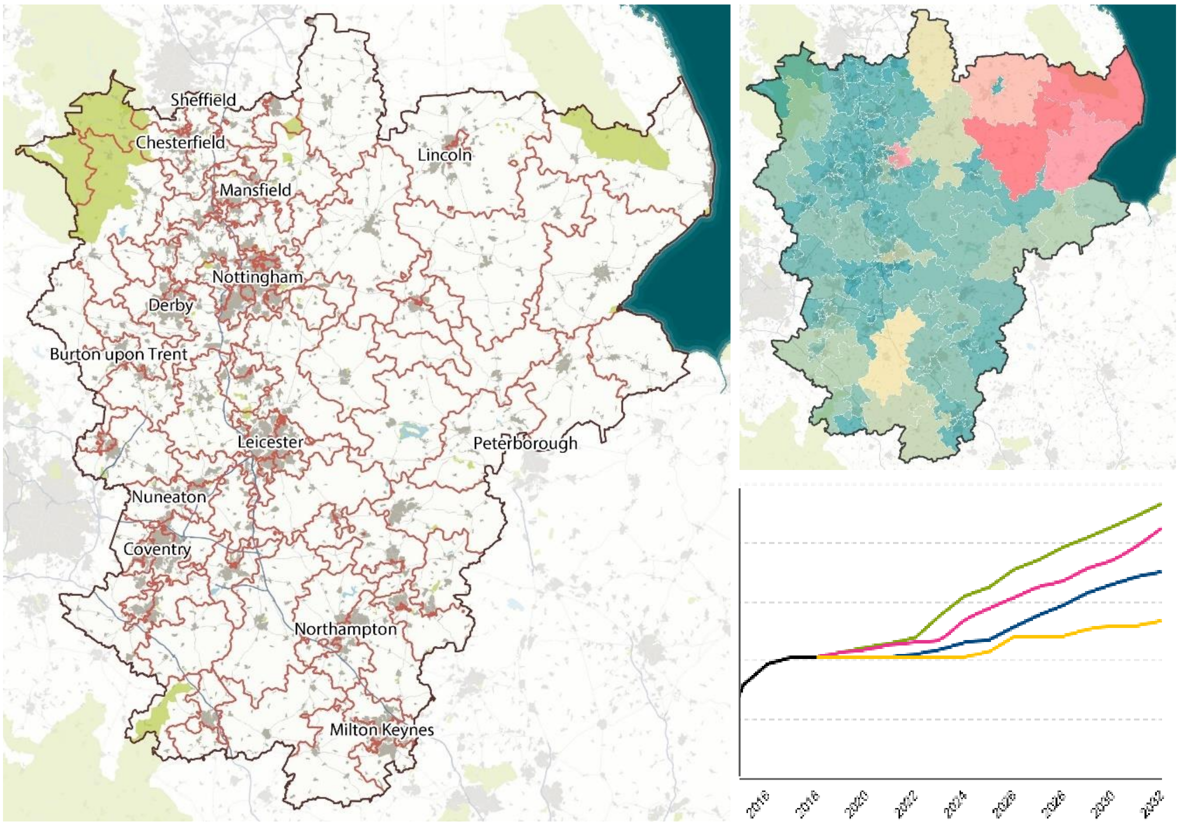
Distributed generation and demand study

Technology growth scenarios to 2032



East Midlands licence area

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Acronym	Definition
AD	Anaerobic Digestion
ANYC	Accepted-not-yet-connected
ASHP	Air Source Heat Pump
ATT	Advance Thermal Treatment
BEIS	Department for Business Energy and Industrial Strategy
CCC	Committee on Climate Change
CfD	Contract for Difference
CHP	Combined Heat and Power
DNO	Distribution Network Operator
DNS	Developments of National Significance
DSR	Demand Side Response
DSO	Distribution System Operator
Duos	Distribution Use of System
EFR	Enhanced Frequency Response
EfW	Energy from Waste
ERF	Energy Recovery Facility
ESA	Electricity Supply Area
EPC	Energy Performance Certificate
EV	Electric Vehicle
FES	Future Energy Scenarios
FFR	Firm Frequency Response
FIT	Feed in Tariff
GIS	Geographic Information System
Ha	Hectares
kW(h)	Kilowatt (hour)
LCOE	Levelised cost of electricity
LDP	Local Development Plan
MW	Megawatt
PEV	Pure Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PPA	Power Purchase Agreement
PV	Photovoltaics
REPD	Renewable Energy Planning Database
RHI	Renewable Heat Incentive
RO	Renewables Obligation
RTFO	Renewable Transport Fuel Obligation
STOR	Short Term Operating Reserve
SSA	Strategic Search Areas for onshore wind
ULEV	Ultra-Low Emission Vehicle
WPD	Western Power Distribution

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Introduction

This report is the second future electricity demand and generation scenario report for Western Power Distribution's (WPD's) East Midlands licence area. The report sets out scenarios for how much generation and battery storage might be connected to WPD's network by 2032 and for the growth of technologies that could have significant impacts on electricity demand.

There has been rapid growth in distributed generation across the UK in the past decade. This growth has already caused network constraints in the licence area (see Figure 0-1). Further technological changes including battery storage, smart technologies and electric vehicles are widely expected to change how electricity networks are used.

The East Midlands licence area is characterised by two halves. There is a high population corridor to the west along the M1 through Leicester, Milton Keynes and Nottingham. The east of the area in comparison is sparsely populated agricultural land. On the coast there are popular seaside resorts such as Skegness.

The densely populated west corridor is likely to see high levels of electric vehicles and rooftop solar PV. The agricultural areas could see further increase in anaerobic digestion and biomass generation along with potential for further onshore wind. Ground-mounted solar could be developed further on lower grade agricultural land to the north and south of the licence area.

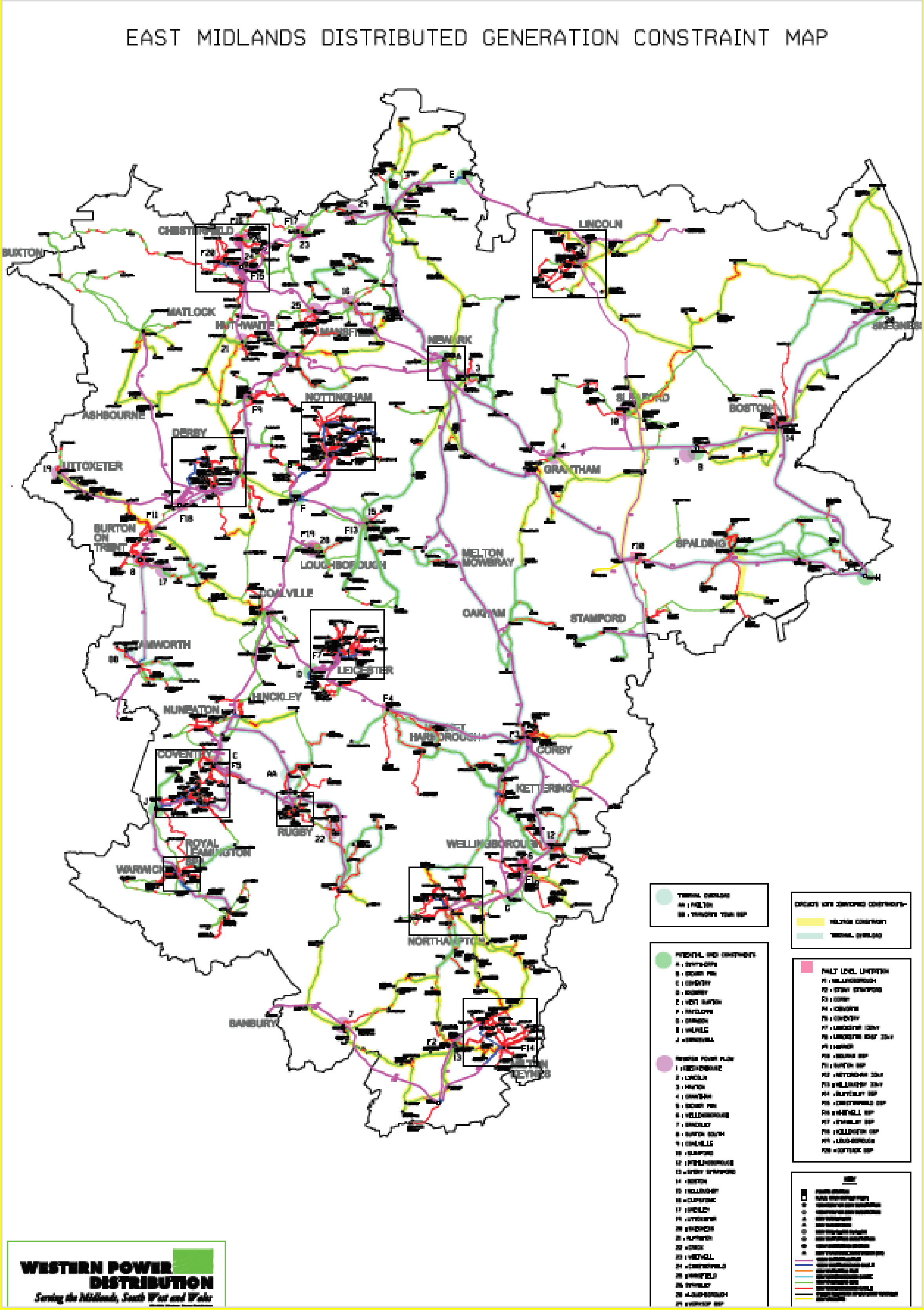
Regulatory developments

In response to the growth of decentralised generation, and the need to actively manage the electricity distribution system, Department for Business Energy and Industrial Strategy (BEIS) and Ofgem have set out a goal for Distribution Network Operators (DNO) to become Distribution System Operators (DSOs) and to actively manage capacity and usage on their networks. WPD published the latest version of their DSO strategy in December 2017 and their latest forward plan for DSO transition in August 2018.[1]

Ofgem are also running two Significant Code Reviews (SCR) on the future of network charging, looking at how transmission and distribution networks should be used and paid for in the future. This is to ensure that existing network capacity is used efficiently and that networks receive appropriate value signals to fund network upgrades when needed. The changes suggested as part of the SCRs are likely to mean significant changes to the cost of new connections to the grid and use of system charges leading to significant uncertainty for future projects. [2]

[1] https://www.westernpower.co.uk/About-us/Our-Business/Our-network/Strategic-network-investment/DSO-Strategy.aspx
[2] See Charging Futures Forum: https://www.ofgem.gov.uk/publications-and-updates/charging-futures-forum

Figure 0-1: East Midlands licence area distribution network constraints[3]



Strategic network reinforcement

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

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

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

This report is part of the process to develop investment options and responds to Ofgem request for "enhanced forecasting and planning" from DNOs[4]. It provides scenarios, at Electricity Supply Area (ESA) level, for the potential growth of distributed generation, electricity demand and electricity storage in the East Midlands licence area.

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

Table 0-1: Strategic investment methodology

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

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

Report methodology

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

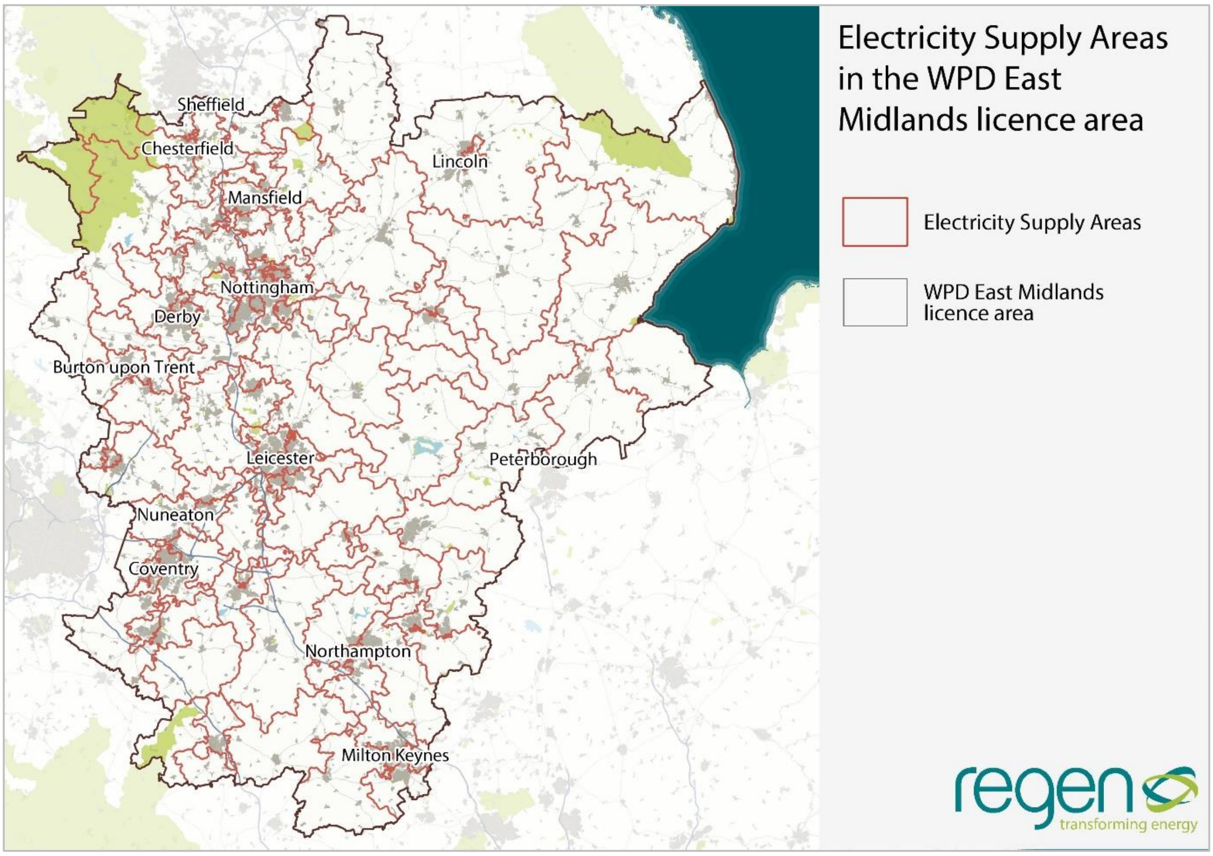
This report accompanies a dataset that WPD uses for network planning and records the key market insights, assumptions and methodologies used in the scenario process.

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

Electricity Supply Areas (ESAs)

The information is presented to WPD as a dataset by each of the 125 ESAs in the licence area (see Figure 0-2). ESAs are defined as geographic areas served by the same upstream network infrastructure. Regen and WPD have created these by mapping data on individual substations and the upstream network points using Geographic Information System (GIS) software.

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



Scenario process

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

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

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

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

Stage 4 - A scenario projection to 2032. The scenarios are based on National Grid's Future Energy Scenarios (FES) 2018 and interpreted for specific local resources, constraints and market conditions. The findings from a local consultation event along with interviews with developers, investors and analysis of current market reports is used. In addition to using Regen's existing analysis and knowledge.

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

Future Energy Scenarios 2018

This assessment used the Future Energy Scenarios[5] 2018 developed by the National Grid as a starting point.

This FES framework aligns future scenarios to two key axes: speed of decarbonisation and level of decentralisation. Two scenario pathways meet the UK's 2050 emissions reduction target of 80% by 2050.

Along with the FES 2018 growth pathways the Regen study used specific local attributes, characteristics, 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 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.

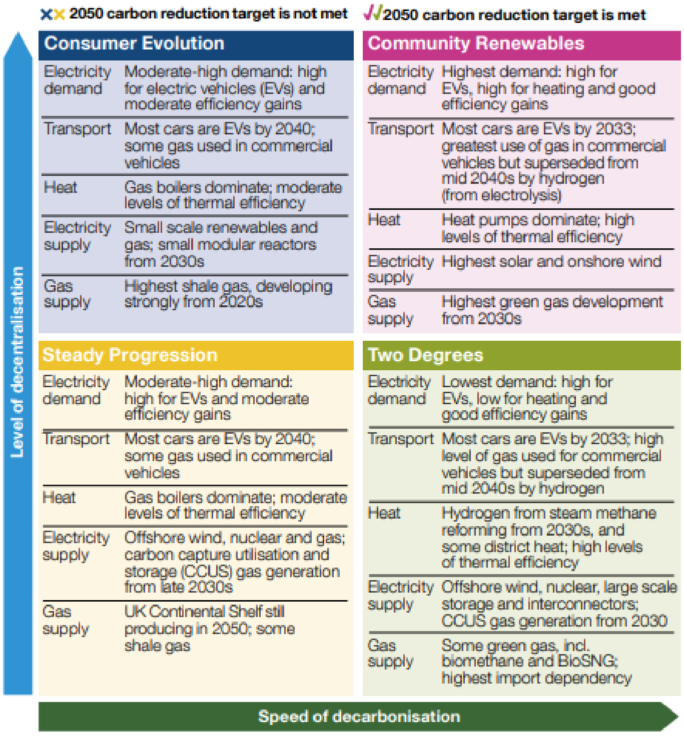


Figure 0-3: National Grid's Future Energy Scenarios Framework.

The four scenarios in summary are:

- **Two Degrees** explores how the decarbonisation target can be achieved with a focus on larger and more centralised technologies. This scenario features changes to the energy landscape such as hydrogen heating networks and large-scale transmission connected generation technologies such as nuclear and 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.
- **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 generation continuing to play a significant role.

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

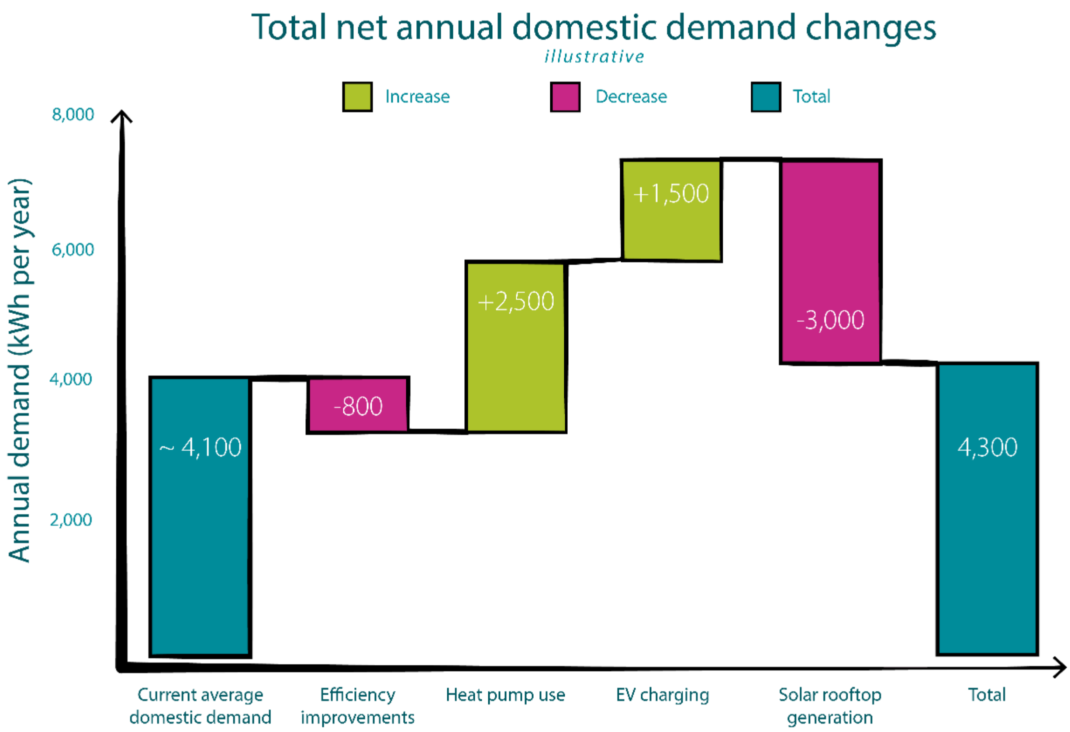
A. Introduction to disruptive demand technologies

Factors disrupting electricity demand

Despite the recent UK trend of decreasing electricity demand from households and businesses year-on-year[6], FES 2018 predicts that demand will start to increase again over the medium and longer term due to more new housing and commercial developments along with the increasing electrification of heat, cooling and transport.

Figure A-1 shows the potential increases from both an EV and an electric heat pump in the annual consumption of a typical household. If the house is suitable for rooftop solar PV, this could provide a significant proportion of the annual electricity use. However, the majority of this will be generated during the summer months only.

Figure A-1: Illustrative impact of new technologies at a household level between 2018 and 2032



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

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

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

Demand scenario summary

Although each technology has particular drivers and barriers, the most important factors that will determine the level of deployment for heat pumps, EVs and batteries 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 including subsidies and where they might be focused.
- **Building regulations:** New build or other regulations around 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 paid for flexibility services to the network.

Although 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 electric vehicles. The result of these uncertainties means that there are large differences in the highest and lowest scenarios for the technologies covered in this section

Table A-1 presents the findings for the level of growth of disruptive demand technologies in the East Midlands licence area under the four scenarios. In the Community Renewables scenario electric vehicles could account for over 40% of vehicles in 2032 with heat pumps in 18% of properties. In Steady Progression these numbers are 12% and 2% respectively.

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

	Electric vehicles (% of all cars)	Heat pumps (% dwellings)	Air conditioning (% dwellings)
Two Degrees	56.7%	10.8%	1.5%
Community Renewables	41.7%	17.8%	3.1%
Consumer Evolution	11.4%	4.7%	5.9%
Steady Progression	11.7%	2.1%	5.9%

1. Electric vehicles

WPD East Midlands licence area has 8.4% of GB households. Currently the area has above average numbers of electric vehicles registered (10.2% of GB total). The total annual mileage driven in the licence area is 10.3% of the GB total.

There are around 15,000 hybrid and battery electric vehicles (EVs) in the licence area[7]. Government policy, commitment by manufacturers and new investment in charging infrastructure is expected to significantly increase EV usage 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 high vehicle numbers.

Electric vehicle uptake in the East Midlands is ahead of the GB average by around 10%.

1.1. Electric vehicle baseline

Table 1-1 summarises the current baseline of mileage, vehicles registered and type of EV vehicles registered in the licence area. There are over 15,000 EVs registered in the licence area which represents 10.2% of the total EVs registered in GB[8].

Table 1-1: Baseline of vehicles and electric vehicles registered in the East Midlands licence area

Proportion of vehicles in the East Midlands licence area	**All Vehicles**	**Cars**	**LGVs**	**HGVs**	**Buses & Coaches**	**Motor-cycles**
All vehicles in licence area	3,770,605	1,140,616	417,162	3,296	14,215	125,316
% of all GB vehicles in licence area	10.0%	9.9%	10.6%	14.6%	8.8%	9.3%
Electric vehicles in East Midlands	15,895	15,115	537	30	81	131
East Midlands% of GB electric vehicles	10.2%	10.2%	11.2%	7.2%	25.9%	10.3%

[7] Source DfT 2018

[8] 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 2018 vehicle types.

1.2. Electric vehicle growth factors

National and local legislation will be key drivers of future electric vehicle growth in the licence area. The UK government has announced a ban on new petrol and diesel sales in 2040[9]. Derby and Leicester have both raised the potential for congestion charging. [10]

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

Despite the current barriers, the FES 2018 presents a much higher growth projection for electric vehicles than FES 2017, reflecting the UK government's proposed ban on new diesel and petrol vehicles in 2040. The key question is now about the speed of up-take in the short and medium term. Regen's recent market insight paper 'Harnessing the EV Revolution' [11]discussed the factors influencing uptake including the level of investment by manufacturers leading to greater model choice and lower costs.

The two highest scenarios in FES 2018 (Two Degrees and Community Renewables) show a similar growth profile, with the UK electric car fleet reaching around 15 million units[12] by 2032 rising to over 38 million by 2038. To provide a wider profile for network analysis in this study Regen have amended the Two Degrees scenario to show a more explosive growth profile which sees growth accelerating ahead of the FES 2018 and then levelling by 2050.

Regen's EV growth model also assumes that EV uptake in the licence area stays ahead of the national average uptake of EVs in the short and medium term but will return 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 emission reduction initiatives in and around urban centres[13].

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[9] E.g. UK Government Road to Zero Strategy 2018

[10] https://www.leicestermercury.co.uk/news/uk-world-news/nearby-cities-propose-congestion-charges-1844792

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

[12] Pure Battery EV and Hybrid

[13] For example Derby: https://www.derbytelegraph.co.uk/news/derby-news/how-much-you-could-charged-1842285 and Leicester: https://www.leicestermercury.co.uk/news/leicester-news/congestion-charges-back-agenda-leicester-1255999

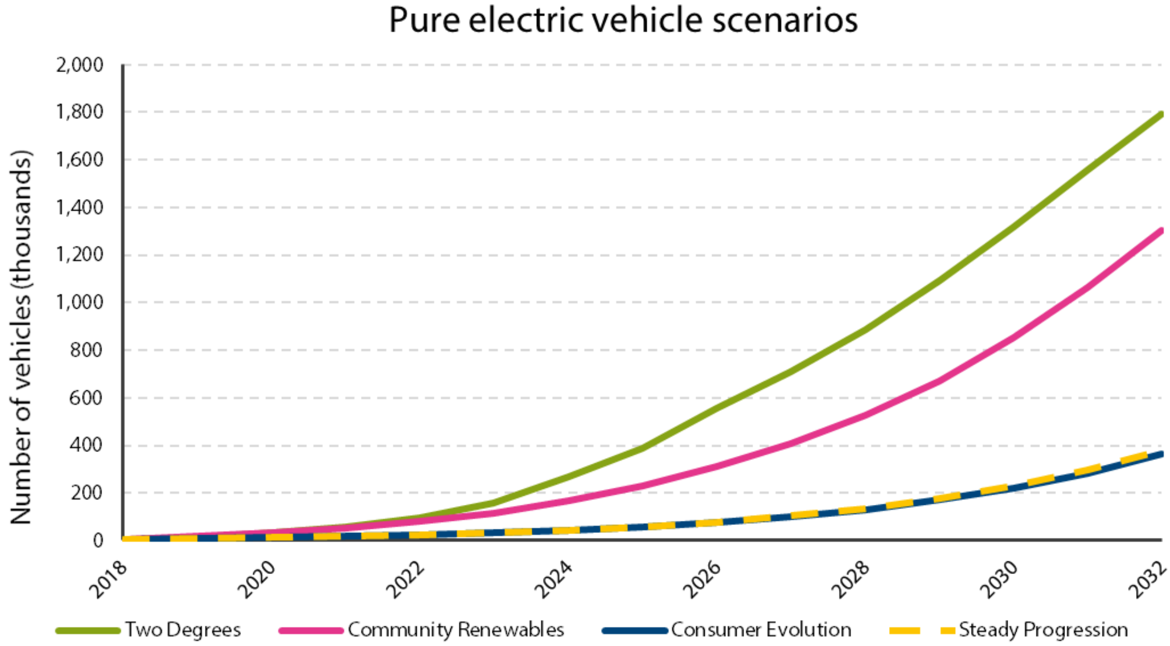
The factors associated influencing electric vehicle deployment in the licence area and how they relate to the scenarios are summarised in Table 1-2.

