The geographic distribution is based on the total number of homes projected in an ESA. The number of properties which are off the gas grid and the numbers of new housing developments projected in each ESA are also considered. Affluence of different areas is also used to distribute heat pump deployment during the scenario period.

3. Air conditioning

Air conditioning has limited uptake in the UK at present. However, higher extremes of temperatures from heatwaves and warmer summers due to climate change could increase demand for air conditioning towards the end of the scenario period.

Uptake of air conditioning is likely to be focused in the urban areas, such as Birmingham, due to higher density of building floor area and warmer temperatures from heat island effects.

Recent heatwaves have increased attention on technological options for active cooling in buildings.

Table 3-1: Number of properties in WPD West Midlands licence area that have an air conditioning unit installed.

Number of domestic properties with an air con unit	2018	2020	2025	2032
Two Degrees	24,795	25,230	26,217	27,185
Community Renewables		27,137	39,872	80,092
Consumer Evolution		28,878	57,767	149,833
Steady Progression		28,878	57,767	149,833

Baseline

There is a lack of reliable baseline data for air conditioning installations, although one study estimates that 203,000 air conditioning units were sold in the UK in 2018, up from 153,000 in 2013[25]. The large urban and industrialised areas in the licence area are likely to have higher deployment levels. These scenarios use the FES 2018 estimate of 1% of homes in the UK with air conditioning. This analysis is limited to domestic air conditioning.

Pipeline

As there are no pipeline data available for air conditioning uptake, scenario projections start in 2019.

Air conditioning growth factors

Climate and temperature rise

The UK's mild island climate is starting to change. The top ten warmest years for the UK, since records began in 1884, have occurred since 2002, and hot summers are predicted to be much more common[26]. The recent heatwaves in the UK and across Europe in 2018 and 2019 reached record temperatures, with a direct health impact and increase in deaths[27]. This is likely to cause a significant increase in demand for air conditioning.

[25] https://www.jraia.or.jp/english/World_AC_Demand.pdf

[26] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp-headline-findings-v2.pdf

[27] https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/causesofdeath/articles/dosummerheatwavesleadtoanincreaseindeaths/2019-10-07

Urban areas experience higher temperatures due to the urban heat island effect, where urban surfaces reflect and re-radiate heat in comparison with natural surfaces. Therefore, deployment of air conditioning is likely to be focused in urban areas.

Building regulations

Recent extreme heatwaves in the UK have increased the attention on active cooling technologies. Existing UK building regulations, which have traditionally been focused on heat retention in buildings, may increase the need for active cooling. The Committee on Climate Change has raised the need for further work and changes to regulations to ensure overheating in properties is managed efficiently and air conditioning is used as a last resort in some urban areas[28]. Passive cooling measures are expected to be the main solution for maintaining healthy temperatures in buildings in the greener scenarios, meaning they see lower increase in air conditioning deployment.

There has already been a shift in standards to account for cooling. The new Future Homes Standard[29], for example, includes plans to increase the minimum efficiency of cooling technologies such as air conditioning.

Certain types of heat pumps can also be used for cooling in buildings[30]. With heat pumps being a key technology in new buildings post-2025 in greener scenarios such as Community Renewables, it is anticipated that some of these units may also be used for cooling.

Running costs

Uptake of air conditioning will be heavily influenced by running costs, and therefore affluence is a key a factor for deployment. Research for the Committee on Climate Change has shown that air conditioning could cost up to £266 per year in a flat and £140 per year in a detached property[31]. There is potential for rooftop solar PV to reduce these costs if air conditioning is running concurrently with solar PV generation.

Table 3-2 outlines the factors that are anticipated to be the key drivers of air conditioning uptake.

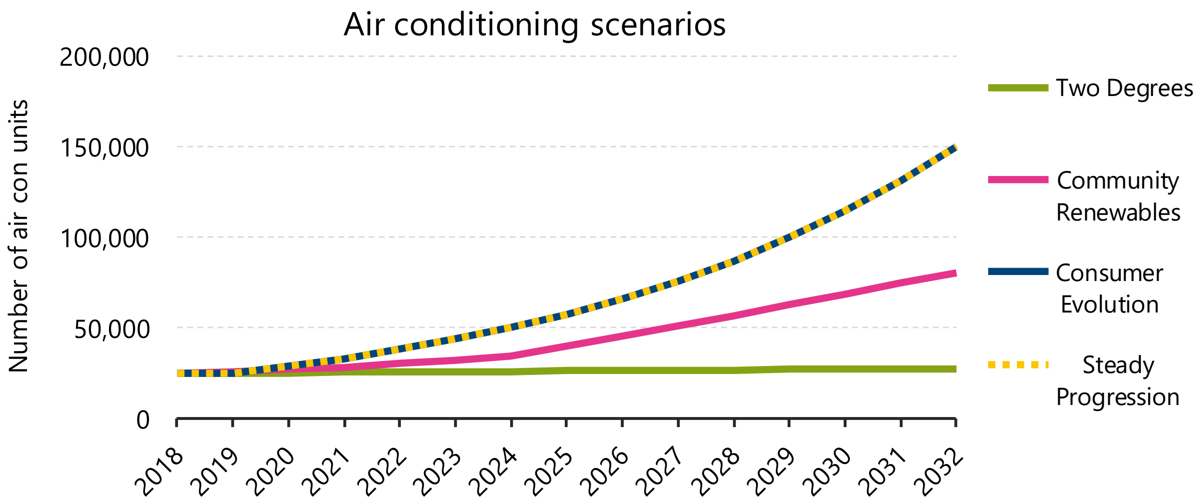
[28] https://www.theccc.org.uk/wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf
[29] https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings
[30] https://www.coolingpost.com/products/daikins-first-heat-pump-hybrid-r32/
[31] https://www.theccc.org.uk/publication/updating-an-assessment-of-the-costs-and-benefits-of-low-regret-climate-change-adaptation-options-in-the-residential-buildings-sector/

Table 3-2: Assumptions for factors influencing growth in the number of air conditioning units

Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Infrastructure and Government support				
Building regulations on cooling	Strong regulations driving passive cooling	Strong regulations driving passive cooling	Some regulation on standards	No regulation
Technology cost and performance				
Unit and running costs	High unit and running costs	High unit and medium running costs (local solar)	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 or repurpose heat pumps	Low economic growth restricts demand	Low economic growth restricts demand
Resource factors				
Climate and temperature rise	Temperature rise minimised	Temperature rise minimised	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

Air conditioning scenarios

Figure 3-1: WPD West Midlands licence area air conditioning scenarios



Scenario summary

In Consumer Evolution and Steady Progression there are much higher levels of uptake for air conditioning in UK homes, due to increasing temperatures and limited regulation to avoid active cooling measures. From a baseline of 1.1% of homes in 2018, up to 6% of homes in Consumer Evolution and Steady Progression could have air conditioning by 2032. Community Renewables also shows an increase, with 3.1% of all homes with air conditioning by 2032, reflecting the high number of heat pumps in this scenario. In Two Degrees there is a small rise in the number of homes with air conditioning, as building standards minimise new installations.

Relationship to other scenarios

The scenarios for air conditioning are taken from FES 2019 future energy scenarios. We have amended Community Renewables to show a higher number of homes with air conditioning, primarily due to higher levels of heat pump deployment in this scenario.

Distribution by ESA

The distribution of air conditioning has been weighted by location of existing homes, locations of new housing developments and population density to reflect the impact of heat islands in high density urban areas in the licence area.

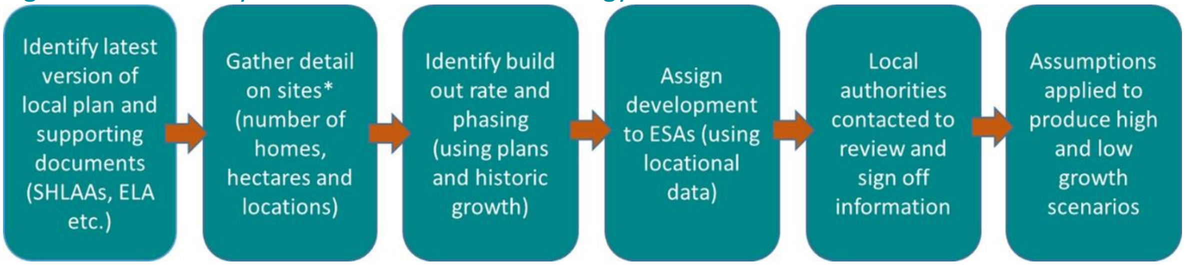
4. New development growth

The scenarios estimate where and how much new development is projected in the licence area. The impact of these new domestic and commercial developments is then calculated by WPD to understand their impact on electricity demand at an ESA level. The methodology for this assessment is outlined in the section below and Figure 4-1.

New development sites for housing or commercial developments can have a significant impact on local electricity demand. To understand what sites are expected within the licence area and to produce scenarios, planning documents from local authorities, which are either fully or partly within WPD's extended licence area, were reviewed to collect data on location, size and type of planned future developments. It should be noted that the data in these planning documents typically only considers new development and not demolitions or floorspace loss, unless specifically planned and noted.

As discussed previously, there are 38 local authorities in the extended licence area that are included in this analysis.

Figure 4-1: Summary of data collection methodology for residential and non-residential sites



Data sources

Local authority Local Plans and supporting documents are the primary data source for this analysis. The plans contain a core strategy which is reviewed every five years and is supplemented by additional supporting documents, policies and maps identifying potential sites with varying levels of detail on the prospective building type and end use.

In the majority of cases additional supporting documents were used to collect the details of sites, including Five-Year Housing Land Supply documents, Annual Monitoring Reports and Strategic Housing and Economic Land Availability Assessments, which are updated more regularly than the Local Plans.

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 and floorspace (m²) of non-residential property to be built.
- Any indication of phasing, amount of property to be built per year etc. until 2032.
- The site's location and the relevant ESA/ESAs it would be expected to 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 4-1 and cover 15 different electricity profiles.

Table 4-1: Non-domestic demand 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 were sent to planning and economic development officers in the 38 local authorities for review and comment. Of these local authorities, 30 (80%) signed off the data used in this report.

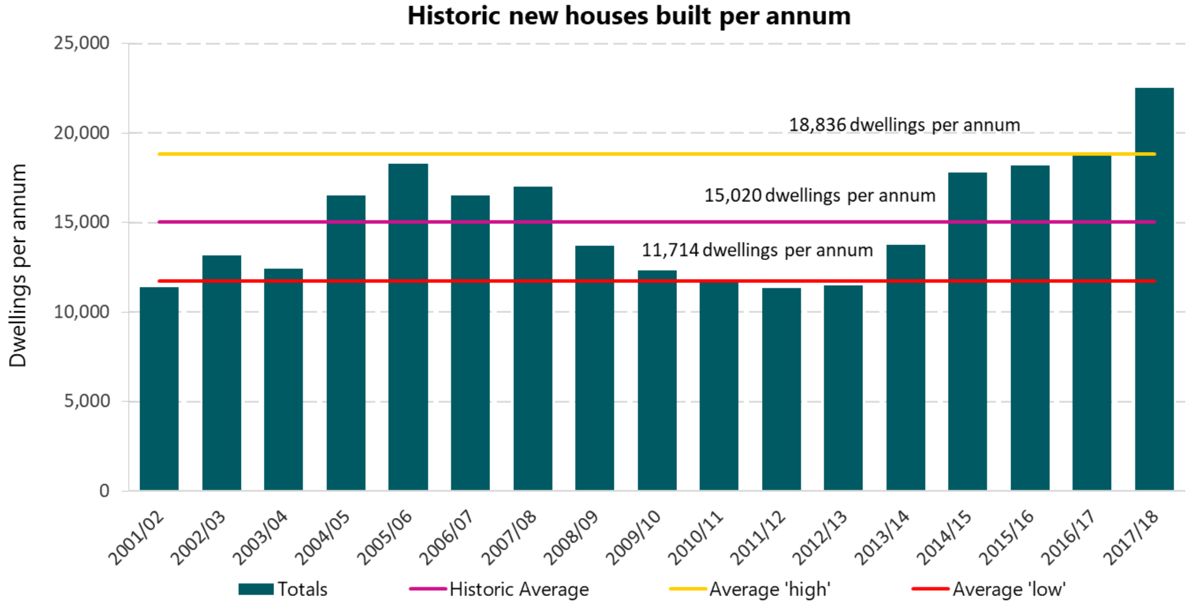
A stakeholder engagement event was also held in Birmingham in June 2019, to which all 38 local authorities were invited. This allowed local authorities to understand more about the objectives of the scenarios and feedback to WPD and Regen any further information on the process.

WPD West Midlands 2017 new developments study data

The development sites were cross-checked with the data that was produced in 2017 DFES study. For the most part, the construction of the larger strategic developments remains on the same path as was previously recorded, with a few being delayed a couple of years. However, for many local authorities, the smaller sites have changed significantly from the 2017 study. This change is a result of construction delays, omission of unviable sites and addition of new sites.

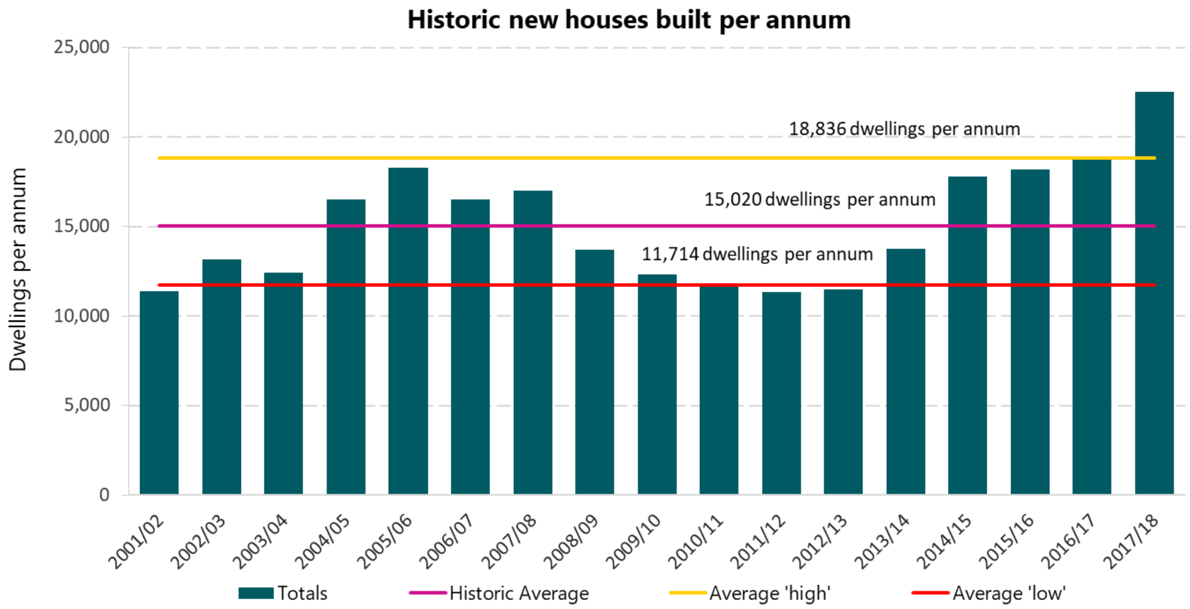
Baseline

Figure 4-



2 illustrates that the historic housing build rate fluctuates between 11,700 to 18,800 new builds per year over the past two decades. It also illustrates that the West Midlands is currently in a period of high housing growth. Last year (2017/18) had the highest build rate of the last 20 years, with 22,518 new dwellings.

Figure 4-2: Annual totals for new houses in the West Midlands licence area, new-build homes per annum in WPD's West Midlands licence area with high, medium and low averages for 2010-2018[32]



[32] https://www.gov.uk/government/statistical-data-sets/live-tables-on-net-supply-of-housing

The local authority planned rates are somewhat higher than the average build rates for the licence area in the near-term. Assumptions have therefore been used to delay the planned rates in order to delay future developments to be more consistent with historic averages.

Assumptions

Details of assumptions made to produce these scenario profiles for domestic developments in the 'High', 'Medium' and 'Low' scenarios are in Table 4-2.

Table 4-2. Details of assumptions made in the build-out rate for domestic developments in the 'High', 'Medium' and 'Low' growth scenarios

Year	Assumptions for 'high growth' scenario	Assumptions for 'medium growth' scenario	Assumptions for 'low growth' scenario
First year (2018/19)	100% of planned development goes ahead, as the majority of sites are already under construction.	95% of planned development goes ahead, as the majority of sites are already under construction.	100% of planned development goes ahead, as the majority of sites are already under construction.
Second year (2019/20)	90% of planned development goes ahead, as the majority of sites are already under construction with the remainder delayed by up to four years.	75% of planned development goes ahead, as local plan estimations are high, with the remainder delayed by four years.	80% of planned development goes ahead, as local plan estimations are high, with the remainder delayed by up to four years.
Years three to five (2020-2022)	85% of planned sites are built on-schedule, with the remainder delayed by up to eight years.	65% of planning sites are built on-schedule, with 35% delayed by up to eight years.	60% of planning sites are built on-schedule, with 35% delayed by up to ten years and 5% not going forward.
Years six to nine (2023-2026)	80% of planning sites are built on-schedule, with the remainder delayed by up to eight years.	55% of planning sites are built on-schedule, with 45% delayed by up to ten years.	50% of planning sites are built on-schedule, with 35% delayed by up to ten years and 15% not going forward.

Year ten and beyond (2027-)	75% of planning sites are built on-schedule, with the remainder delayed by up to five years.	50% of planning sites are built on-schedule, with 50% delayed by up to five years.	50% of planning sites are built on-schedule, with 30% delayed by up to five years and 20% not going forward.

Domestic scenario results

The data collected from local authorities often only covers a 5-10 year trajectory and as a result, the scenarios are more certain in the near-term. The amount of robust data available reduces towards the end of the period, particularly for monitoring reports based on planning applications, hence the decline in dwellings per annum post-2028 shown in Figure 4-3.

The high growth scenario average to 2025/26 is 21,600 dwelling additions per year. It is important to note that in a high growth scenario, further development sites would be projected to come forward towards the middle of the plan period, however, no assumptions about these sites have been included and as a result, the high growth scenario declines significantly towards the end of the period.

The medium growth and low growth scenarios show the decreased level of growth in a slower economic climate. They do not decline as significantly because the existing planned sites are delayed up to and beyond 2032. For the low growth scenario, the build rate decreases significantly in the middle of the plan period whereas the build rate in the medium growth scenario is consistent throughout the plan period. The average annual growth rate is 16,700 for medium growth and 14,800 for low growth, with a low of 12,100 in 2024/25.

Figure 4-3. Domestic development projections, with average historic growth and draft projections for 'High', 'Medium' and 'Low' growth scenarios

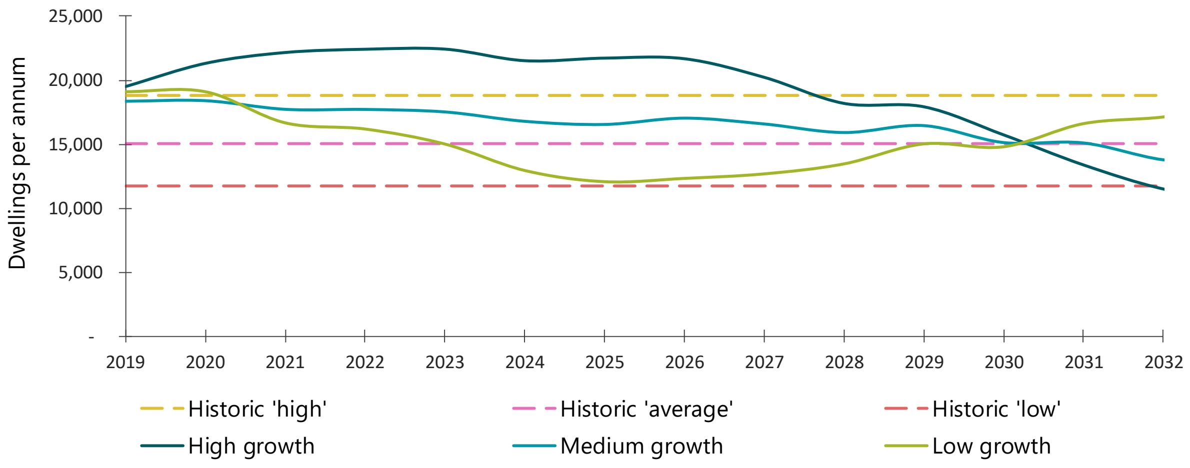
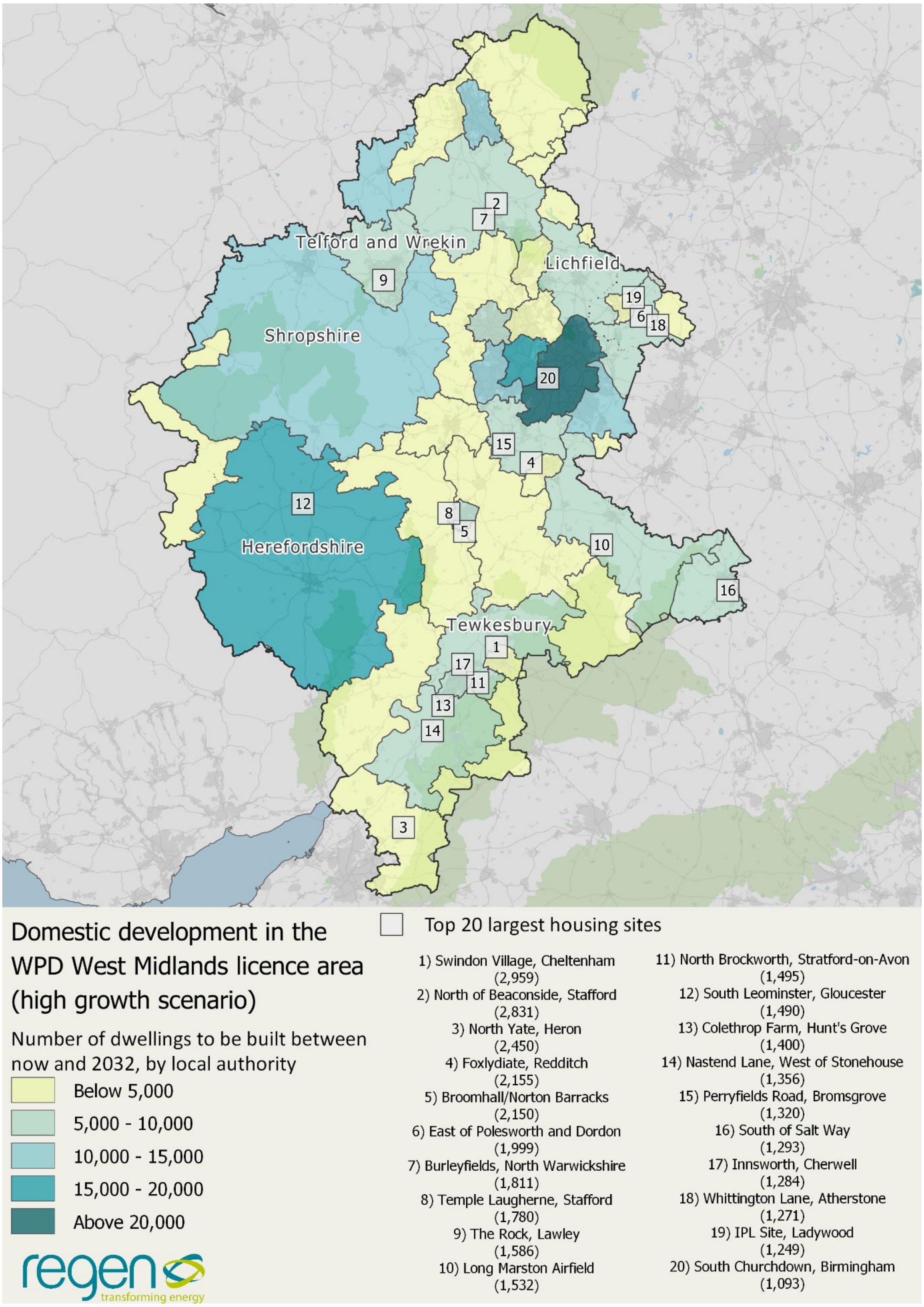


Table 4-3. 2026 totals for domestic developments – top ten local authorities

Local Authority – number of domestic developments	High growth – Community Renewables	Medium growth – Two Degrees	Low growth – Consumer Evolution and Steady Progression
Birmingham	23,878	19,515	17,971

Herefordshire	10,430	8,528	7,547
Sandwell	9,928	7,514	6,511
Dudley	8,780	7,127	6,293
Shropshire	8,662	7,231	6,345
Wolverhampton	8,431	6,969	5,975
Gloucester	6,798	5,399	4,519
Lichfield	6,635	5,413	4,642
Telford and Wrekin	6,614	5,406	4,781
Stroud	5,861	4,815	4,109

Figure 4-4. Domestic development projections under a high growth scenario across the West Midlands licence area.



Non-domestic development projections

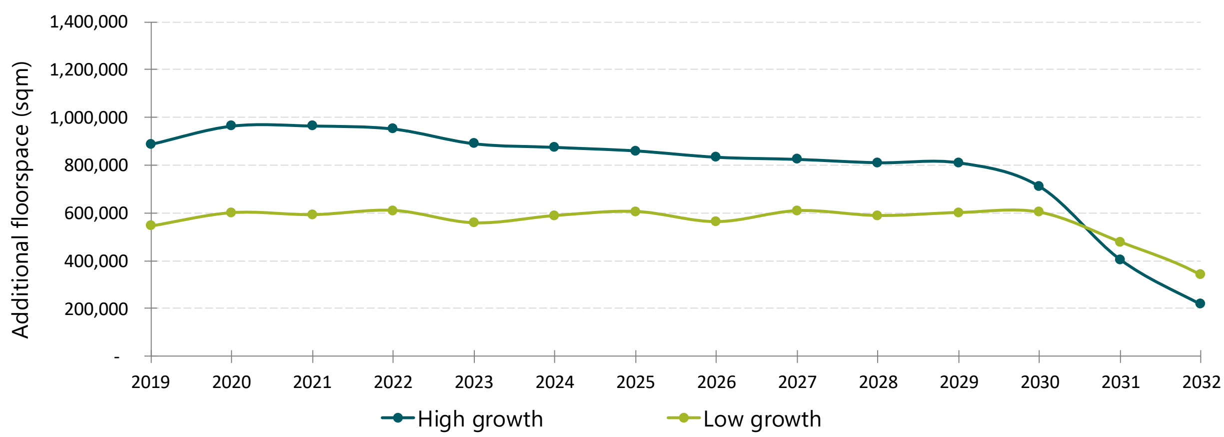
Non-domestic developments are difficult to accurately project as local authorities do not typically report on the timeframe in which they project the site to be built out. To account for this, the construction of these developments is spread out across the plan period.

Table 4-4. Details of assumptions made in the build-out rate for non-domestic floorspace in the 'High' and 'Low' growth scenarios

Year	Assumptions for 'high growth' scenario	Assumptions for 'low growth' scenario
First year (2018/19)	55% of floorspace built with 45% delayed up to eight years.	35% of floorspace built with 55% delayed up to eight years.
Years two to four (2019-2021)	45% of floorspace built with 55% delayed up to eight years.	25% of floorspace built with 65% delayed up to ten years.
Year five and beyond (2022-)	40% of floorspace built with 60% delayed up to eight years.	20% of floorspace built with 65% delayed up to ten years.

Figure 4-5 shows the high and low growth scenarios for non-domestic developments in the West Midlands. The construction of each development is spread out across the local authority's plan period, which varies from 2028 to 2035.

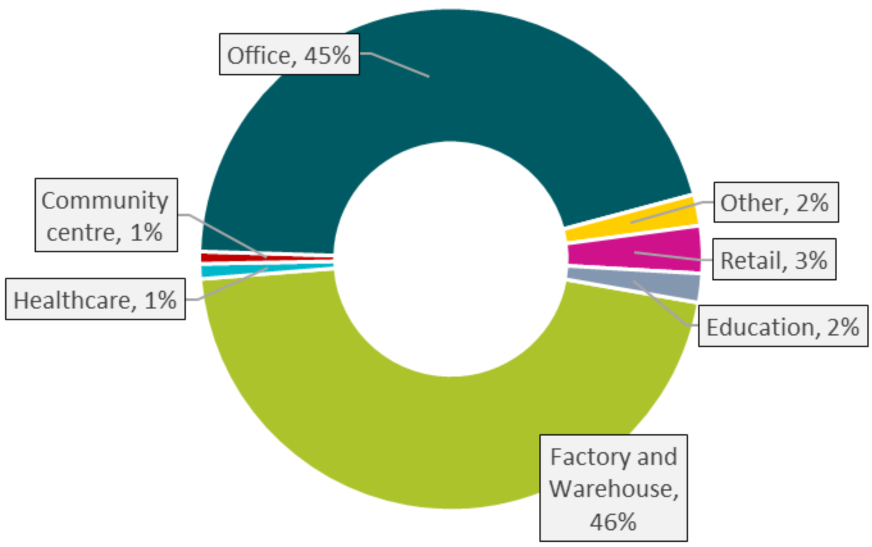
Figure 4-5. Additional non-domestic floorspace in 'High' and 'Low' scenarios in WPD's West Midlands licence area



The historic data for non-domestic sites shows the *net* change in floorspace for rateable properties. This means that floorspace gain and floorspace loss are combined and therefore cannot be compared to Regen's projections of local plan allocations, which only considers floorspace gain. Nevertheless, the years of high growth in the historic data broadly indicate the scale of floorspace gain and therefore are used to check projections.

Figure 4-6. Net change in floorspace for taxable non-domestic properties in WPD's West Midlands licence area[33].

Figure 4-7. Proportion of the projected floorspace and classification in the WPD's West Midlands licence area



As Figure 4-7 shows the majority of the total projected floorspace is classified as either Factory and Warehouse or Office with only 9% outside those categories.

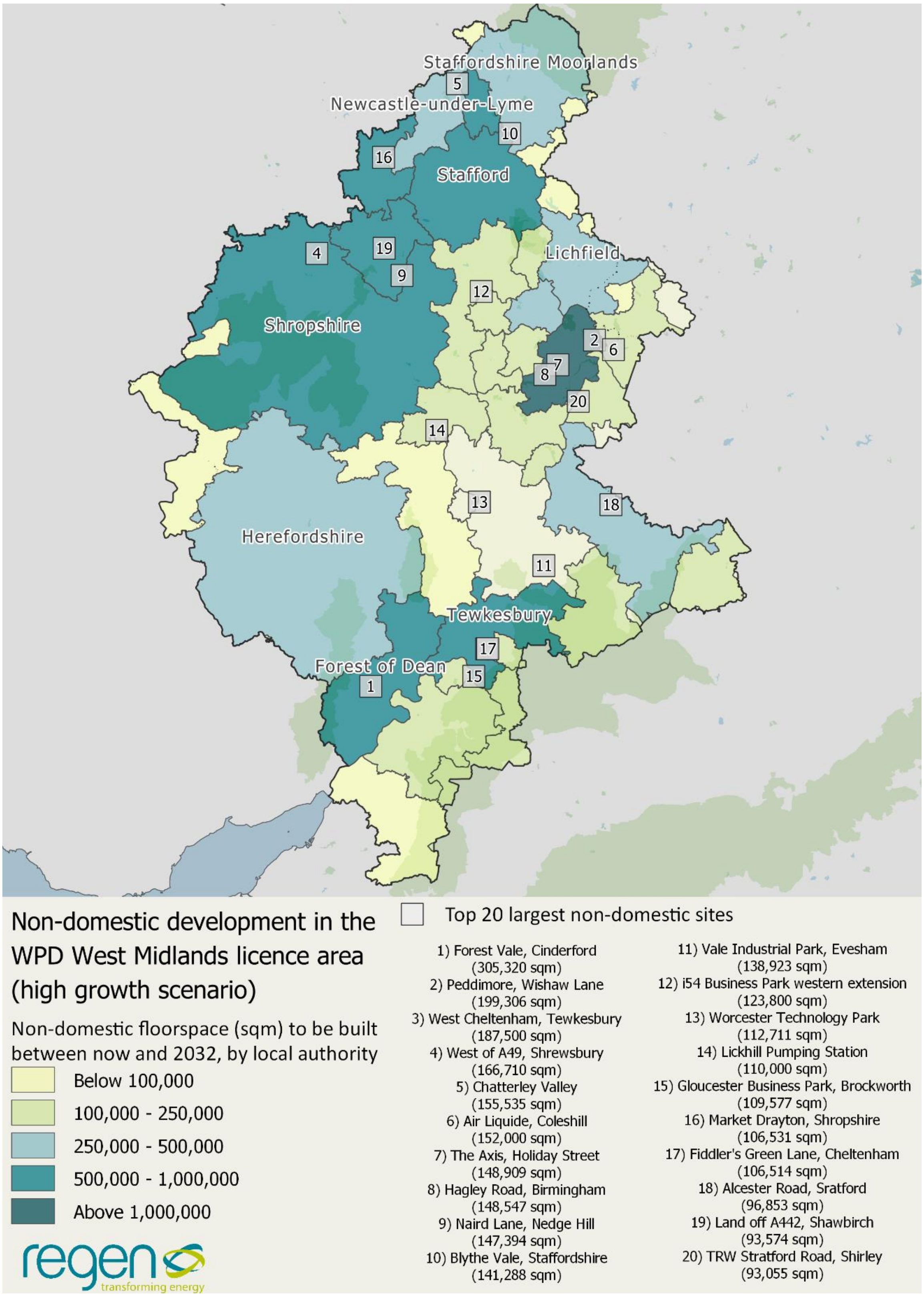
Table 4-5 below shows that Birmingham local authority has the highest amount of planned non-domestic development. Birmingham also includes the largest non-domestic development site, a 71-hectare factory and warehouse site at Peddimore, Wishaw Lane.

33 https://www.gov.uk/government/statistics/non-domestic-rating-stock-of-properties-including-business-floorspace-2019

Table 4-5. Top 10 local authorities for non-domestic floorspace by 2026

Local Authority – m^2 of non-domestic floorspace	High growth – Community Renewables and Two Degrees	Low growth – Consumer Evolution and Steady Progression
Birmingham	997,686	638,892
Tewkesbury	597,103	383,799
Forest of Dean	495,423	314,420
Telford and Wrekin	419,526	270,456
Shropshire	397,846	251,687
Stoke-on-Trent	364,847	239,356
Stafford	343,069	222,897
Lichfield	302,718	197,887
Worcester	246,342	159,143
Herefordshire	206,354	132,007

Figure 4-7. Non-domestic development projections under a high growth scenario across the West Midlands licence area.



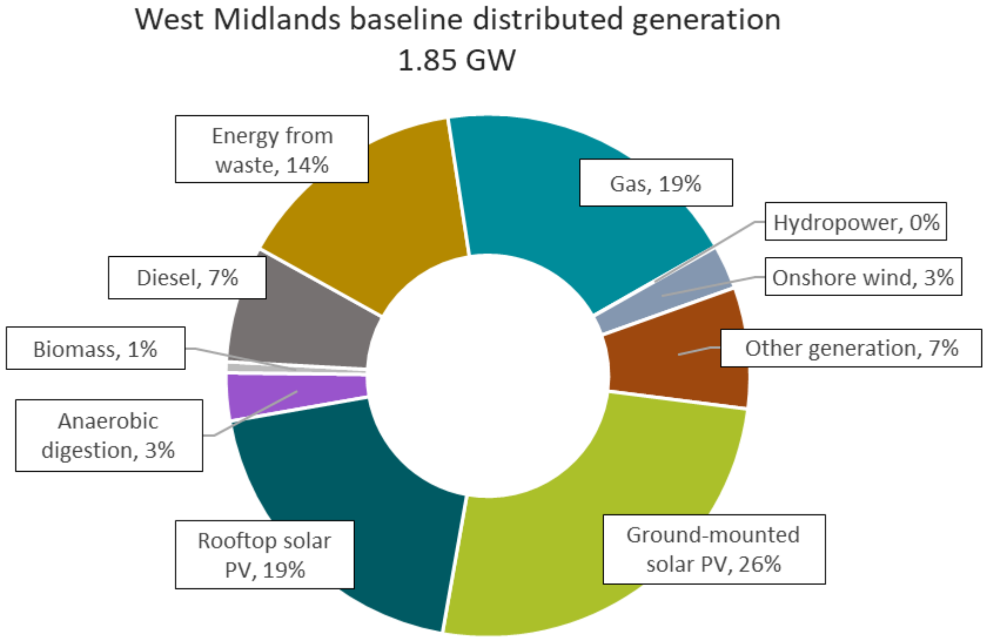
B. Introduction to generation

West Midlands baseline generation

There is 1.85 GW of distributed generation[34] capacity in the West Midlands licence area.

The licence area has 1.35 GW of low carbon and renewable energy installed capacity, with 0.5 GW of fossil fuel-based capacity. This represents 3% of the UK's total 44.3 GW of renewable energy capacity. 45% of the licence area's generation capacity is solar PV, while only 3% is onshore wind.

Figure B-1: Baseline distributed generation in the licence area



Pipeline of projects

To build a pipeline of projects for the West Midlands we use a WPD database of projects which have accepted a network connection offer but are yet to connect by the end of 2018. This database contains 189 projects with a total of 2.1 GW of potential installed capacity. The largest share of this capacity is from 33 gas projects, with a total of 675 MW installed capacity. By far the largest of these projects is the 294 MW gas power station at Meaford Business Park. The largest number of sites comes from solar PV with 101 potential sites equating to 626 MW potential of capacity. This is closely followed by electricity storage which has 32 pipeline projects totalling 60 MW of capacity.

[34] Generation that connects to the distribution network as opposed to the transmission network.

Table B-1: Summary of pipeline projects that have accepted a network connection offer but are yet to connect in the West Midlands licence area (December 2018)

Generation technology	Number of projects	Capacity (MW)
Gas	33	675
Solar PV	101	626
Electricity storage	32	605
Energy from waste	10	168
Diesel	3	22
Onshore wind	1	2
Anaerobic digestion	2	8

Factors for future growth

The UK government has confirmed in law a net-zero target for all greenhouse gas emissions by 2050[35]. This is alongside hundreds of cities and local authorities in the UK that have declared a climate emergency under growing pressure from youth-led climate strikes. This is driving localities to be more ambitious and could change the speed and scope of the energy transition.

The increase of installed renewable energy generation capacity in the UK has continued in 2018. Coal generation has hit record lows, with an 84% reduction in coal-fired electricity generation in 2018 compared to 2010[36]. This reduction in coal generation, and increase in renewable energy generation, has resulted in lower carbon factors for electricity supply, benefitting technologies such as heat pumps and electric vehicles that are central to the decarbonisation of the energy system in the UK.

The shift away from subsidy support for renewable energy generation has continued with the closure of the Feed In Tariff (FIT) in March 2019. The new Smart Export Guarantee (SEG)[37] has been confirmed and is due to be available in January 2020[38]. Other regulatory changes, such as changes to the network charging arrangements[39], are providing further uncertainty for new and existing business models.

Interest and activity for post-subsidy ground-mounted solar PV at scale (30 to 50 MW) is growing, with a large pipeline of projects and investment. Other technologies are looking for sites with high electricity demand, or selling their power to large corporations to make a business case.

The following factors are key to the futureprospects for distributed generation in the licence area:

- **Technology cost reduction:** The potential for continuing falls in the costs and efficiencies of renewable technologies.
- **Revenue support:** A price guarantee mechanism such as a CfD is important to provide a level of fixed income for developers, lowering risk for investment.
- **Local and national planning policies:** Higher levels of deployment, particularly for onshore wind, will require changes to the local planning process to be more supportive of distributed generation.

[35] https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law
[36] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/840015/DUKES_2019_MASTER_COPY.pdf
[37] https://www.gov.uk/government/consultations/the-future-for-small-scale-low-carbon-generation
[38] https://www.ofgem.gov.uk/environmental-programmes/smart-export-guarantee-seg/generators
[39] https://www.ofgem.gov.uk/electricity/distribution-networks/charging-arrangements

Overview of future energy scenarios for generation technologies

Table B-1 shows the growth in installed generation capacity projected by 2032 in the four scenarios, along with the projected storage capacity. These numbers are based on the FES 2019 trajectories along with a detailed bottom-up analysis of the resources in the licence area, known pipeline projects and expectations of potential growth.

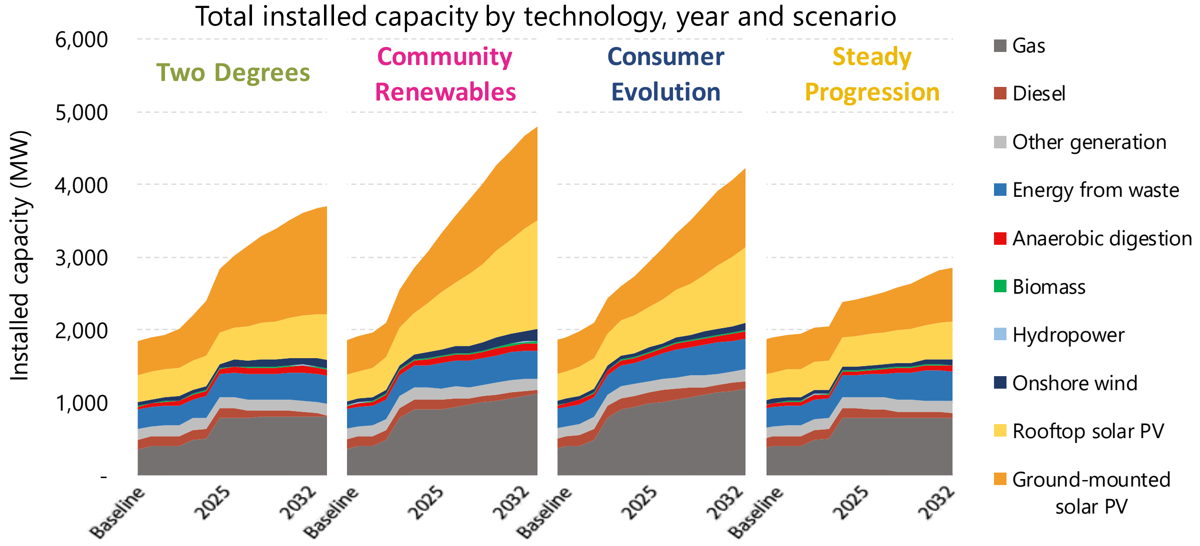
Table B-1: West Midlands scenarios for the increase in overall generation capacity per scenario

Generation capacity (MW)	2018	2032	Increase (%)
Two Degrees	1,842	3,706	101.2%
Community Renewables		4,810	161.1%
Consumer Evolution		4,224	129.4%
Steady Progression		2,854	55.0%

Key findings for the different generation technologies include:

- **Ground-mounted solar PV** installed capacity triples in Two Degrees, from a baseline of 476 MW to 1,467 MW by 2032. A large pipeline of 616 MW of solar PV is looking to connect in the licence area.
- **Onshore wind** installed capacity has a low baseline of 52 MW, mainly from one32 MW project. In Community Renewables installed capacity reaches 158 MW by 2032.
- **Rooftop solar PV** installed capacity increases in all scenarios, from 359 MW to 523 MW in the lowest growth scenario. In Community Renewables capacity more than quadruples to 1,567 MW, as revenue support and new regulations drive uptake.
- **Anaerobic Digestion** has a relatively high baseline of 48 MW installed capacity. The most ambitious scenario, Community Renewables, shows an increase to 102 MW by 2032.
- **Energy from Waste** has a 266.9 MW baseline of installed capacity in the licence area, with four operational Advanced Conversion Technologies (ACT) sites. A large pipeline of sites shows growth in installed capacity for ACT and incineration. With more ACT capacity deployed under Community Renewables and more incineration in Steady Progression by 2032.
- **Biomass CHP** has a low baseline of 13 MW installed capacity and sees only limited capacity growth in all scenarios.
- **Hydropower** has a low baseline with 0.8 MW installed capacity in the licence area. In Community Renewables we project capacity to rise to 1.6 MW by 2032.
- **Diesel and gas** installed capacity is 134 MW and 355 MW respectively in the baseline. Diesel shows some initial growth in all scenarios, followed by significant reduction in installed capacity in Two Degrees and Community Renewables due to regulations encouraging cleaner energy generation. Gas shows growth in installed capacity in all scenarios. Community Renewables shows the highest installed gas power capacity, with 1,189 MW by 2032.

Figure B-2: Scenario summaries of total installed capacity in West Midlands licence area



5. Onshore wind

The West Midlands has relatively low onshore wind resource which has resulted in below-average deployment of this technology

There are 165 onshore wind projects, totalling 52 MW in the licence area. The vast majority of sites are single small-scale turbines, and over half of this capacity is from one 34 MW project.

The installed capacity equates to 0.9% of the total installed capacity in Great Britain, in a licence area that makes up 6.6% of GB's land area.

The licence area has below average deployment for onshore wind and relatively low potential for future capacity growth

Table 5-1: Summary of onshore wind scenarios in the West Midlands licence area

Onshore wind capacity (MW)	2018	2020	2025	2032
Two Degrees	52	52	84	110
Community Renewables		52	87	158
Consumer Evolution		52	56	92
Steady Progression		52	54	68

Baseline

Within the licence area, there are 165 onshore wind projects with a total installed capacity of 52 MW. The vast majority of the projects are small-scale sites connected before 2016, with an average size of 300 kW. Only five projects are above 500 kW capacity.