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

Growth factors	Two Degrees (explosive)	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
Public charging infrastructure provision	Focused on public charging e.g. park and rides	Focus on home and fast charging e.g. petrol stations	Focus on home and fast charging e.g. petrol stations	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 early-2020s	Parity 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				
Manufacturer models and promotion	Model options increase and heavily promoted	Model options increase and heavily promoted	Increased options but remain under promoted	Continue with limited range and low promotion
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
Affluence and economic growth	Capital available to invest in new vehicles	Capital available to invest in new vehicles	Lower economic growth restrains EV demand	Lower economic growth restrains EV demand

1.3. Electric vehicle scenarios

Figure 1-1: WPD East Midlands licence area electric vehicle growth scenarios



Scenario summary

The summary scenario results in Table 1-3 show that, in a high growth scenario, the East Midlands licence area could have over 1.5 million electric vehicles by 2032. The bulk of these would be battery electric vehicles (BEV)[14] with other vehicle types making up a small but potentially significant contribution.

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

EV Growth All Vehicles	Baseline 2018	2020	2025	2032
Two Degrees (explosive growth)	15,895	71,814	582,460	2,138,335
Community Renewables		74,362	351,259	1,572,815
Consumer Evolution		28,231	90,416	430,740
Steady Progression		27,964	90,269	442,903

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

EV Growth by 2032	All Vehicles	Cars (BEV)	LGVs	HGVs	Buses/ Coach	Motor-cycles	Hybrid Cars	Hybrid LGVs
Two Degrees (explosive)	2,138,335	1,794,466	24,317	5,664	1,221	52,409	257,642	2,616
Community Renewables	1,572,815	1,302,862	17,369	4,053	874	37,435	208,238	1,985
Consumer Evolution	430,740	364,229	5,558	1,002	414	18,007	40,584	946
Steady Progression	442,903	378,560	5,558	1,002	429	18,007	38,401	946

[14] The proportion of hybrid vehicles, which is currently very high, is expected to fall significantly as consumers adopt pure electric, hybrid incentives are removed and emission controls are increased

Relationship to other scenarios

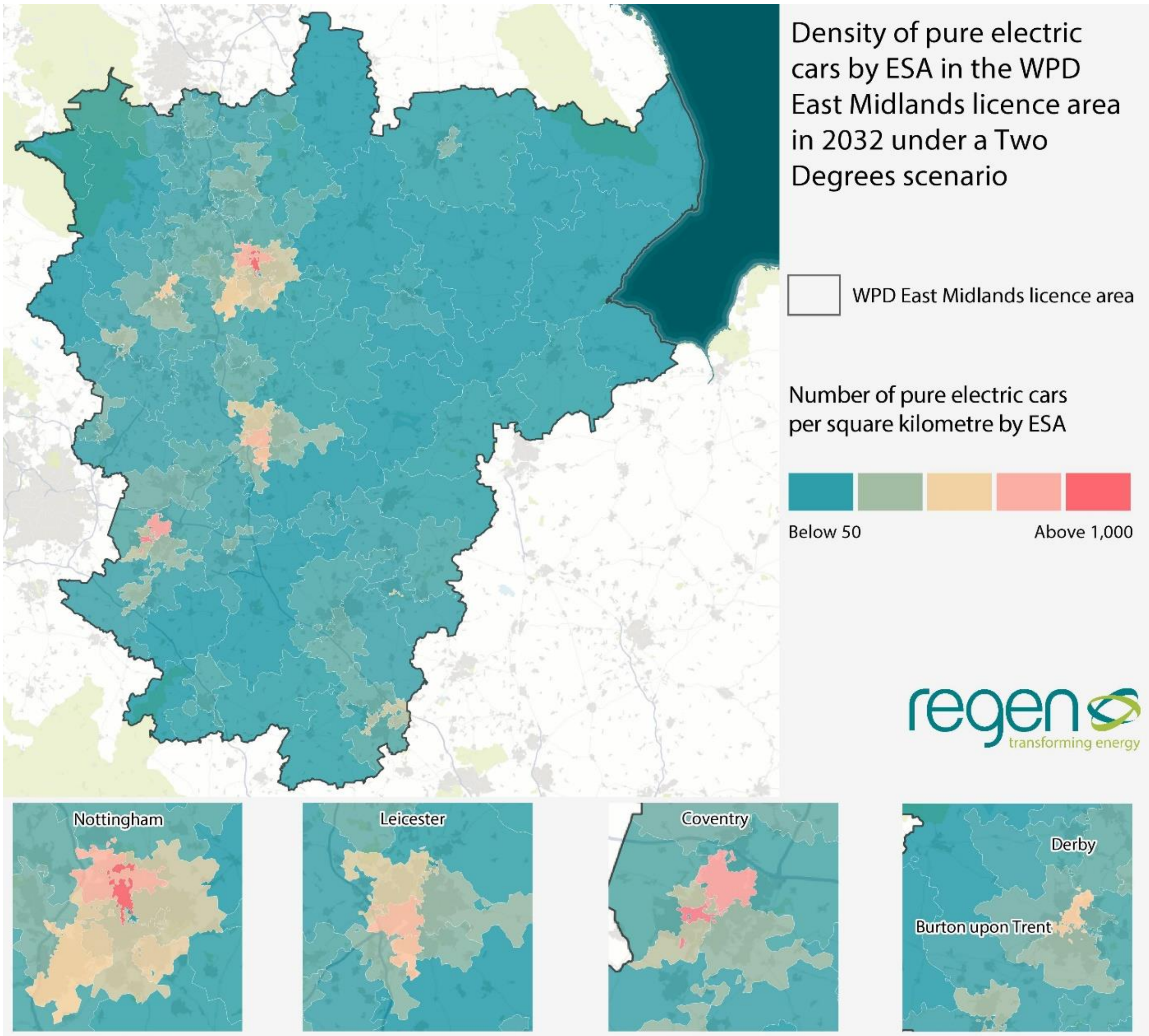
The scenarios, except for Two Degrees, have been developed based on the FES 2018 projections in regards to the magnitude of growth and vehicle type. The Two Degrees projection has modelled a more explosive growth profile, with faster take up in the 2020s. The national figures have been adjusted to reflect the East Midlands existing position which is c. 10% ahead of the rest of the UK. This position reduces over time to meet national average levels of electric vehicles towards the end of the scenario position which reflects other areas 'catching up' with deployment over the next decade.

The highest growth projections in this report are around double the projections in the 2017 report, reflecting the increased policy focus and 2040 ban date 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 overall distribution of electric vehicles 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 development.

Figure 1-2 Electric vehicle density



2. Heat pumps

East Midlands has around 8,680 heat pumps currently registered under Renewable Heat Incentive (RHI) producing in total around 87MWth.

Higher subsidies and UK government focus on decarbonising heating in 2020s means there is likely to be an increase in heat pumps under all scenarios in the analysis period.

Table 2-1: Total number of properties with heat pump by scenario

Total domestic properties with a heat pump	2018	2020	2025	2032
Two Degrees	8,680	16,441	84,964	301,143
Community Renewables		19,232	132,097	497,973
Consumer Evolution		12,567	31,335	129,763
Steady Progression		12,845	25,270	58,255

2.1. Baseline

The East Midlands licence area is estimated to have had around 8,700 heat pumps installed by the end of 2018, equivalent to c. 0.33% of houses. Figure 2-1 shows how the deployment rate has been slowing increasing over time with 2017 and 2018 the highest years for installations in East Midlands licence area since the RHI started.

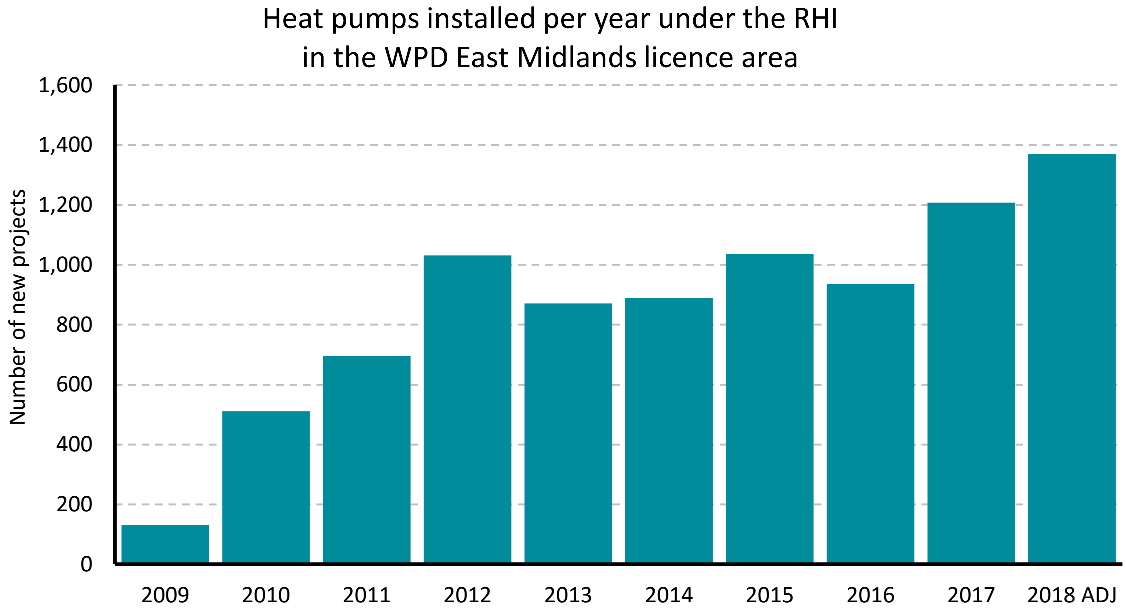
This increase is likely to be as a result of the higher RHI tariffs which were introduced in September 2017 and run to April 2021. These included around a 30% increase for air source heat pumps and a marginal increase for ground source systems.

The new tariffs also introduced a 'heat demand limit' which prevents large domestic properties with a very high energy use claiming a disproportionately large amount of the RHI budget.

It is possible that more heat pumps may have been installed in new homes built by developers. Heat pumps in new build properties are not able to access the RHI and, therefore, are not currently recorded in government data or covered in this analysis. Figures from The Building Services Research and Information Association[15] suggest that 22,000 heat pumps both commercial and domestic were sold in 2017 compared to under 7,000 total domestic RHI accreditations. The scenarios do not currently project commercial heat pumps as this market is expected to continue to be small.

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

Figure 2-1: Accreditations under RHI scheme 2009-2018 (GB data BEIS June 2018)[16]



**Data up to date June 2018, 2018 is adjusted for the full12 months*

2.2. Pipeline

There is no data on the pipeline of heat pumps, as a result the scenarios start in 2019.

2.3. Heat pump growth factors

The scenarios break down the heat pumps into three categories, retrofit on-gas, retrofit off-gas and new build as well as into two types of heat pump, electric and gas back up (hybrid systems). A summary of the assumptions is outlined below.

Table 2-2: Number of properties and predicted type of heat pumps under a Community Renewables scenario

Types of property	Number of properties	% with a heat pump in 2032	Type of heat pumps assumed in the model
On-gas existing	2,187,182	15%	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 back-up.
Off-gas existing	259,029	37%	Assumes that 100% are single heat pump systems with higher proportion of larger ground-source heat pumps due to space available. A proportion by 2032 may also be hybrid systems with oil back-up.
New build properties	354,533 (high growth)	70%	The building standards of new homes mean that it is assumed 80% are likely to be single system Air Source Heat Pumps with 20% as hybrid systems.

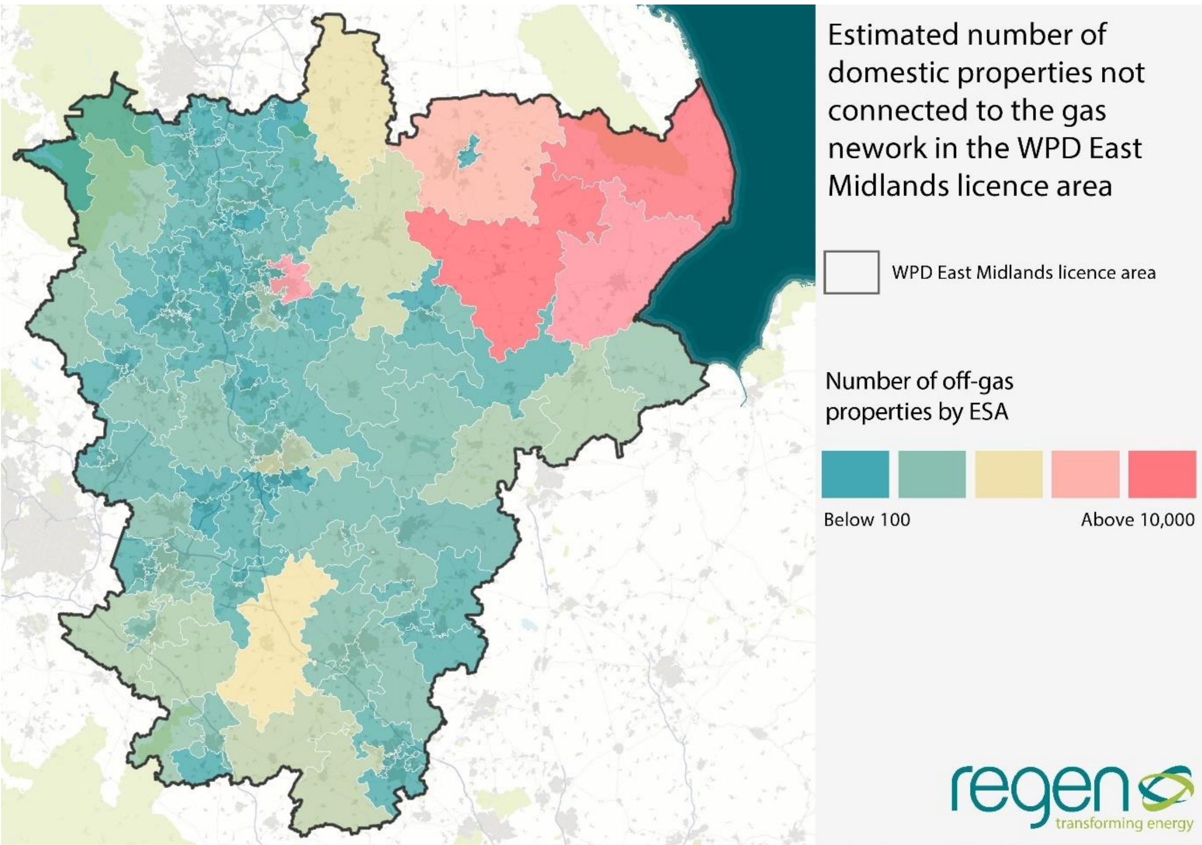
[16] 2018 adjusted for a full year estimate from six monthly BEIS statistic

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

The installation rate of heat pumps remains very uncertain with deployment rates continuing to fall far short of government aspirations. Heat pumps have higher upfront costs than conventional heating systems. These can be from £7,000 to £12,000 depending on the size and technology[17], but the key barrier is the cost of retrofitting properties to enable a ground or air source heat pump to work efficiently. This includes adding new large radiators or underfloor heating, as well as upgrading to higher insulation standards.

As a result, new regulation and policies will be key to driving growth. The National Infrastructure Assessment calls for the government to "establish an up to date evidence base on the performance of heat pumps within the UK building stock and the scope for future reductions in the cost of installation" by 2021[18]. The UK government's Clean Growth Strategy 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) during the 2020s*"[19]. A 'Call for Evidence' reaffirmed these ambitions in March 2018 and noted that action would be taking place during the 2020s[20].

Figure 2-2 The distribution of off-gas homes



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[17] Renewable Energy Hub (2018) https://www.renewableenergyhub.co.uk/heat-pumps-information/heat-pumps-cost-and-savings.html

[18] National Infrastructure Commission (2018) *National Infrastructure Assessment* https://www.nic.org.uk/assessment/national-infrastructure-assessment/low-cost-low-carbon/

[19] P.79, Clean Growth Strategy, (2017) https://www.gov.uk/government/publications/clean-growth-strategy

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

Hybrid heat pumps for retrofit and 'hard to treat' on-gas properties

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

A study into the potential of heat pumps for BEIS by Element Energy[21] found that the carbon savings achieved could be significant but depended on well-managed and well-sized systems for the housing they served. The study found savings as high as 55% of annual carbon emissions. However, in poorly managed systems this dropped to 18%. The report identified the cost compared with traditional boilers as the key barrier for both single and hybrid heat systems but concluded that for "typical existing buildings, hybrid heat pumps offer substantially more cost-effective heat decarbonisation option than standard heat pumps." For thermally efficient buildings, those that have been extensively retrofitted, or new builds, then a single heat pump system remains the most cost effective.

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

A further benefit not costed in the BEIS study is the impact of high levels of electric heating installed on a local distribution network. High numbers of heat pumps with electrical back up could cause a significant network stress during winter peaks. Hybrid systems would significantly lessen this impact if smart systems could revert to back-up systems during peaks. The concept is being explored by the Wales and West Utilities and Western Power Distribution Freedom Project[22].

New build regulations

In 2018, changes were announced to the Standard Assessment Procedure (SAP) regulations, including lowering the carbon emissions factor for electricity by 55%, reflecting the decarbonisation of the UK's electricity supply. Heat pumps will now only need a coefficient of performance (COP) of 1.1 to have carbon emissions lower than a gas boiler, according to CIBSE[23]. This suggests that heat pumps are more likely to become the technology of choice to meet local and national regulations on the decarbonisation of new developments. SAP 10 will come into effect when national building regulations are updated, which is likely to be either in 2019 or 2020.

Local authorities can currently set higher than national requirements to reduce carbon emissions from new developments. For example, the Greater London Authority has a zero carbon homes policy that requires all major new residential developments to achieve a 100% reduction in CO_2 emissions. A recent report by Etude examined the role for heat pumps in decarbonising heat supply in London, finding significant potential for widespread roll-out[24].

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

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

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

23 CIBSE (2018) https://www.cibsejournal.com/general/sap-in-building-regulations/

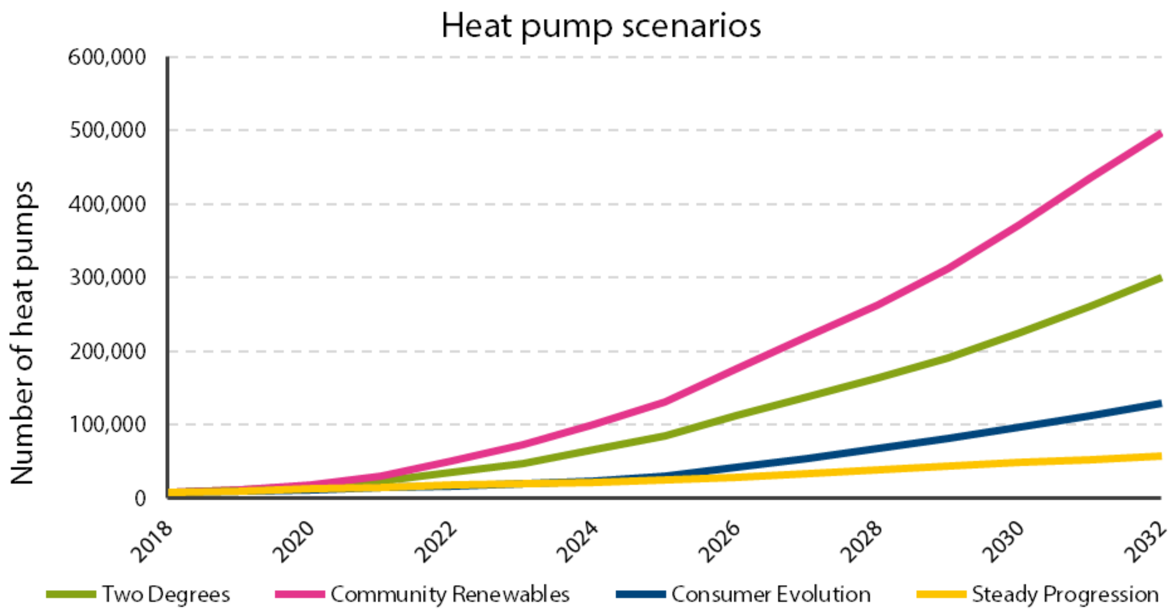
24 Etude (2018) *Low Carbon Heat: Heat Pumps in London* https://www.london.gov.uk/sites/default/files/low_carbon_heat_-_heat_pumps_in_london_.pdf

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 replacement boilers in **off-gas properties**	Introduced in early 2020s	Introduced in early 2020s	Introduced later in 2020s	None in scenario period
Regulations/incentives encouraging heat pumps for replacement boilers 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 development**	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 mid-2020s policy leads to widespread use of heat pumps in new builds	Policies don't encourage widespread uptake of heat pumps in new developments
Subsidy for installations	No subsidies	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 mid-2020s	Come online 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

2.4. Heat pump scenarios

Figure 2-3: WPD East Midlands licence area heat pump growth scenarios.



Scenario summary

The highest growth scenario, Community Renewables, sees growth in heat pumps accelerating from the mid-2020s in both on and off-gas homes. In Two Degrees the increase is lower and is focussed on off-gas homes as a result of a government policy drive. In Steady Progression the scenario sees a continuation of the current low trend.

Relationship to other scenarios

The expected level of heat pump installations has been increased significantly from the scenario projections in the 2016 East Midlands scenarios report due to the government's Clean Growth Strategy plan on phasing out high carbon heating for off-gas grid properties in 2020s and development of hybrid heat pumps. The results align with the FES 2018 projections.

Distribution by ESA

The scenarios project heat pump installation growth separately for new home developments, on-gas and off-gas properties. The geographic distribution is based on the total number of homes in an ESA, as well as the number of properties which are not connected to the gas grid and the numbers of new houses expected in each ESA. In the near term there is a weighting towards the current baseline, though this weighting reduces over time in the scenarios with widespread heat pump take up.

3. Air conditioning

Although domestic air conditioning has low uptake at present, higher temperatures due to climate change could drive demand for mechanical cooling, particularly in the west of the licence area which sees large urban centres which are likely to experience 'heat island' impacts. The FES 2018 scenarios suggest this new source of demand could grow significantly towards the end of the scenario period.

Community Renewables could see higher air conditioning than FES 2018 predicts as some of the high level of heat pumps installed could be operated as cooling units.

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

Number of domestic properties with air con unit	2018	2020	2025	2032
Two Degrees	25,307	27,396	32,860	41,124
Community Renewables		28,393	42,061	86,473
Consumer Evolution		33,893	66,440	166,844
Steady Progression		33,893	66,440	166,844

3.1. Baseline

The UK's mild climate means that demand for domestic cooling is currently low. The FES 2018 estimates that air conditioning is currently installed in around 1% of homes.[25] However, as summer peak temperatures rise due to climate change, demand for cooling is expected to increase, particularly in dense urban areas that act as 'heat islands'.

With no data on which to make assumptions currently on the growth of commercial air conditioning, it is not included in the scenario's projections.

3.2. Pipeline

There is no pipeline for air conditioning uptake, scenarios start in 2019.

3.3. Air conditioning growth factors

FES 2017 predicts that temperatures after 2040 could rise to levels that would drive exponential growth of air conditioning in homes with nearly 60% adoption by 2050.[26] The impact of the extra demand would potentially add over 16 GW at peak demand next to a total peak currently around 60 GW[27].

Building standards have traditionally focused on heat retention in buildings, some of which may ultimately increase the need for mechanical cooling and ventilation in the summer. If summer

[25] Assuming one unit per household
[26] http://fes.nationalgrid.com/media/1290/ac-2050-v212.pdf
[27] FES 2018

temperatures rise significantly in the UK, standards would need to be adjusted to encourage passive cooling.

In greener scenarios, particularly Community Renewables, a further driver for use of air conditioning may be the use of heat pumps as summer cooling units[28].

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

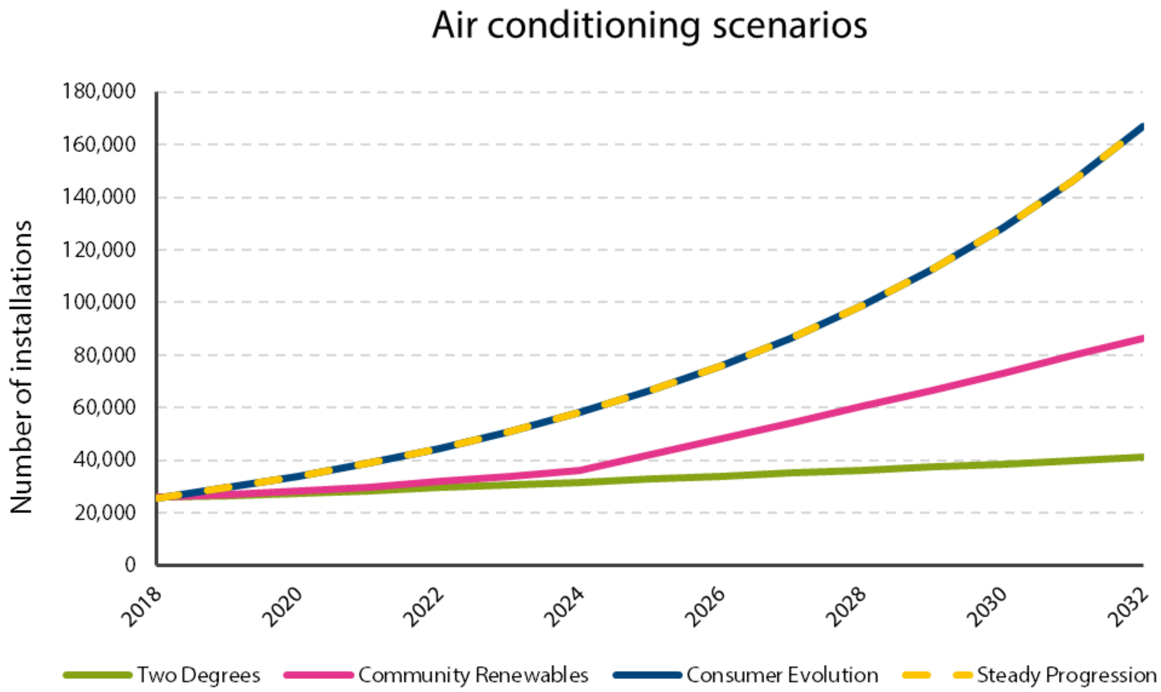
Table 3-2: Assumptions for factors influencing growth in the number of air conditioning units

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 restrains demand	Low economic growth restrains 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

[28] https://www.coolingpost.com/products/daikins-first-heat-pump-hybrid-r32/

3.4. Air conditioning scenarios

Figure 3-1: WPD East Midlands licence area air conditioning growth scenarios.



Scenario summary

Air conditioning take up grows significantly in the two scenarios that do not meet the UK climate commitments. Household uptake increases from just over 1% to around 6% within the scenario period. The greener scenarios are expected to have significantly less heat pumps, Two Degrees remaining static and Community Renewables increasing to around 3% of households.

Relationship to other scenarios

The scenarios for air conditioning are taken from FES 2018 growth scenarios which but are adjusted in the green scenarios to project a low level of growth. This differs from FES which assumes zero growth for both green scenarios. The Community Renewable scenario is higher to reflect the air conditioning relationship with high heat pumps in this scenario. The Two Degrees increases slightly reflecting a level of population growth.

Distribution by ESA

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

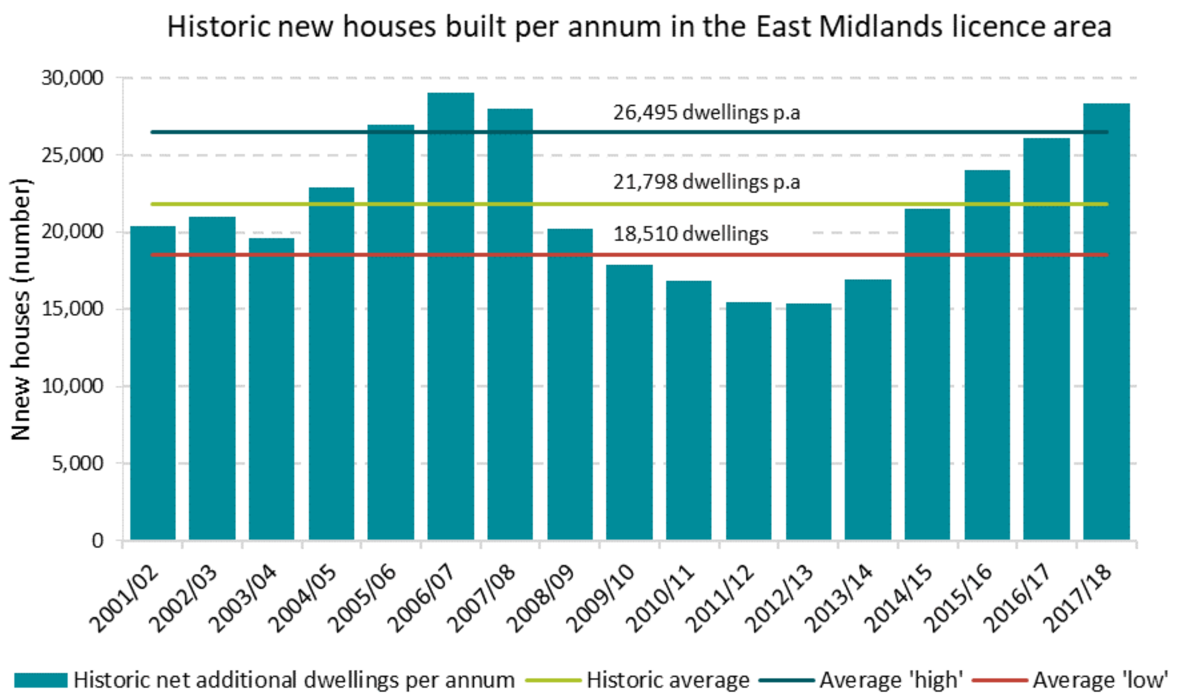
4. New development growth

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

4.1. Baseline

Figure 4-1 shows the numbers of dwellings being completed since 2001 along with the historic average and high and low average figures. The chart illustrates that the total numbers of new build houses in East Midlands licence area have increased since 2013/4.

Figure 4-1: Annual totals for new houses in the East Midlands licence area, 2010-2018[29]



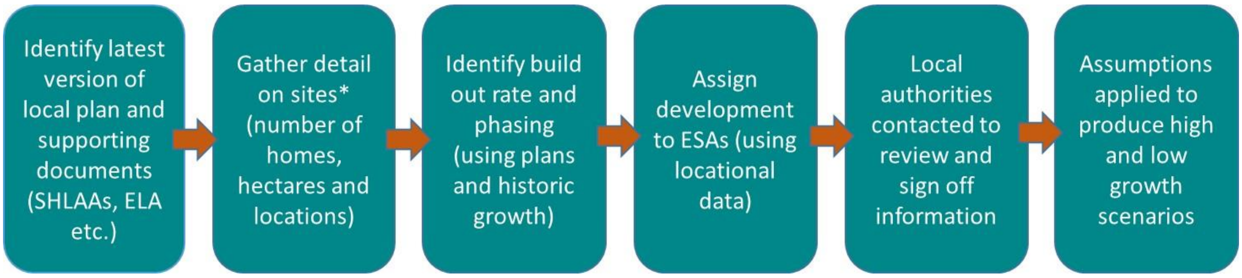
4.2. Methodology

New development sites can have a significant impact on local electricity demand. To understand what sites are expected within the licence area and to produce growth scenarios, the plans from 57 local authorities which are either fully or partly within WPDs East Midlands licence area, were reviewed to collect data on location, size and type of planned future developments.

The methodology for this analysis is set out in Figure 4-2. The information collected is reviewed with local authorities to ensure information is up-to-date and local insight is captured.

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

Figure 4-2: Summary of data collection methodology for residential and non-residential sites



Data sources

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

In the majority of cases additional supporting documents were used to collect the details of sites such as the Five-Year Housing Land Supply and Annual Monitoring Reports which are often updated more regularly than the Local Plans.

Types of development - Development sites

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

- **Strategic sites:** These are highlighted in local plans as areas of development with significant growth potential. Each site is given a specific location within the policies map. There is no established single definition for what constitutes a strategic site; however, generally these are large developments, either housing led or mixed-use regeneration projects. Where sites are not classified, developments of over 100 homes are assumed to be strategic.

- **General allocation sites:** These cover additional housing or non-residential developments that will be built outside of the strategic sites. These developments tend to be smaller sites without specific policies in the Local Plan.

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

Information gathered about development sites

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

- An estimate of the number of residential units to be built.
- The site area and floorspace (m^2) of non-residential property to be built.
- Any indication of phasing, amount of property to be built per year etc.

- The site's location and the relevant ESA/ESAs it would connect to.
- Status of the local plan.
- The category of planned end-use for non-residential sites/areas of sites. The non-residential categories provided by WPD are listed in Table 4-1 and cover 15 different electricity profiles.

Table 4-1: Non-domestic profile categories

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

Review with local authorities

To ensure the most up to date information on future developments, data collected was sent to planning and economic development officers in the 57 local authorities for review and comment. Of these local authorities, 40 (70%) signed off the data used in this report.

A stakeholder engagement event was also held in Nottingham in December 2018 and all local authorities were invited. This allowed local authorities to feedback any further information on the process.

4.3. New development growth factors

Economic growth - high and low growth scenarios

The key factor affecting the growth rate of new developments is the economic environment. The level of green ambition will have little relevance to the number of developments – although it may change the energy demand of a property (the demand profile of housing and non-domestic properties is outside the scope of this report).

In domestic developments Community Renewables and Two Degrees are considered as one scenario that assumes high growth rates due to a better economic environment and Consumer Evolution and Steady Progression as a second scenario with a lower growth rate. In commercial developments there is a high, low and ultra-low growth scenarios to reflect historic growth rates in the licence area.

As illustrated in Figure 4-3, the local authority planned rates are somewhat high than the average build rates for the licence area. Assumptions have been used to reduce the planned rates in order to be more consistent with historic averages.

Details of assumptions made to produce these scenario profiles are below.

Domestic sites

- **Strategic sites:** it is assumed that the vast majority of strategic sites go ahead but are more likely to suffer delays or cancellation in low growth scenarios due to the poorer economic environment. Table 4-2 shows the assumptions that have been made to delay a proportion of the development between one and nine years.

Table 4-2: Details of assumptions made in development of strategic housing sites in the high and low growth scenarios

Year	Assumptions for high growth scenarios	Assumptions for low growth scenarios
First two years (2018-2019)	100% of planned strategic development goes ahead, as the majority of sites are already under construction.	95% of planned strategic development goes ahead, as the majority of sites are already under construction.
Years three to five (2020-2022)	80% of planned strategic sites are built on-schedule, with the remainder delayed by up to five years.	65% of planning strategic sites are built on-schedule, with 20% delayed by up to five years and 15% not going forward.
Years six to nine (2023-2026)	80% of planning strategic sites are built on-schedule, with the remainder delayed by up to eight years.	55% of planning strategic sites are built on-schedule, with 30% delayed by up to ten years and 15% not going forward.
Year ten and beyond (2027-)	75% of planning strategic sites are built on-schedule, with the remainder delayed by up to five years.	55% of planning strategic sites are built on-schedule, with 30%

		delayed by up to five years and 15% not going forward.

- **General allocation:** the planned target figure has been multiplied by 64% for both high and low growth scenarios, based upon previous build out rate of planned housing.

- **Unallocated houses:** as with general allocation, the planned target figure has been multiplied by 64% for high and low growth.

Non-domestic sites

- **Strategic sites:** it is assumed that the vast majority of strategic, non-domestic sites go ahead, but are more likely to suffer delays in low growth scenarios due to the poorer economic environment. Table 4-3 shows the assumptions that have been made to delay a proportion of the development between one and nine years.

Table 4-3: Details of assumptions made in development of strategic non-domestic sites in the high and low growth scenarios

Year	Description of reductions - high growth	Description of reductions - low growth	Description of reductions – Ultra low growth
First year (2018)	95% of planned strategic development is goes ahead, as the majority of sites are already under construction, with 5% not going forward.	90% of planned strategic development goes ahead, as the majority of sites are already under construction, with 10% not going forward.	82.5% of planned strategic development goes ahead, as the majority of sites are already under construction, with 17.5% not going forward.
Years two to four (2019-2021)	75% of planning strategic sites are built on-schedule, with 20% delayed by up to five years and 5% not going forward:	60% of planning strategic sites are built on-schedule, with 20% delayed by up to five years and 20% not going forward:	50% of planning strategic sites are built on-schedule, with 15% delayed by up to five years and 35% not going forward:
Year five and beyond (2022-)	60% of planning strategic sites are built on-schedule, with 35% delayed by up to five years and 5% not going forward:	45% of planning strategic sites are built on-schedule, with 35% delayed by up to five years and 20% not going forward:	40% of planning strategic sites are built on-schedule, with 25% delayed by up to five years and 35% not going forward.

- **General allocation and unallocated houses:** the planned target figure has been multiplied by 34% for both high and low growth scenarios.

4.4. Scenario results

Domestic developments

Figure 4-3: illustrates that the local authority plans are significantly higher than the long term historic average build rate for domestic dwellings. As a result, the high and low-growth scenarios assume a level of delay in order to better reflect the likely build rates over the scenario period.

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

The high-growth average to 2025/6 is 31,000 a year. In a high growth scenario, further development sites could be expected to come forward towards the middle of the scenario period however, assumptions about development that are not yet identified have not been included. The low growth scenario shows the decreased level of growth in a slower economic climate. The average annual growth rate for slow growth over the study period is 25,400.

Figure 4-3: The planned new build dwellings next to historic averages, high and low-growth scenarios

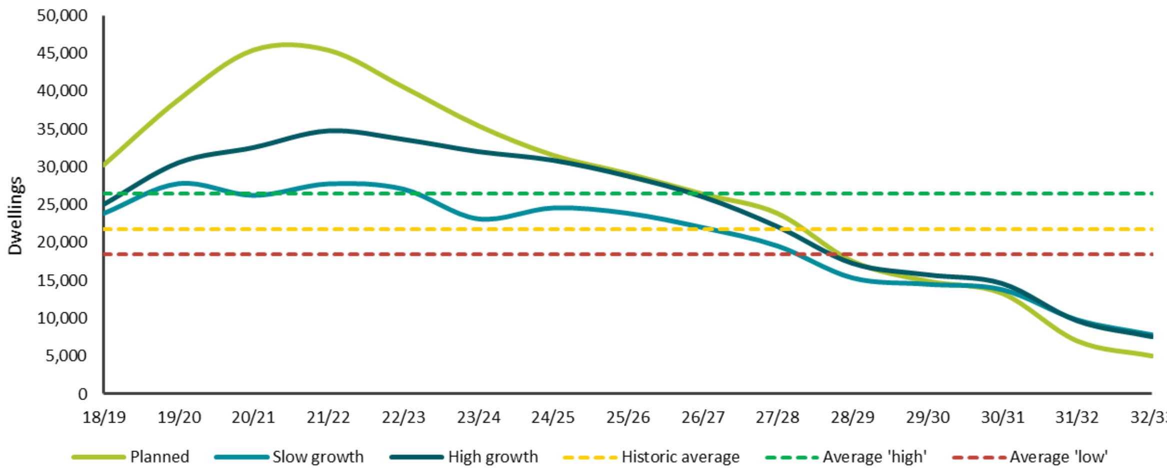
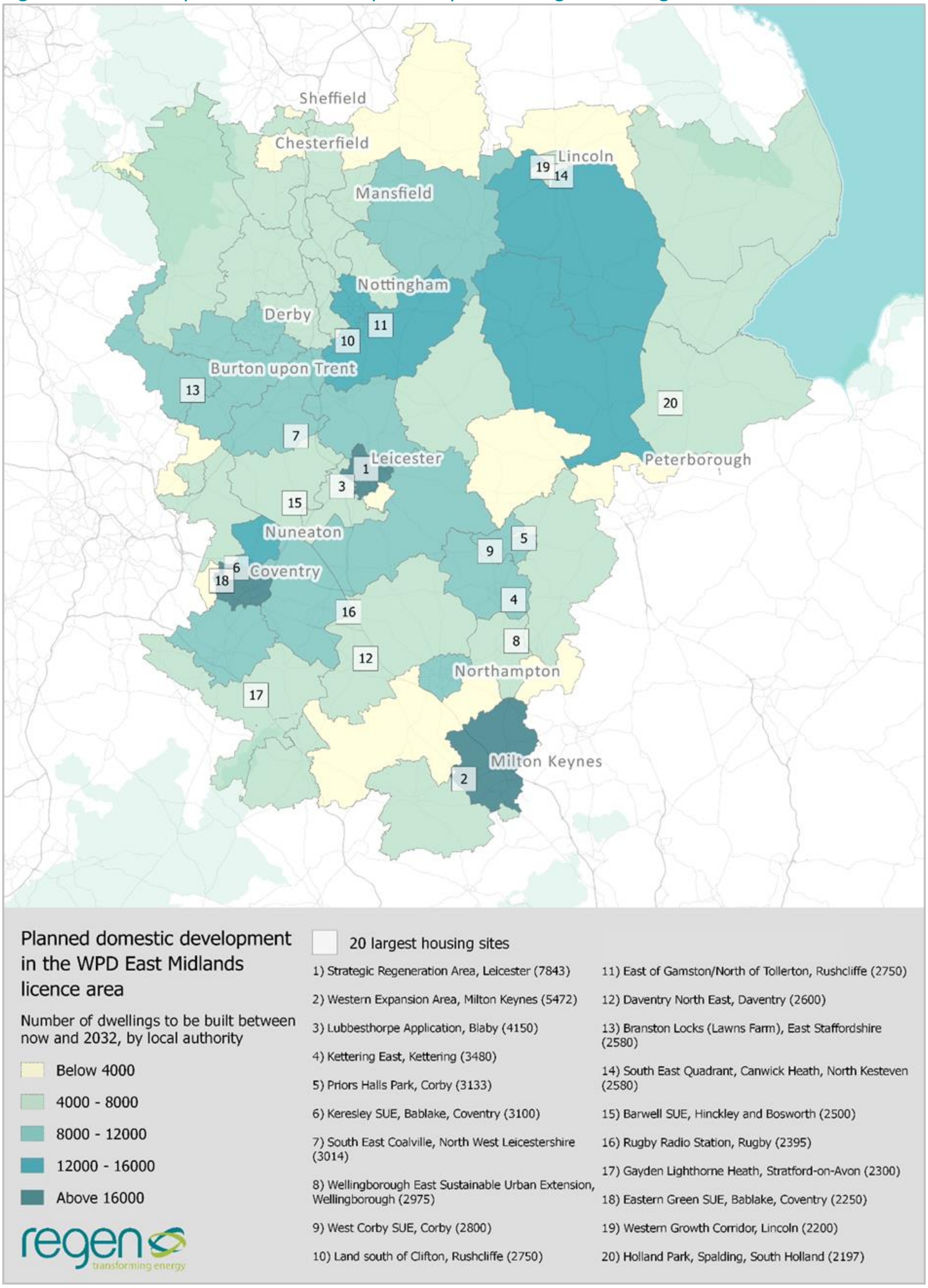


Table 4-4: Top 10 local authorities 2025 totals for new domestic developments

Local Authority – Number of domestic developments	Planned new dwellings	High Growth – Two Degrees and Community Renewables	Low Growth – Consumer Evolution and Steady Progression
Milton Keynes	17,298	14,430	12,952
Nottingham	10,257	8,185	7,506
Rushcliffe	9,954	8,186	7,254
Coventry	9,899	8,090	7,255
Leicester	9,657	7,727	6,976
South Derbyshire	9,090	8,126	7,355
Nuneaton and Bedworth	8,343	6,978	6,161
South Kesteven	7,790	4,568	4,059
Northampton	7,677	6,795	6,071
Warwick	7,491	6,047	5,254

Figure 4-4. Summary of domestic development by LA and largest housing sites.



Non-domestic development

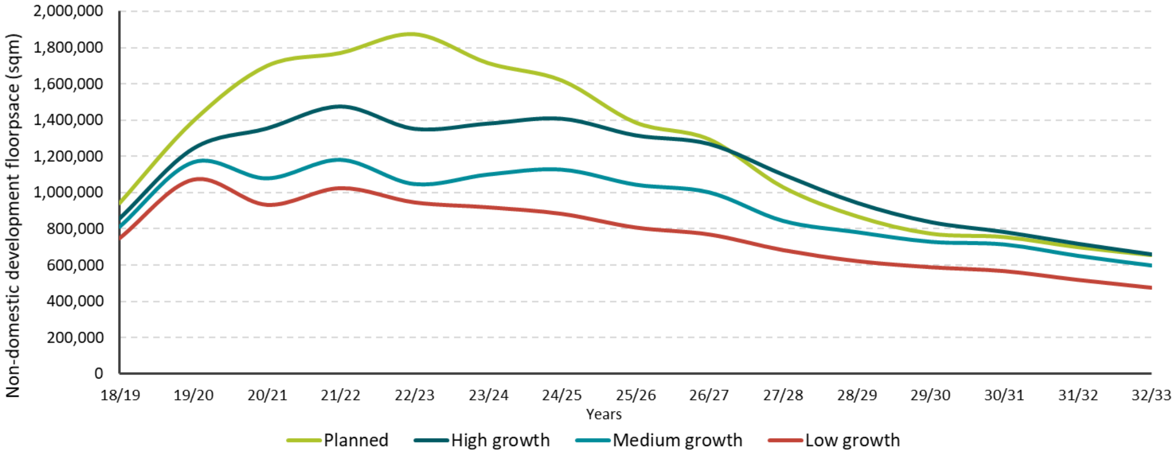


Table 4-5 below shows that Corby local authority has the highest amount of planned non-domestic development. Corby also includes the second largest non-domestic development site, a 143-hectare factory and warehouse site at Geddington Road. The largest site is in Warwick local authority, with 200 ha of employment land around Coventry Airport.

The majority of the total floor space is expected to be classified as either Factory and Warehouse or Office with only 11% outside that category. Of the 917 sites, over 100 are designated for schools.

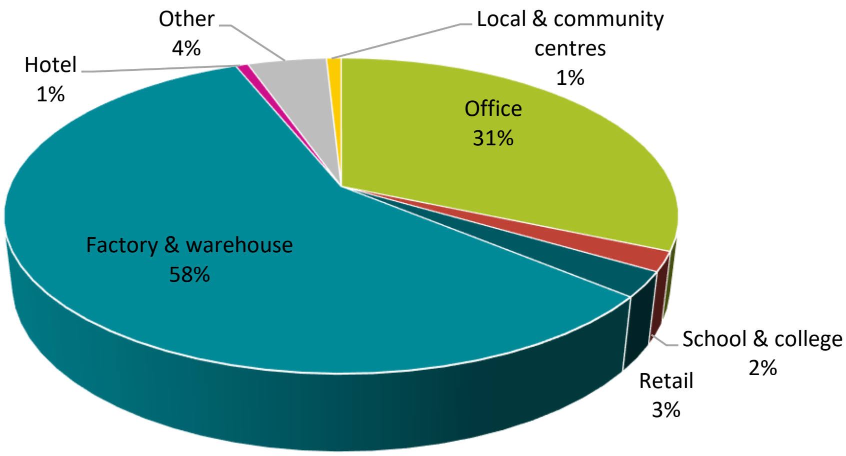


Figure 4-5: Planned, high and slow growth scenarios for non-domestic developments by m^2 floor space

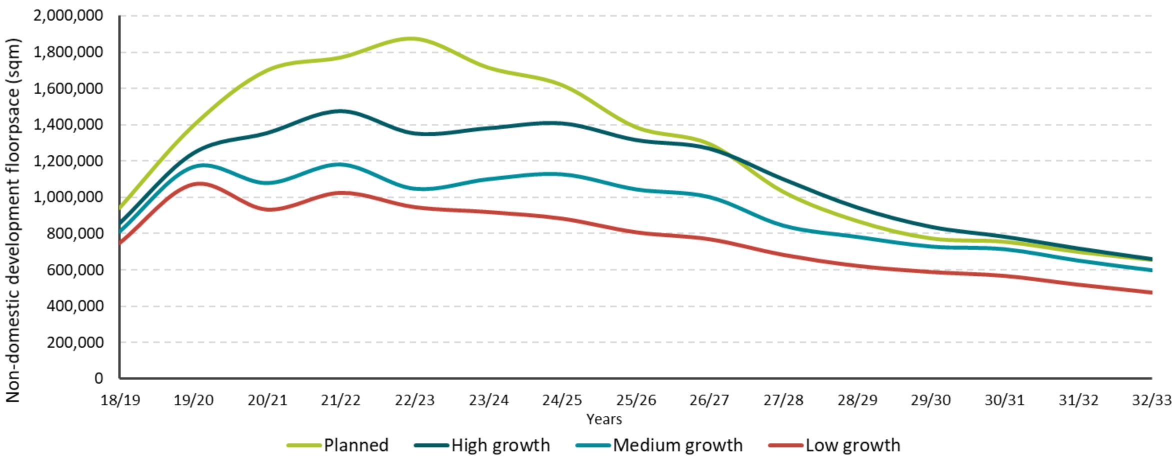
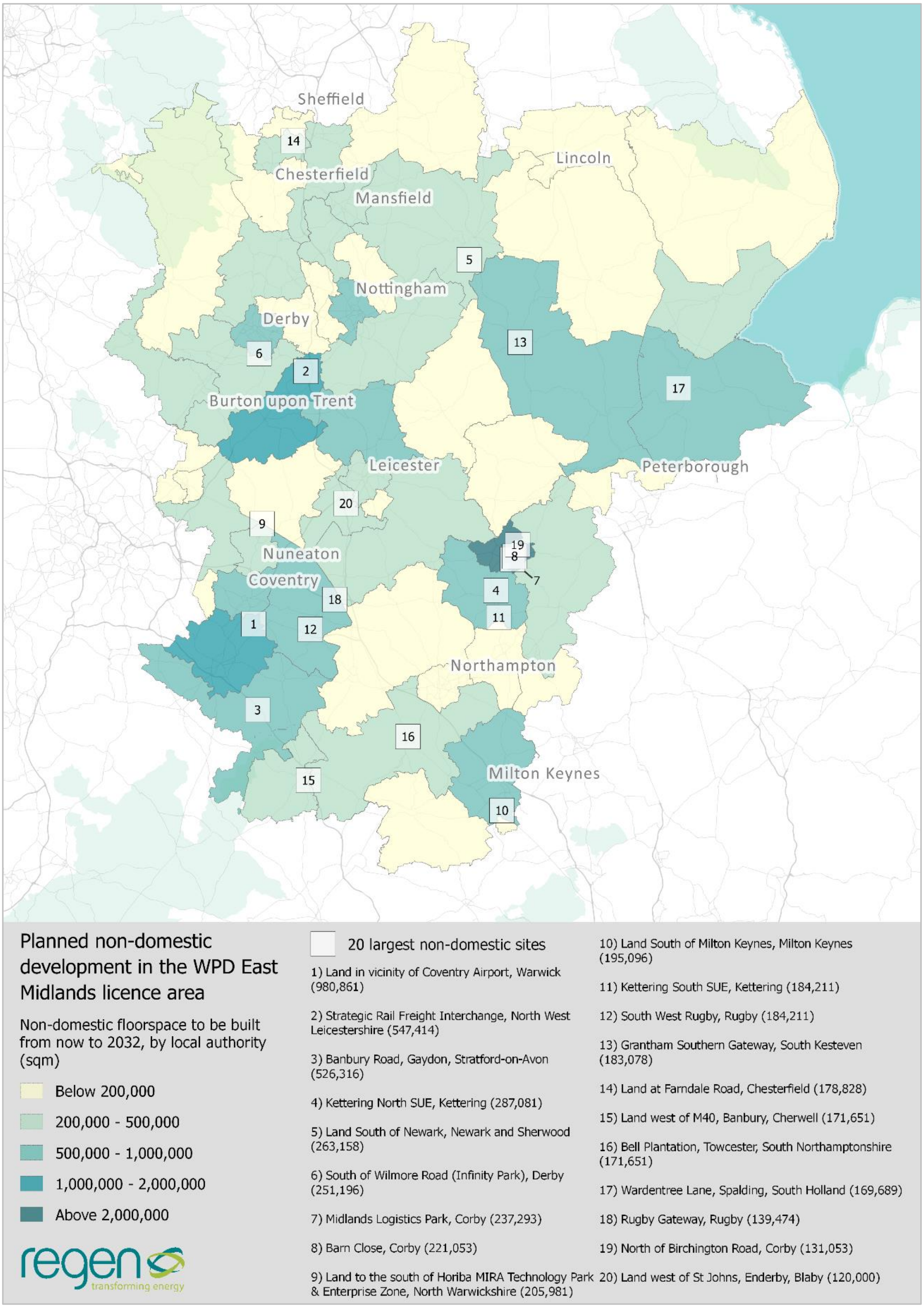