There is one large project which is in the west of the licence area:

- 34 MW Garreg Lwyd wind farm, with 17 turbines

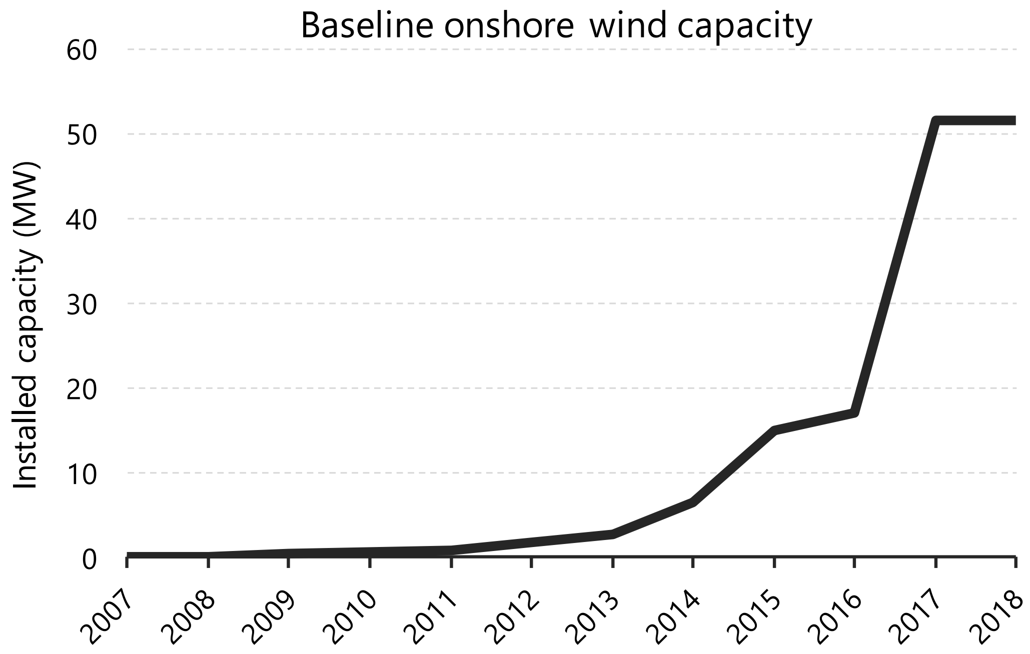
The installed capacity of onshore wind in the West Midlands is very low in comparison with other WPD licence areas. This is due to the relatively large amount designated landscapes (AONBs), low technical resource available (Figure 5-2) and sizeable coverage of urban and industrial areas. For example, East Midlands currently has 430 MW of installed onshore wind capacity.

Figure 5-1 shows that the annual deployment of onshore wind projects in the licence area peaked in 2017, with the commissioning of the Garreg Lwyd wind farm.

The planning refusal rate for onshore wind projects in the West Midlands over 1 MW is also high, with 50% of sites refused planning permission, compared with an overall refusal rate in England of 38%[40].

[40] Analysis of data in BEIS Renewable Energy Planning Database

Figure 5-1: Baseline onshore wind capacity in West Midlands



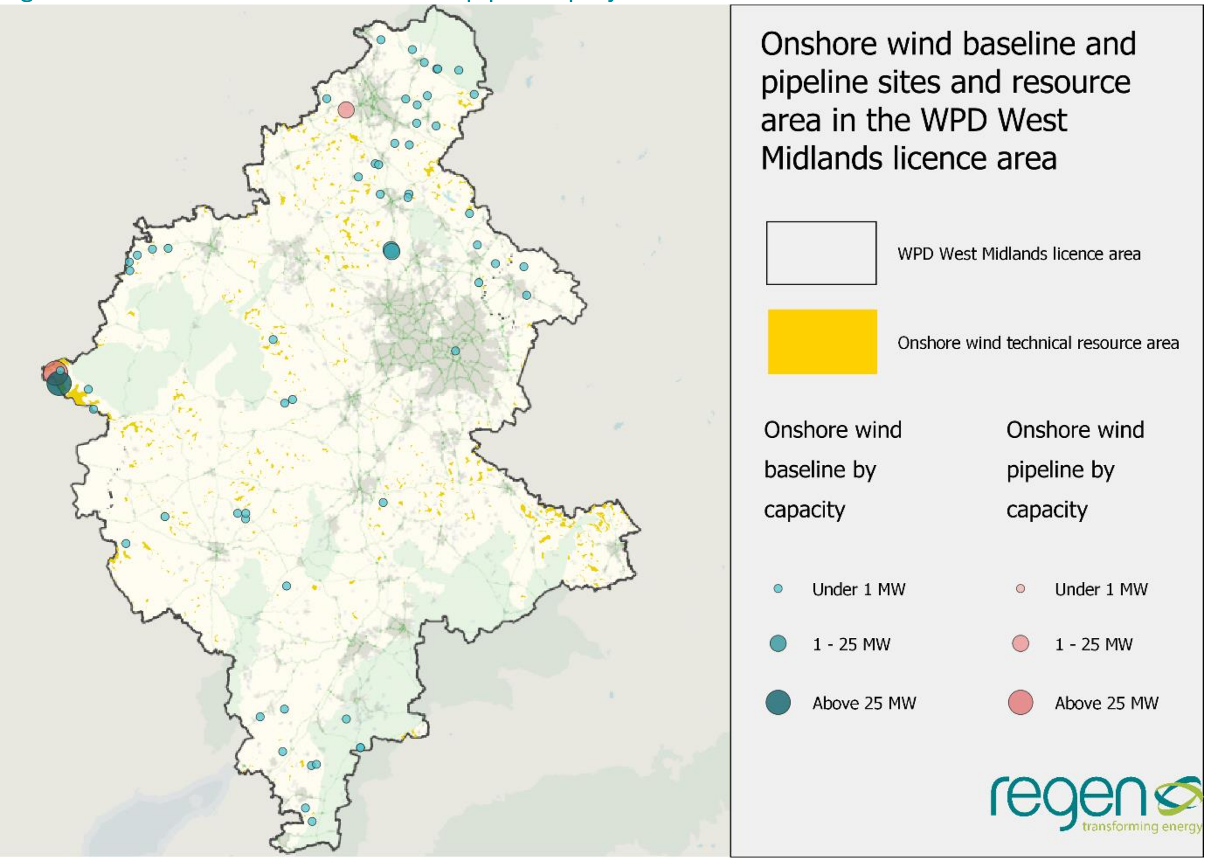
Pipeline

There is one onshore wind project that has accepted a connection offer from WPD. This is the 1.9 MW Keele University project (a mixed technology site including a solar farm and electricity storage). A further project in the pipeline is the 30.6 MW Bryngydfa wind farm. This site is located in Wales but inside the licence area. However, it is a stalled project that does not have a connection offer, and the existing planning application is from 2009. Table 5-2 has an overview of how the pipeline projects have been treated in the different scenarios.

Table 5-2: West Midlands onshore wind pipeline projects

Pipeline project	**Total capacity (MW)**	**Community Renewables**	**Two Degrees**	**Consumer Evolution**	**Steady Progression**
Bryngydfa wind farm	30.6	2024	2025		
Keele University	1.9	2021	2022	2024	2025

Figure 5-2: Onshore wind baseline and pipeline projects in the West Midlands licence area



Onshore wind growth factors

Onshore wind installations in the UK fell to 598 MW in 2018, down from a record high of 2,666 MW the previous year. The effective planning ban in England and the end of subsidy support are the main drivers for this difference. However, in Scotland and Wales, post-subsidy models are being developed using bigger and more efficient wind turbines at highly suitable sites. The West Midlands is unlikely to see many significant developments in the short term due to planning barriers and a lack of suitable large-scale sites.

Planning for onshore wind

The restrictive planning regime in England mean that only onshore wind sites in Scotland and Wales are currently going ahead. A written ministerial statement in 2015 stated that new sites need to be "identified as suitable for wind energy development in a Local or Neighbourhood plan" and to demonstrate that "the planning impacts identified by affected local communities have been fully addressed and therefore the proposal has their backing". This requirement is possible to meet but requires considerable local effort and engagement. Developers have chosen to focus efforts on new projects in Wales and Scotland due to their more supportive planning requirements. The two large-scale (above 20 MW) onshore wind sites in this licence area assessment (the connected Garreg Lwyd wind farm and Bryngydfa wind farm in the pipeline) are therefore located in Wales.

At the time of writing, government policy after the 2019 General Election is not clear. Increasing renewable energy ambition from local authorities in England who have declared climate emergencies could lead to a change in interpretation from planning authorities. Updating local plans and neighbourhood plans will, however, take time to implement. The different scenarios outlined here explore the impact of changing planning policy.

Cost reductions and larger project scales leading to subsidy-free viability

Cost reductions and increased power output have increased the potential for subsidy-free onshore wind projects over recent years[41]. The capacity of the largest UK onshore wind turbines has increased from 1.5 MW in 2000, to around 3 MW in 2019. In addition, the cost of installation has reduced 40% between 1990 and 2018[42]

New onshore sites are expected to be larger with a lower number of larger-scale turbines that are taller and have a larger swept area. Viable access to the site and the visual/landscape impact of these larger turbines are further challenges for prospective projects.

Due to limited resource in the licence area, within the scenario timeframe only a few additional sites are expected, and only in the greener scenarios. No further growth is expected in small-scale wind capacity, except in Community Renewables.

Price support for onshore wind

At present, the CfDs for onshore wind[43] are closed, except for remote island sites. Despite the levelised cost of onshore wind being below current wholesale electricity prices, the risk for investors is still quite high due to the increasing volatility in the electricity price. As a result, access to the UK government's CfD price support or equivalent will be important in more ambitious scenarios to support the projected capacity growth. Over the past few years, the National Infrastructure Commission and others have called for government to include onshore wind projects in the CfD auctions[44]. CfD Round 3 results show that 275 MW of remote island onshore wind in Scotland did succeed in getting a contract at clearing prices from £39 MWh to £42 MWh[45]. This price is below the current wholesale price for electricity. Remote island onshore wind and offshore wind are included as 'less established technologies' (Pot 2) in CfD auctions. Successful auctions in 2018 for onshore wind in the EU have offered slightly higher prices[46].

In the absence of price support, corporate PPAs have allowed onshore wind projects to get higher prices for their power and allow large companies to reduce their carbon emissions. In Europe, 2018 was a record year for corporate PPAs, with 2.4 GW of onshore wind and solar PV capacity contracted[47]. This market has been growing considerable in the UK, with UK universities[48] and Google making significant recent announcements. PPAs are expected to support subsidy-free viability but would represent a small amount of capacity growth in the scenarios.

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[41]https://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-0602

[42]https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Renewable-Power-Generations-Costs-in-2018.pdf?la=en&hash=99683CDDBC40A729A5F51C20DA7B6C297F794C5D

[43] https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference

[44]https://www.theplanner.co.uk/news/government-urged-to-support-onshore-wind

[45]https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-3-results

[46]https://www.theguardian.com/business/2019/oct/07/uk-universities-in-landmark-deal-to-buy-energy-direct-from-windfarms

Decision on whether to repower existing sites

Repowering older sites with larger, more efficient turbines is expected to help increase onshore wind capacity. However, in the licence area, there are no onshore wind projects over 1 MW in scale that were connected in 2012 or before. Therefore, the impact of repowering is likely to be negligible.

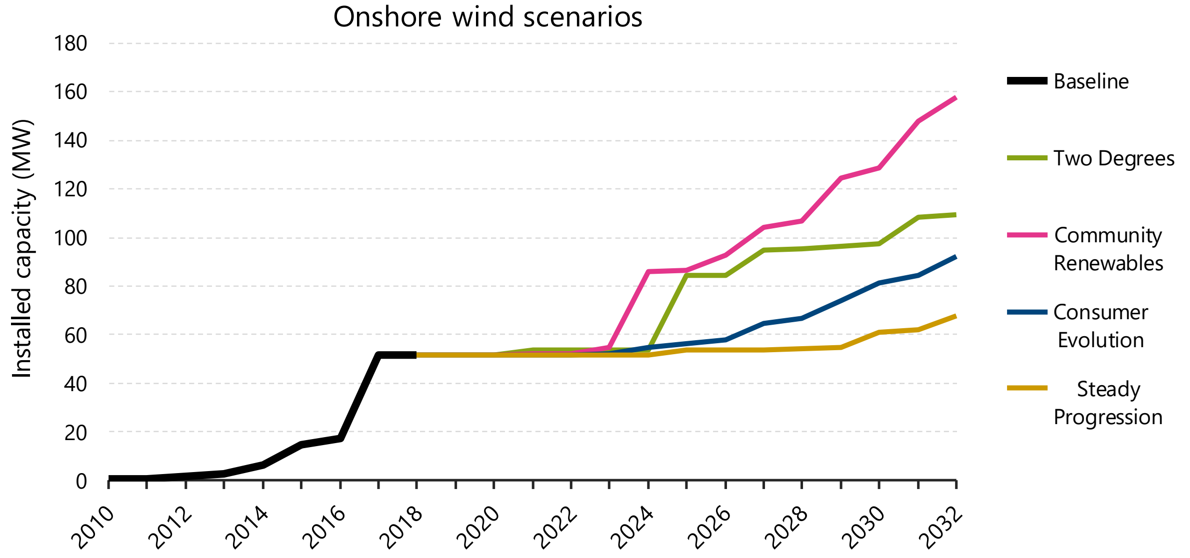
Table 5-3 summarises the factors that are anticipated to be the key drivers of onshore wind deployment.

Table 5-3: Factors considered in onshore wind scenarios

Growth factors	Community Renewables	Two Degrees	Consumer Evolution	Steady Progression
Government policy and support				
CfD or price support mechanism open to onshore wind	Price support available from early 2020s - weighted towards local-scale projects	Price support available from early 2020s - weighted towards large-scale projects	Low price support	No price support
Local and community factors				
Planning environment	Planning environment and communities supportive of local projects	Planning environment favours large-scale strategic wind projects	Planning environment less favourable, although some support for local-led projects	Current prohibitive planning environment continues
Market and technology factors				
Subsidy-free viability and technology improvements	Significant cost reductions in early 2020s. Widespread subsidy-free viability in mid 2020s	Significant cost reductions in early 2020s. Widespread subsidy-free viability in mid 2020s	Cost reductions impact in mid 2020s. Widespread subsidy-free viability in late 2020s	Cost reductions impact in late 2020s. Widespread subsidy-free viability in early 2030s
Repowering assumptions	Projects repower after 20 years, with 50% increase in capacity	Projects repower after 20 years with 40% increase in capacity	Projects repower after 25 years with 10% increase in capacity	Projects repower after 30 years with 5% increase in capacity

Onshore wind scenarios

Figure 5-3: WPD West Midlands onshore wind scenarios



Scenario summary

The scenarios project limited further deployment of onshore wind in the licence area until the mid 2020s even in the most ambitious scenarios, Community Renewables and Two Degrees.

In Community Renewables, price support and improved planning environment help new project development across the licence area. Installed capacity reaches 158 MW in 2032, three times the baseline in 2018. A small number of smaller-capacity projects also go ahead up to 2025, and the 30.6 MW pipeline project Bryngydfa wind farm is installed in 2024.

Two Degrees shows much lower growth in installed capacity in comparison with Community Renewables. Deployment is instead focused on larger onshore wind projects outside the licence area where wind resource is better, there is a positive planning environment, and price support is available for this scale of project.

Consumer Evolution and Steady Progression have little installed capacity growth due to lack of price support and continuing planning barriers. Consumer Evolution does have a small number of small-scale projects going ahead in the late 2020s.

Comparison with other scenarios

This scenario analysis shows a faster growth in installed capacity initially with a very similar total by 2032 in Community Renewables compared with FES 2019. Two Degrees has a higher installed capacity in this analysis in contrast to FES 2019, as the large pipeline site connects, and medium scale sites are viable with the price support available. The biggest difference is between Consumer Evolution in the FES 2019 and this analysis, due to lack of subsidy and limited large-scale developments in this scenario for the West Midlands.

The projections in this analysis are slightly lower than those in the 2017 West Midlands report. This is due to the continuing hiatus in onshore wind capacity growth. In the 2017 West Midlands analysis the baseline was lower for onshore wind, despite no new onshore wind projects going ahead since 2017. This is due to further baseline sites being identified in FIT data during this study.

Distribution in ESAs

The geographic distribution of onshore wind uses wind speed, proximity to the electricity network, distance from houses and environmental designations (e.g. national parks) to identify areas of technically unconstrained wind resource. There are limited areas of the licence area with suitable wind resource, which are used to distribute the projected onshore wind capacity (Figure 5-2).

6. Ground-mounted solar PV

The licence area has over 476 MW of ground-mounted solar capacity with a pipeline of 616 MW of new projects.

The licence area has good availability of technically unconstrained solar resource, and reasonable coverage of network infrastructure. However, it also has some signficant areas of designated and protected landscape which will limit large-scale sites. This section covers solar PV projects above 250 kW.

Subsidy-free project development is gaining pace in the licence area with a large pipeline of sites waiting to connect.

Table 6-1: West Midlands ground-mounted solar PV scenarios

Ground-mounted solar capacity (MW)	2018	2020	2025	2032
Two Degrees	476	479	982	1,467
Community Renewables		479	813	1,297
Consumer Evolution		479	621	1,092
Steady Progression		479	509	748

Baseline

In December 2018, there were 113 ground-mounted solar PV projects over 250 kW in scale[49] in the WPD West Midlands licence area. These total 476 MW of capacity and equate to around 4.9% of GB installed capacity.

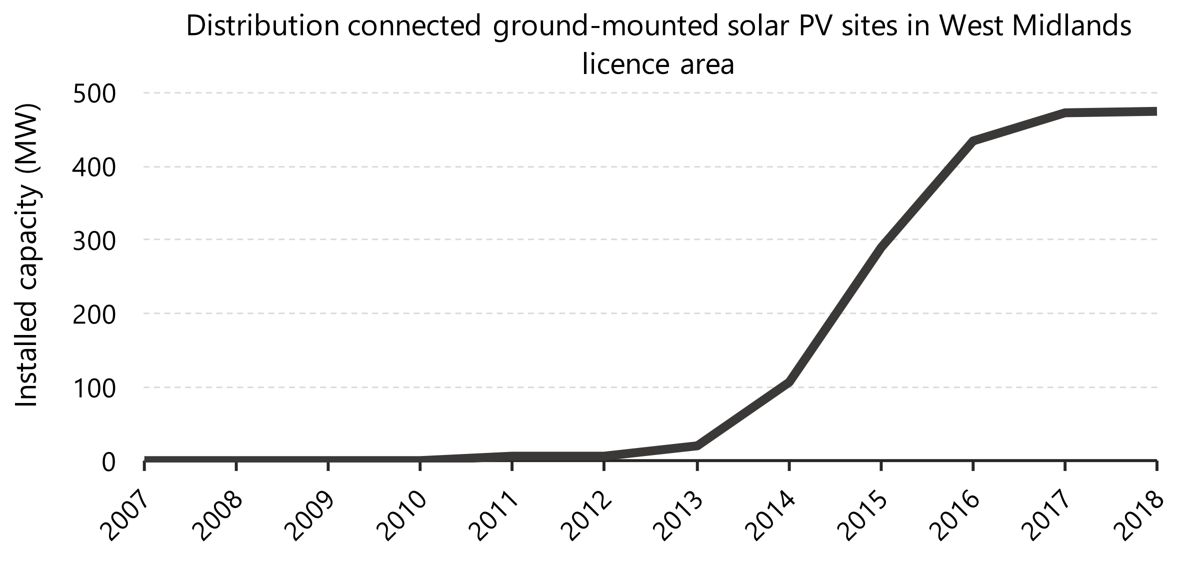
The largest project in the licence area is the 30 MW solar farm west of Stroud at Cambridge, near the Severn estuary commissioned in 2015. Most of the existing sites in the baseline are between 1 MW and 7 MW. Only 8 projects are 15 MW capacity and above.

The increase in installed capacity and number of ground-mounted solar PV projects is shown illustrated in Figure 6-1. This shows the number of projects being installed peaked in 2015, with 183 MW of new projects commissioning in that year. Since 2016, deployment has slowed considerably. In the two years since the 2017 West Midlands licence area study, 31 new projects have commissioned, adding 40 MW of capacity.

A total of 39 ground-mounted solar PV projects above 1 MW have been refused/withdrawn/abandoned in the WPD West Midlands licence area. Of these 39 projects, 29 are planning refusals, six are planning application withdrawals, and four projects were abandoned. The vast majority of these (88%) occurred in the last four years. The success rate of projects in gaining planning permission is around 74%.

[49] Ground-mounted solar projects below 250 kW are treated as "rooftop" for this analysis as their characteristics are more similar to roof-mounted commercial and domestic projects. We analysed the baseline and pipeline project list and identified any large rooftop installations via their location (e.g. business park) and name (above 500 kW only). Projects were then re-categorised as appropriate.

Figure 6-1 Ground-mounted solar sites by year and total capacity



Pipeline

There are 27 ground-mounted solar PV projects in the pipeline, with a total capacity of 614 MW, that have accepted a connection offer from WPD but are yet to connect. This has increased since 2017, where there was over 500 MW of capacity in the pipeline.

Almost all of the pipeline projects are new sites which accepted a network connection offer in 2018 or 2019, and most of them are in the process of gaining planning permission. This volume suggests that the licence area is likely to see significant near-term growth in solar PV capacity.

The end of government-backed revenue price support has meant much larger projects are now being proposed, between 25 MW and 50 MW capacity; for example, the 49 MW Croome Airfield solar farm.

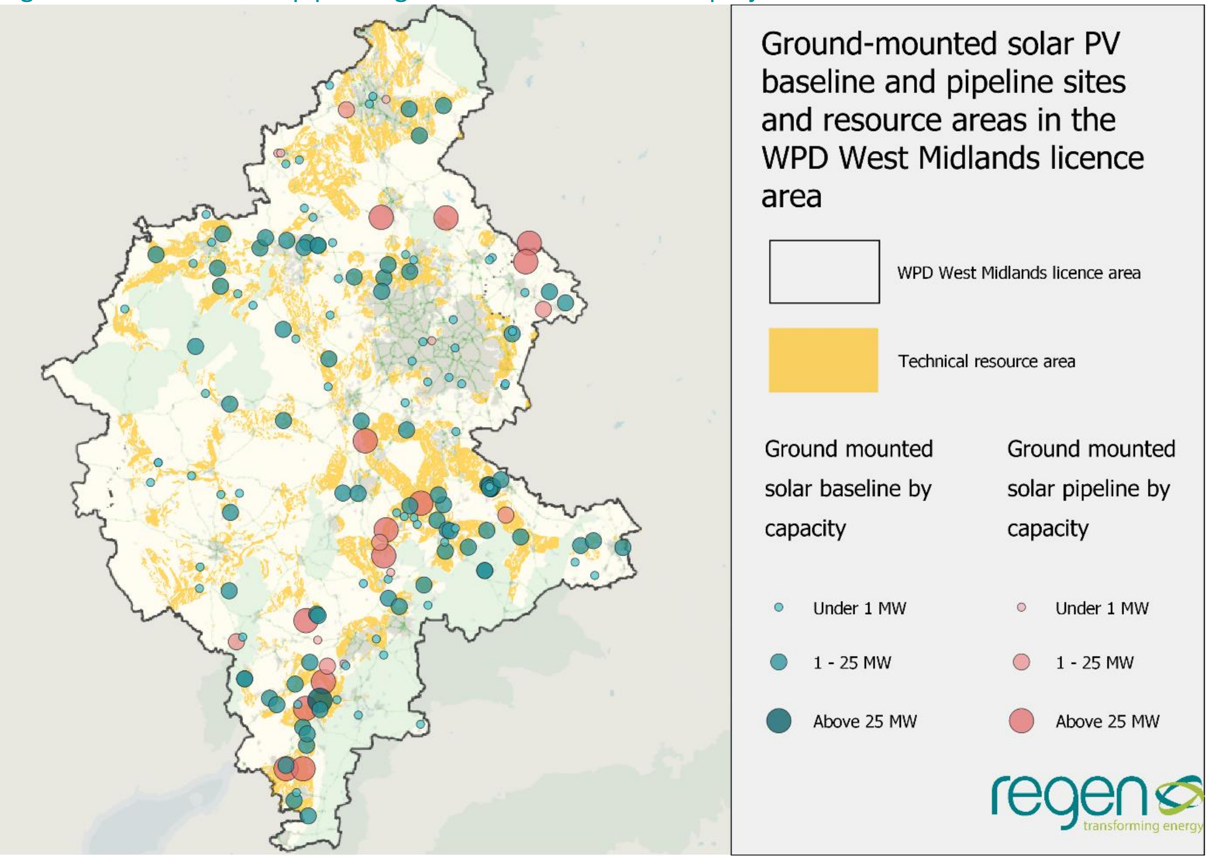
Pipeline assumptions

We have used a logic framework to determine the date of connection for the pipeline ground-mounted solar PV sites, which is set out in Table 6-2.

Table 6-2: Ground-mounted solar PV West Midlands licence area project pipeline and treatment in scenarios

No. of projects	Project status	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
4	Planning permission granted and connection offer accepted	2021	2023	2024	2025
3	Planning permission applied for and connection offer accepted	2022	2023	2025	2030
11	No planning permission and connection offer accepted	2024	2025	2027	.

Figure 6-2: Baseline and pipeline ground-mounted solar PV projects



Ground-mounted solar PV growth factors

Subsidy-free viability and price support

There are challenges for developers of ground-mounted solar PV to develop profitable sites post-subsidy. The closure of the RO and FIT, and lack of a Pot 1 auction programme for the CfD, mean that large-scale ground-mounted solar projects are currently not supported by government[50]. As a result, the viability of new projects relies on reducing the cost of the installation and increasing the efficiency. The cost of solar PV technology is expected to continue to drop, making sites more attractive. Competition in the international solar developer market has led to record low prices being paid for solar PV capacity in other countries. According to Bloomberg, the global levelised cost of electricity from solar is set to reduce 63% to $25/MWh by 2050, with module costs declining 34% from today by 2030[51].

Improvements in technology are also improving the yield of ground-mounted solar PV projects, with new solar PV modules that are more efficient, along with new bifacial modules and tracking systems, being deployed. This makes projects more productive and extends power generation to a greater proportion of the day, increasing revenues.

In Community Renewables and Two Degrees, reduced installation and capital costs, combined with new technology (e.g. bifacial panels), enable high levels of ground-mounted solar PV development. In

[50] Sub-5 MW ground-mounted solar PV farms may have preliminary accreditation under the FIT, which closed on 1 April 2019. They have up to 12 months as a grace period for grid works out of their control.

[51] https://bnef.turtl.co/story/neo2019?teaser=true

addition, a floor price support mechanism is introduced to reduce the investment risk for ground-mounted solar PV farms. Cost reductions are more limited and there is a lack of price support under Consumer Evolution and Steady Progression, meaning subsidy-free viability occurs later in the 2020s under these scenarios.

Investment challenges and price cannibalisation risk

Post-subsidy solar PV is dependent on the wholesale market price of power. This business model is inherently riskier in comparison with previous government-backed projects. One of the challenges is the potential for lower wholesale power prices during periods of peak solar generation, known as price cannibalisation, due to high levels of coincident supply from solar PV across the country. This would reduce the revenues available and impact the solar PV business model.

There are a variety of views on the potential impact of price cannibalisation on the market. Aurora Energy Research estimate a 9% reduction in revenues by 2030[52]. Others, such as Bloomberg and Foresight, have been more optimistic about the future. Recent high wholesale power prices and a growing PPA market are helping reduce risks for investors and increasing the attractiveness of subsidy-free business models.

In Consumer Evolution and Steady Progression, we assume there is no floor price support available and this reduces the number of new sites deployed.

Co-location with energy storage potential

Co-locating energy storage at new ground-mounted solar sites is a way of hedging against price cannibalisation risk and increasing the capture price for the solar power, by exporting the low-cost energy in peak price periods as well as providing grid and flexibility services. Not all subsidy-free ground-mounted solar PV sites are due to use energy storage co-location, as the business model remains challenging. Nevertheless, as the energy storage technologies improve and the market opportunities increase, co-location will be an increasing driver of business models; in the most ambitious scenario, 30% of new ground-mounted solar PV to have co-located energy storage by 2032.

Planning environment

Unlike for onshore wind projects, the planning environment for ground-mounted solar PV is less restrictive. The West Midlands licence area has experienced a low number of refusals for ground-mounted solar PV projects, with a 74% planning success rate compared to 65% nationally.

The scenarios use different approaches to planning based on project size, with the decentralised scenarios favouring smaller, locally led projects.

Table 6-3 summarises the key factors that are anticipated to be the key drivers of ground-mounted solar PV deployment.

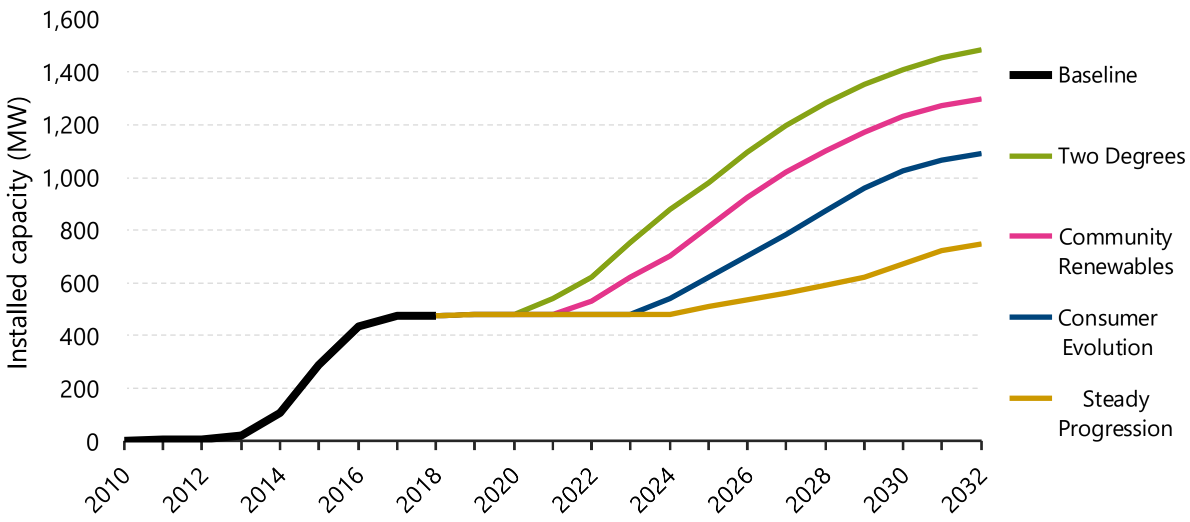
[52] https://www.auroraer.com/insight/the_economics_of_colocation/

Table 6-3: Assumptions for factors influencing capacity growth for ground-mounted solar

Growth factors	Community renewables	Two Degrees	Consumer Evolution	Steady Progression
Government policy and support				
Price support mechanism that reduces risk for investors	Price support available from early 2020s - weighted towards local-scale projects	Price support available from early 2020s - weighted towards large-scale projects	No price support exposes investors to market risks	No price support exposes investors to market risks
Local and community factors				
Planning environment	Supportive planning environment for local projects, as well as high levels of support from the public	Supportive planning environment for large-scale strategic projects only	Planning environment less favourable, although there is some support for local-led projects	Planning environment does not prioritise decarbonisation and favours large-scale projects
Subsidy-free viability through technology improvement s and cost reductions	Subsidy-free for smaller schemes viable in early/mid 2020s.	Economies of scale from larger projects mean subsidy-free viability in early 2020s.	Widespread subsidy-free viability reached in mid 2020s	Widespread subsidy-free viability reached in late 2020s
Co-location with storage potential due to cost or charging changes	Co-location model widely viable from mid 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

Ground-mounted solar PV scenarios

Figure 6-3: West Midlands ground-mounted solar PV scenarios



Scenario summary

Two Degrees has the highest level of deployment as large-scale solar farms (between 25 and 50 MW) are completed from 2021 onwards and a floor price support mechanism is introduced. The overall rate of deployment remains lower than in 2015 and 2016, as there aren't the same attractive subsidies available. The growth rate of solar capacity is faster in the early 2020s compared to the 2030s.

Community Renewables remains lower than Two Degrees, although the scenario sees a larger number of smaller-scale projects installed.

In Consumer Evolution, growth of new ground-mounted solar PV capacity is delayed to the late 2020s, where technology cost reductions start to make subsidy-free projects viable. The lack of price support, lower cost reduction and lower levels of technology innovation limits growth. Steady Progression shows even more limited growth in deployment.

Relationship to other scenarios

The West Midlands licence area scenario projections are proportionally higher than FES 2019 in all scenarios. This higher growth is due to the low baseline capacity, a large pipeline of projects, and the good resource available in the area.

The West Midlands licence area scenario projections are also above the previous 2017 study, reflecting the increase in pipeline and market evidence that the sector is expecting to see significant post-subsidy growth.

Distribution in ESAs

The sites projected in the West Midlands licence area have been distributed to ESAs using proximity to the electricity network, avoidance of environmental designations and housing, slope and aspect of land and location of existing sites.

7. Rooftop Solar Photovoltaics

Around 2.9% of properties have rooftop solar photovoltaic (PV) installations in the licence area, which is significantly lower than in the East Midlands licence area (3.9%).

The rate of growth in rooftop solar PV capacity has reduced considerably since 2015 as the FIT support was reduced before being removed in March 2019.

The amount of rooftop solar PV installed in the West Midlands licence area has dropped from 94 MW installed in 2015 to 9 MW in 2018.

Table 7-1: Summary of rooftop solar PV capacity by scenario in the WPD West Midlands licence area

MW	2018	2020	2025	2032
Two Degrees	359	382	453	650
Community Renewables		408	774	1567
Consumer Evolution		399	562	1025
Steady Progression		378	416	523

Baseline

In the licence area, domestic scale rooftop solar PV has been installed on nearly 66,000 homes or 2.8% of the homes in the licence area, a total of 359 MW of installed capacity. The average size of all domestic installations is 3.6 kW. The level of rooftop solar PV uptake (2.8%) is lower than the East Midlands and South Wales which is likely due to fewer suitable rooftops as a result of the lower proportion of detached homes and a higher proportion of flats in the licence area.

On commercial premises there is a further 120 MW of rooftop solar PV capacity from a total of 3,331 installations. The average capacity is 36 kW.

The initial cost of the solar PV system remains a barrier to deployment, with companies delaying investment decisions due to economic uncertainty. Although there has been a 12.3% reduction in the installation cost of 0-4 kW rooftop solar PV project since 2014[53], this has not compensated for the significant reductions in FIT tariff in 2016 and the subsequent closure of the scheme in March 2019 which have significantly reduced investment in rooftop although also caused a rush of projects to be installed before the respective deadlines.

Pipeline

There is a 9.2 MW pipeline of commercial rooftop solar PV, made up of 56 projects. There are five projects above 250 kW, with the largest site being 2.25 MW rooftop solar PV capacity. These projects are projected to be connected in all scenarios, with different timings, depending on the scenario.

Small domestic installations are required to register with WPD following installation. As a result, there is no pipeline data available for these sites.

[53] https://www.gov.uk/government/statistics/solar-pv-cost-data

Rooftop solar PV growth factors

Future subsidy support

The FIT has been the main incentive for rooftop solar PV deployment. The scheme was closed to new entrants at the end of March 2019. With some projects able to preliminary accreditation or pre-registration (community and school only) for a FIT for their project, and build the project over a given period depending on the technology and applicant[54]. There is also a grace period for specific grid works delays[55].

The Smart Export Guarantee (SEG)[56] has been confirmed as a replacement price support scheme. This new export tariff would put a requirement on large electricity suppliers to provide small-scale generators (under 5 MW) with a payment for their exported electricity. No floor price has been proposed, except for the requirement that generators will not have to pay suppliers in the event of negative pricing. This can be a fixed or flexible tariff rate, with no requirements on contract length and requires a smart meter. Large electricity suppliers (above 150,000 customers) and those suppliers that volunteer to do so, are obligated to offer a tariff from 1 January 2020. Some suppliers have started offering SEG tariffs, mainly focused on domestic consumers.

The delay in the launch of the SEG has led to a gap following the FIT closure. This uncertainty means rooftop PV deployment is likely to be low in the short term. In the scenarios, Community Renewables benefits from a small subsidy or price support above the SEG rate for rooftop solar PV through the 2020s leading to a greater number of installations. Other scenarios assume exported electricity is only paid the market rate.

A further issue has been changes to the rateable value of business premises with solar PV. Unless the panels are owned by a separate party, rooftop systems result in an increase in business rates payable, which has also had an adverse impact on commercial installations. As a result, only businesses with a high energy demand and long-term environmental objectives are likely to invest.

Matching rooftop solar PV with local demand

With lower levels of price support for exported generation available, the energy savings from the use of solar power over the lifetime of the installation becomes a much more important source of value. It will be increasingly important to match the size of the solar PV system to the demand of the building so all the energy is used, rather than exported. Flexibility through demand side response and electricity storage also achieves this. Commercial properties with the right roof, solar PV system, and demand profiles can get payback on their initial investment in five to eight years[57]. Domestic properties where more of the power is exported will have longer payback periods although, new demand from electric vehicles and heat pumps should reduce the payback period of the system if they are used or charging whilst solar is generating.

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[54] https://www.ofgem.gov.uk/publications-and-updates/essential-guide-applying-preliminary-accreditation-under-feed-tariffs-fit-scheme
[55] https://www.ofgem.gov.uk/system/files/docs/2019/03/guide_to_closure.pdf
[56] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769601/The_future_for_small-scale_low-carbon_generation_SEG.pdf
[57] Industry sources, October 2019

Falling technology costs

The latest UK data shows that the cost of installation for 0-4 kW solar PV projects has dropped over 10% since 2013[58]. This price drop is mainly as a result of the reducing cost of the solar PV modules which has decreased by 89% since 2010, and is predicted to drop further[59]. Other costs (e.g. scaffolding if required) are harder to reduce, particularly at the domestic scale, which means that larger systems are often the most economic although the size needs to balance with onsite usage to achieve shorter payback periods.

Deployment on social housing

Social housing is an important factor for future growth in rooftop solar PV deployment. Rooftop solar PV can be used to reduce tenant energy bills, address fuel poverty and help meet carbon reduction commitments. The longer-term investment windows and use of different funding models will help social housing solar PV deployment. There are recent examples of successful partnerships in the licence area[60].

In Consumer Renewables social housing retrofit with rooftop solar PV is an important additional area of growth.

Future homes standard, SAP assessments and local planning policies

The scenarios all project a significantly higher proportion of solar PV in new build housing than on retrofit properties. Many new build developments already use rooftop solar PV to improve the energy rating of the property under Standard Assessment Procedures (SAP). This technique is a way of meeting standards (for carbon and energy) that are lower cost than higher level building fabric measures (such as triple glazing). As the carbon intensity of the network has reduced, due to higher levels of renewable electricity generation, the carbon benefits of solar PV are due to be reduced significantly in future SAP methodologies[61]. How this is implemented alongside the Future Homes Standard over the next few years, will determine the new build rooftop solar PV market.

Another driver of installations is local planning authorities requiring new housing developments to meet energy requirements that are stricter than national building regulations, normally via their Local Plans. With more ambition coming from local authorities following climate emergency declarations, changes to the planning requirements are likely. Current proposals from government in the Future Homes Standard consultation[62] could however remove the ability of local authorities to be able to set higher standards than those at a national policy level[63]. As a result, in this assessment we vary the amount of support depending on the scenario.

[58] https://bnef.turtl.co/story/neo2019?teaser=true
[59] https://bnef.turtl.co/story/neo2019?teaser=true
[60] https://communityenergyscheme.com/
[61] https://www.cibsejournal.com/general/sap-in-building-regulations/?utm_source=marketingcloud&utm_medium=email&utm_campaign=Journal%20Newsletter%20September%202018&utm_term=0030O00001uyUSdQAM
[62] https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings
[63] https://www.regen.co.uk/future-homes-standard/

Co-location and flexibility business models

The addition of electricity storage to rooftop solar PV systems can increase the revenue streams available. Stacking value with a combination of solar PV and electricity storage with time of use tariffs and grid services is likely to be the basis of a business model for consumers.

These extra revenues, such as those from Demand Side Response (DSR) or flexibility services via aggregators could help incentivise deployment of rooftop solar PV in domestic and commercial settings. In our scenarios this increase is seen during the 2020s.

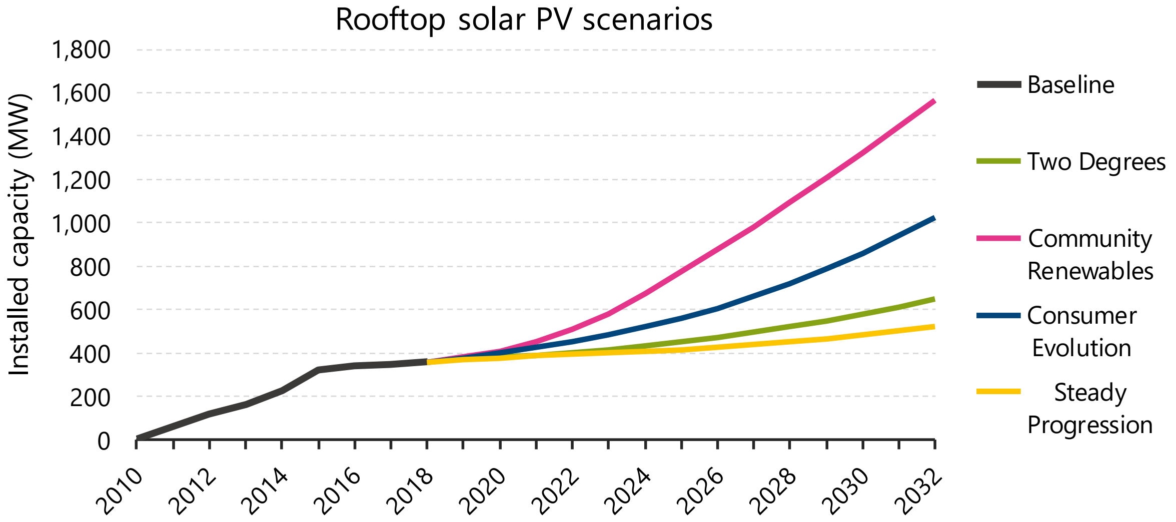
Table 7-2 summarises the key factors that are anticipated to be the key drivers of rooftop solar PV deployment.

Table 7-2: Factors considered in rooftop solar PV scenarios

Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government policy and support				
Support for domestic and commercial installation	No subsidy post 2019	Small incentive post 2019	No subsidy post 2019	No subsidy post 2019
Social housing support	No subsidy post 2019	Small incentive/subsidy post 2019	No subsidy post 2019	No subsidy post 2019
New housing regulations drive solar PV deployment	Regulations favour larger installations	Carbon targets drive solar PV from early 2020s	Regulations focus on decentralised small-scale installations	No incentives
Market and technology factors				
Technology cost reductions	Cost reductions slow down	Continued falls through scenario period	Continued falls through scenario period	No further cost reduction
Consumer factors				
Rooftop PV and battery flexibility revenue	Domestic benefit from time of use tariff and commercial from flexibility revenue from 2022	Flexibility revenue/savings available from 2022 with electricity storage or EV	Flexibility revenue /savings for commercial and domestic late in period	No flexibility market developed - low battery and EV take up
Affluence and economic growth	Capital available to invest in PV	Capital available to invest in PV	Lower economic growth with less money for investment	Lower economic growth with less money for investment

Rooftop solar PV scenarios

Figure 7-1: Rooftop solar PV scenarios in West Midlands licence area



Scenario summary

Community Renewables is the most ambitious scenario, with 1,567 MW of installed capacity by 2032. Around 12.4% of all homes and 5% of commercial properties would have rooftop solar PV by this stage.

Consumer Evolution has no subsidy support, but additional building regulations and continued cost reductions drive an increase in installed capacity for new builds. This scenario has 21% of new builds and 8.3% of all homes with rooftop solar PV by 2032.

The Two Degrees scenario favours centralised renewable energy capacity and has a less favourable policy environment for rooftop solar PV. Steady Progression sees low levels of installation, continuing the slower post-FIT growth trend.

Relationship to other scenarios

Community Renewables in this scenario analysis is slightly lower than the FES 2019 projection for installed capacity by 2032, due to the delay and lower value available from the SEG. Whereas Consumer Evolution shows a slightly higher level of installed capacity by 2032 in this analysis due to a high level of new build and commercial properties in the licence area. Two Degrees is also marginally higher than the FES 2019 projection.

In comparison with the 2017 scenario assessment there is a higher level of installed capacity in the most ambitious scenario, Community Renewables. This is due to a better understanding of the post FIT support structures and new government proposals for tighter building regulations. Consumer Evolution and Steady Progression are both below the 2017 scenario levels.

Distribution by ESA

The geographical distribution of the rooftop solar PV capacity to the ESAs in the licence area is based on several factors including the existing baseline, levels of social housing, affluence, location of new housing developments, and location of new non-domestic developments. There are three categories of rooftop solar PV. Domestic retrofit, domestic new build and commercial, have all been distributed separately.