Table 4-5: Top 10 local authorities for non-domestic floor space by 2025

Local Authority – m^2 of non-domestic floor space	Planned new floor space (m^2)	High Growth – Community Renewables	Low Growth – Two Degrees	Ultra-low Growth – Consumer Evolution and Steady Progression
Corby	814,662	645,683	520,443	425,617
South Kesteven	731,957	566,464	469,030	409,757
Charnwood	710,593	563,337	434,583	370,149
North West Leicestershire	527,973	425,196	338,157	289,965
Milton Keynes	496,209	479,939	425,140	368,996
Stratford-on-Avon	451,629	435,723	387,234	336,138
Warwick	448,711	381,930	310,468	267,799
Kettering	439,523	414,845	362,752	314,549
Nuneaton and Bedworth	379,770	303,768	235,838	201,364
Daventry	368,655	318,063	263,363	228,135

Figure 4-6. Summary of non-domestic development by LA and largest housing sites



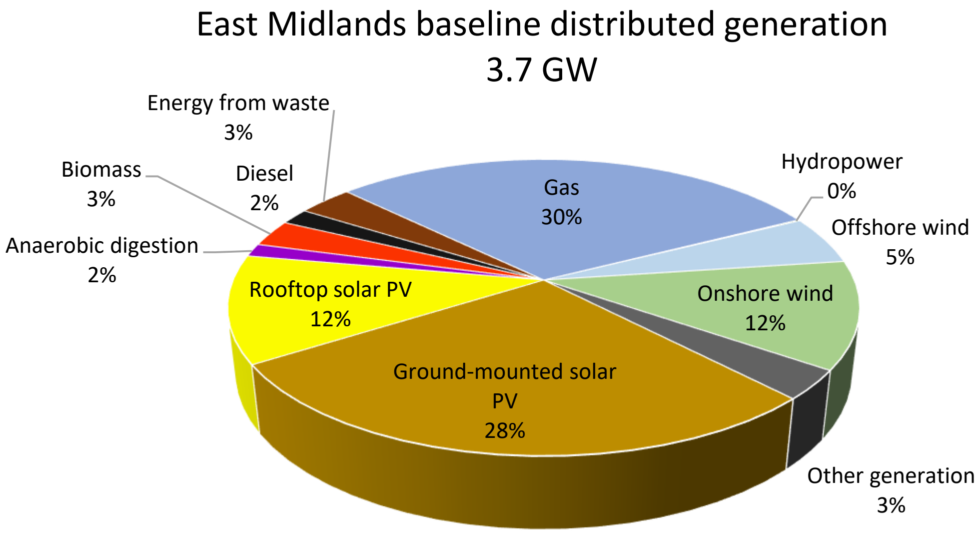
B. Introduction to generation

East Midlands baseline generation

There is 3.7 GW of distributed generation[30] capacity in the East Midlands. Fossil fuel capacity comprises 1.2 GW of this, predominantly gas generation with a small amount of diesel capacity.

Around 2.5 GW of East Midlands distributed capacity is low carbon and renewable accounting for around 5% of the UK's 42.2 GW of renewable energy capacity. In the East Midlands 40% of total capacity is solar PV and 12% is onshore wind.

Figure B-1: Baseline distributed generation in East Midlands licence area in 2018



Accepted-not-yet-connected

WPDs accepted-not-yet-connected (ANYC) database contains 200 projects with a total of 2.1 GW of capacity. The largest contribution to both the number of sites, and to total capacity, comes from solar PV. Solar PV projects account for 80 sites and 0.7 GW of capacity in the ANYC database.

Both gas generators and battery storage also have a high number of ANYC projects accounting for 526 and 450 MW respectively.

Figure B-2: Summary of WPDs Accepted-not-yet-connected projects

Generation technology	ANYC projects	ANYC Capacity (MW)
Solar PV	80	724
Gas	32	527
Battery storage	26	451
Diesel	11	155
Energy from Waste	3	121
Onshore Wind	4	65

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

Factors for future growth

With higher levels of intermittent generation and closure of older generation such as coal, the price of power on the electricity market is becoming more variable. Added to this are increased risks and regulatory uncertainties such as the network charging review or the impact of Brexit. As a result, financing new generation, low carbon, or otherwise, has become increasingly problematic without a level of guaranteed income.

At the same time as increasing risk to income, renewables have also faced the swift removal of generation subsidies, the renewable obligation and network 'embedded benefits'. The final subsidy remaining, the Feed-in-Tariff (FIT), for small generators is being removed by March 2019 without the replacement proposal for owners to receive money for their exports, the 'Smart Export Guarantee'[31], being in place.

New business models which attempt to access a more stable income are being developed, for example by selling power directly to corporates or developing projects 'behind the meter'.

These new business models, along with falling costs of technologies particularly onshore wind and solar, have started to counteract some of these investment risk issues. As a result solar developers have restarted development activity in large ground-mounted schemes and new projects are starting to come forward for connections to the network.

The following factors are key to the future growth prospects for distributed generation in the licence area:

- **Technology costs:** The potential for continuing falls in the costs and efficiencies of renewable technologies, including the cost of installation and maintenance.
- **Government price support:** A price guarantee mechanism such as a CfD is important to provide a level of fixed income for developers. Key to growth will be whether government decide to hold future CfD auctions to enable more established technologies such as onshore wind and solar to access price support and secure investment.
- **Network capacity and charging:** Changes to charging methodologies could unlock more capacity by reducing the cost of connection for new projects on the distribution network but may increase annual network costs and undermine business cases for behind-the-meter assets.
- **Local planning policies:** Higher levels of deployment, particularly for onshore wind, will need changes to the local planning process to be more supportive of distributed generation.

Table B-1 shows the growth in generation expected by 2032 in the four scenarios along with the projected storage capacity. These numbers are based on the FES 2018 trajectories along with a detailed bottom up analysis of the resources of the licence area, known pipeline projects and expectations of potential growth.

[31]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769601/The_future_for_small-scale_low-carbon_generation_SEG.pdf

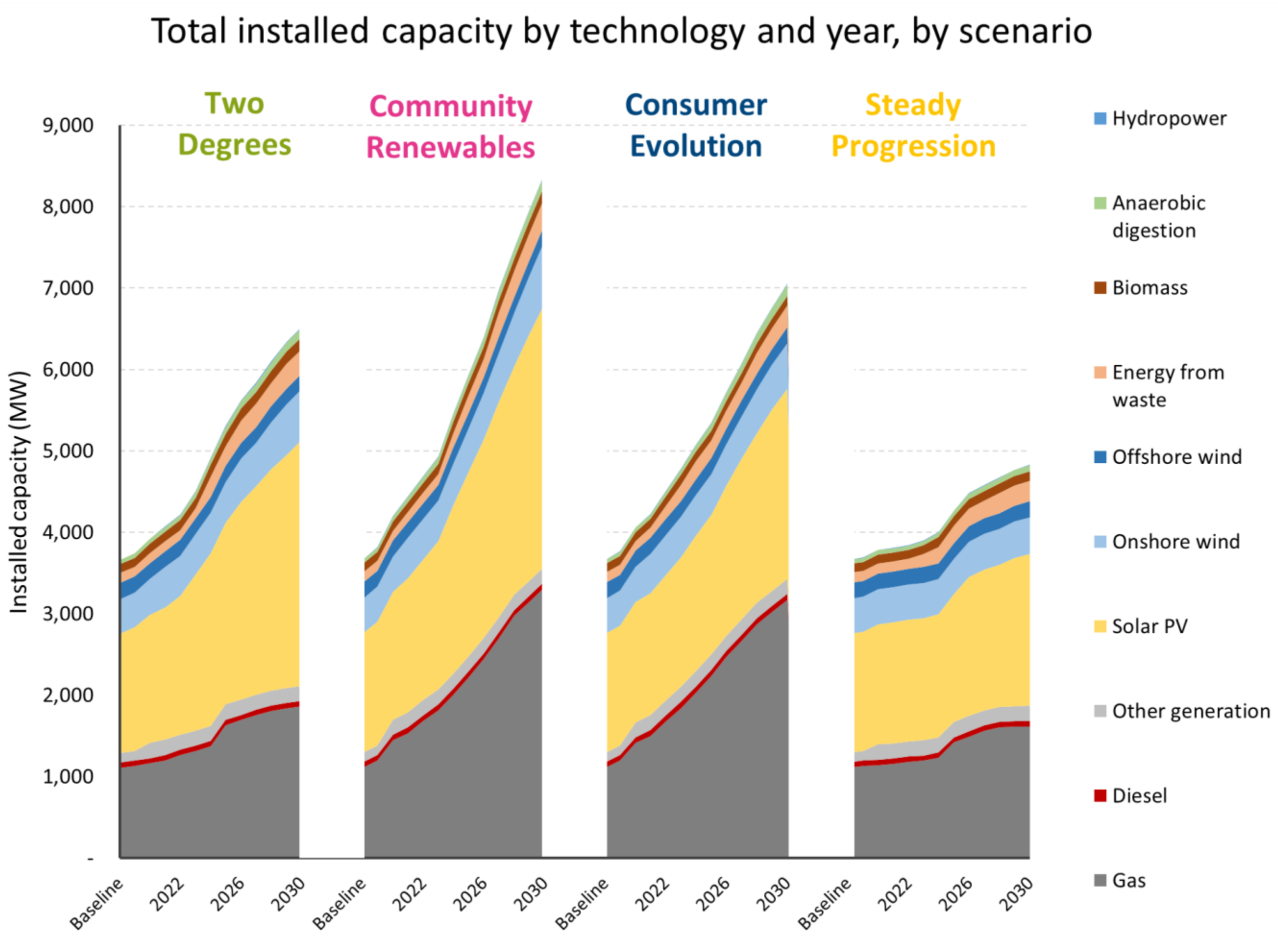
Table B-1: East Midlands scenarios for the increase in generation capacity and battery storage.

Generation capacity (MW)	2018	2032	Increase (%)	Solar (%)	Gas (%)
Two Degrees	3,674	6,899	88%	49%	27%
Community Renewables	3,674	9,269	152%	40%	38%
Consumer Evolution	3,674	7,465	103%	34%	45%
Steady Progression	3,674	4,994	36%	39%	34%

Key findings from the generation scenarios are:

- **Ground-mounted solar PV** doubles in both green scenarios from just over to 1 GW to 2.3 GW in Two Degrees as large-scale solar becomes feasible in the early 2020s.
- With relatively good wind resources in East Midlands, **onshore wind** capacity increases from 430 MW to 920 MW in Community Renewables.
- **Rooftop solar PV** increases in all scenarios from 430 MW to 615 MW in the lowest growth scenario. In Community Renewables capacity quadruples to 1.6 GW as subsidy and low-cost technology drive uptake.

Figure B-3: Scenario summaries of total installed capacity



- **Gas is over 1.1 GW** in the baseline and sees significant growth in all scenarios. Gas will function either as baseload generation in Steady Progression and Consumer Evolution or as peaking plants in the green scenarios.

- **Energy from Waste (EfW)** has 123 MW of existing capacity and has potential to growth through both Advanced Conversion Technologies in green scenarios or continued incineration in Steady Progression.

- **Anaerobic digestion** has a baseline of 52 MW. Agricultural areas to the east of the area could see significant further growth up to 159 MW in Consumer Evolution where there remains high levels of feedstock and a preference for decentralised generation.

- **Biomass** has a baseline of 108 MW and sees only limited growth in all scenarios due to limitations of feedstock's and concerns over sustainability of the technology at a large-scale.

- **Hydro** has a small footprint in the area with 4.5 MW installed to date. There is some developable resource and pipeline that could increase the capacity to 13 MW in Consumer Renewables by 2032.

5. Onshore wind

The East Midlands has relatively good wind resources. There are 398 onshore wind projects, totalling 430 MW in the East Midlands licence area.

This equates to 4% of the total installed capacity in Great Britain in a licence area that makes up 7% of Great Britain's land area.

The East Midlands licence area ranks in the top five for onshore wind capacity in England, with above average deployment.

Table 5-1: summary of onshore wind scenarios

Onshore wind capacity (MW)	2018	2025	2032
Two Degrees	430.2	499.7	682.3
Community Renewables		530.8	924.5
Consumer Evolution		502.7	608.1
Steady Progression		430.7	482.8

5.1. Baseline

Within the licence area, there are 43 onshore projects over 500 kW in scale, totalling 391 MW. There are a further 54 smaller projects with turbines of 500 kW, adding 27 MW. The remaining 301 smaller projects provide a total of 12 MW of capacity. The average scale of a large project (projects over 500kW) in the licence area is 4.3 MW, which is lower than the national average of 5.3 MW in England.

There are four projects above 20 MW in the licence area:

- The Burton Wold wind farm has gone through various stages of development. Ten turbines (20 MW) were commissioned in 2006, then 9 more turbines were constructed in 2014, and finally 3 more in 2017 taking the total up to 42 MW.
- A nine turbine, 33 MW project at Chelveston Renewable Energy Park, commissioned in 2013.
- EDF's thirteen turbine, 26 MW project at Bicker Fen wind farm, commissioned in 2008.
- Vattenfall's 11 turbine, 22 MW project at Swinford wind farm, commissioned in 2012.

Onshore wind capacity in the licence area increased at a steady rate between 2010 and 2016.

Since 2016, there has been only one new large-scale project (three turbines added to Burton Wold wind farm) and two new small-scale projects: a 5 kW domestic project near Boston and a 30 kW project near Kettering. This slow down reflects the national hiatus in wind development due to changes to England's planning law and subsidy cuts.

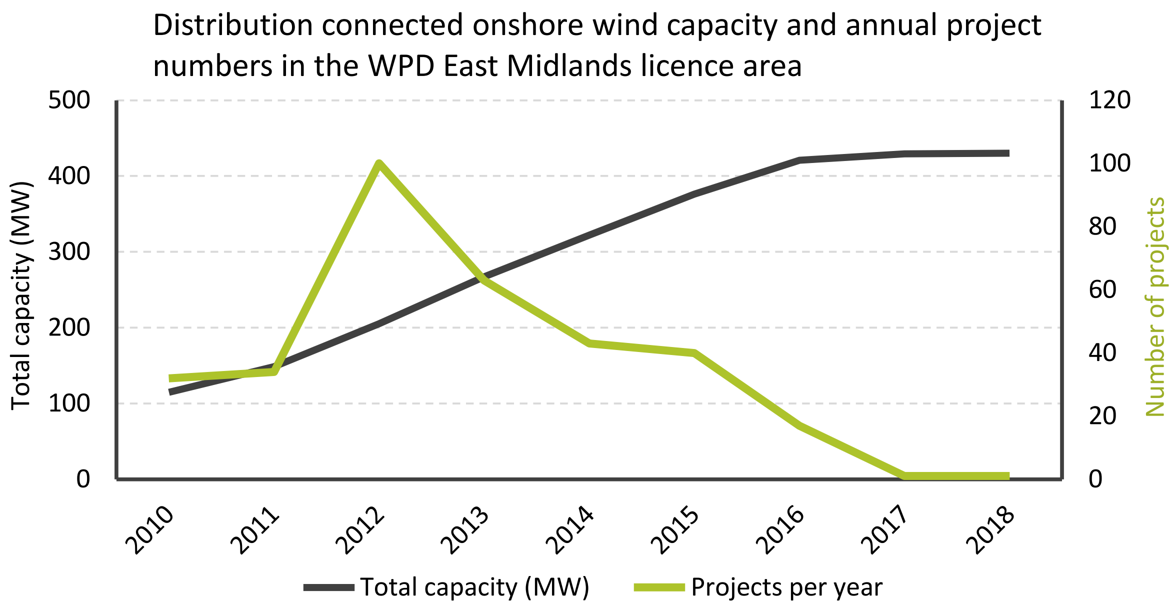
Figure 5-1 shows the annual deployment of onshore wind projects in the licence area peaked in 2012, with nearly 100, largely small-scale, projects commissioning that year.

Despite the high deployment, there is a reasonably high rate of refusals in the licence area with 47 large-scale refusals and a further 27 projects that have been withdrawn or abandoned. The refusal rate for onshore wind projects over 1 MW in the licence area is 40%, compared with a national refusal rate in England of 38%[32]. Where projects have been approved these have tended to have been

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

approved at appeal by a Planning Inspector rather than by the local planning authority. Certain local authorities, such as West Lindsey and East Staffordshire, have seen no large-scale wind projects approved, despite several applications.

Figure 5-1: Capacity and project numbers in East Midlands



5.2. Pipeline

There are three large-scale and one small-scale projects in the ANYC database. These are:

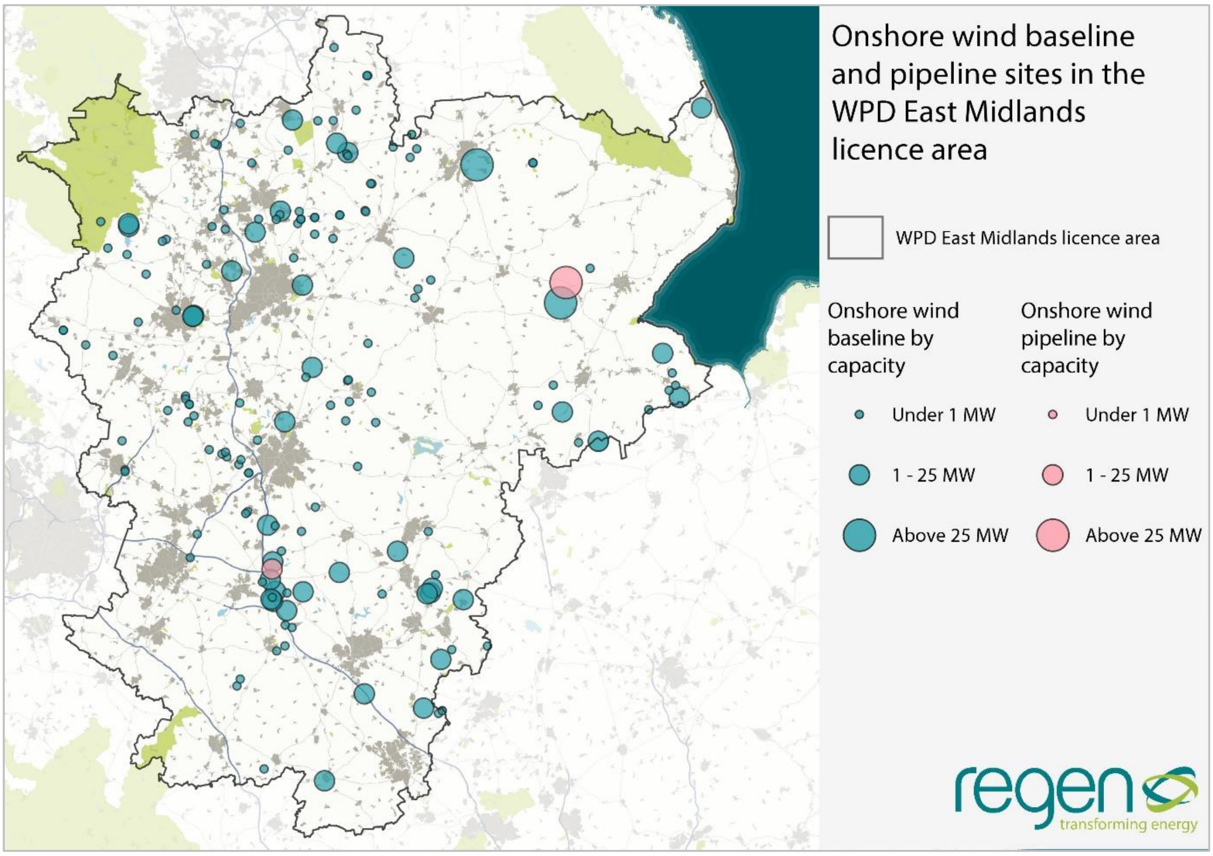
- Ecotricity was granted planning permission in 2013 for a 54 MW project, (22 turbines) at Heckington Fen, North Kesteven. The current planning permission was due to expire in 2018. In 2018, Ecotricity have applied for an extension to the planning permission to allow commencement of the development up to 2023.
- Swinford wind farm, connected in 2012 at 22 MW, has a further connection agreement of 10 MW accepted in late 2018.
- An 800 kW project near Walton has an accepted connection agreement from 2014.
- A 100 kW project near Mansfield has an accepted connection agreement from 2016.

Table 5-2: East Midlands onshore wind pipeline projects

Pipeline project	Total MW	Community Renewables	Two Degrees	Consumer Evolution	Steady Progression
Heckington Fen	54	Project commissions in 2021	Project commissions in 2021	Project commissions in 2024	Extension to planning permission fails
800 kW and 100 kW project	0.9	Project commissions in 2019	Project commissions in 2020	Projects not built	Projects not built
Swinford wind farm	22	Project commissions in 2020	Project commissions in 2021	Project commissions in 2023	Project not extended

The pipeline from the 2017 study contained 7 projects totalling 152 MW. Two years on, only the 54 MW Heckington Fen project remains in the pipeline, awaiting construction. 3 projects were refused planning permission or withdrawn, and 3 projects have been commissioned and are now in the baseline.

Figure 5-2: Baseline and pipeline onshore wind in East Midlands



5.3. Onshore wind growth factors

Planning is currently the major constraint for onshore wind

Despite increasingly favourable project economics for onshore wind projects, planning constraints in England are the dominant issue restricting the deployment of onshore wind in England. On 15 June 2015, the Secretary of State published a Written Ministerial Statement (WMS) that requires onshore wind projects to be in an area “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.”

As a result, onshore wind developers have stopped working on new sites in England and are focussing their development efforts in Wales and Scotland or further afield. Labour’s environmental policy statement “The Green Transformation” commits Labour to reversing this policy.

The scenarios explore the impact of altering this constraint as the dominant factor affecting the projections.

Cost reductions leading to subsidy free viability

Falling costs have increased the potential for subsidy free wind projects:[33]

- Onshore wind costs have fallen consistently in recent years, with IRENA estimating a 30% decrease in UK installed costs between 1983 and 2016[34].
- Turbine efficiencies have improved with the UK average capacity factors increasing from 20% to 30% over a 20-year period, to 2018.
- Costs are expected to continue to fall due to savings from larger turbines and lower maintenance costs, with Bloomberg predicting a further 47% decrease in the levelised cost of energy from onshore wind by 2040[35].
- Two companies have offered to build schemes in Germany by 2024 that rely on market power prices alone[36].
- In the UK, subsidy free projects are starting to appear in the development pipeline in Scotland and Wales.
- Aurora Energy Research estimates that subsidy free onshore wind projects could be viable in the UK by the early 2020s.[37]

Other than network connection costs, scale is the key factor in determining whether a site could currently be viable (putting aside the issue of the current planning regime); the greater the turbines tip height and rotor diameter, the more likely the project economics are to work. Sites need to be able to accommodate these large turbines from both a landscape planning and access point of view. Scottish Power's chief executive gave a newspaper interview in January 2019 stating that the company would only be exploring new sites in Scotland and Wales due to a lack of large enough sites in England with high enough wind speeds to be viable[38].

If the current planning issues are resolved, the rate at which costs continue to fall will be a dominant factor in determining the rate of deployment in the licence area. The scenarios explore the impact of viable subsidy free wind on the deployment rate.

Price support for onshore wind through the CfD or another mechanism

The National Infrastructure Commission has recommended that government sets out a programme of Pot 1 auctions[39] as part of Round 3 of the CfD in early 2019. Analysis by Arup shows that if onshore

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[33]https://www.agora-energiewende.de/fileadmin/Projekte/2017/Future_Cost_of_Wind/Agora_Future-Cost-of-Wind_WEB.pdf
[34]http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf
[35] https://about.bnef.com/new-energy-outlook/
[36] https://www.ft.com/content/1960c6fe-2dea-11e8-a34a-7e7563b0b0f4
[37] https://www.auroraer.com/insight/prospects-subsidy-free-wind-solar-gb/
[38]https://www.dailymail.co.uk/news/article-6561375/Building-wind-farms-England-pointless-isnt-windy-enough.html
[39] https://www.nic.org.uk/publications/national-infrastructure-assessment-2018/

wind were to be included in Round 3 of the CfD, it would offer the cheapest form of electricity generation for the UK[40].

A price support mechanism such as the CfD could play a significant role in supporting the development of onshore wind in England. Uncertainty around the market price for power adds risk to project economics, increasing the cost of capital and decreasing its availability. Making the CfD accessible to onshore wind, the provision of government backed PPAs or of other price guarantee mechanisms would offer certainty to the market, reducing risk and, therefore, the cost of capital.

A form of price support for onshore wind is included under Community Renewables and Two Degrees scenarios.

The poor economics of smaller turbines (under 500 kW) and planning obstacles in England means this part of the sector has almost entirely disappeared in England. With price support availability under Community Renewables, there is the potential for some growth at this smaller scale. Under the other scenarios, growth at this scale will be limited.

[40] https://www.arup.com/news-and-events/news/inclusion-of-onshore-wind-in-cfd-mechanism-key-to-reducing-cost-of-uk-decarbonisation

Decision on whether to repower existing sites

The National Planning Policy Framework excludes repowering wind projects from the current planning constraints on onshore wind. Repowering decisions are likely to be based on the prevailing costs and power price, with developers currently tending to choose to extend the life of a project rather than repower.

In the East Midlands licence area, there are nearly 200 MW of projects over 1 MW in scale that were connected in 2012 or before and so would potentially repower in the study's timescales.

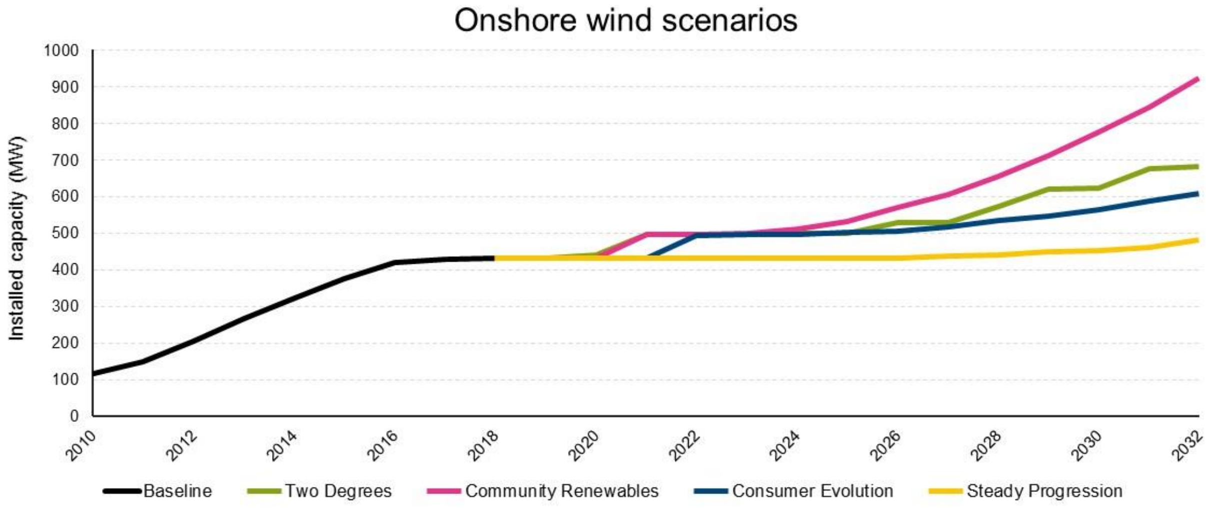
Table 5-3 summarises the key factors that are anticipated to be the key drivers of onshore wind deployment.

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	Projects repower after 20 years, with 15% increase in capacity	Projects repower after 20 years with 20% increase in capacity	Projects repower after 25 years with 10% increase in capacity	Projects repower after 30 years with 10% increase in capacity

5.4. Onshore wind scenarios

Figure 5-3: WPD East Midlands onshore wind growth scenarios



Scenario summary

There is no deployment of further onshore wind projects apart from projects in the pipeline under any scenario until 2024. This is due to the current planning restrictions needing to change and the time it takes to develop new projects through planning.

Community Renewables is the scenario with the highest growth of onshore wind capacity. The positive planning regime and price support for local projects leads to a high number of projects between 500 kW and 20 MW being deployed across the licence area. The growth rate increases through the decade, reaching a similar level to the 2015 peak.

Two Degrees sees lower growth than Community Renewables as the policy environment, though positive for onshore wind, focusses development on large-scale transmission connected sites in windier locations outside of this licence area.

Growth under Consumer Evolution and Steady Progression is muted by continued planning issues and low or no price support.

Comparison with other scenarios

A comparison of the current 2019 baseline data against the 2017 study's baseline and projections, shows that current 2019 capacity lines up against the previous projections under a Steady Progression scenario.

The growth rate under Community Renewables for this licence area is lower than the national rate predicted in the FES 2018. The growth rate in this licence area is not expected to exceed its previous peak, even under this supportive scenario and together with an extended hiatus until 2024, this results in a lower growth rate.

For Two Degrees, the scenario for this licence area exceeds the FES 2018 prediction. A lack of very large sites in the licence area means that there is unlikely to be transmission connected onshore wind developed in the area. However, some growth in relatively large distribution connected projects on available sites is anticipated given the relatively favourable conditions of this scenario and licence area.

The Consumer Evolution scenario for this licence area is significantly lower than under the FES 2018, as Regen analysis shows, without price support or significant changes to the planning regime, onshore wind capacity is unlikely to grow significantly until later in the 2020s.

The Steady Progression scenario is consistent with the FES 2018.

The baseline recorded in the 2017 study totalled 381.4 MW. The difference between this and the current 2019 baseline (430 MW) can be explained by discrepancies in the connection data for projects installed in 2014 and 2015.

The 2019 study's highest scenario, Community Renewables predicts around 100 MW less of new installed capacity by 2030 than was predicted in the Gone Green scenario in the 2017 study. This reflects the ongoing hiatus in wind development in England.

6. Ground-mounted solar PV

The East Midlands licence area has over 1 GW of ground-mounted solar capacity with 734 MW in WPD's ANYC database. The licence area has relatively good availability of unconstrained solar resource, with only small areas of designated landscape and good coverage of network infrastructure. This section covers solar projects above 250 kW.

The widespread viability of subsidy free solar is the key growth factor with Two Degrees seeing this early in 2020s due to price support, economies of scale and falling costs.

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

Ground-mounted solar capacity (MW)	2018	2025	2032
Two Degrees	1,052	1,639	2,267
Community Renewables		1,462	2,055
Consumer Evolution		1,190	1,700
Steady Progression		1,100	1,296

6.1. Baseline

In December 2018, there were 226 ground-mounted solar PV projects over 250 kW in scale[41] in the WPD East Midlands licence area. These total 1,034 MW of capacity and equate to around 8% of Great Britain's installed capacity in a licence area that makes up around 7% of the country's land area. The East Midlands geographic region is fourth in Great Britain in terms of ground-mounted solar capacity.

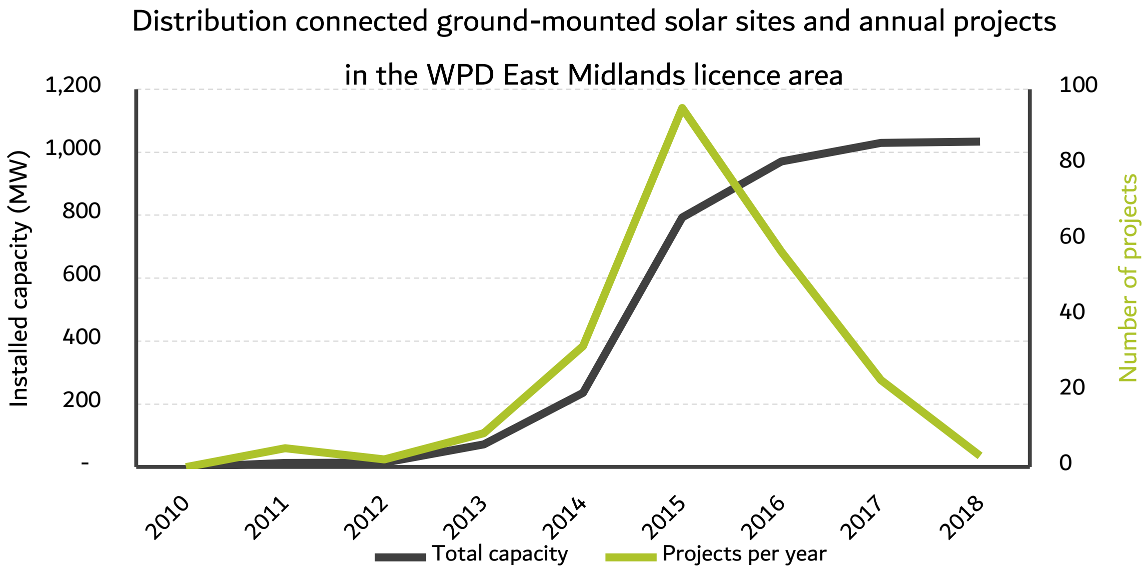
The largest project in the licence area is the 40 MW solar farm at Chelveston Airfield commissioned in 2015. The majority of ground-mounted projects in the area are between 1 MW and 5 MW. A fifth of projects are over 5 MW.

Figure 6-1 shows the cumulative growth in installed capacity of ground-mounted solar and the number of projects installed each year. The number peaked in 2015 with 95 new projects commissioning. Since 2015, deployment has slowed considerably. In the two years since the 2017 study, 31 new projects have commissioned, adding 84.7 MW of capacity, as projects built out against RO (Renewables Obligation) grace periods. Since March 2017, only 9 projects have commissioned.

There have been 70 refused/withdrawn/abandoned ground mount solar PV projects above 1 MW in the WPD East Midlands licence area. Of the 70 projects, 40 are refusals, 13 are withdrawals, and 17 projects were abandoned. The vast majority of these (90%) occurred in the last 4 years. The success rate of projects in gaining planning permission is around 75%.

[41] 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.

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



Pipeline

WPD's ANYC database has 46 ground-mounted solar PV projects with a total capacity of 635 MW. In 2017, there was over 1 GW of projects in the database, which Regen's analysis cut down to a two-year viable pipeline of 190 MW; in fact, 84.7 MW went ahead in that time.

30 new projects have entered the ANYC database since 2017, totalling 490 MW, with 320 MW of those accepting connections in 2018. Five of these projects have been identified within the BEIS Renewable Energy Planning Database (REPD) planning database at various stages of the planning process.

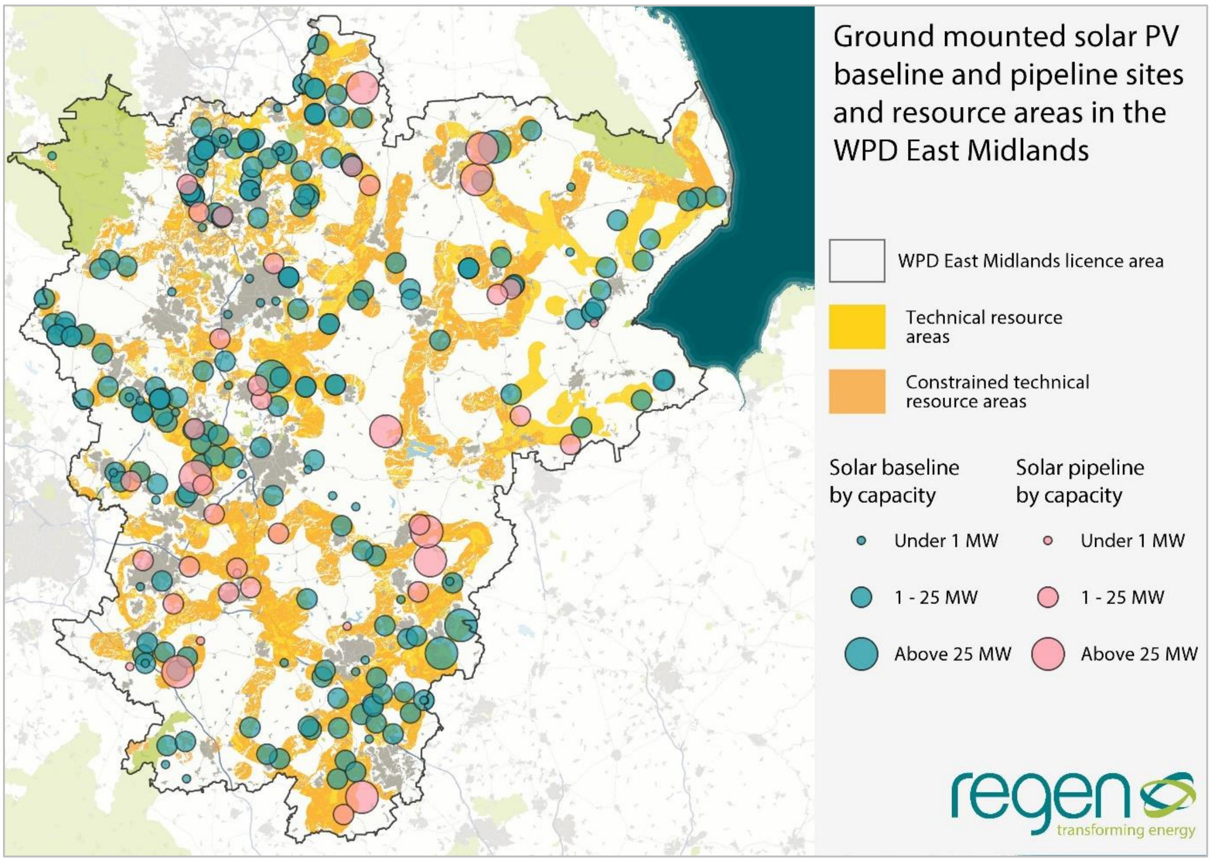
The end of the FIT and shift to subsidy free development has meant much larger projects are now being proposed. Of these, 24 are above 5 MW in capacity, with the largest two just under 50 MW:

- Lullington solar farm (accepted 31/10/2018) which is not on the BEIS REPD
- Thurlaston estate which received a connection agreement in 2016, and planning permission in September 2018.

Pipeline assumptions

- Sites with a connection agreement that was accepted after 2016 and that have planning permission connect from 2019 onwards under the Two Degrees and Community Renewable scenarios.
- Large-scale sites with a connection agreement from 2017 onwards for which no planning activity has been identified connect from 2023 onwards under all scenarios.
- Projects with a connection agreement prior to 2017 and without planning permission in place connect at the earliest in 2026 under Two Degrees, and later in other scenarios.

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



6.2. Ground-mounted solar PV growth factors

Subsidy free viability

The closure of the RO and lack of a Pot 1 auction programme for the CfD mean that large-scale ground-mounted solar projects are currently without a subsidy[42]. The UK government has explicitly ruled out further subsidies for solar until at least 2025.

The challenge for developers of solar PV is to develop profitable sites post-subsidy. Solar Power Portal concludes that the currently viable UK pipeline of post-subsidy solar PV farms contains 55 projects totalling 573 MW[43].

Competitive auctions in overseas power markets, global competition amongst experienced solar developers, production volumes and technology development are all contributing to continuing falling global costs.

- The installed cost of large-scale ground-mounted solar PV in the UK fell by 76% between 2010 and 2017 according to the International Renewable Energy Agency (IRENA) 2017 market report.

[42] Sub-5 MW ground mounted plants are eligible for the FIT until March 2019 but this has been significantly reduced.

[43] https://www.solarpowerportal.co.uk/blogs/revealing_the_true_uk_large_scale_solar_farm_pipeline_for_2019

- By 2020, IRENA expects solar PV (and other mainstream renewables) to have average costs that are competitive with fossil fuel power stations in the global market[44].
- According to Bloomberg, the global levelized cost of electricity from solar is set to drop another 66% by 2040. By 2021, Bloomberg consider ground-mounted solar will be cheaper than coal in the UK[45].

Under Community Renewables and Two Degrees, reduced module costs, R&D investment and reinvigorated supply chains enable strong solar development. Cost reductions are more limited under Consumer Evolution and Steady Progression, meaning subsidy free viability occurs later in the 2020s.

Investment challenges and price cannibalisation risk

Post-subsidy solar PV is dependent on the wholesale price of power for its revenues. This business model is seen by investors as presenting higher risks than projects backed by public subsidy.

In particular, there is concern that if deployment is widespread then at peak times of high solar generation, excess electricity generation is likely to depress the wholesale price or to have an impact that causes regulators to change network charges. Research from Aurora suggests that by the 2020s, there will be considerable decreases in wholesale electricity prices at times of high solar load[46]. Cornwall Insight estimate that "a representative 5 MW standalone solar project will experience wholesale market revenues reducing 22% from 2018 by 2031"[47]. Similarly, investment group, Foresight, are predicting an average 3% annual decrease in power prices from 2022/23[48].

There is potential that changes to the market, such as how PPAs function and co-location with storage, could serve to mitigate this effect. This factor has a dampening effect on deployment under Consumer Evolution and Steady Progression, the scenarios where there is no price support available.

Price support from government subsidy

The difficulty of financing based on the wholesale price of power alone is likely to slow down deployment of post-subsidy solar PV. A price support mechanism would reduce the risk for new projects and therefore the cost of capital, enabling greater investment and more rapid deployment.

The National Infrastructure Commission's National Infrastructure Assessment recommends that government sets out a programme of Pot 1 auctions under the CfD[49]. Cornwall Insight have called for a revamped CfD with a floor price mechanism.

Under the high decarbonisation scenarios, a CfD or another price support mechanism is introduced to reduce risks of solar PV farms, overcoming some of the investment challenges.

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[44] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf
[45] https://about.bnef.com/new-energy-outlook/#toc-download
[46] http://www.auroraer.com/wp-content/uploads/2017/11/Aurora-Battery-Conference-31-Oct-2017.pdf (2017)
[47] https://www.cornwall-insight.com/landing-pages/wholesale-power-price-cannibalisation
[48] https://www.solarpowerportal.co.uk/news/increased_renewables_penetration_at_risk_of_delaying_second_wave_of_strong
[49] https://www.nic.org.uk/publications/national-infrastructure-assessment-2018/

Co-location with energy storage potential

Co-location with energy storage is a key business model for post-subsidy renewable development. Combining solar and storage may facilitate increased renewable energy development by reducing output intermittency and reducing peak generation. It could also help mitigate the electricity market price risk either through flexibility services or through arbitrage by storing and selling low cost solar power during higher priced evening peaks. This has the potential to transform the sector but Regen analysis indicates that co-location currently remains a very challenging business model[50].

Planning environment

The licence area has experienced a higher rate of refusals for solar farms than other licence areas, with around a third of projects refused or abandoned. Whether the planning environment is supportive of solar farms and what scale is explored through the scenarios.

Table 6-2Table 5-3 summarises the key factors that are anticipated to be the key drivers of ground-mounted solar PV deployment.

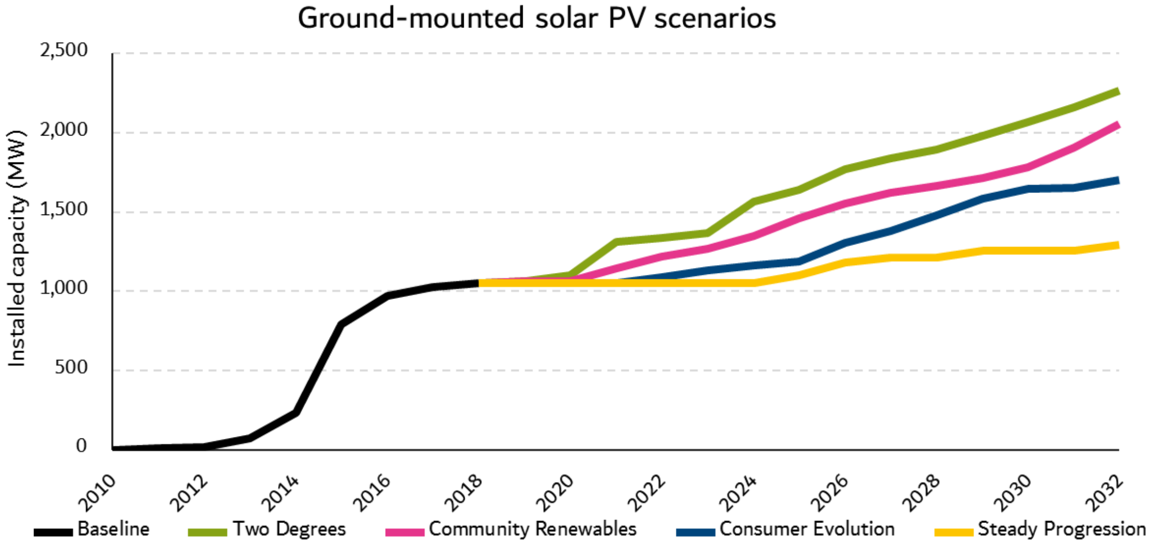
Table 6-2: Assumptions for factors influencing capacity growth for ground-mounted solar

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 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

50 https://www.regensw.co.uk/Handlers/Download.ashx?IDMF=9d010979-7cc4-4515-b900-a65a4a4765b7

6.3. Ground-mounted solar PV scenarios

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



Scenario summary

Two Degrees has the highest level of deployment as large-scale solar farms (between 30-50 MW) are completed from 2020 onwards and a price support mechanism is reintroduced. However, the installation rate remains considerably slower than the previous 2015 peak when attractive subsidies and subsidy deadlines drove growth.

Community Renewables has the second highest growth with a large number of smaller scale farms under 5 MW. The growth in smaller scale ground-mounted solar increases as the cost of the technology continues to fall during the scenario period.

In Consumer Evolution new capacity is delayed up to the mid-2020s, where technology cost reductions start to make subsidy-free schemes viable; growth under this scenario is dampened by a lack of price support meaning investors are exposed to market risk. Growth is focussed in areas with the most supportive planning environments. Steady Progression sees very low growth in deployment.

Relationship to other scenarios

All the scenarios are above the FES 2018 projections as a result of the good resource in the area.

The scenarios in the 2019 report are also above those made in the 2017 study as a result of renewed optimism in the sector about the potential scale of post-subsidy growth.

7. Rooftop Solar Photovoltaics

Around 3.9% of properties have rooftop solar photovoltaic (PV) installations in the WPD East Midlands licence area, comparable with the South West (also 3.9%) and 3.1% in South Wales.

Growth has slowed considerably over the last few years, reflecting the slowdown across the UK caused by the significant reduction in subsidies available through the Feed in Tariff.

The rooftop solar PV market in WPDs East Midlands licence area has dropped from 100 MW installed in 2014 to 5 MW in 2017.

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

MW	2018	2020	2025	2032
Two Degrees	431	461	613	1022
Community Renewables		475	817	1613
Consumer Evolution		454	536	763
Steady Progression		448	495	613

7.1. Baseline

Domestic rooftop solar PV is installed on nearly 93,000 homes or 3.9% of homes in the East Midlands licence area, a total of 340 MW of capacity. The average size of all installations is 3.6 kW, but this has been increasing over time, and in 2017 the average size was 4.1 kW. The level of rooftop solar PV uptake (3.9%) is similar to the south west licence area and therefore relatively high given that the irradiance in the region is lower than the southern UK. The high number of houses with rooftop solar PV is likely to be due to a combination of lower housing costs and high ownership levels[51] which increase the likelihood of people investing in longer term assets.

There is a further 93 MW capacity of PV on commercial rooftops from around 3,200 installations. The average size was around 40 kW at peak but, with the reduction in subsidies, this has dropped to around 9 kW.

The significant reduction in the FIT for rooftop solar PV from 2016 was intended to reflect the falling cost of technology which, since 2009, has reduced the cost of small systems by around two thirds. Upfront costs, however, remain significant. It costs between £4,000–£6,000 for a 3 kW system[52]. As the falling rates of installations reflect, many of the payback periods are currently too high and the economy too uncertain for many companies and households to invest.

7.2. Pipeline

There is no pipeline data available for domestic installations due to the short lead in time of these projects, no need for planning permission and the fact that they register for a network connection after installation. There is a small 2.3 MW pipeline of commercial rooftop solar PV from 27 projects in WPDs accepted-not-yet-connected database with an average size of 86 kW, only 9 of which are above

51 https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/researchoutputssubnationaldwellingstockbytenureestimatesengland2012to2015/2017-12-04#comparing-our-estimates-with-regional-dwelling-stock-estimates (accessed October 2018)

52 https://www.theecoexperts.co.uk/solar-panels/1kw-pv-systems , accessed October 2018

100 kW in capacity. In all scenarios, these are expected to be connected before the final FIT closure in March 2019.

Without a subsidy, future projects will depend on matching solar generation with demand used on site, along with flexibility through storage or demand side response. This will be key to ensuring that most of the power generated will offset the retail price of power. Commercial properties with the right usage profile can already have payback periods of five to six years[53].

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

7.3. Rooftop solar PV growth factors

Future subsidy support

The FIT has been the key driver for rooftop solar PV installations. In 2015, the government announced their intention to close the generation element of the FIT in March 2019. The summer 2018 consultation on the details of the FIT closure also announced the closure of the export tariff in March 2019.

BEIS have now proposed a replacement, the Smart Export Guarantee (SEG)[54]. This new export tariff would put a requirement on large suppliers to provide small-scale generators (under 5 MW) with a payment for their export. Suppliers will be free to decide the rate, and no floor price has been proposed, except for the requirement that generators will not have to pay suppliers in the event of negative pricing. There is expected to be a gap between the closure of the export tariff and the initiation of SEG.

Feedback from the market indicates that the cuts will drive a short-term increase in deployment ahead of the deadline date and then deployment will fall back.

The scenarios assume that under the Community Renewables scenario there is a small subsidy or price support for rooftop solar PV reintroduced in the 2020s.

Falling technology costs

Bloomberg New Energy Finance[55] New Energy Outlook predicts that by 2030, new solar PV installations will have a technology cost of around half of what they do today. This fall would be driven both by decreases in the cost of the solar panel, as well as the cost of inverters and other components. In the UK, the removal of the EU tariff on Chinese solar panels in September 2018[56] may also help to bring down the costs of a system in the short and medium term and reduce payback periods on domestic and commercial installations.