8. Anaerobic Digestion

There are 46 Anaerobic Digestion (AD) projects identified in the licence area, totalling 48 MW in installed electrical capacity. Four sites have multiple units installed. The largest site is 14.5 MW, connected in 2015 at Bridgnorth Aluminium.

The West Midlands region has a relatively high capacity of AD with 12% of the total GB capacity in 6.6% of the GB land area

The West Midlands has the potential for further growth in AD capacity due to its proximity to significant food waste streams and a large amount of agricultural land.

Table 8-1: Summary of AD capacity (MW) by scenario in the WPD West Midlands licence area.

	2018	2020	2025	2032
Two Degrees	48	56	78	96
Community Renewables		56	81	106
Consumer Evolution		56	73	99
Steady Progression		56	60	73

Baseline

The West Midlands has a relatively high baseline of AD projects and installed capacity. This increase in installed capacity occurred gradually from 2011, with a peak of 27 MW of capacity installed in 2015. Since 2015 only 4 MW of new capacity has been added. The average capacity of AD sites is 1.1 MW. Three sites have a capacity over 3 MW.

Figure 8-1: Baseline growth in AD in West Midlands

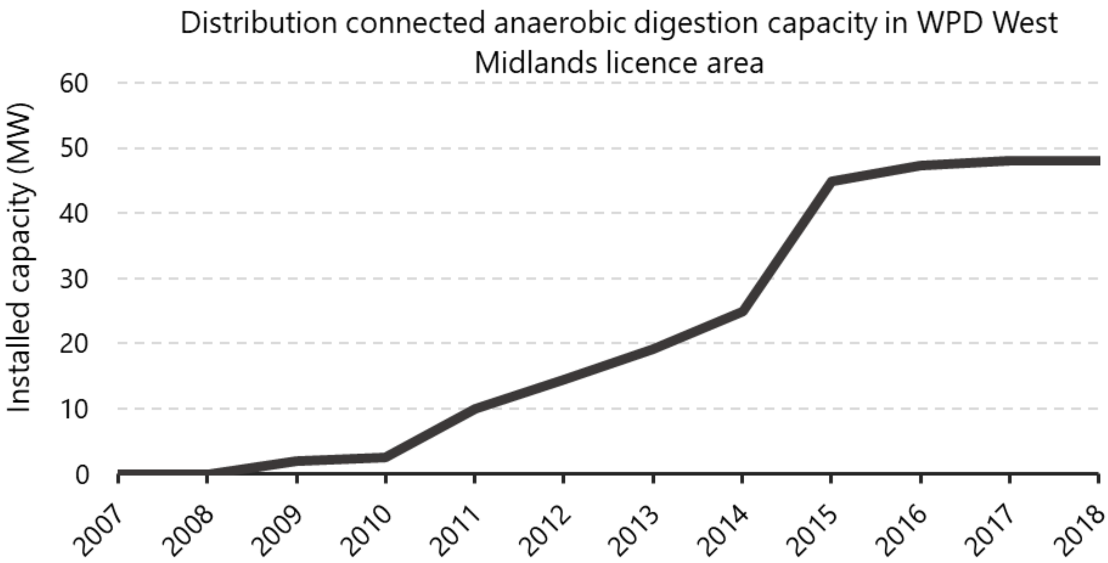
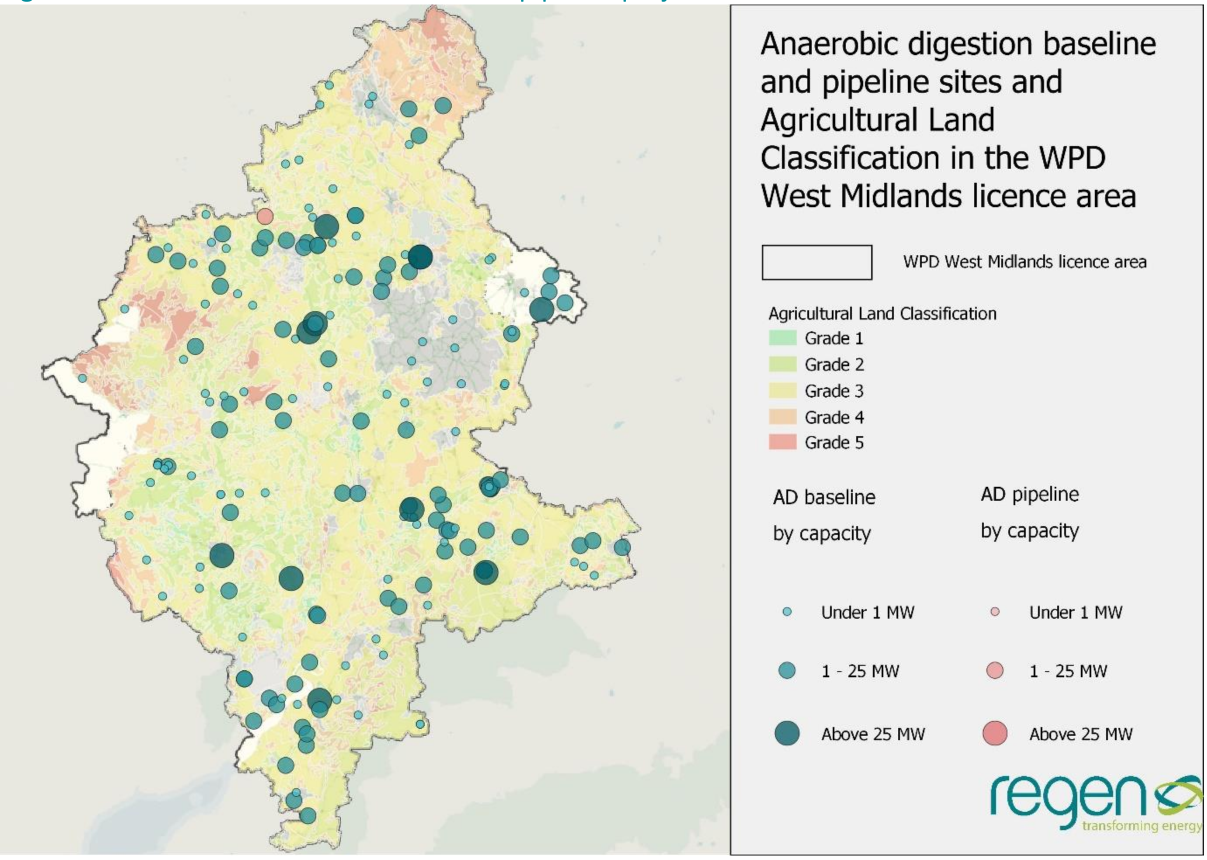


Figure 8-2: West Midlands AD baseline and pipeline projects.



Pipeline

There are two AD projects in the WPD pipeline that have accepted a connection offer. One is a 1.2 MW scheme which accepted a network connection in 2019. The second is a 6.6 MW project that accepted a network connection offer in 2018. Both sites are projected to connect to the network in 2020, in all scenarios.

AD growth factors

AD is a technology that has a variety of different uses, including processing food and agricultural waste, producing biomethane for the gas grid and transport (such as HGVs), producing onsite electricity and heat; and generating electricity using CHP engines for export to the electricity network.

Availability of feedstock

AD requires a feedstock and the availability and volume of that feedstock is key to capacity growth in that sector. There are a range of feedstock options available, including:

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

The licence area has large agricultural areas, mostly in the west of the region. Over 80% of the AD projects in the region are identified as farm-fed AD projects.

Gaining reliable long-term contracts for high quality food waste with the right calorific content remains a challenge for AD operators. Gate fees charged by AD projects for food waste have been declining over the past four years, with an average of £27 per tonne in 2018 (down from £44 in 2010)[64]. There is more competition between different AD projects in the West Midlands, leading to lower gate fees in the area, due to proximity and good road transport connections to urban areas.

Increasing the amount of food waste is an important factor for future capacity increase in AD. An important source is via the collection of food waste from urban areas and commercial premises. Currently local authorities in England are not required to collect food waste separately, with a third of those in England currently doing so[65]. The recent England Resource and Waste Strategy contains plans to consult on mandatory separate food waste collection for households and businesses, to be in place by 2023[66].

Government support and subsidy

A further key area for future capacity increase is the likelihood of further government support and subsidy. The historic growth in AD electrical capacity has been incentivised by the RO and FIT price support. The FIT ended in March 2019, with projects able to build out up to 31 March 2020, if they received preliminary accreditation. Over recent years, higher wholesale power prices than predicted have helped to increase revenues for those projects already operational but few new plants have been built.

However, price support is still available for AD that generates heat and for biomethane injection under the RHI. This has incentivised newer AD sites to focus on heat and biomethane gas injection. The tariffs for heat and biomethane production from AD were raised back to 2016 levels in spring 2018, providing

[64] http://www.wrap.org.uk/gatefees2019
[65] http://laportal.wrap.org.uk/
[66] https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

a recent boost for the industry[67]. The RHI tariff guarantee, introduced to support the development of larger heat generation projects under the RHI, has successfully supported 32 biomethane projects since 2018[68]. The tariff guarantee was extended until 31 January 2021 to allow the pipeline of projects to be built[69].

The government is coming under pressure to decarbonise the transport system. In September 2017, the Department for Transport announced a doubling of the supplier obligation on renewable fuels to 9.75% by 2020, along with increased Renewable Transport Fuel Obligation rates[70]. Increasing opportunities for AD projects to provide biogas for vehicle use. Projects can benefit from both RHI and RTFO support[71], adding to the opportunities away from generating electricity network from AD.

The support for AD project that deliver heat, biomethane and biogas for transport is a key factor considered in our scenarios. Investment in research and innovation in AD technology options may provide opportunities for cost reduction. Biomethane technology improvement is considered as a factor in the scenarios.

Table 8-2: Factors considered in anaerobic digestion scenarios

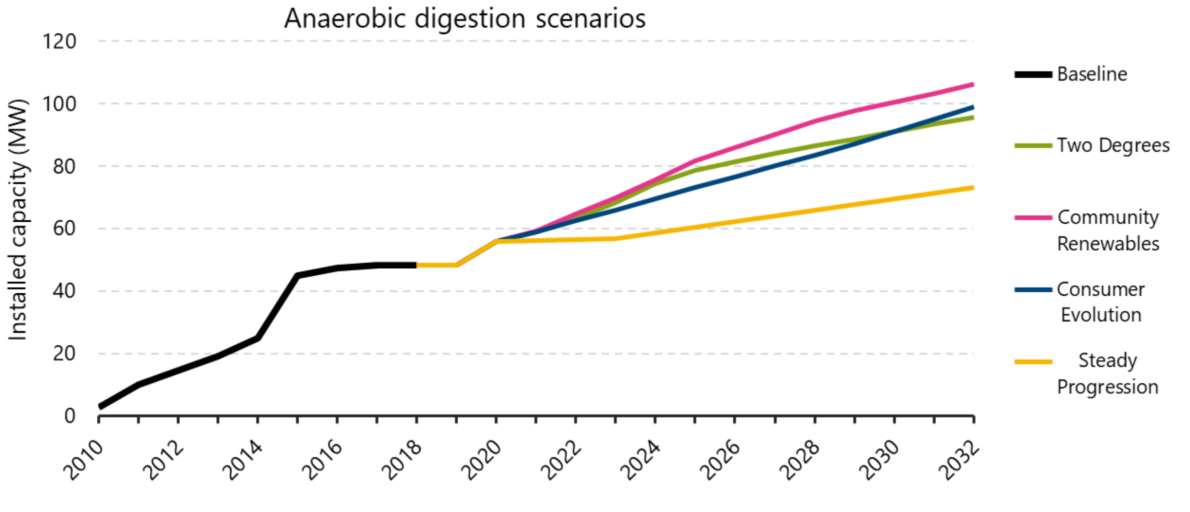
Key factors influencing uptake	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government policy and support				
Subsidy for AD electricity generation	Low subsidy for electricity post-2019	Significant subsidies or support provided to smaller projects	No subsidy for electricity post-2019	No subsidy for electricity post-2019
Subsidy incentive for heat and biomethane AD plants	High, with support extended after 2021. Focus is on biomethane and heat plants.	High, with support extended after 2021. Focus is on biomethane and heat plants.	No further support after 2021.	No further support after 2021.
Transport subsidy – renewable transport fuel obligation	Strict transport emissions regulation incentivises production of biomethane	Strict transport emissions regulation incentivises production of biomethane	Limited incentive to use AD for road fuels, focus remains on electricity generation	Limited incentive to use AD for road fuels.
Market and technology factors				

[67] ADBA (2018) http://adbioresources.org/news/press-release-anaerobic-digestion-industry-welcomes-laying-of-rhi-legislation
[68] https://www.ofgem.gov.uk/publications-and-updates/tariff-guarantee-applications
[69] http://adbioresources.org/news/tag/1111-rhi-tariff-guarantees
[70] DfT (2017) https://www.gov.uk/government/consultations/renewable-transport-fuel-obligation-proposed-changes-for-2017
[71] https://www.bioenergy-news.com/news/generators-of-biomethane-can-claim-rhi-and-rtfo-payments/

Availability of food waste	Medium resource availability: high levels of food waste collection offset by achievement of waste reduction targets	Medium resource availability: high levels of food waste collection offset by achievement of waste reduction targets	High resource availability: high levels of food waste collection and waste reduction target is missed.	Medium resource availability: lower levels of food waste collection and waste reduction targets missed.
Agricultural waste projects	High resource availability and availability of finance	High resource availability and availability of finance	High resource but lower finance	High resource but limited finance
Investment in R&D to improve biomethane technology	Focus on green gas to decarbonise heat leads to investment in biomethane technology	Focus on green gas to decarbonise heat production leads to investment in biomethane technology	Lack of investment in biomethane technology	Lack of investment in biomethane technology

Anaerobic digestion scenarios

Figure 8-3: Anaerobic digestion by scenario in West Midlands licence area



Scenario summary

The Community Renewable scenario has the largest growth in installed AD capacity. The growth rate is consistent to 2025, due to subsidy support and smaller projects prospering from positive policy changes. The rate of capacity installation decreases post 2025 as projects increasingly switch towards biomethane and heat projects.

In Two Degrees larger projects are more frequent, with lower subsidy support for electricity generation AD projects pushing developers to heat and biomethane faster. Resulting in less growth in AD installed capacity.

Consumer Evolution has a slower but more consistent rate due to high resource availability and less sites switching to heat and biomethane. Steady Progression has a smaller number of AD projects going ahead due to lack of subsidy and resource availability.

Relationship to other scenarios

Consumer Evolution is the most ambitious scenario in the FES 2019 assessment, due to large projects being deployed and less switching to biomethane and heat production. However, there is a relatively high baseline of smaller AD sites and we therefore project higher future increases in AD capacity in Community Renewables in the region, in comparison with FES 2019. As a result, this is the most ambitious scenario in this analysis. Our scenarios also show a faster move away from electricity focused AD projects in Two Degrees and Community Renewables post 2025 compared to FES 2019 scenarios, due to the high level of support available for biomethane and heat projects. Steady Progression tracks but is behind the FES 2019 assessment.

In the 2017 scenarios report for the licence area the increase in capacity was more ambitious from a lower baseline. Updated data has reclassified a 15 MW site as AD. The most ambitious scenario projection in the 2017 analysis matches the maximum level of capacity in Consumer Power (102 MW) in this report slightly earlier. The 2017 report has higher levels of ambition and growth.

Distribution by ESA

The distribution of future AD projects is based on several spatial factors including agricultural land classification and existing project locations. ESAs close to urban areas were weighted for higher AD deployment, as these locations are close to both potential food waste and agricultural resources and contain brownfield development locations.

9. Energy from Waste

There are 16 Energy from Waste (EfW) projects in the licence area, with an installed capacity of 266.9 MW. This is considerably higher than other licence areas and a there is a large pipeline of projects being developed, with 10 projects and 168.1 MW of capacity. This is primarily due to high waste resource availability.

With four Advanced thermal Conversion Technology (ACT) plants now operational in the area, the West Midlands is a leading region in this technology.

Table 9-1: Summary of growth in installed capacity of incineration EfW in WPD West Midlands licence area.

Energy from waste (MW)	Baseline	2020	2025	2032
Two Degrees	195	195	217	228
Community Renewables		195	217	228
Consumer Evolution		195	217	311
Steady Progression		195	217	311

Table 9-2: Summary of growth in installed capacity of ACT in WPD West Midlands licence area.

Energy from waste (MW)	Baseline	2020	2025	2032
Two Degrees	72	72	118	157
Community Renewables		72	142	157
Consumer Evolution		72	101	118
Steady Progression		72	72	101

Baseline

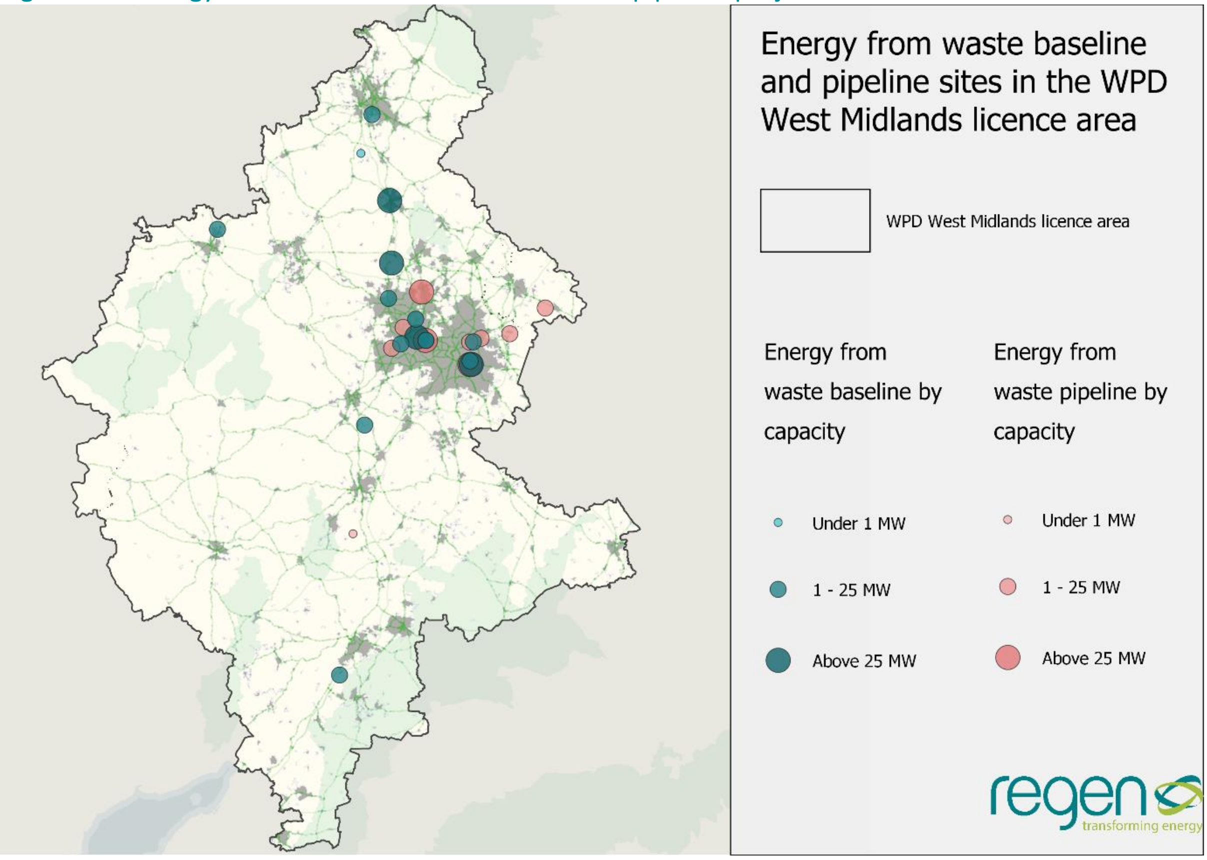
The licence area has a large baseline of EfW installed capacity. Four ACT[72] plants and 12 incineration plants are operational. These technologies have an installed capacity of 72.3 MW and 194.6 MW respectively.

Of these projects, five have connected to the electricity network since 2014. These are:

- 9.5 MW Birmingham bio power in Tyseley, Birmingham, which uses waste wood in an ACT process.
- 22.7 MW Hartlebury plant developed by Severn Waste, uses incineration to process municipal waste.
- 3.8 MW Wednesbury plant near Birmingham, treats municipal waste via ACT.
- 22 MW Urbaser Balfour Beatty plant near Gloucester, uses incineration to process residual waste from recycling and composting. Construction is complete and is in advanced testing phase ahead of commissioning.
- 0.6 MW Infinis plant near Stone, using incineration technology to process waste from a landfill site.

[72] Advance thermal conversion technologies include gasification and pyrolysis and work by producing a gaseous product (can be liquid) from waste, which can be processed and burnt in a generation station to create electricity and heat.

Figure 9-1: Energy from Waste and ACT baseline and pipeline projects



Pipeline

The 2017 study's pipeline included five EfW projects. Of these, one project is operational, one project has been constructed, one is awaiting construction, one has re-submitted a planning application for a larger incineration project (rather than the ACT they had planning permission and a CfD contract for), and one has been abandoned.

There are ten projects in the pipeline with a total installed capacity of 168 MW. Four of these are ACT, with a total of 69.2 MW installed capacity, and the six others are incineration EfW projects, with a total installed capacity of 98.9 MW.

We outline the treatment of these projects in the scenario analysis in Table 9-, taking into account the technology, planning status and connection offer acceptance.

Table 9-3: EfW incineration and ACT West Midlands project pipeline and treatment in scenarios

No. of projects	Project status	Technology type	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
1	Planning permission granted and connection offer accepted	ACT	2023	2022	2025	2026
2	Planning permission granted and no	Incineration	2025	2025	2023	2024

	connection offer accepted					
2	Planning permission granted and no connection offer accepted	ACT	2024	2023	2026	
1	No planning permission and connection offer accepted	Incineration	2029	2029	2026	2027
1	No planning permission and no connection offer accepted	Incineration			2027	2028
2	Refused planning permission and connection offer accepted	Incineration		2029	2030	
1	Refused planning permission and connection offer accepted	ACT	2026	2025		

Energy from waste growth factors

Availability of resource

Waste availability is the key variable for the future development of EfW. Most sources predict a reduction in total UK waste tonnage, mainly due to higher recycling rates[73] but there is uncertainty about whether and when EfW capacity might outstrip the supply of waste. The West Midlands high EfW installed capacity means this area is likely to see increasing competition for waste resources.

Significant policy changes alongside the resources and waste strategy for England are planned and being consulted on, which could impact the amount and the calorific value of the waste[74]. These are due to drive higher recycling rates through more consistent collections, more food waste collection and a plastic packaging tax. Further factors include the amount of export post Brexit and uncertainty on commercial waste availability[73].

Subsidy availability

There is no subsidy support for new mass burn incineration EfW facilities for electricity production. Projects earn revenue from power generation and from gate fees which were an average £89 per tonne in 2019, a small rise from the previous year[75].