Deployment on social housing

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[53] Industry sources, September 2018

[54]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769601/The_future_for_small-scale_low-carbon_generation_SEG.pdf

[55] Bloomberg New Energy Outlook (2018) https://bnef.turtl.co/story/neo2018?teaser=true

[56] Business Green (2018) https://www.businessgreen.com/bg/news/3062016/european-commission-ditches-tariffs-on-chinese-solar-imports

Although price drops may encourage private households to invest in the medium term, an important additional area of domestic growth in both the Consumer Evolution and Community Renewables scenarios could be social housing. In this sector, the longer-term investment horizons and economies of scale make a stronger investment case for retrofit.

This could be boosted in some scenarios with government subsidy support or policies such as requiring higher energy efficiency in social housing.

Building regulations, SAP assessments and local planning policies

Rooftop solar PV is also likely to feature more in new build housing where the installation is cheaper and there are benefits from economies of scale. Building regulations or planning policies could be used to encourage developers to install PV.

A driver of rooftop solar PV on new homes has been SAP (Standard Assessment Procedures) for energy and carbon rating of homes. Developers have used rooftop solar PV to improve the energy rating of properties ahead of more costly interventions. With the increase in renewable generation and reduction in use of coal, the carbon intensity of grid electricity has dropped from over 500 g/kWh in 2012 to around 300 g/kWh in 2017[57]. Future updates to SAP[58] methodology are due to significantly reduce the assumed carbon emissions from grid electricity to reflect this.

Depending on how this is implemented, this could affect the drivers for housing developers to put solar PV on new developments to meet national building regulations and local planning policies.

Through their Local Plans, local authorities can require new developments to meet energy requirements that are stricter than national building regulations. The extent to which local authorities take up this opportunity will affect the deployment of solar PV on new developments. This is explored through the scenarios.

Co-location and flexibility business models

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

The extra income commercial or domestic systems could receive from an integrated system of generation and storage is expected to start providing attractive returns and result in an uptick in domestic and commercial rooftop PV installations during 2020s in some scenarios.

As a result, the technology costs of the combined systems coupled with the price of energy will determine growth towards the mid-2020s.

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

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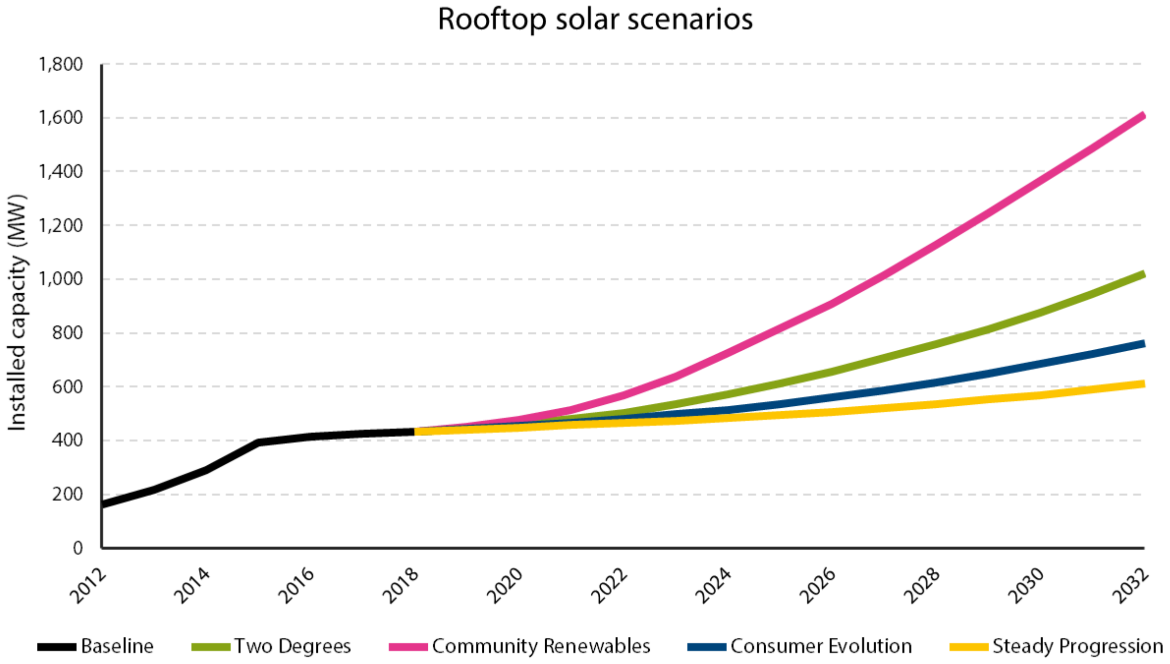
[57] Electricity Info (2018) http://electricityinfo.org/real-time-british-electricity-supply/
[58] CIBSE Journal (2018) https://www.cibsejournal.com/general/sap-in-building-regulations/?utm_source=marketingcloud&utm_medium=email&utm_campaign=Journal%20Newsletter%20September%202018&utm_term=0030O00001uyUSdQAM

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 installation	Regulations favour larger installations	Carbon targets drive solar PV from early 2020s	Carbon targets drive solar PV later in period	No incentives
Market and technology factors				
Technology cost reductions	Cost reductions slow down	Continued falls through scenario period	Cost reductions slow down	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 battery 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

7.4. Rooftop solar PV scenarios

Figure 7-1: Rooftop solar PV scenarios in WPD East Midlands



Scenario summary

Community Renewables has a significantly higher level of rooftop PV than all other scenarios. By 2032, over 11% of households would have rooftop solar PV installed.

The Two Degrees scenario favours centralised decarbonisation and has a less favourable policy environment for small-scale and rooftop solar; however, with drivers such as the reduction in technology battery costs, installations still increase to around 7.5% of households in 2032.

Consumer Evolution and Steady Progression see low growth, continuing the post-FIT slow growth trend.

Relationship to other scenarios

The FES 2018 does not specify the level of rooftop solar capacity specifically, it includes total solar capacity, and total micro-generation capacity. The growth rates within the scenarios presented here are similar to the growth rates of micro distributed generation in the FES 2018 scenarios.

Compared with the 2017 scenarios, the lowest growth scenario is similar to the No Progression scenario. The highest scenario is Community Renewables which is slightly higher than the previous highest projections, 1.4 GW in 2030 compared to 1.2 GW in the 2017 Gone Green scenario.

Distribution by ESA

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

8. Anaerobic Digestion

There are 39 anaerobic digestion (AD) units identified in the licence area, totalling 52 MW in installed capacity. Four sites have multiple units installed. The largest site is 10 MW connected in 2013 on Newark Sugar Factory.

The East Midlands region has potential further growth in AD due to its proximity to both urban centres and areas of significant agricultural production.

The East Midlands continues to have potential growth in AD as a result of both its proximity to significant urban areas for food waste processing as well as large agricultural resources to the east of the licence area. [59]

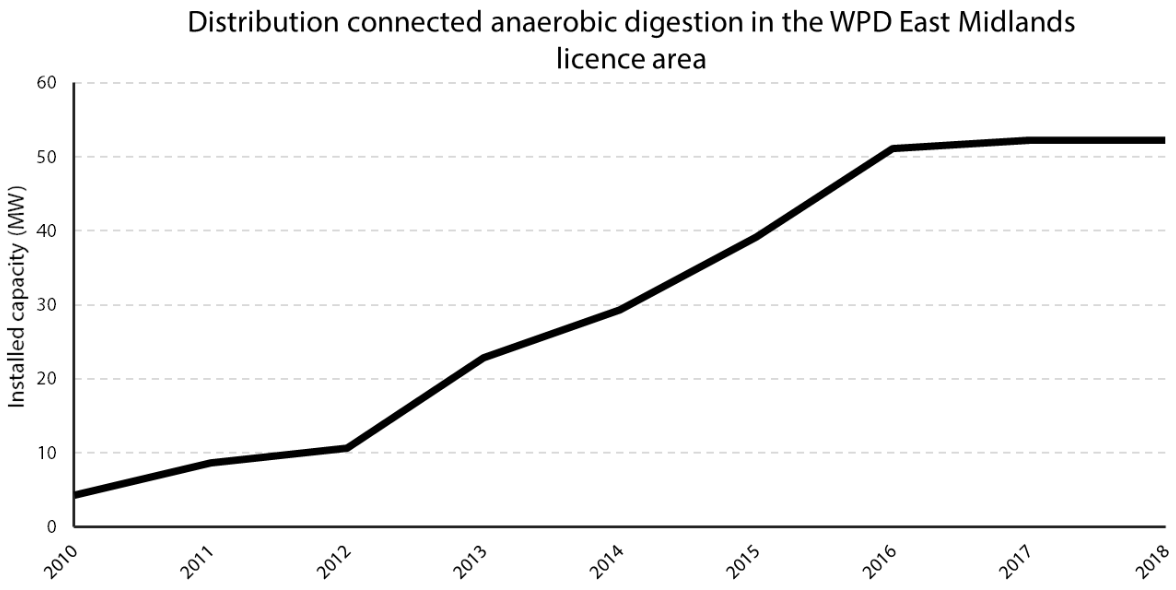
Table 8-1: Summary of AD capacity (MW) by scenario in the WPD East Midlands licence area.

	2017	2020	2025	2032
Two Degrees	52	54	88	123
Community Renewables		59	96	140
Consumer Evolution		52	90	160
Steady Progression		52	60	81

8.1. Baseline

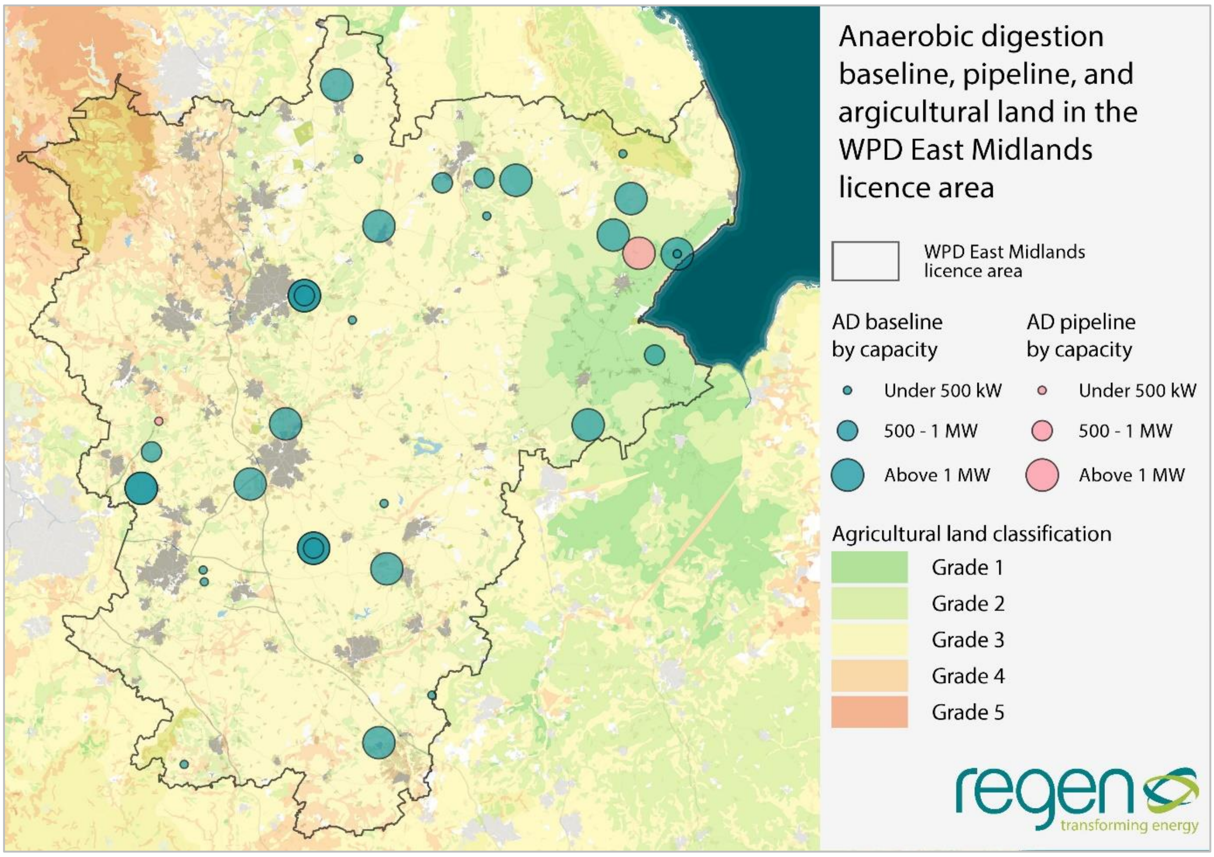
AD grew strongly in the East Midlands between 2012 and 2016 with up to 12 MW a year. However, growth has slowed since 2016 with only 1.2 MW from one site added in 2017.

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



[59] https://renewablelocator.green-alliance.org.uk/area/110 (accessed 16.01.19) to note that the region is slightly larger than WPD's licence area

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



8.2. Pipeline

There are two AD projects in the WPD accepted-not-yet-connected database. A 1.2 MW scheme in Boston which applied for connection in 2018 and is expected to go ahead in all scenarios but later in the low growth scenarios. A further 0.5 MW project applied for connection in 2016 and is expected to go ahead only in the more decentralised scenarios.

8.3. Anaerobic digestions growth factors

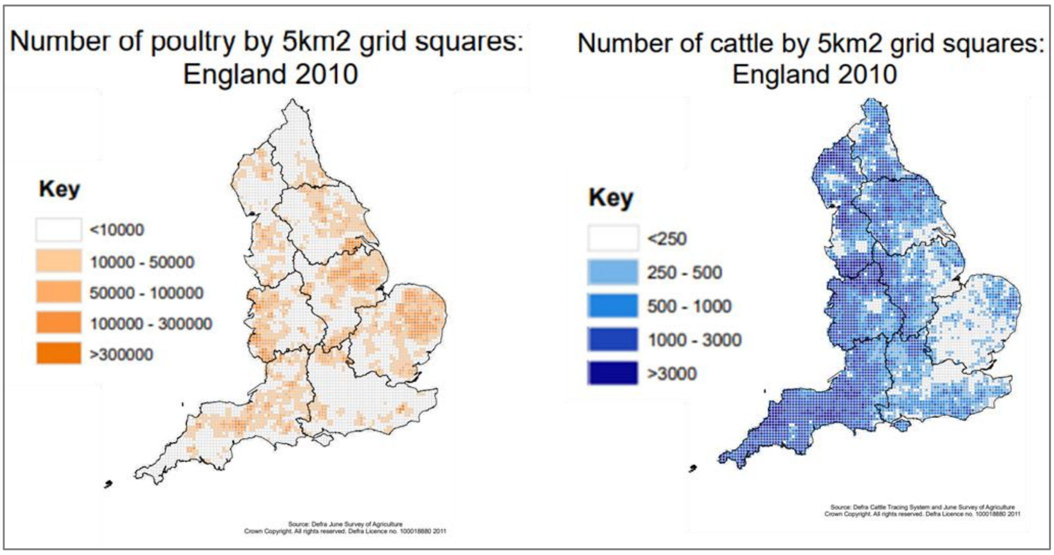
Availability of feedstock

Anaerobic digestion has a variety of different uses and feedstock. The technology can be used for processing food waste and manure; producing biomethane for the gas grid and transport; producing onsite electricity and heat; and generating electricity for export. It is also fed by a range of feedstocks including:

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

Each have different market drivers depending on the type of AD.

Figure 8-3: Comparison of livestock distribution in England[60]



For the East Midlands agriculture remains a significant source of AD projects and feedstock. On the AD register of projects in the licence area 75% are classified as farm-fed with 62% of the capacity. As shown in Figure 8-3, the licence area has relatively high numbers of both cattle and poultry along with horticultural and vegetable farms to provide feedstock and agricultural waste to AD projects. As a result, there remains growth potential if the economics of new projects can be made to work.

A further driver is food waste availability. With significant numbers of urban areas within the licence area, the frequency and availability of food waste collections are important for improving fuel supply and improving gate fees for AD. Local authorities are not currently required to collect food waste separately and there are no mandatory UK food waste reduction targets. Just 14% of the total food waste produced by households in the UK is collected separately and 45% of councils in England offer no food collection at all.

Government support and subsidy

Removal of FIT subsidies for electricity generation means that future projects are likely to skew towards onsite heat and power, biomethane injection to the gas network or for transport fuels rather than biogas for exported electricity production. This means new plants may have less impact on the electricity network and face fewer network constraints.

The government are keen to encourage decarbonisation in heat and transport and as a result, RHI tariffs for heat and biomethane production from AD were reset to 2016 levels in spring 2018, providing a boost for the industry[61]. 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[62].

The continuation of government subsidies for heat and biomethane is a key factor considered in the scenarios. AD that produces heat and electricity is a relatively mature technology, however, with

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60 Defra June Survey of Agriculture (2010)
61 ADBA (2018) http://adbioresources.org/news/press-release-anaerobic-digestion-industry-welcomes-laying-of-rhi-legislation
62 DfT (2017) https://www.gov.uk/government/consultations/renewable-transport-fuel-obligation-proposed-changes-for-2017

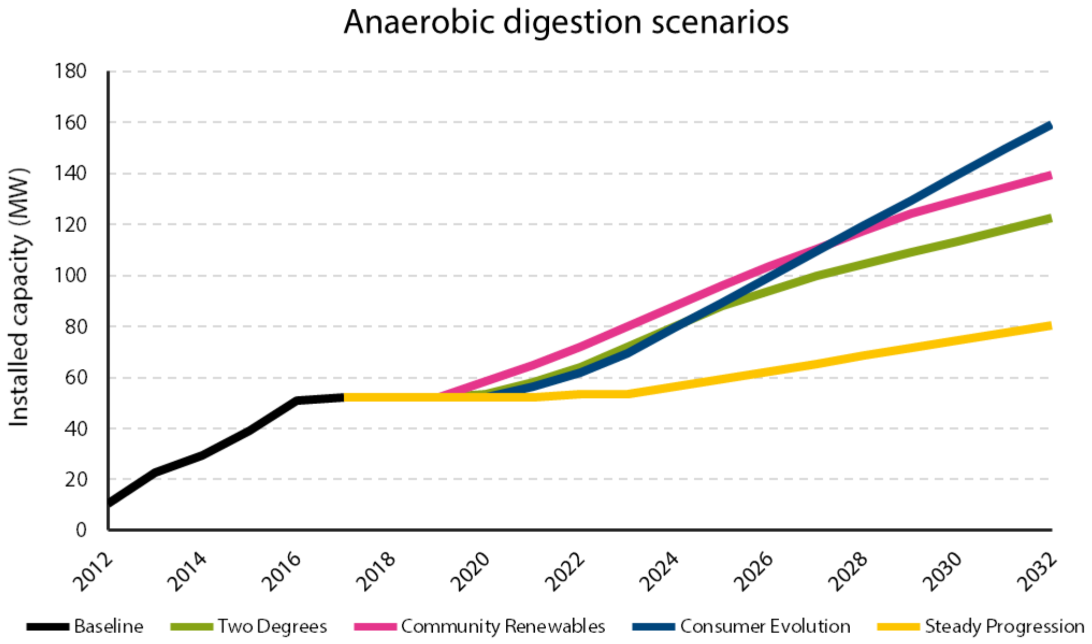
investment in research and design, there may be opportunities to reduce the cost of the technology and installations. Biomethane technology improvement is considered as a factor in the scenarios.

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	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				
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

8.4. Anaerobic digestion scenarios

Figure 8-4: Anaerobic digestion by scenario in East Midlands licence area



Scenario summary

The Community Renewables scenario sees viable subsidy levels and support for small-scale projects resulting in high numbers of electricity and heat AD plants being developed in the near term. However, towards the end of the scenario period Consumer Evolution sees increasing levels of AD plants as Community Renewables AD plants become increasingly focused on biogas and not electricity generation.

Under Two Degrees, a small number of network connected large food waste plants are commissioned early in the 2020s with a switch to biomethane by mid-2020s. Steady Progression sees limited and slow deployment of a small number of food waste or crop waste plants in the licence area

Relationship to other scenarios

The growth of AD in the East Midlands has been matched to the FES 2018 growth rates overall with very little growth happening in Steady Progression and the highest growth in Consumer Evolution where new waste availability is higher than other scenarios and drives take up from early to mid-2020s. The 2017 scenarios report had highest growth in 'Gone Green' up to around 120 MW in 2030. This study increases that level to around 190 MW by 2032 for Consumer Evolution reflecting both FES 2018 and the higher baseline resulting from the large projects connecting in the last few years.

Distribution by ESA

The scenario projects are distributed based on several spatial factors including total availability of agricultural land within each ESA for the distribution of on-farm generation. ESAs on the outskirts of dense 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. Proposed food waste AD projects that either failed in planning or were abandoned are considered as likely sites in the scenarios.

9. Energy from Waste

There is extensive development activity in energy from waste (EfW) projects in the East Midlands licence area, with 11 projects deployed to date and 10 more in the pipeline. The area has two operational Advanced Thermal Conversion Technology (ACT) plants and seems to be shifting towards deployment of this technology over incineration projects. The extent to which the current pipeline is built out will largely depend on the development of ACT as a reliable waste treatment method.

With two ACT plants now operational in the area, the East Midlands could see relatively high deployment of this technology type if it can be proven to work reliably.

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

Energy from waste (MW)	Baseline	2020	2025	2032
Two Degrees	94	119	241	300
Community Renewables		119	207	342
Consumer Evolution		119	214	280
Steady Progression		119	214	250

9.1. Baseline

The WPD East Midlands licence area currently has 11 EfW projects totalling 119 MW. The sizes range from 1.1 to 27 MW. Two of these projects use ACT and the remaining nine incinerate the waste.

Of the 11 projects, four came online since late 2016 when the baseline for the previous study was collated. These are:

- 19.5 MW plant in Sinfin, Derby which is yet to be fully commissioned. It is an ACT plant that has reportedly had issues with the commissioning process[63].
- 5.8 MW Milton Keynes EfW developed by Amey, uses ACT to process municipal waste. It commissioned in 2018 following a two year delay due to the previous technology developer, Energos, going into liquidation.
- 10.7MW waste wood processing site at Pebble Hall farm in Leicestershire which commissioned in December 2016.
- 11.7 MW waste wood processing site at Riverside Industrial Estate in Boston, which became operational in March 2018.

[63] Building (November 2018) *Interserve misses another EfW deadline* https://www.building.co.uk/news/interserve-misses-another-efw-deadline/5096408.article

9.2. Pipeline

The 2017 study's pipeline had seven projects in it. Of these:

- Two projects have come on line: Milton Keynes ACT and the ACT plant at Sinfin in Derby
- Three projects remain in the pipeline:
    - A site at Willowbrook Industrial Estate, at Shelton in Corby submitted a planning application in 2019
    - Newhurst Quarry EfW is due to begin construction in 2019
    - An extension to Eastcroft EfW secured funding in 2018.
- Two projects have been abandoned.

Seven new projects have entered the pipeline and, therefore, the current 2019 pipeline consists of 10 projects.

Regen's analysis reviewed progress on the projects against planning, connection agreement and financial or subsidy milestones. Whether these projects go ahead and when is varied depending on milestones achieved, developer information about planned commissioning dates and whether they are incineration or advanced conversion technologies.

Table 9-2: EfW and ACT East Midlands project pipeline and treatment in scenarios

No. of projects	Project status	Tech. Type	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
2	Awaiting construction	EfW	2024	2024	2022	2023
1	Planning permission granted but financial issues	EfW	Not constructed	Not constructed	2023	2024
2	In or prior to planning	EfW	Not constructed	2024 / Not constructed	2023 - 2024	2024 - 2025
1	Under construction	ACT	2026	2025	2028	2028
2	Planning permission granted	ACT	2023 - 2027	2021 -2026	2028 - 2030	2030 or Not constructed
1	Planning permission granted but financial issues	ACT	2029	2028	2032	Not constructed
1	In or prior to planning	ACT	2024	2026	Not constructed	Not constructed

9.3. Energy from waste growth factors

Availability of resource

The key variable for the future development of EfW is the availability of the waste resource. Industry sources differ on when they believe EfW capacity will exceed supply as it will depend on variables such as the level of export or import of waste to the EU post Brexit, the setting and achievement of recycling targets and the availability of untapped resources such as commercial and industrial waste. The UK government's Clean Growth Strategy includes the pledge to achieve "zero avoidable waste by 2050".

The available resource in the licence area is likely to be relatively constrained in the future due to the existing widespread provision of municipal energy from waste plants.

Subsidy availability

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

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

As the biogas market takes off, there is potentially a significant role for ACT technologies in waste management and energy generation.

ACT projects can also produce biogas for direct injection into the gas grid or use in transport, with subsidy support available through the RHI and the RTFO.

If the market for biogas accelerates there is likely to be an upsurge of interest in ACT[65] [66]. There may be opportunities for small-scale ACT plants to develop processing commercial waste streams, such as medical waste.

Incineration tax

The 2018 Budget included provision for a tax on the incineration of waste to encourage recycling and waste reduction[67]. This tax is assumed to be introduced in the early 2020s in the high decarbonisation scenarios for incineration projects but not ACT projects.

ACT development

There are few ACT plants successfully operating in the UK, with issues around the reliability of the technology and projects failing to commission as a result. Further investment is needed in ACT to develop a reliable technology and the rate of development is considered under the different scenarios.

In the East Midlands licence area, the planning failure rate for EfW projects is slightly lower the UK average.

In the UK, there is an active network of opposition to proposed EfW facilities, including ACT plants despite their lower local impacts. Opposition focuses on not reclaiming the valuable resources in residual waste as well as local pollution concerns[68].

Based on the UKWIN[1] interactive map of sites, around 50% of proposed EfW incineration and ACT sites have been effectively opposed or have otherwise failed to progress.