The resources and waste strategy for England is looking at ways to encourage greater efficiency from EfW plants by using the heat produced in processes or heat networks in addition to electricity

[73] http://www.esauk.org/application/files/6015/3589/6453/UK_Residual_Waste_Capacity_Gap_Analysis.pdf
[74] https://www.gov.uk/government/news/government-sets-out-plans-to-overhaul-waste-system
[75] http://www.wrap.org.uk/sites/files/wrap/WRAP%20gate%20fees%20report%202019.pdf

production. Linking plants with nearby heat networks is one suggested option. This would bring the sector in line with other EU countries where there is a greater focus on heat generation[76].

In contrast, ACT projects are eligible for CfD revenue support for electricity production. In 2017 six contracts were awarded to ACT. Two of those are in the licence area, with only one still planning to go ahead. In 2019 two projects were awarded a CfD in the UK. One of those is the Small Heat Bio Power project in Birmingham with an initial strike price of £41.61 MWh, targeting commissioning at the end of 2024.

ACT projects can also produce biogas for injection into the gas grid or use in transport and therefore can attract additional subsidy support available through the RHI and the RTFO. RTFO rates have been increasing due to increased ambition in decarbonising transport[77], and therefore the demand for biogas. In greener scenarios this support drives increasing ACT capacity but fewer that are generating electricity.

Incineration tax

A tax on waste incineration was included as a policy option in the 2018 Budget to encourage recycling and waste reduction[78]. The resources and waste strategy for England mentions that an incineration tax is still a policy option, if 'wider policies do not deliver the government's waste ambitions in the long term'[79]. This tax is assumed to be introduced in the mid 2020s in the high decarbonisation scenarios for incineration projects, but not for ACT projects.

ACT development

ACT is a new technology that is facing considerable development challenges. Construction and commissioning delays are often considerable with, some project developers deciding to switch to incineration technology. There are now three operational ACT projects in licence area. The performance and reliability of these projects will inform other developers of the technology. ACT is seen as a reliable technology by developers under Two Degrees and Community Renewables.

Planning support

Gaining planning permission for incineration and ACT projects is increasingly challenging which is expected to keep growth rates relatively modest in all scenarios. There is an active network of opposition groups[80]. Local pollution concerns, additional traffic and impacts on recycling rates are often raised as issues.

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76 https://www.tolvik.com/wp-content/uploads/2019/06/Tolvik-EfW-Statistics-2018-Report_July-2019-final-amended-version.pdf
77 https://www.gov.uk/government/news/new-regulations-to-double-the-use-of-sustainable-renewable-fuels-by-2020

79 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765914/resources-waste-strategy-dec-2018.pdf
80 United Kingdom without Incineration Network http://ukwin.org.uk/

Table 9-4: Factors considered in energy from waste scenarios

Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government policy and support				
Policy supports biogas production	Support for biogas production from early 2020s	Support for biogas production from early 2020s	Lack of support for biogas. Some support available for incineration	Lack of support for biogas.
Government introduces tax on incineration of waste	Incineration tax introduced from mid 2020s	Incineration tax introduced from mid 2020s	No incineration tax	No incineration tax
Competition for resource availability	Low waste resource availability: High recycling rates and lower waste production.	Low waste resource availability: High recycling rates and lower waste production.	Medium waste resource availability: higher recycling rates but lack of strong government policy.	Highest waste resource availability: Lower recycling rates and lack of strong government waste policy
Local and community factors				
Planning environment	Centralised, strategic approach to planning enables larger scale projects to gain planning permission.	Projects that can demonstrate local support and eco credentials - i.e. ACT plants producing biomethane and useable heat	Less engaged population with decarbonisation leads to higher level of projects being rejected at planning	Centralised, strategic approach to planning enables larger scale projects to gain planning permission.
Technology cost and performance				
ACT development	Investment in R&D leads to development of reliable ACT technology	Investment in R&D leads to development of reliable ACT technology, including small-scale plants	Lack of investment leads to slow progress in developing ACT	Lack of investment leads to slow progress in developing ACT

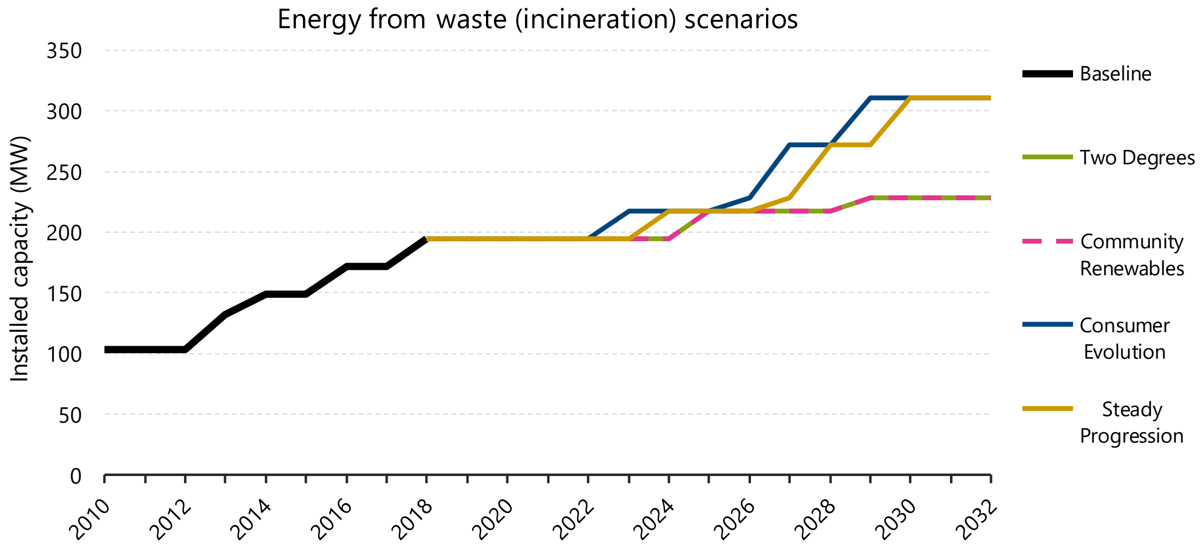
Energy from waste scenarios

The scenario analysis is split between incineration projects and ACT projects.

Incineration summary

The scenario analysis for incineration does not include any projects that are not already in the pipeline. This is due to the high baseline of projects and the large pipeline of future projects in the licence area, as well as the long development timelines for EfW projects. Under the Consumer Evolution and Steady Progression all the planned incineration projects are built, with no incineration tax and medium to high waste resource availability. Under Two Degrees and Community Renewables, projects in the pipeline go ahead that have planning permission and accepted a connection offer. The incineration tax is introduced in Two Degrees and Community Renewables from the mid 2020s reducing deployment of this technology.

Figure 9-2: WPD West Midlands energy from waste (incineration) capacity by scenario

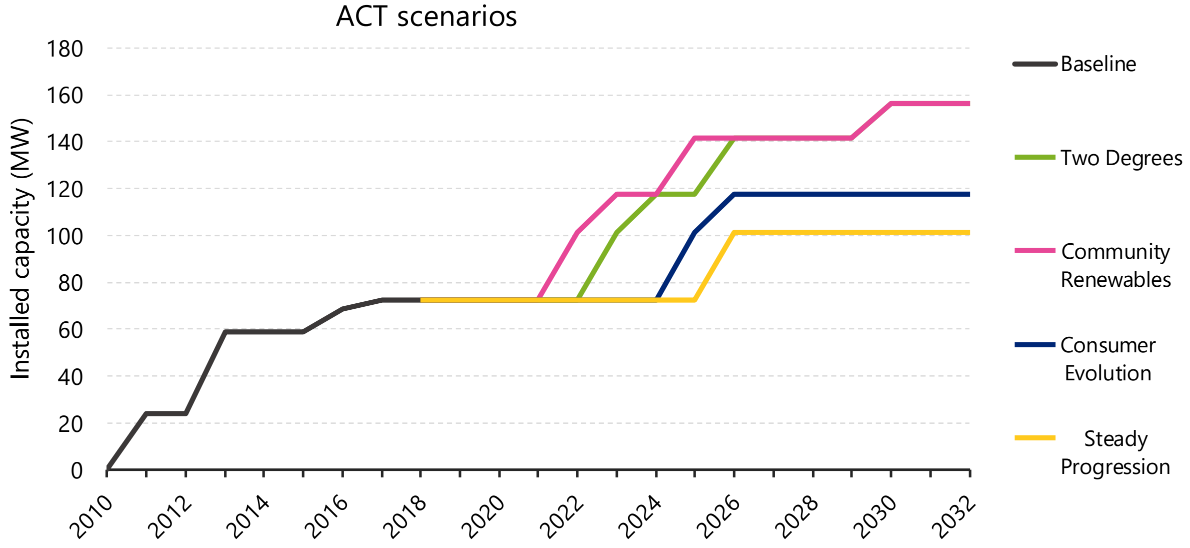


ACT summary

In Community Renewables and Two Degrees all the projects in the pipeline are deployed. For ACT we include one further project beyond the current pipeline of projects. Community Renewables is the most ambitious scenario, with 157 MW of installed capacity by 2032. Subsidy support, technology advances and a favorable planning system supports this level of future growth.

In Consumer Evolution the majority of pipeline projects go ahead but with delays in comparison to the more ambitious scenarios. Steady Progression has the most developed ACT project in the pipeline going ahead. These scenarios have lower deployment due to no incineration tax, a lack of subsidy and less technology advances

Figure 9-3: WPD West Midlands ACT growth by scenario



Comparison to other scenarios

For incineration projects Consumer Evolution and Steady Progression in this analysis match the level of installed capacity projected by 2032 in FES 2019 scenarios. In our analysis, Community Renewables has the introduction of an incineration tax which drives projects towards ACT rather than incineration. This is not included in FES 2019 which shows Community Renewables as the most ambitious scenario.

For ACT projects, the licence area has a high baseline of ACT projects, with 39% of the GB baseline in FES 2019. This proportion is unlikely to be maintained as more projects are installed across GB. There is a limited amount of waste, and anticipated higher recycling rates will reduce the opportunity for new site development. A large pipeline of projects is evident in the licence area, which is represented by the stepped growth in the projection growth curves.

There is a higher baseline in this scenario analysis in comparison with the 2017 West Midlands report, 172 MW compared to 146 MW in 2017. In the 2017 analysis there were five projects in the pipeline. One of those projects has since been connected to the network, the rest remain in the pipeline of projects for the licence area.

The 2017 West Midlands scenario assessment did not split the ACT and incineration technology projections. Therefore they are not directly comparable.

Distribution of technology across ESAs

The additional projects are all based on locations of potential projects in the pipeline. One further ACT project is projected to be in an urban area which does not have any installed EfW or ACT capacity within a reasonable distance.

10. Biomass CHP

Biomass CHP is projected to have a relatively small role in the energy transition.

West Midlands has 13 MW of installed biomass CHP capacity, from 20 projects. There is one 100 kW project in the pipeline.

With tighter sustainability requirements being introduced, there is a limited role for Biomass CHP as an electricity generation technology. The low baseline and pipeline in the licence area, limits the level of installed capacity growth that is projected within the timescale of these scenarios.

Table 10-1: Summary of growth in capacity of biomass CHP in West Midlands licence area.

MW	2018	2020	2025	2032
Two Degrees	13	13	15	16
Community Renewables		14	16	29
Consumer Evolution		13	15	18
Steady Progression		13	13	13

Baseline

Biomass CHP deployment in the licence area is significantly lower than the East Midlands and comprises of a number of small projects. The East Midlands has 108 MW installed capacity, in contrast to the 13 MW in the West Midlands. The largest project is 4.2 MW Longma Clean Energy project near Hereford. The average installed capacity of the projects in the licence area is 600 kW, which is significantly lower than the 2 MW average in the East Midlands licence area.

Pipeline

There is one 100 kW in the pipeline. This assumed to go ahead in all scenarios with the timing varied according to the scenario in Table 10-2.

Table 10-2: West Midlands Biomass CHP pipeline

ESA	MW	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Four Ashes 33 11kV	0.1	2022	2020	2022	2022

Biomass CHP growth factors

Planning policy

Biomass can provide useful baseload and dispatchable low carbon electricity production. However, *t*he growth of biomass as a fuel for electricity generation is controversial due to sustainability and air quality concerns. There is also dispute regarding the carbon emissions and use for electricity generation ahead of heating or other hard to decarbonise sectors. More stringent quality assurance and sustainability requirements have been introduced to combat these concerns.

Biomass CHP is not used widely in heat networks at present, with only 5% of the Heat Network project pipeline in the UK stating it as a technology[81]. Concerns regarding air quality will need to be addressed, as heat networks are mainly in urban centres with closely monitored air quality levels.

Ongoing subsidy support

New biomass CHP plants are likely to need some level of subsidy support from CfD, RHI or both. The government has strengthened the sustainability requirements regarding the CfD price support available[82]. Biomass CHP generation is now only eligible for CfD subsidy if it produces useable heat through CHP. There is also a greenhouse gas threshold of 29kg CO_2/MWh for new biomass projects under the CfD[83]. At present there are three dedicated biomass CHP plants in in the UK with a CfD contract, including the Rebellion Biomass LLP 640 kW project which is located just outside the boundary of the West Midlands licence area.

Biomass CHP projects can also benefit from the RHI, including the tariff guarantee. Two projects have been granted a tariff guarantee so far in the UK.

The greatest increase in projects is in Community Renewables where new sustainability criteria together with subsidy support over a doubling of capacity in Biomass CHP projects over the scenario time period.

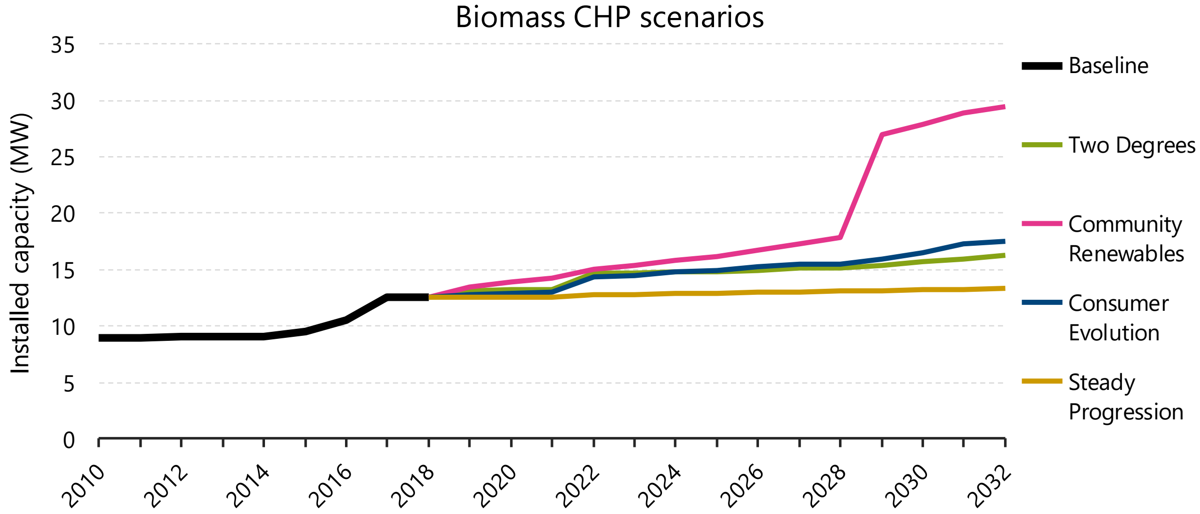
81 https://www.gov.uk/government/publications/hndu-pipeline
82 https://www.lowcarboncontracts.uk/sites/default/files/publications/LCCC%20SC%20guidance%20final.pdf
83 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/736588/Part_B_Consultation_Response.pdf

Table 10-3: Assumptions for factors influencing capacity growth for biomass generation

Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government policy and support				
Continued subsidy support for projects	Subsidy support for biomass projects that meet sustainability standards until late 2020s	Subsidy support for biomass projects that meet sustainability standards until late 2020s	No subsidy support	No subsidy support
Planning permission				
Planning environment	Centralised, strategic approach to planning enables larger scale projects.	Local approach to planning means smaller projects that can demonstrate strong environmental credentials	Planning less engaged with decarbonisation leads to higher level of projects being rejected at planning.	Little support for decarbonisation means biomass projects less likely to get permission.

Biomass CHP scenarios

Figure 10-1: Biomass projections by scenario for WPD West Midlands



Scenario summary

The low baseline of Biomass CHP projects in the West Midlands licence area means there is some opportunity for growth in installed capacity. Community Renewables is the most ambitious scenario, with 29.5 MW installed capacity by 2032. The other scenarios show limited deployment in the licence area.

Relationship to other scenarios

In the analysis for the licence area, Community Renewables Biomass CHP capacity is significantly lower than the FES 2019 projection, due to a low baseline and pipeline of new projects. The other scenarios in this analysis are aligned with the FES 2019 installed capacity for biomass CHP in the West Midlands.

Biomass CHP was not included as a technology in the previous 2017 West Midlands analysis.

Distribution across ESAs

New biomass CHP capacity is geographically distributed across the West Midlands licence area, using the locations of existing and abandoned sites.

11. Hydropower

The West Midlands licence area has relatively low hydropower deployment with 0.8 MW from 29 projects. This is 0.14% of the GB hydropower installed capacity. Hydropower deployment is projected to continue to be relatively slow in the scenario analysis but could double in the most ambitious scenario.

The West Midlands has some good resource areas for hydropower, but deployment has been relatively slow. There is some potential for an increase in capacity under the right conditions.

Table 11-1: Summary of growth in capacity of hydropower in WPD West Midlands licence area.

Hydropower capacity growth MW)	2018	2020	2025	2032
Two Degrees	0.8	0.9	1.0	1.2
Community Renewables		0.9	1.0	1.6
Consumer Evolution		0.8	0.9	1.0
Steady Progression		0.8	0.9	1.0

Baseline

Across the 29 installed hydropower projects the average installed project is 29 kW. There are two hydropower sites over 100 kW installed capacity in the licence area.

A significant increase in installed hydropower capacity occurred between 2011 and 2014. There has been limited growth in installed capacity since 2014.

Pipeline

There is one 75kW hydropower site in the pipeline. This project accepted a network connection offer in 2019. The Congleton Hydro project is a community energy scheme developed by Dane Valley Community Energy, using a weir with good resource potential. They have received planning permission for the Havannah weir site.

The pipeline for the hydropower pipeline is outlined in Table 11-2.

Table 11-2: Pipeline treatment for the hydropower pipeline.

Scheme	Capacity (kW)	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Havannah weir	75	2020	2020	2022	2023-

Hydropower growth factors

Subsidy availability

Hydropower is a predictable and reliable renewable energy resource. However, it is relatively expensive to deploy per kW installed, limiting its installation potential. The lack of government-backed guaranteed income following the closure of the FIT scheme in March 2019, makes raising finance for the high upfront costs, including detailed feasibility and extensive civil works, more challenging. Projects have two years to build out if they received preliminary accreditation or pre-registration under the FIT.

There has not been the same reduction in installation costs for hydropower that there has been in other technologies (such as solar PV). However, the longer lifetime of the asset can make up for the higher upfront costs.

There are new technology options for low resource sites that could increase the potential for hydropower developments[84]. This could make sites that have lower vertical drops in the West Midlands possible, if the installation and environmental permitting costs are viable.

> Hydropower has a high cost per kW installed compared to other technologies. The lack of price support available makes the business model for new projects challenging.

Environmental permitting

Hydropower projects in England require considerable feasibility work including environmental permitting assessments from the Environment Agency. Studies to look at the ecological and flood risk impact are often required. Most of these requirements apply to small hydropower projects as well as larger ones. Overall, hydropower has more environmental permitting requirements than other technologies though there can be positive as well as negative impacts on the local ecosystems. Often a requirement for a fish pass is included, which can help improve migration routes where weirs had previously removed them. In the more ambitious scenarios these permitting processes are more supportive of hydro schemes and maximise their positive environmental impacts.

New business models

New business models for hydropower are being trialled to help match local generation to local demand. The Energy Local project in Bethesda Wales is the best-known example[85]. It is hoped that this would raise the income of existing sites and therefore improve the viability of new hydropower sites in the absence of further subsidies. The potential for this model is considerable given the predictable nature of hydropower generation which can be matched to domestic demand by using new power pricing periods to move demand.

Other models include co-locating energy storage with hydropower sites. Barn Energy are a recent example, which are two 1.2 MW batteries next to two river hydro projects[86]. These sites use the low-cost hydropower to deliver high value grid services via the battery installations. Limejump, a leading UK aggregator and energy company, has increased its portfolio of hydropower sites, in order to obtain new revenue stream opportunities[87].

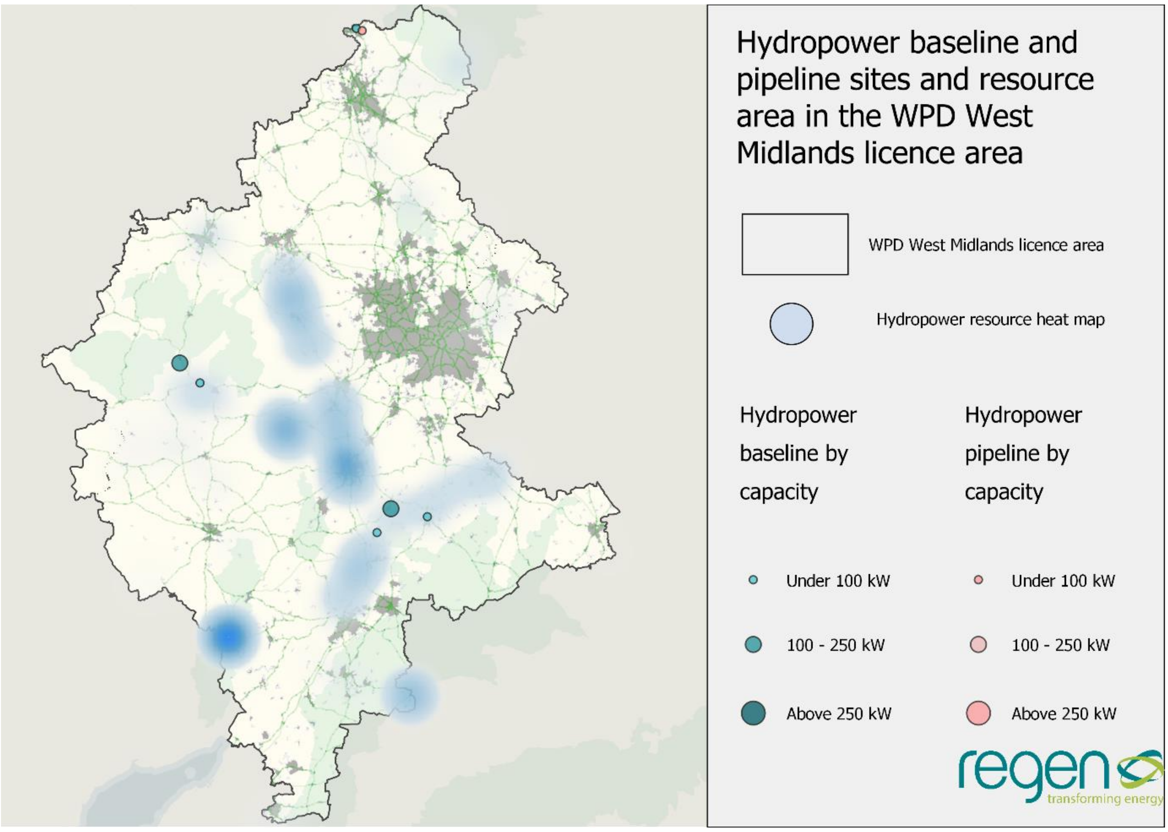
[84] For example https://www.aquazoom.com/
[85] http://www.energylocal.co.uk/cyd-ynni/
[86] http://www.barnenergy.co.uk/single-post/2018/03/22/First-Co-Location-of-Batteries-at-UK-Hydro-Schemes-in-the-UK
[87]https://limejump.com/scaling-limejumps-hydro-portfolio-provides-asset-optimisation-for-all-and-offers-another-push-towards-100-carbon-net-zero-energy/

A summary of the factors influencing the deployment of hydropower are outlined in Table 11-3.

Table 11-3: Assumptions for factors influencing capacity growth for hydropower

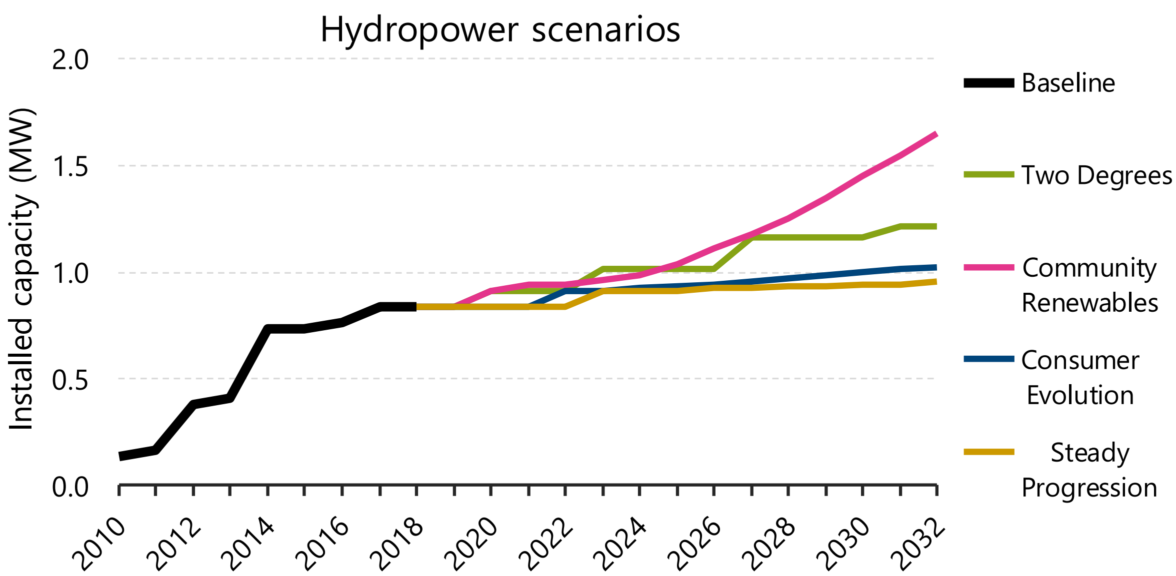
Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government support				
Subsidy availability	Government subsidy for hydro in place	Government subsidy focused on small-scale projects	No subsidy for hydropower under this scenario.	No subsidy for hydropower under this scenario.
Environmental permitting	Environmental improvement opportunities from hydropower recognised, and incentivised.	Environmental improvement opportunities from hydropower recognised, and incentivised.	Environmental improvement opportunities from hydropower recognised but not incentivised.	Current environmental permitting requirements are sustained.
Technology performance				
New business models – flexibility and balancing	Flexibility and balancing markets are developed for larger-capacity sites	Flexibility and balancing markets are developed to include all sites	Changes slower to develop, and business models focused on power price	New business models fail to develop in scenario period.

Figure 11-1 Hydropower resource and the baseline and pipeline projects



Hydropower scenarios

Figure 11-2: WPD West Midlands hydropower growth scenarios.



Scenario summary

Community Renewables has the most ambitious level of hydropower capacity growth, due to subsidy support which allow new business models to emerge faster, meaning a larger number of smaller sites are developed. Two Degrees shows a smaller number of larger sites go ahead over the period.

Consumer Evolution and Steady Progression project slow growth continuing for the next decade as business models for hydropower remain challenging.

Relationship to other scenarios

This scenario analysis shows more hydropower installed capacity by 2032 in comparison with FES 2019. The relatively high resource potential in the licence area and low baseline, provides options for deployment, particularly in Community Renewables.

The baseline has been updated with an increase in installed hydropower capacity in this analysis in comparison with the 2017 report, due to one new project and the identification of an additional large site in the licence area. The two most ambitious scenarios in this study show lower levels of installed capacity growth compared to 2017.

Distribution across ESAs

The hydropower capacity projected is distributed across the licence area ESAs based upon technically available hydropower resource and locations of existing baseline projects.

12. Diesel and Gas

At present, fossil fuelled electricity generation technologies continue to play a critical role in the UK energy system. The mode of operation of gas generation is increasingly changing from providing baseload supply to a more flexible peaking and backup role. Other than for backup generation, diesel is however set to decline even further, due to emissions limits and decarbonisation legislation.

In all scenarios diesel capacity declines from the mid-2020s, while gas capacity grows over the scenario period.

Table 12-1: Summary of growth in capacity of diesel in WPD West Midlands licence area.

Diesel Generation (MW)	2018	2020	2025	2032
Two Degrees	134	135	120	12
Community Renewables		135	123	52
Consumer Evolution		156	155	105
Steady Progression		136	135	73

Table 12-2: Summary of growth in capacity of gas and gas CHP in WPD West Midlands licence area.

Gas and Gas CHP (MW)	2018	2020	2025	2032
Two Degrees	355	393	791	793
Community Renewables		393	905	1,117
Consumer Evolution		393	979	1,189
Steady Progression		393	784	784

Baseline

Both diesel and gas generation capacity have increased in recent years in the West Midlands. Gas generation capacity connected to the distribution network increased from 113 MW in 2015 to 314 MW in 2018, while diesel capacity grew from 60 MW to 134 MW over the same timeframe. Of this total 448 MW of fossil fuel generation capacity, 367 MW comes from of projects that are over 5 MW, with the seven largest baseline sites totalling 287 MW.

This increase in connected fossil fuel generation in the West Midlands is consistent with the rest of the country and coincides with the launch of the Capacity Market (CM) in 2014. The CM was introduced to ensure that there was enough generation capacity available to manage winter peaks in demand, mitigate against future electricity system stress events or blackouts and to encourage dispatchable generation and demand-side response generation to be built. The CM has not been wholly successful in bringing forward new large gas plants. For example, no new Combined Cycle Gas Turbine (CCGT) plants were procured in the 2017 T-4 auction.

Pipeline

The West Midlands licence area has 33 gas generation projects with which have accepted network connection offers, totalling 675 MW of potential additional capacity. This includes the 294 MW Meaford Energy Centre, which has been granted permission under the National Infrastructure Planning regime and is projected to go forward in all scenarios. In addition, a further 286 MW of capacity in the pipeline (13 sites) has been active in the CM, showing that this revenue stream continues to be a clear driver for distributed gas-fired generation in the near term.

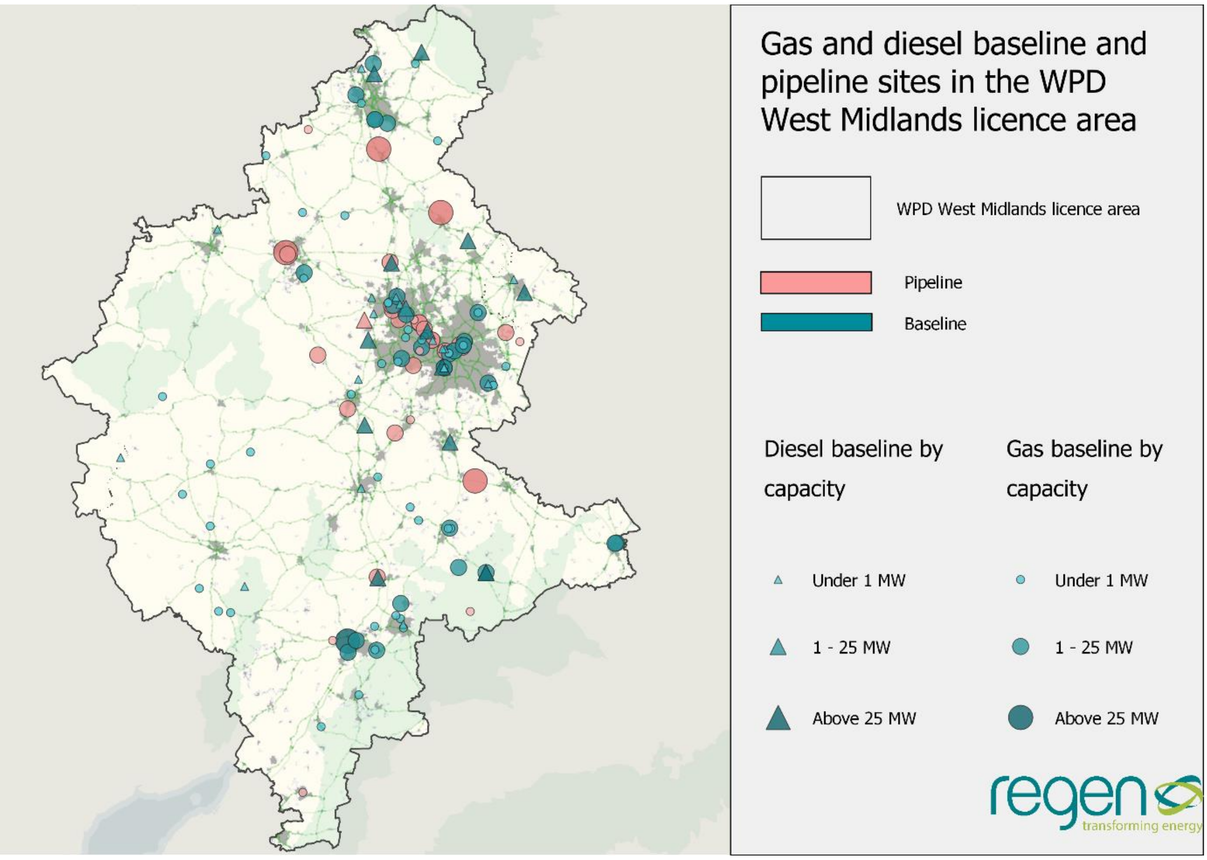
There are also three diesel projects with accepted-not-yet-connected offers, totalling 22 MW of capacity. However, within this pipeline is a single 20 MW site with no evidence of development beyond an accepted connection from 2015. This 20 MW site is therefore only projected to proceed in the Consumer Evolution scenario.

The decline in new diesel generating capacity is linked to a piece of European legislation called the Medium Combustion Plant Directive (MCPD). The UK government has passed this legislation into UK law, introducing new emission limits for medium combustion plants (mid-sized generators that produce exhaust emissions) from December 2018. The legislation establishes a ceiling on nitrogen oxide, sulphur dioxide and dust and particulate emissions, primarily aimed at curbing the commercial operation of diesel engines in 'balancing services' such as the CM and National Grid ESO's STOR programme.

Backup generation is not classed as participating in these 'balancing services', and therefore is exempt from meeting these new emission limits. In order to qualify for exemption, these plants can operate for 'testing purposes' for up to 50 hours a year at full capacity, which many organisations are leveraging as an opportunity to lower consumption during likely Triad periods during the winter, though the Environment Agency have clarified that Triad avoidance does not qualify as a relevant balancing service under the MCPD[88].

[88] See The Energyst news article, April 2018: https://theenergyst.com/mcpd-environment-agency-makes-triad-u-turn/

Figure 12-1 Diesel and gas baseline and pipeline sites by capacity



Pipeline allocation

Four of the 'pipeline' sites have already connected in 2019, at time of writing, so are included in every scenario. The remaining pipeline projects have been assessed against the following criteria:

- Activity in auctions such as the CM (registration, pre-qualification and Capacity Agreements)
- Planning application activity
- Desk-based research of projects and developers

Using this information, each project is assessed in terms of a likely connection year and export capacity within each of the four FES scenario environments.

Projects with CM Agreements are assumed to be operational in their relevant CM delivery year in every scenario. Projects with strong evidence of development, such as planning permission and auction bids/pre-qualifications, are likely to go ahead sooner and are included all scenarios.

Projects with limited development activity are more uncertain, and have therefore been projected to go ahead later, or not all, in the more centralised scenarios. Gas generation sites with no evidence of development, beyond an accepted export capacity agreement with WPD, are not projected to connect in any scenario. Diesel sites with no development information are projected to connect in the Consumer Evolution scenario only.

Diesel and gas growth factors

Capacity market and balancing services revenues

The CM is a key element of the UK's plan to maintain security of supply at low cost. The European Commission's annulling of State Aid approval for the CM in November last year[89], and its resultant suspension, has since been reversed[90], with new T-1, T-3 and T-4 auctions slated to run in early 2020. The range of future scenario projections reflect the possibility of gas generation continuing to participate strongly in next year's auctions, or a fall back in activity as CM prices continue to fall. Latest CM prices have come in lower than expected, reducing the profitability new gas generation projects.

Future role of flexible generation

Gas generation capacity is projected to increase under all scenarios out to 2032:

- A trebling of capacity, compared to 2018 levels, under the more decentralised scenarios; Community Renewables and Consumer Evolution. The new capacity in these scenarios will be operating as flexible plant, running increasingly infrequently during periods of high electricity prices or system events.
- A more modest doubling of capacity under the centralised scenarios, Steady Progression and Two Degrees, as policy focusses on larger-scale, transmission-level electricity generation and balancing. However, this lower capacity is expected to operate more frequently. The 294 MW Meaford site represents most of this increase; without this project, gas capacity increases by only 40% compared to 2018 levels.

[89] See Regen article summarising the Capacity Market Suspension, November 2018: https://www.regen.co.uk/capacity-market-suspension/

[90] See Current news article, October 2019: https://www.current-news.co.uk/news/european-commission-clears-capacity-market-scheme-to-continue

Table 12-3: Factors influencing gas and diesel projections

Growth Factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Infrastructure and Government support				
Tightening air quality standards and emission limits	MCPD tightened substantially by 2032	MCPD emission limits tightened slowly	Existing MCPD limits only	Existing MCPD limits only
Role of flexible, distributed peaking plant in the UK	Limited distributed flexibility services, as generation and flexibility are focussed on transmission-level solutions	High demand for small peaking plant. Increase in proportion of green gas in the system	High demand for small peaking plant, particularly gas and battery generation technologies	Greater emphasis on large-scale (transmission connected) generation
Technology cost and performance				
Competition with storage and DSR	Flexibility and peaking services mainly provided by interconnectors and large-scale electricity storage	Small gas plants provide the most cost-effective flexibility as the rest of the system decarbonises quickly	Small gas plants provide the most cost-effective flexibility as new technologies are explored	Gas plant still used for peaking, but lowest level of all scenarios
Consumer factors				
Commercial and Industrial customers investing in onsite fossil generation	Limited financial value in onsite flexibility. Small-scale units increase in cost as demand drops	Energy decentralisation drives uptake of owner-operated gas, and CAPEX costs fall, even as gas prices rise	Energy decentralisation drives uptake of owner-operated gas, and CAPEX costs fall, even as gas prices rise	Improvements in gas technology continue to make medium scale units cost effective
Resource factors				
Gas mix by 2032, impacting security of supply, cost and level of government support	Level of imported natural gas is steadily reduced, from 2025 onwards	Gas supplies are stretched as more peaking plant is required.	Gas supplies are stretched as more peaking plant is required	Natural gas is steadily reduced, from 2025 onwards

Diesel and gas scenarios

Figure 12-2: WPD West Midlands licence area diesel capacity scenarios

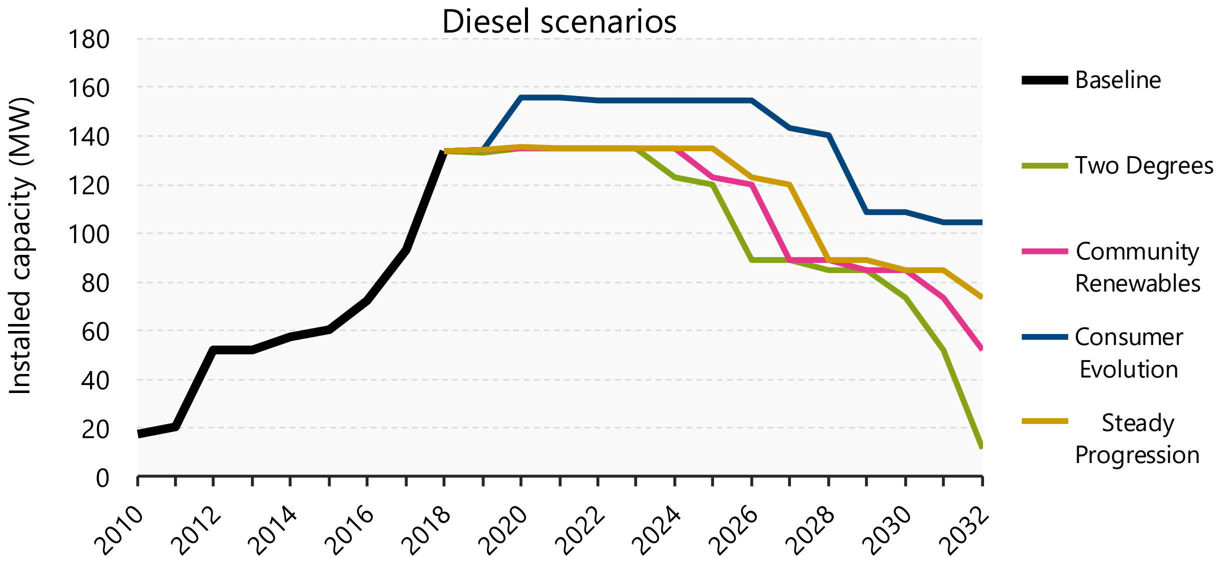
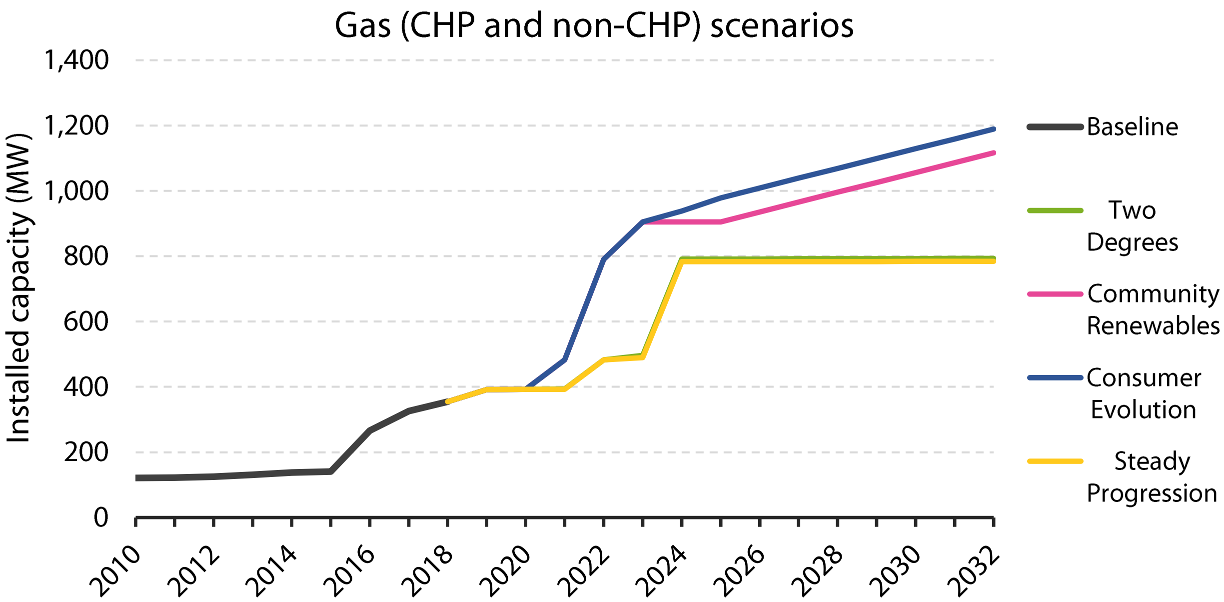


Figure 12-3: WPD West Midlands licence area gas capacity scenarios



Scenarios summary

Diesel capacity drops in all scenarios after the pipeline period, as local air quality mandates and emission abatement controls make the technology unviable for electricity generation; see Figure 12-2. This has been reflected in the modelling as decommissioning existing baseline diesel generation projects in each scenario, depending on age and operation (commercial or backup).

For gas generation, as illustrated in Figure 12-3, the pipeline of new projects with strong evidence of development results in an increase in overall capacity in every scenario, not least due to the 294 MW Meaford site going forward in every scenario. Within and beyond this pipeline period, the more decentralised Community Renewables and Consumer Evolution scenarios continue the recent trend of increasing deployment of distributed, medium-scale gas power generation sites, whereas the centralised Two Degrees and Steady Progression scenarios see growth limited to the most active pipeline projects.

Relationship to other scenarios

The 2017 scenario assessment for the West Midlands conducted for WPD did not include modelling for fossil fuelled technologies. The modelling for these technologies follows the trends seen in the FES 2018 and FES 2019. When combining gas and gas CHP in the FES, there are two clear trends: high growth in the decentralised scenarios, and a lower growth in the more centralised scenarios. The level of decarbonisation in the scenarios therefore has less of an impact on capacity growth within the timeframe of the assessment. In contrast, diesel capacity projections in the FES are influenced by both the level of decentralisation and decarbonisation within each scenario.

Distribution of technologies across ESAs

There is no additional diesel capacity, beyond the pipeline, in any scenario. The distribution of this capacity is therefore the location of baseline and pipeline sites.