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[64] MRW (2017) https://www.mrw.co.uk/latest/act-and-biomass-schemes-backed-in-cfd-auction/10023285.article

[65] ENDS waste and bioenergy (2018) https://www.endswasteandbioenergy.com/article/1464257/cadent-highlights-biosng-potential

[66] Barrow Green Gas (2016) http://www.barrowgreengas.co.uk/industry-news/2016/5/4/biogas-comes-of-age

[67] HM Treasury (2018) *Budget 2018* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/752202/Budget_2018_red_web.pdf

[68] United Kingdom without Incineration Network http://ukwin.org.uk/

Table 9-3: 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 early 2020s	Incineration tax introduced from early 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 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

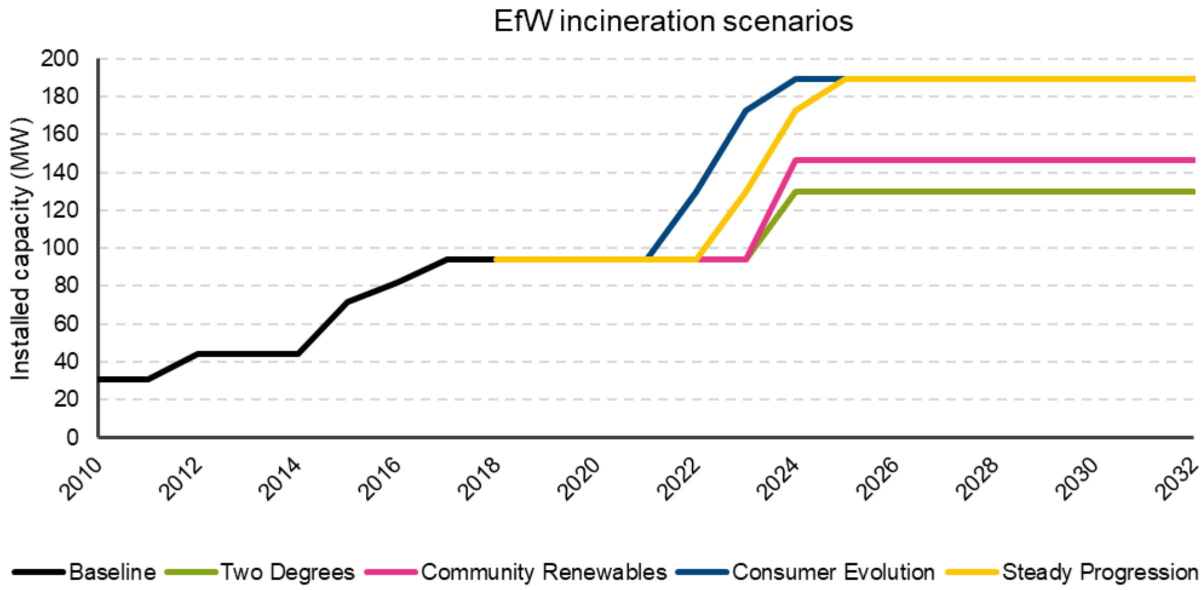
9.4. Energy from waste scenarios

The analysis is split between EfW projects and ACT projects.

EfW Incineration summary

The EfW incineration scenarios do not include any new projects that are not already in the pipeline. This reflects the relatively high deployment in the licence area to date, the long lead in times for EfW projects and the relatively strong pipeline. Under the Consumer Evolution and Steady Progression all the planned incineration projects are built. The other scenarios see lower deployment as an incineration tax is introduced.

Figure 9-1: WPD East Midlands energy from waste capacity by scenario

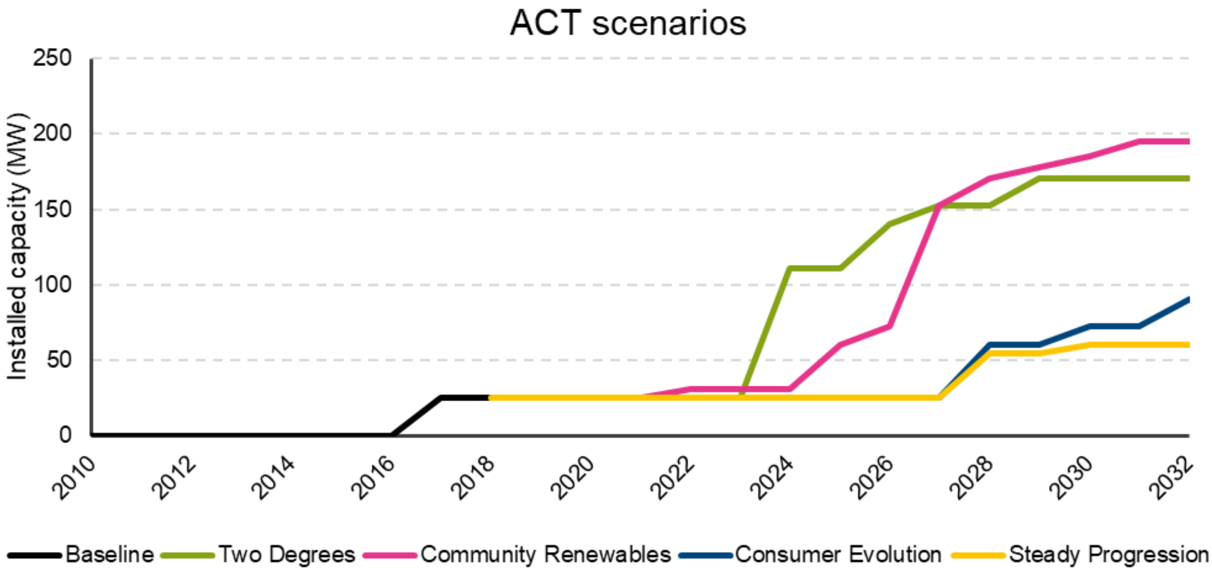


ACT summary

The Community Renewables scenario sees the highest level of deployment of ACT projects, with three additional projects as well as the five in the pipeline being built, thanks to support for medium scale ACT plants both with subsidy and through the planning system. Under Two Degrees, only the pipeline ACT projects are built, with an 80 MW proposed plant constructed earlier under this scenario than Community Renewables due to support through the planning system for this larger scale project.

Under Steady Progression only ACT plants that are already well advanced are built. Under Consumer Evolution, a small number of ACT projects are built later in the 2020s as the technology becomes cheaper and more developed.

Figure 9-2: WPD East Midlands ACT growth by scenario



Comparison to other scenarios

The 2017 scenarios did not show the results split by ACT and incineration technologies and as a result the studies are not direclty comparable. Under Consumer Evolution there is around 95 MW of new incineration capacity (from pipeline projects) in the 2019 study, which is broadly in line with the 2017 study which assumed an additional 82 MW of pipeline capacity. The 2017 study concluded that no new incineration plants would be built beyond the pipeline and this remains the result in this study.

The 2017 study hypothesised that up to 7 new ACT plants would be built by 2030. This has been increased to eight potential new plants by 2032 under the Community Renewables scenario, reflecting the extended timescale and the commissioning of two new ACT plants in the licence area in 2018.

Alll the scenarios see higher deployment of incineration plants than might be expected under a direct apportioning of the FES 2018. This is due to the relatively strong pipeline in the area. The introduction of a possible incineration tax as a factor has changed the shape of the scenarios relative to the FES.

For ACT technologies, the scenarios are broadly in line with the FES 2018, although the growth rate is below what the FES predicts for all scenarios except Two Degrees. The shape of the scenarios differs from the FES due to them being based on estimated deployment dates for projects in the pipeline.

Distribution of technology across ESAs

The additional projects are all based on locations of potential projects in the pipeline.

10. Biomass CHP

East Midlands has around 108 MW of biomass from 31 projects and a relatively significant pipeline of 10 projects totalling 41 MW.

The continuing role of biomass in generating electricity is controversial due to sustainability concerns. If sustainability criteria are met, there could be a limited but increased role for biomass generation.

The FES 2018 predicts a small intermediate technology role for biomass generation in the energy transition.

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

MW	2018	2020	2025	2032
Two Degrees	108	118	156	156
Community Renewables		116	150	150
Consumer Evolution		108	121	121
Steady Progression		108	117	117

10.1. Baseline

Biomass is a relatively significant technology for the licence area with 31 biomass fuelled electricity generation plants operational in the licence area. The largest is a 45 MW Sleaford Renewable Energy Plant which uses straw and has been operating since 2013.

The rest are significantly smaller with an average size of 2 MW. This capacity is installed in a variety of locations, waste processors, farms and 7.8 MW at a sawmill.

10.2. Pipeline

There are 10 biomass projects in the WPD East Midlands ANYC database. Table 10-2 sets out how these are treated in the scenario projections. Projects with 2018 connection agreements go ahead earlier and all projects go ahead in Community Renewables.

Table 10-2: East Midlands biomass CHP pipeline

ESA	MW	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Hinckley 132/33	10.0	2022	2021		2025
CORBY No2 33kV S STN	9.0	2024	2023		
CORBY No2 33kV S STN	9.0	2024	2023		
Burton 132/33	5.0	2021	2020	2022	2024
PAILTON 33KV S STN	3.0	2022	2021	2024	
BUXTON 132kV S STN	2.7	2021	2020	2022	2024
WILLOUGHBY 33kV S STN	0.8		2020	2022	2024
DAVENTRY 33KV S STN	0.6		2021	2024	
HARBURY 33kV S STN	0.5		2021	2023	

10.3. Biomass growth factors

The growth of biomass as a fuel for electricity generation is controversial for sustainability reasons. For energy balancing however, it provides useful baseload and dispatchable generation.

Biomass generation will need to meet high sustainability standards in order to play an effective role in decarbonising the UK energy mix.

Opponents of the technology believe that the sustainability impacts could be significant due to air pollution, carbon emissions and energy crops displacing food. Most believe that waste wood should be prioritised for heating rather than electricity generation.

FES 2018, however, assumes a low level of growth in the medium term. Despite sustainability concerns, the UK has seen significant growth in biomass electricity generation capacity, with a 145 MW increase in capacity from 2016 to 2017, representing a 5.1% increase[69]. The Medium Combustion Plant Directive which is effectively halting the use of diesel generators, may be steering potential site owners towards biomass generation.

Ongoing subsidy support for projects meeting sustainability standards

The government has recognised the sustainability issues surrounding biomass generation, whilst continuing to offer subsidy support through the CfD.

Firstly, biomass generation is only eligible for subsidy if it produces useable heat through CHP. Secondly the government published plans in autumn 2018 to adopt a new greenhouse gas threshold of 29kg CO_2/MWh for new biomass projects under the next round of the CfD. This is a sharp reduction compared with the 180kg CO_2/MWh under the Renewables Obligation. According to Business Green, "the tightening of the standards means biomass plants would have to operate with almost 95% lower carbon emissions than the average EU fossil power plant." If these sustainability criteria are successful, there is likely to be continued subsidy support for a small number of biomass CHP projects.

The debate about the role of biomass in generating electricity is likely to continue. In the high decarbonisation scenarios, the assumption is made that the new sustainability criteria together with subsidy support are successful in producing projects that meet high decarbonisation standards, allowing for some growth in capacity.

69 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/712458/Energy_Trends_March_2018.pdf

10.4. Biomass scenarios

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

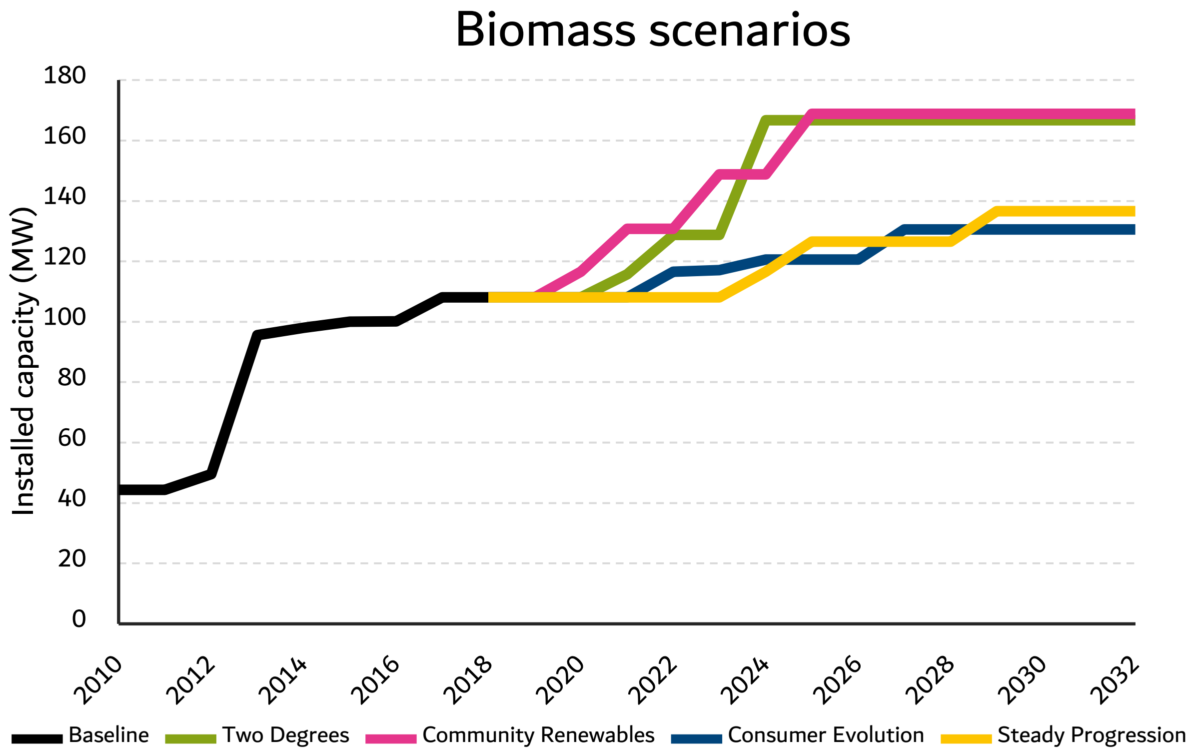


Table 10-3: Assumptions for factors influencing capacity growth for biomass generation

Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government policy and support				
Continued subsidy support for projects meeting sustainability standards	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				
Supportive 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.

Relationship to FES 2018

The FES 2018 recognised the limitations on biomass electricity deployment. It includes a role for biomass electricity generation that increases until 2030 and then falls again as further decarbonisation is required and biomass generation no longer provides sufficient carbon savings.

The relatively high baseline and pipeline in the East Midlands means there is less potential growth in the area and therefore all scenarios are slightly lower than the FES 2018.

Distribution of technology

There is only a single site projected for development other than those identified as pipeline projects, which goes ahead near Northampton ESA.

11. Hydropower

The East Midlands licence area has 28 hydro projects with 4.5 MW of installed capacity. Capacity could more than double in the highest green scenarios.

Within the licence area, Derbyshire has many small projects, Nottingham and the River Trent have the greatest installed capacity, as well as the majority of the pipeline.

There are a few significant areas of potential for hydropower development in East Midlands in both Nottingham and Derbyshire.

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

Hydropower capacity growth MW)	2018	2020	2025	2032
Two Degrees	4.5	4.5	10.4	10.4
Community Renewables		4.5	9.6	13.1
Consumer Evolution		4.5	7.1	8.1
Steady Progression		4.5	5.5	7.0

11.1. Baseline

Of the 28 hydropower projects in the licence area, 15 are in Derbyshire with an average size of 90 kW and four in Nottingham including the biggest 1.7 MW at Beeston Weir installed in 2000.

Although most capacity has been installed before 2000, 11 projects were supported by FIT and installed between 2013 and 2017 adding 1.5 MW of capacity.

11.2. Pipeline

There are five hydro projects in the pipeline including a 1.6 MW project at Cromwell Weir on the River Trent which received planning permission in 2018 but this was revoked shortly afterwards due to further environmental assessments. Three of the four smaller projects are also in Nottingham and had applied for connections towards the end of 2018. The smallest scheme is in Derby.

The pipeline treatment for the hydropower pipeline is outlined in Table 11-2. All go ahead in Community Renewables with fewer in Steady Progression.

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

Scheme	Capacity (kW)	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Cromwell Weir	1600	2021	2022	2023	-
Derby	188	-	2023	2025	-
Gunthorpe Weir	780	2022	2023	2025	-
Stock Lock	999	2022	2024	-	2025
Hazelford Lock	999	2022	2024	-	2027

11.3. Hydropower growth factors

The hydropower resource in the East Midlands licence area tends to be low head on existing weirs and locks. Such as the Hazelford Lock on the River Trent.

Subsidy availability

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

The technology is relatively mature, with limited market scale, and so it is unlikely to see the type of cost reductions that other renewable technologies are expected to achieve; it is unlikely that hydropower will be widely viable without further subsidies in the near or mid-term.

> Hydro technology installation costs remain high and with a volatile power price and no subsidy it is expected to be difficult to finance.

Environmental permitting

Environmental requirements increase the cost of installing even the smallest scale hydro projects. In March 2016, the UK government proposed new legislation requiring the removal of river obstructions or the building of fish passes to provide a route around or through these hurdles.[70] The legislation is yet to be passed. There are opportunities for hydropower projects to benefit river ecosystems offering win-wins, e.g. by installing fish passes around existing barriers.

New business models

Hydropower has the potential to play a role in the development of local energy markets. For example, the Energy Local project in Bethesda, North Wales, is trialling a local energy club that uses the electricity generated from a local hydropower project[71]. In addition, the predictable nature of hydropower generation, alongside its potential to store energy, make it a suitable technology to potentially provide flexibility and balancing services.

In 2018 Barn Energy announced the co-location of two 1.2 MW batteries next to two river hydro projects. Both were delivering fast frequency response and exporting during high price periods to maximise the value of the hydro schemes. [72]

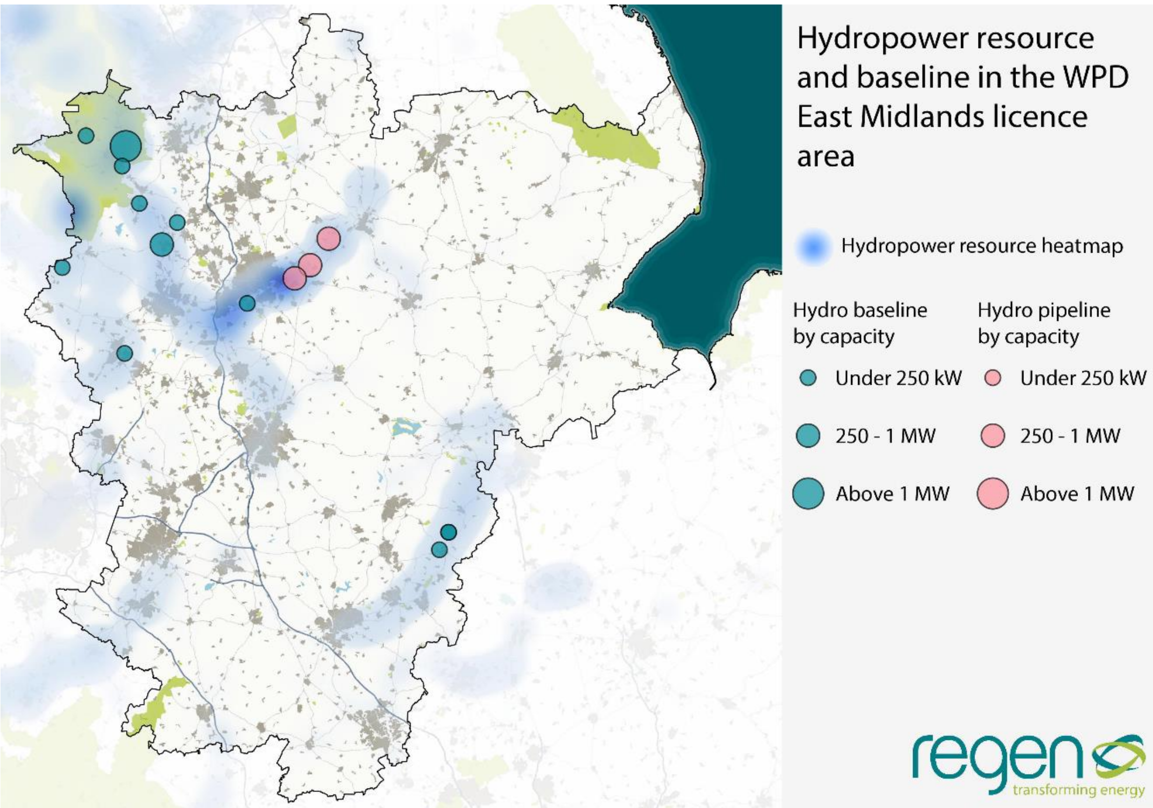
[70] http://www.renewablesfirst.co.uk/hydropower/hydropower-consenting/hydropower-environmental-consenting/
[71] http://www.energylocal.co.uk/cyd-ynni/
[72] http://www.barnenergy.co.uk/single-post/2018/03/22/First-Co-Location-of-Batteries-at-UK-Hydro-Schemes-in-the-UK

A summary of the growth factors for hydropower are outlined in Table 11-3.

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

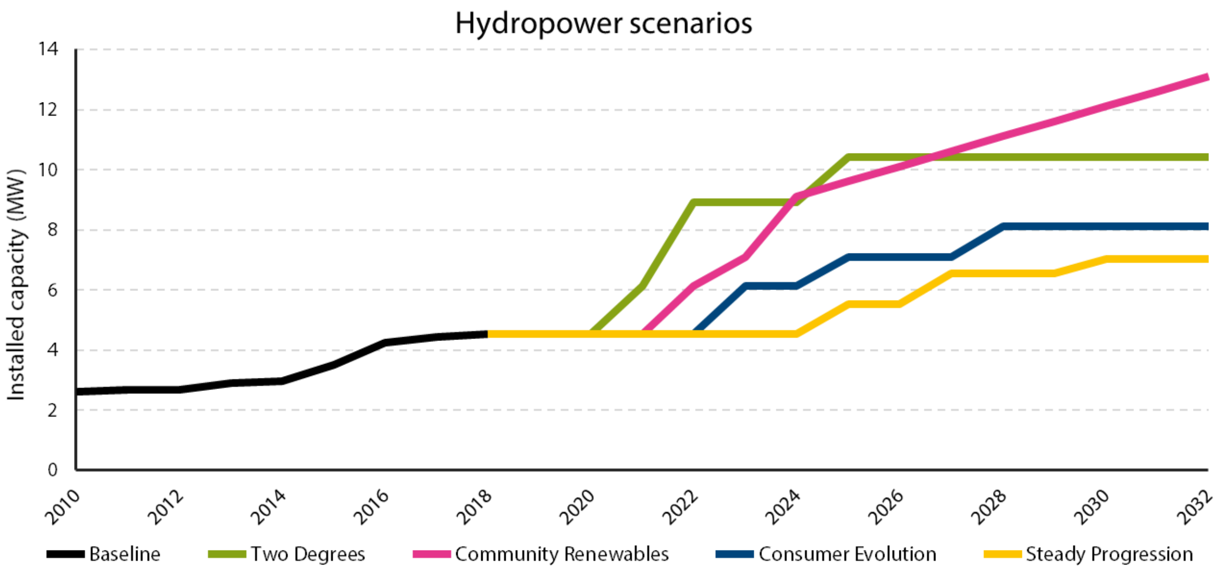
Growth factors	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Government support				
Subsidy availability	Government subsidy for hydro in place	Government subsidy focused on small-scale projects	No subsidy for hydropower under this scenario.	No subsidy for hydropower under this 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



11.4. Hydropower scenarios

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



Scenario summary

Community Renewables has the highest level of growth with all the pipeline projects going ahead by mid 2020s. Further small projects continue to go ahead during the rest of the scenario period. Two Degrees sees the larger pipeline projects go ahead and two further large projects.

Both Consumer Evolution and Steady Progression see little further growth outside the pipeline.

Relationship to other scenarios

The scenarios are ahead of both the 2017 study and 2018 FES projections because of the relatively good small-scale hydro resource and pipeline.

Seven projects totalling 1 MW have connected since the previous study with another four projects in the pipeline of 4.5 MW. As a result of the resource in Nottingham, Amber Valley and Derbyshire Dales, the licence area is likely to see growth slightly ahead of the FES 2018 projections.

Distribution of technology across ESAs

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

12. Diesel and Gas

Fossil fuelled electricity generation technologies continue to play a critical role in the UK energy system, but increasingly their modes of operation are changing from providing the bulk of baseload to more of a peaking and backup role.

Over the next two decades, the capacity of electricity generation from gas increases in all scenarios, whilst conversely diesel generating capacity reduces in all scenarios from the early 2020s onwards.

In all scenarios, diesel generation capacity starts to decline by the mid-2020s with gas capacity accelerating over the scenario period.