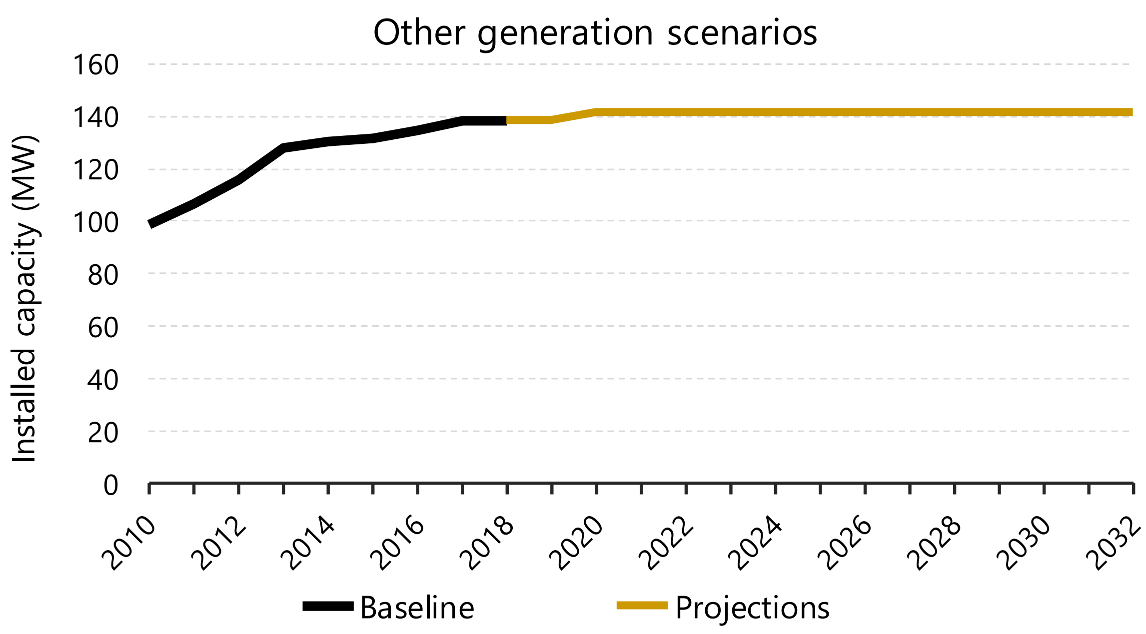
Gas, and gas CHP have been projected and distributed separately. Each has been distributed according to the current technology baseline capacity in each ESA.

13. Other generation

Baseline

There is a total of 75 projects in the 'other generation' category, with a total of 138 MW installed capacity. This includes 18 sewage gas sites with total installed capacity of 75.5 MW. Landfill gas sites are also included in this technology type, with 25 projects and 52.2 MW of installed capacity. The remaining 'other generation' projects are not identified against a specific generation technology.

Figure 13-1 Historic growth in 'other generation' in the West Midlands licence area



Pipeline

There are six projects in the 'other generation' pipeline. Only one 2.7 MW project has accepted a connection offer.

C. Electricity storage introduction

The interest in connecting electricity storage[91] projects to the distribution network has been significant since around 2016. While the West Midlands has the potential to see a notable increase in electricity storage capacity, the market for storage has stalled in recent years, due to a number of policy, regulatory and commercial market changes. The potential for the scenarios with more significant increases in connected storage capacity is therefore subject to solidification of electricity storage business models.

In Regen's 2016 energy storage whitepaper[92], a set of business models were developed to categorise different classes of storage assets, describing the type(s) of revenue streams (i.e. sources of income and/or savings generated) that different classes of storage asset might target and their related operating behaviour, see Table 13-1.

As per the 2017 West Midlands scenarios report, these business models are used as the basis of the growth scenario projections for electricity storage.

Table 13-1: Electricity storage business models developed by Regen

1. Response service - Providing higher value, rapid response 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 also providing onsite energy continuity

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

5. Generation co-location - Storage co-located with variable energy generation (e.g. wind or solar) 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.

Evolving business models and revenue streams

Since electricity storage assets began to connect to the network in 2016, project developers, investors and operators have had to adapt business models to ever evolving policy and market changes. As a result, the six business models in Table 13-1 have undergone an evolution over the past 2-3 years.

The changes to the regulation and policy that affects electricity storage, combined with the evolution and saturation of many commercial markets that storage projects are active in, have all had detrimental effects to business cases for new storage assets (see Table 13-2). The shifting policy and

[91] We use the term electricity storage to include all types of energy and battery storage technologies that store electricity.

[92] Energy Storage: Towards a Commercial Model (November 2016): https://www.regen.co.uk/publications/energy-storage-towards-a-commercial-model/

market environment for storage 2018 and into 2019 has caused storage projects to either need to compete to secure multiple sources of income or potentially not be developed at all. As it stands some 3.7GW of new electricity storage projects have been granted planning permission across the UK[93], but what proportion of these projects progress through to development in this challenging environment, is uncertain. With control systems, innovative solutions and hybrid/co-location sites starting to appear, it is likely that storage assets will increasingly act as merchant energy traders, participating in a number of the six business models detailed in Table 13-1. However, stability around income, clarifications around future network charging structure and clear signposting of the size and value of commercial flexibility markets is all needed to drive storage project development to the level that it may be required in the licence area and the country as a whole. If this happens, development of new projects could ramp up quickly in the medium term, but projects are currently struggling to secure viable business models.

Table 13-2: Evolutions to electricity storage business models

Business Model	Market evolutions and impacts on new storage projects
Response Services	**Enhanced Frequency Response** (EFR) had only one round of auctions, in 2016. The potential for another is not clear, though National Grid have proposed the procurement of more, faster-acting response services[94]. The **Fast Frequency Response** (FFR) market has seen interest from a variety of technology providers. The oversubscription of bidders into FFR auctions has resulted in year-on-year price drops[95]. As the FFR market becomes diluted, storage projects that are reliant on could possibly be abandoned or delayed until alternative revenue streams are found.
Reserve Services	The **CM** has historically seen attention from electricity storage operators. The substantial de-rating of shorter-duration storage in the CM in 2017 was a heavy blow[96] for storage business cases, compounded by the recent drop in clearing prices[97]. The European Commission's annulling of State Aid approval for the CM in November last year[98], and its resultant suspension, have since been reversed[99], with T-1, T-3 and T-4 auctions slated to start in early 2020.

[93] See BEIS Renewable Energy Planning Database, valid as of Sep 2019: https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
[94] See National Grid *Product Roadmap for Frequency Response and Reserve*, December 2017: https://www.nationalgrid.com/sites/default/files/documents/Product%20Roadmap%20for%20Frequency%20Response%20and%20Reserve.pdf
[95] See Energyst article showing Baringa analysis of dynamic FFR prices 2015-2018: https://theenergyst.com/can-balancing-mechanism-replace-ffr-price-erosion/
[96] See Energy Storage News article, December 2017: https://www.energy-storage.news/news/major-blow-for-uk-energy-storage-in-capacity-market-following-de-rating-rul
[97] See Charles River Associates article around falling CM T4 auction clearing prices: http://www.crai.com/industry/energy/blog/results-of-t4-gb-capacity-market-auction
[98] See Regen article summarising the Capacity Market Suspension, November 2018: https://www.regen.co.uk/capacity-market-suspension/
[99] See Current news article, October 2019: https://www.current-news.co.uk/news/european-commission-clears-capacity-market-scheme-to-continue

	Other reserve services such as **STOR** and **Fast Reserve** also fall under National Grid's Future of Balancing Services process. Proposals in the relevant product roadmap describe rationalisation of reserve products within 2018, as well as implementation of the **Trans European Replacement Reserves Exchange** (**TERRE**). As part of the transition to DSO, recent developments of the DNO led **local flexibility markets** have created a new type of commercial service for flexible assets such as storage to bid into. WPD's Flexible Power programme is one of the most active in signposting and seeking to procure flexibility at specific network locations[100]. Storage developers may be looking to target these flexibility zones to secure a contract, potentially as an additional source of income to CM agreements or response contracts. However, it is acknowledged by Regen, developers and other industry analysts that the scale of revenue from a local flexibility contract will not be the basis of a business case for a storage asset.
Commercial & Industrial	The business model for locating storage behind-the-meter at high energy-using sites was set to be a strong area of growth, with the potential to use storage to reduce exposure to high cost periods (such as '**red-band' distribution network charges** or **Triad penalties**). However, as part of Ofgem's wider Targeted Charging review, Ofgem is consulting on how users (and generators) pay for using the network[101]. Among the options being considered is the removal of the Triad charging mechanism to recover TNUoS customer costs, moving the 'residual' portion of the DUoS charges to be fixed charges, determined by installed capacity or network location. This introduces new uncertainty to the business case for this business model.
Domestic & community	The potential for homeowners to pair storage with rooftop solar PV to increase self-consumption, reducing electricity import, is a key factor for domestic storage. Currently, bill savings are not enough to repay the cost of a domestic battery. The removal of the FIT export payments and its potential replacement[102], live examples[103,104] of domestic storage engaging with DNO local flexibility markets and wider feasibility studies around community level flexibility aggregation services[105] suggest that domestic and community batteries could engage in additional value streams in the future, in addition to reducing imports.

[100] See WPD Flexible Power campaign website: https://www.flexiblepower.co.uk/
[101] See Ofgem access and forward-looking charges consultation, July 2018: https://www.ofgem.gov.uk/system/files/docs/2018/07/network_access_consultation_july_2018_-_final.pdf
[102] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726977/FITs_closure_condoc_-_Final_version.pdf
[103] https://www.powervault.co.uk/article/powervault-to-deliver-local-flexibility-in-london-with-ukpn/
[104] https://www.centrica.com/news/residential-installs-begin-cornwalls-local-energy-market
[105] See BEIS Flexibility Markets Feasibility Study Competition research project around an Energy Community Aggregator Service (ECAS): https://www.regen.co.uk/project/beis-domestic-flexibility-feasibility-study/

Generation co-location	The business model around co-locating storage with generation, including variable renewables, is relatively new. Co-located electricity storage could allow more renewable energy sites to secure grid connection capacity by '**peak-shaving**' generation. It could also provide value through securing **response/reserve flexibility contracts** or **price arbitrage**, by storing low cost generation and selling during higher price periods. Currently, storage costs coupled with marginal benefits from price arbitrage makes it difficult for co-location to stack up. Enabling generation projects to access more volatile price markets could unlock the value required to make co-location truly viable. The role of storage in providing an alternative route to market through co-location could provide a renewed opportunity and role for longer duration electricity storage projects co-located with generation in the CM. Onshore wind and solar PV currently suffer from de-rating of around 8.5% and 1.5% respectively, compared to 15-17% for 30-minute-duration electricity storage.
Energy Trader	With the right level of flexibility and risk policy, more 'merchant' storage projects and operators could target multiple operating modes and related sources of revenue. Higher value price markets such as the **Balancing Mechanism** could provide lucrative price arbitrage income.

14. Electricity storage

> A small baseline and large pipeline with evolving business models makes future electricity storage scenarios highly variable.

With an installed baseline of 11 storage projects, totalling 47 MW and with good network availability, the licence area has high potential for an increased amount of connected electricity storage, particularly compared to other WPD areas such as the South West and South Wales. Whilst there is a mixture of storage business models in both the baseline and near-term pipeline, most of the storage capacity in the near-term pipeline falls under 'standalone' business models, response or reserve services. Beyond this pipeline there is the potential for an increase under other storage business models, e.g. 'generation co-location', 'high energy commercial and industrial' and 'domestic and community'. See

Table 14-1.

Table 14-1: Summary of growth in capacity of energy storage in WPD West Midlands licence area

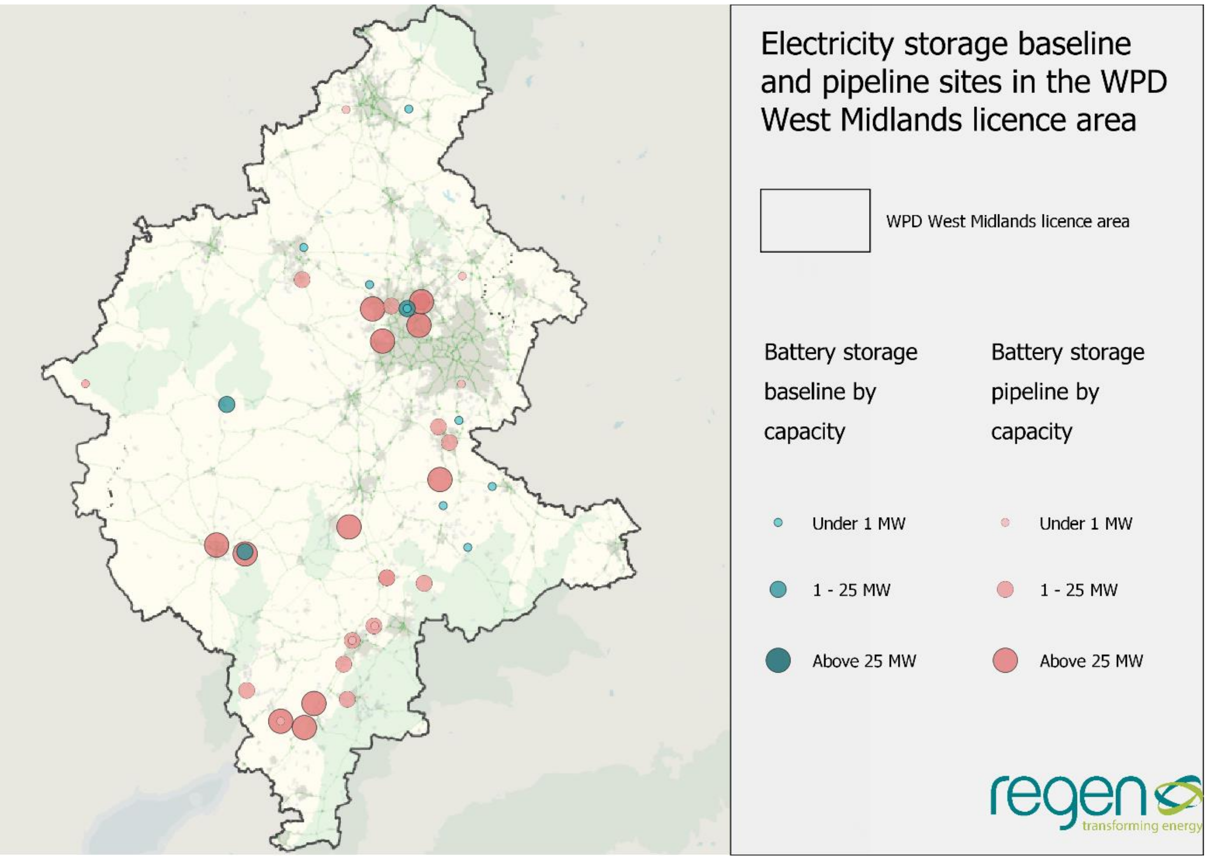
Scenario	Business model	Baseline	2020	2025	2032
Two Degrees	Response services	40	40	225	225
	Reserve Services	0	96	292	292
	High energy commercial and industrial	4	38	90	181
	Domestic and community	0	3	11	36
	Co-location	3	40	101	175
	Energy Trader	0	0	0	0
	Total	**47**	**216**	**720**	**908**
Community Renewables	Response services	40	40	225	225
	Reserve Services	0	96	292	292
	High energy commercial and industrial	4	49	120	241
	Domestic and community	0	5	30	109
	Co-location	3	40	101	205
	Energy Trader	0	0	0	0
	Total	**47**	**230**	**768**	**1,072**
Consumer Evolution	Response services	40	40	108	108
	Reserve Services	0	47	232	232
	High energy commercial and industrial	4	15	60	120
	Domestic and community	0	3	9	30
	Co-location	3	21	37	87
	Energy Trader	0	0	0	0
	Total	**47**	**126**	**446**	**577**
Steady Progression	Response services	40	40	40	105
	Reserve Services	0	47	146	232
	High energy commercial and industrial	4	27	30	60
	Domestic and community	0	3	7	18
	Co-location	3	21	29	55
	Energy Trader	0	0	0	0

	Total	**47**	**137**	**252**	**470**

Baseline

There are 11 electricity storage projects connected to the distribution network in the licence area, totalling 47 MW. Two of these are projects are 20 MW, operating under the response services business model. The remaining baseline projects are all 2 MW or smaller, operating at commercial/industrial sites or co-located with renewable energy generation. All eleven baseline projects have come online since 2015.

Figure 14-1: Connected and pipeline electricity storage in the West Midlands licence area



Pipeline

There are 32 projects, totalling 602 MW, which have accepted a connection offer but not yet connected in the licence area. 546 MW of this pipeline comes from 12 larger projects, ranging from 24 MW to 100 MW capacity. Five of these projects are sized to fall just below Nationally Significant Infrastructure Projects (NSIP) regime threshold of 50 MW. A 100 MW accepted connection located at Ocker Hill has secured planning approval, but under two 40 MW developments.

Response and reserve service business models dominate the pipeline, totalling 215 MW and 292 MW of potential capacity respectively. This represents a marked acceleration from the baseline position, particularly in Reserve Services, where the baseline is currently at zero. Details of the larger pipeline sites (i.e. >20 MW) are summarised in Table 14-2.

Table 14-2: Pipeline electricity storage projects above 20 MW in the WPD West Midlands licence area

Pipeline project location	Business model	Capacity (MW)
Ocker Hill, Howard Street, West Bromwich	Response services	100
The Pensnett Estate, Kingswinford	Reserve services	49.9
Land north Of Langley Road, Wolverhampton	Reserve services	49.9
Kitts Green Lane, Berkeley	Response services	49.9
Clay Hill Pit, Dormington, Hereford	Reserve services	49
Knighton Lane, Alcester	Response services	48
Bloxwich Industrial Estate, Walsall	Reserve services	41.3
Whitehouse Farm, Rhydd Road, Guarlford	Reserve services	40
Land off Kingston Road, Gloucestershire	Co-location	36
Gloucestershire Science & Tech Park, Berkeley	Response services	30
Land off Perseverance Road, Hereford	Reserve services	28
Ebley Road, Stonehouse	Response services	24

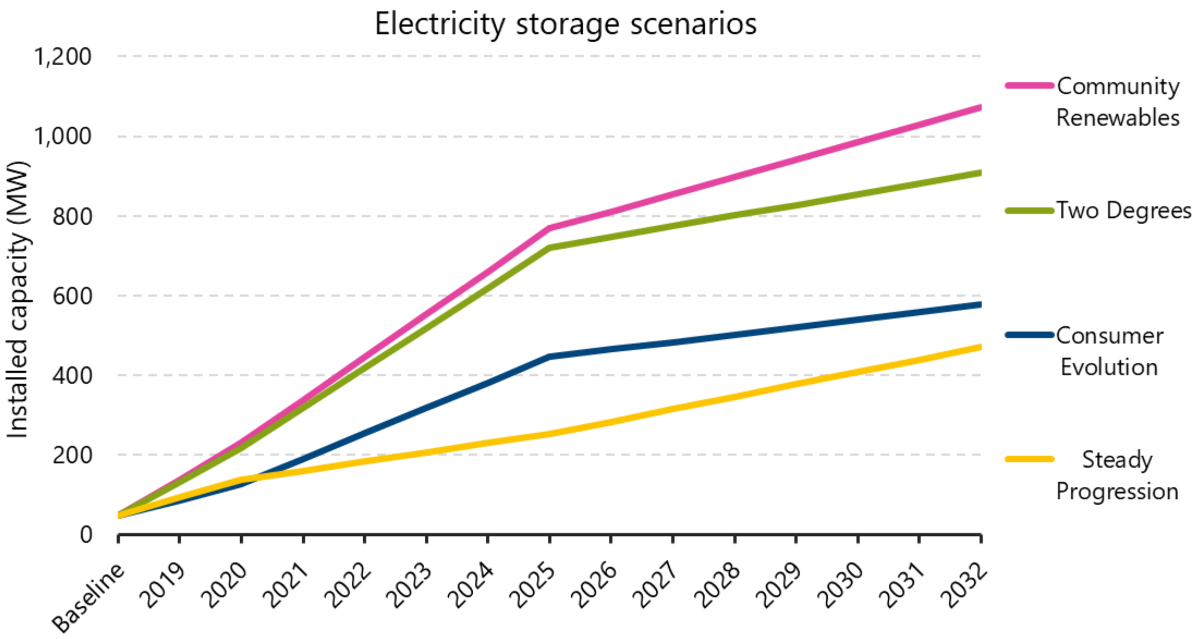
Three of the sites in the near-term pipeline have already connected in 2019, at time of writing so are included in all scenarios. The remaining pipeline projects were then assessed under the following three areas:

- Activity in the CM (registration, pre-qualification and Capacity Agreements)
- Planning application activity (permission granted, declined or withdrawn)
- Desk-based online research of projects and developers (map locations, news articles etc.)

Using this information, each project is assessed in terms of likely connection date and export capacity under the environments of each of the four FES scenarios. Projects with CM Capacity Agreements are assumed to come online in line with their T-4 or T-1 delivery year in every scenario. Projects with strong evidence of development, such as auction bids and planning permission, are seen as likely to go ahead sooner and again in all scenarios. Conversely, projects with limited evidence of development are more uncertain, and are projected to go ahead later, or not all, in the less decarbonised scenarios. Sites with negative activity, (e.g. rejected in the CM or planning refusal) or with no evidence of development beyond an accepted export capacity, are not projected to connect in any scenario.

Electricity storage scenarios

Figure 14-2: WPD West Midlands licence area electricity storage growth scenarios



Scenario summary

The capacity of electricity storage increases significantly in all scenarios, but the highest increase is in Community Renewables and Two Degrees, as increased levels of energy flexibility are needed to provide responsiveness and balancing in a high renewables electricity system, as shown in Figure 14-2.

Relationship to other scenarios

There are now 11 operational storage sites totalling almost 50 MW, compared to a single 3 MW site in the first West Midlands study completed two years ago. The potential for an increase in storage capacity is in line with, and in some areas moderately higher, in all scenarios.

When comparing the outcomes with the FES 2019 regional projections, our assessment of the pipeline sites sees deployment happening in later years than the FES suggests. This is due to market and regulatory uncertainties. Out to 2032 our modelling suggests notably higher overall storage capacity under greener scenarios. This is due to a significant pipeline of Response and Reserve storage projects, coupled with a potential for growth in other business models. Further differences in the 2018 baseline can be seen at an individual GSP level.

Distribution across ESAs

The capacity in the scenarios (except for the pipeline projects) have been distributed according to the following factors.

Table 14-3: Distribution factors for the storage operating models

Storage Business Model	Distribution Factors
Reserve Services, Response Services and Energy Trader	These are distributed by the available land within proximity to 33 kV overhead network lines.
Commercial and industrial	High energy usage industrial and commercial property locations.
Domestic and community	Domestic properties with solar PV, including scenario projections
Generation co-location	Projections for ground-mounted solar PV and onshore wind.