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

Diesel Generation (MW)	2018	2025	2032
Two Degrees	65	49	30
Community Renewables		55	38
Consumer Evolution		67	50
Steady Progression		65	50

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

Gas and Gas CHP (MW)	2018	2025	2032
Two Degrees	1108	1606	1916
Community Renewables		2119	3282
Consumer Evolution		2201	3217
Steady Progression		1410	1625

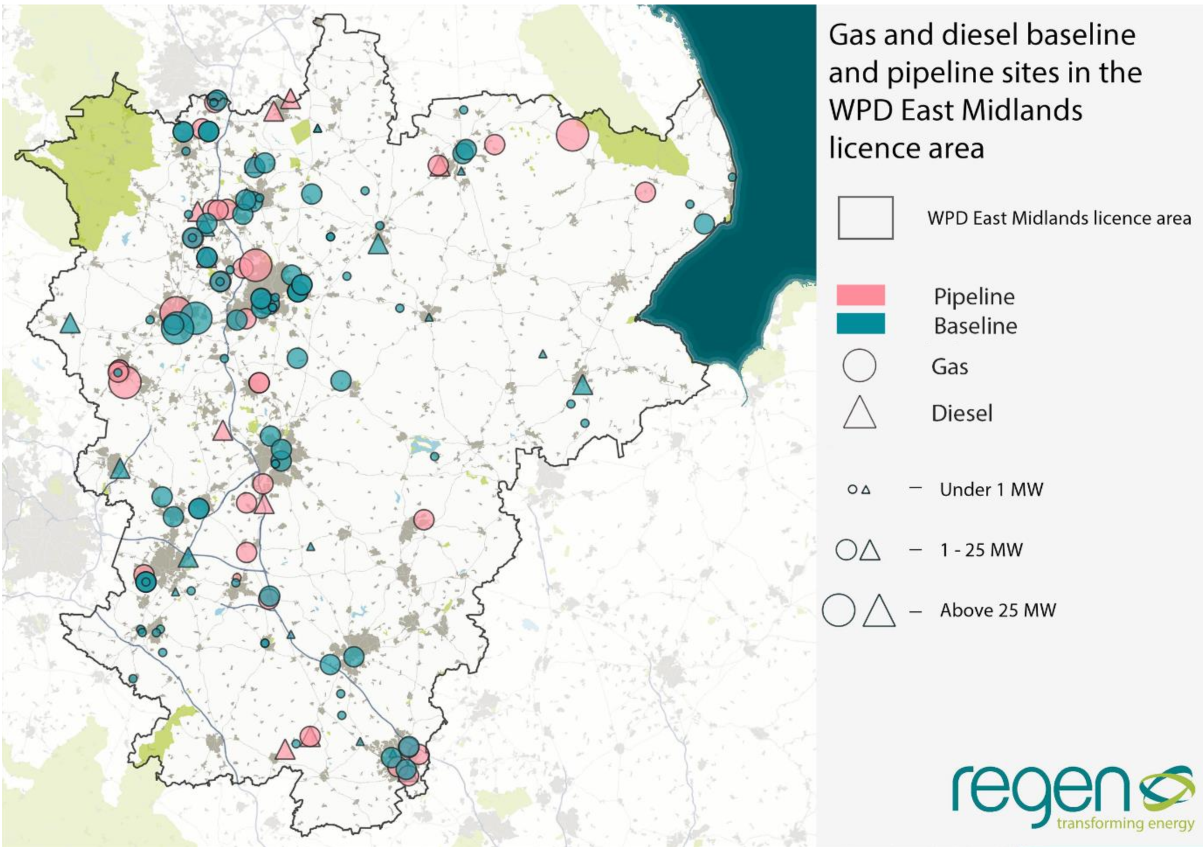
12.1. Baseline

Both diesel and gas generation capacity have seen significant increases in recent years, concentrated mainly in short bursts of project connection. Between 2012 and 2013, there was a huge increase in diesel capacity, jumping from 8 MW to nearly 46 MW. From 2013 until 2018, there was continued growth resulting in 65 MW of connected diesel capacity by 2018.

Connected gas and gas CHP capacity remained stable between 2012 and 2015 (when there was the biggest rise in connected diesel capacity), increasing slightly from 212 MW to 282 MW. In 2015 however, this figure jumps to 962 MW, an increase of 680 MW in just one year, with almost all this growth attributed to gas generating plants rather than gas CHP. 2016 saw a return to more modest growth, with 60 MW connected in 16/17 and 103 MW connected in 17/18. By 2018, about 21% of the installed gas generation capacity was gas CHP.

The huge increase in connected gas generation plant can be explained in part by the launch of the first Capacity Market (CM) auction in 2014. The CM was introduced to ensure that there was enough generation capacity available to cover winter peaks in demand and to encourage gas generation to be built. However, it has not been entirely successful in bringing forward new large gas plants. For example, no new CCGT plants were procured in the 2017 T-4 auction.

Figure 12-1 Gas and diesel baseline and pipeline sites by capacity



12.2. Pipeline

The East Midlands licence area has around 40 diesel and gas generation projects with accepted-not-yet-connected agreements, five of these are diesel projects. Three diesel pipeline projects have won capacity market contracts totalling 49 MW for delivery in 2020/2021. As these plants were bidding in 2016/2017, it may have been hoped they would be built before 20 December 2018 and therefore count as 'existing units' under the Medium Combustion Plant Directive (see below). Projects with capacity market contracts are expected to go ahead in all scenarios.

Gas and gas CHP projects with an accepted-not-yet-connected agreement total 441 MW of capacity. The vast majority of gas pipeline projects are electricity only plants, the largest of which is a 50 MW plant at Horncastle. Of the electricity-generating only gas projects, only six have bid into the CM. The largest five electricity-only gas projects did not bid into the CM, indicating alternative revenue generation.

Medium Combustion Plant Directive

The UK government has passed legislation to introduce new emission limits for mid-sized generators from December 2018. The legislation establishes a ceiling on nitrogen oxide emissions, primarily aimed at curbing the participation of diesel engines in the CM.

The new limits came into effect for new plant from 20 December 2018. Existing generators over 5 MW capacity have until January 2025 to comply, smaller generators of under 5 MW have until January 2030.

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

Industry have been aware of the planned changes since early 2016, with a strong expectation that this would demand emission abatement investment in new plant, almost certainly for diesel but potentially for cheaper gas engines too. Following the success of diesel-fired reciprocating engines in the T-4 auctions of 2014 and 2015, the Department for Farming and Rural Affairs promised to introduce new emissions limits for diesel as part of MCPD to prevent 'dirty diesel' accessing further subsidy. It is widely expected that the MCPD regulations will significant impact the pipeline of diesel projects, and to a lesser extend some of the smaller gas generation plants.

Planning permission

Those projects with planning permission are outlined in Table 12-3. A further 32 projects in the pipeline do not have planning permission currently.

Table 12-3: Pipeline projects with planning permission

Project name	Size (MW)	Fuel type	ESA	Two Degrees	Community Renewables	Consumer Evolution	Steady Progression
Silverstone, Litchlake Farm	5	Gas	BRACKLEY 132kV S STN	2021			
The energy centre, City Hospital Nottingham	3	Gas CHP	Nottingham North 132/11	2022	2022	2022	2025
Limestone Quarries, Buxton	1	Gas CHP	BUXTON 132kV S STN	2021	2020	2020	2025

12.3. Diesel and gas growth factors

Capacity market and balancing services revenues

The CM is key element of the UK's plan to decarbonise electricity generation whilst maintaining security of supply and driving down cost. It was primarily implemented to encourage the building of new CCGT plants and provide contracted supply in times of system stress.

Currently, the CM is in a 'standstill' with no payments to contractors being made. This is following the European Court of Justice ruling in late 2018 that the EU Commission should have consulted more before granting state aid approval for the CM in 2014.

Whilst the CM is likely to be back in action by winter 2020, the impact of its absence on new gas projects may well be limited. For this first time since 2014, no new gas generating plants were awarded a CM contract in the 2017 T-4 auction.

In general, CM prices have come in lower than expected, potentially providing less of an incentive for new gas projects than had been envisaged. As such, the halting of the CM may not make much difference to the pipeline of new gas projects coming forward.

Role of peaking plant / Demand side response (DSR)

Gas generation capacity is expected to increase under all scenarios out to 2032. However, there are to clear trends for this growth:

- A tripling of capacity compared to 2018 levels under Community Renewables and Consumer Evolution scenarios. However, the majority of the capacity will be peaking plant with the utilisation rate expected to be low.
- A more modest 70-80% increase for Steady Progression and Two Degrees scenarios. This capacity is expected to have higher utilisation rates.

The lower growth modelled in Steady Progression and Two Degrees is due mainly to the expectation that, whilst significant new gas peaking plant will be required, it will be provided by larger transmission connected plants.

Table 12-4: Assumptions for factors influencing capacity growth for fossil fuels

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 demand for flexibility services, as there are significant amounts of green, large-scale generation	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 battery 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

12.4. Diesel and gas scenarios

Figure 12-2: WPD East Midlands licence area diesel capacity growth scenarios.

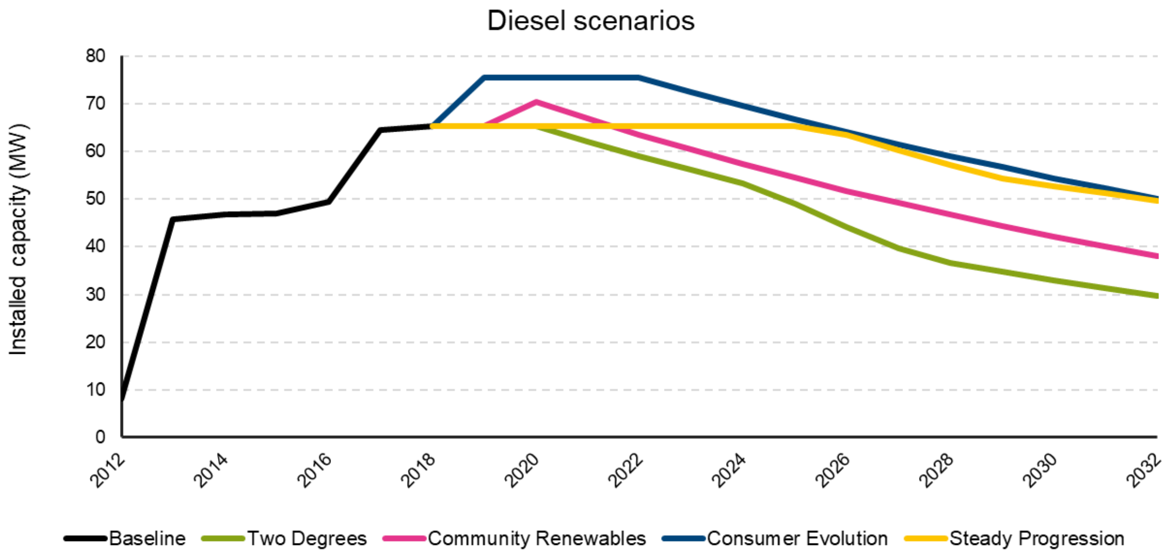
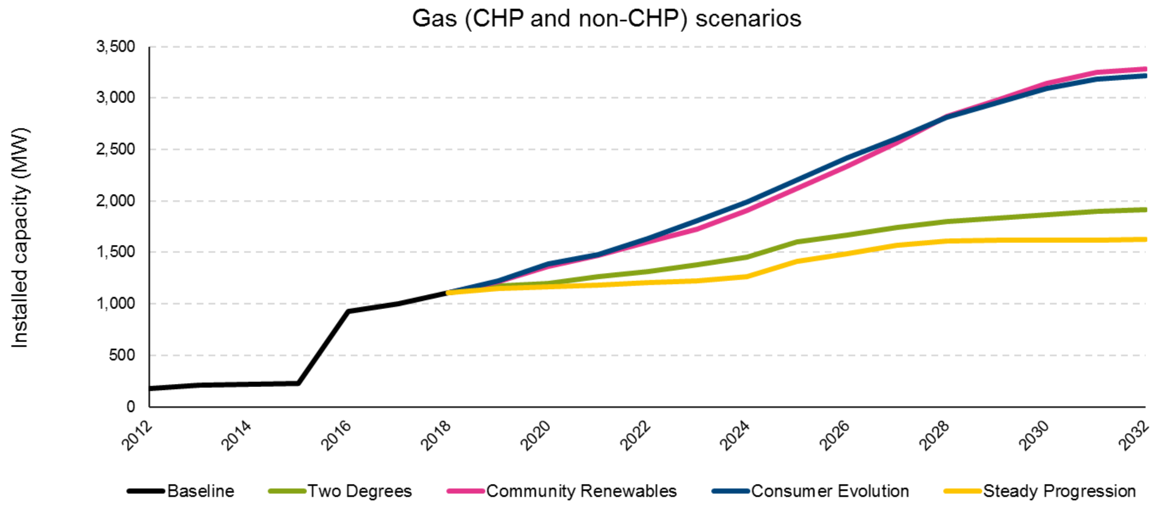


Figure 12-3: WPD East Midlands licence area gas capacity growth scenarios.



Scenarios summary

Diesel capacity drops in all scenarios towards the end of the scenario period as local air quality controls make the technology unviable for electricity generation.

In the gas scenarios, Community Renewables and Consumer Evolution both see a significant jump in gas capacity in 2019 of around 400 MW. However, the scenarios are expected to differ considerably in the utilisation rate of the assets with gas in Community Renewables providing peaking power only. For the Steady Progression and Two Degrees scenarios, a similar jump in capacity is experience later, from 2024. In the former, the growth in capacity continues at pace (although still not as rapid as the connection rate seen in 2015/2016).

Relationship to other scenarios

The 2017 scenario report conducted for WPD did not include modelling for fossil fuelled technologies. However, the modelling undertaken for this report shows similar trends for diesel and gas generation to that undertaken in the 2018 Future Energy Scenarios.

When combining gas and gas CHP in FES 2018, there are two clear trends - a high level of growth for the decentralised scenarios, and a lower, more incremental level of growth for the more centralised scenarios.

Distribution of technology across ESAs

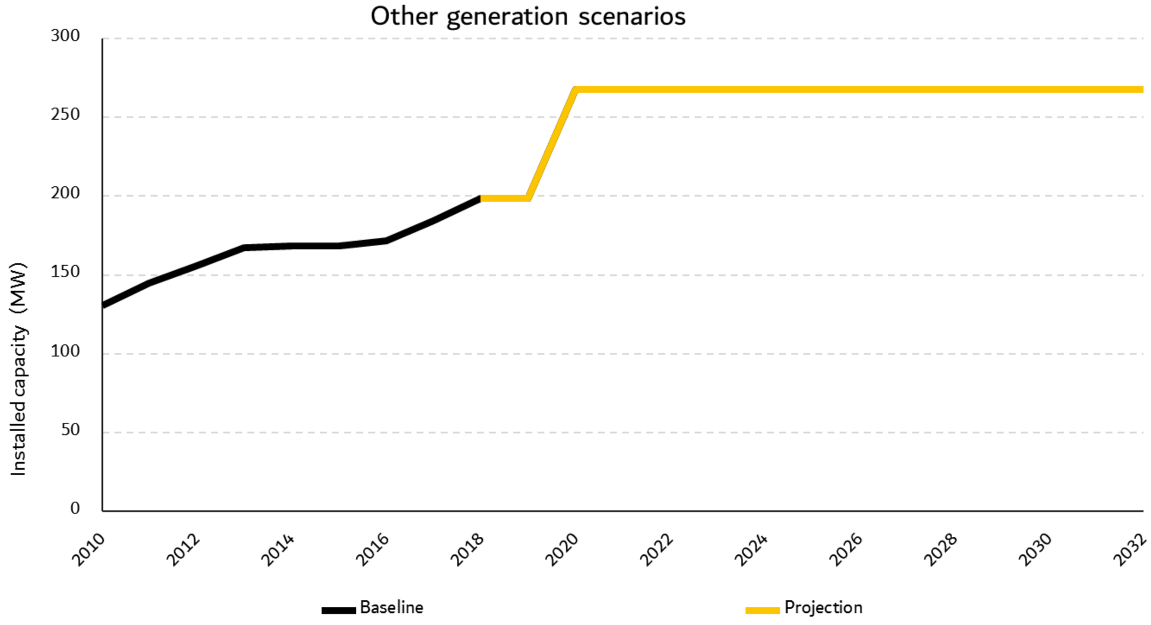
Diesel, gas, and gas CHP have been projected and distributed separately. Each has been distributed according to the current technology baseline capacity in each ESA.

13. Other generation

13.1. Baseline

The projects in the 'other generation' category total 199 MW of capacity. The majority of these projects are landfill gas or sewage gas sites.

Figure 13-1 Historic growth in 'other generation'



13.2. Accepted not yet connected and scenarios

There are 22 sites with 69 MW from projects in the 'other generation' ANYC database.

C. Battery storage introduction

Battery storage has seen significant amounts of interest in the last few years and the East Midlands has good potential for future increases in capacity. However, in order to be built, storage needs a viable business model.

In Regen's 2016 energy storage whitepaper[73], a set of business models were developed to categorise different classes of storage assets, describing the type(s) of revenue streams different classes of asset might target and their related operating behaviour, see Table C-1.

These business models are used as the basis of the growth scenario projections outlined in this chapter and output dataset.

Table C-1: Energy storage business models developed by Regen

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

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

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

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

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

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

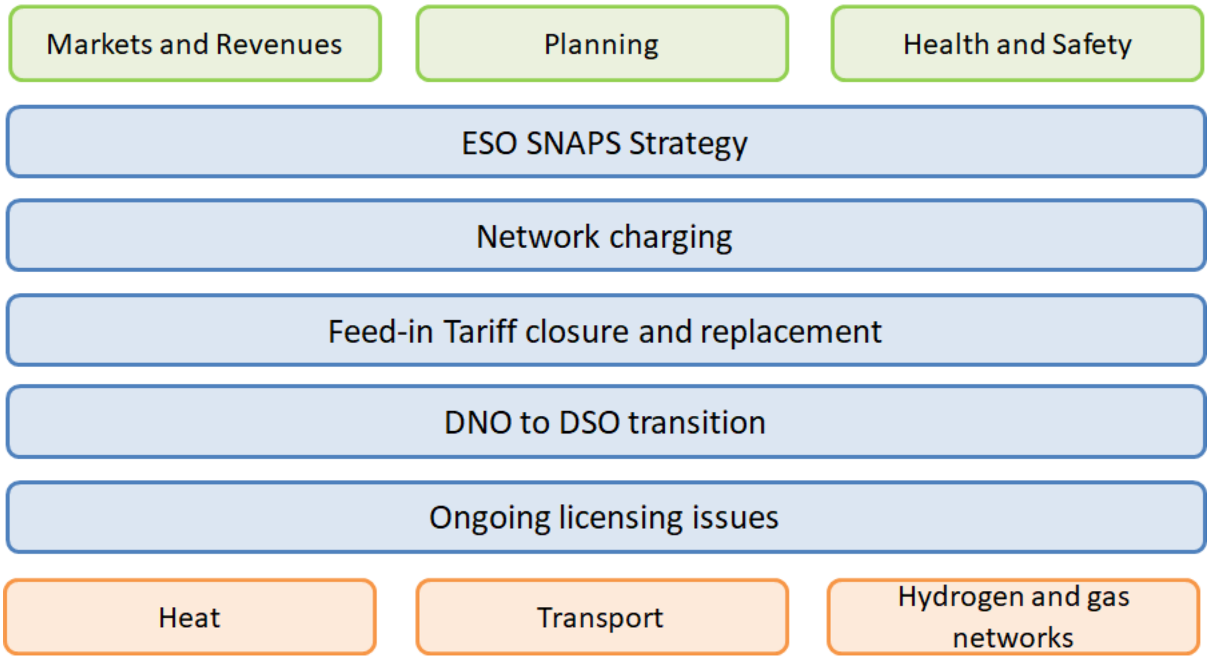
Evolving business models and revenue streams

Since 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 above have undergone an evolution over the past 2-3 years. In 2018 Regen took on the management of the **Electricity Storage Network** (ESN), the only industry organisation dedicated to specifically represent the interests of the electricity storage sector.

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

The near-term policy priority areas for the ESN are predominantly related to markets, revenues and storage business model's evolution, see Figure C-1.

Figure C-1: Electricity Storage Network policy priority areas 2018



The regulatory, policy and market changes that have been implemented in 2017/18 and continue to be progressed further in 2019, have all had detrimental effects to business cases for storage assets. This shifting policy and market environment for storage has caused projects targeting one primary revenue stream to focus on additional or alternative sources of income. In addition to this, with control systems, innovative solutions and hybrid/co-location sites starting to appear, the potential for storage assets to act as more merchant energy traders, switching their attention to target different sources of income, is becoming more commonplace.

In short, flexible technology operating a flexible business model. Some of the key evolutions to the six storage energy business models are outlined in Table C-2.

Table C-2: Evolutions to energy storage business models

Business Model	Market evolutions and impacts on new storage projects
Response Services	**Enhanced Frequency Response (EFR)** has only completed 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[74]. The **Fast Frequency Response (FFR)** market has seen a significant level of interest from a variety of technology providers. The oversubscription of bidders into FFR auctions has resulted in prices dropping notably year-on-year[75]. The future trajectory for FFR prices is unclear, but the more projects are built and bank on FFR income, the more diluted a market it will become. Storage projects that are reliant on FFR or have the income from it as the backbone of their business case, may as a result either be abandoned or delayed from being built, whilst alternative revenue streams are found.
Reserve Services	The **Capacity Market** (**CM**) has historically had a fair amount of interest from electricity storage operators. The substantial de-rating of shorter-duration storage in the CM in 2017 was a heavy blow[76] for storage business cases. In addition to this, auction clearing prices have significantly dropped in recent years[77]. The broader issue of the European Commission's annulling of State Aid approval for the CM in November last year[78], and its resultant suspension, caused further uncertainty around the future of the programme, its existing contracted participants and future auctions. Government narrative around this issue suggests more of a "when the CM will be reinstated" rather than "if it will". The suspension caused the 2018 T4 auction to be delayed, to which the Government have proposed running a T3 auction in 2019 (i.e. same delivery year as T4-2018), whilst also seeking reinstatement of the State Aid funding to get the CM up and running again. More recently, the EMR Delivery body published a consultation around enabling renewable energy technologies to participate in the CM and the methodology by which to de-rate them. The role of storage in providing an alternative route to market through co-location could provide a renewed opportunity and role for longer duration battery projects co-located with generation in the CM. The table below outlines the de-rating (in the form of an Equivalent Firm Capacity percentage rating) for renewable technologies and a 30min duration battery, suggesting that co-location for longer duration storage could be a potential opportunity, to feature as part of either the Reserve Services/Generation Co-Location business models

[74] 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

[75] See Energyst article showing Baringa analysis of dynamic FFR prices 2015-2018: https://theenergyst.com/can-balancing-mechanism-replace-ffr-price-erosion/

[76] 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

[77] 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

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

Technology	Auction (delivery year) Equivalent Firm Capacity	Equivalent annual payment for: £20/kW clearing price 2MW capacity project
Onshore wind	T-1 auction (20/21) = **8.98%** T-3 auction (22/23) = **8.4%** T-4 auction (23/24) = **8.2%**	T-1 auction (20/21) = **£3.6k** T-3 auction (22/23) = **£3.4k** T-4 auction (23/24) = **£3.3k**
Offshore wind	T-1 auction (20/21) = **14.65%** T-3 auction (22/23) = **12.89%** T-4 auction (23/24) = **12.11%**	T-1 auction (20/21) = **£5.9k** T-3 auction (22/23) = **£5.2k** T-4 auction (23/24) = **£4.8k**
Solar PV	T-1 auction (20/21) = **1.17%** T-3 auction (22/23) = **1.76%** T-4 auction (23/24) = **1.56%**	T-1 auction (20/21) = **£468** T-3 auction (22/23) = **£704** T-4 auction (23/24) = **£624**
30minute Duration Battery Storage	T-1 auction (20/21) = **17.19%** T-3 auction (22/23) = **15.04%** T-4 auction (23/24) = **15.04%**	T-1 auction (20/21) = **£6.9k** T-3 auction (22/23) = **£6k** T-4 auction (23/24) = **£6k**

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 asset 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[79], including a number of locations in the East Midlands licence area. 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 FFR contracts. 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 however, nor will it be the 'silver bullet' that can replace the level of income from CM, EFR or early FFR markets.

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 grid import demand and thus 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[80]. Among the options being considered is the removal of the Triad charging mechanism as a means to recover TNUoS customer costs, moving the 'residual' portion of the DUoS charges to be fixed charges, determined by installed capacity (MW) or network location (through Line Loss Factor Class, LLFC). This therefore causes the charging structure for a major user's electricity bill to see some significant changes in the next few years, making it difficult to nail down the business case, especially a proportion of 'time of use' based charges move to be fixed costs.

[79] See WPD Flexible Power campaign website: https://www.flexiblepower.co.uk/
[80] 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

Domestic & Community	The potential for homeowners with PV to use storage to make more use of their generation at home, thus reducing imports and saving money on bills, is a key factor for domestic storage. Currently this source of benefit is not sufficient to pay back the cost of a home battery. There is the potential for domestic batteries to play a role in providing financial benefits to individual homeowners due to a number of recent market developments. These developments include the removal of the Feed-In Tariff (FIT) export payments and its potential replacement[81], live examples[82] [83] of domestic storage engaging with DNO local flexibility markets and wider feasibility studies around community level flexibility aggregation services[84]. A key enabler to access other benefits from domestic scale storage, is the deployment of domestic smart meters, which has been often reported as below target levels[85].
Generation Co-location	The business model around co-locating storage with generation (PV, wind or other technologies) is still relatively in its early days. Co-located battery storage may allow more renewable energy sites to secure grid connection capacity by '**peak-shaving**' generation. It could also help mitigate electricity market price risks either through securing response/reserve flexibility contracts or through **price arbitrage**, by storing and selling low cost generation during higher price periods. A key driver for the viability of this business model, is the point when storage co-location starts to improve the business case for investment in ground-mounted solar without the need for ancillary services income. Currently storage costs coupled with marginal benefits from price arbitrage makes it difficult for co-location to stack up. It is possible that enabling generation projects to access **more volatile price markets**, could unlock the level of revenue required to make co-location business cases stack up. Also as discussed earlier, the move to permit renewable energy technologies to participate in the **CM** also provides a potential opportunity for energy storage co-location or 'hybrid sites', potentially improving the levels of income.
Energy Trader	Energy Trader could be a business model that sees a notable amount of growth. It's clear to see that there are a number of instances of market saturation, regulatory 'moving goal posts' and reliance on other sector changes. With the right level of flexibility and risk policy, more 'merchant' storage projects and operators, could adapt to target multiple operating modes and related sources of revenue. Higher value price markets such as the **Balancing Mechanism (BM)** is one area that storage could secure more lucrative levels of price arbitrage income.

[81] See BEIS *Consultation on the Feed-In Tariffs Scheme*, July 2018: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726977/FITs_closure_condoc_-_Final_version.pdf
[82] See Powervault press release regarding home battery portfolio in/around London contracting with UKPN: https://www.powervault.co.uk/article/powervault-to-deliver-local-flexibility-in-london-with-ukpn/
[83] See Centrica Cornwall Local Energy Market update around Sonnen residential battery installations: https://www.centrica.com/news/residential-installs-begin-cornwalls-local-energy-market
[84] 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/
[85] See BEIS Smart Meter rollout progress 2018: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/767128/smart-meter-progress-report-2018.pdf

14. Electricity storage

With an installed baseline of 11 storage projects, totalling 38 MW and still some good network availability, the East Midlands licence area has high potential for growth in the connection of electricity storage, particularly compared to other WPD areas such as the South West and South Wales.

A solid baseline of battery projects, active pipeline and ever evolving business models, makes future energy storage scenarios difficult to predict.

The study shows a diverse mixture of storage business models in both the baseline and near-term pipeline. This reflects the diversity of sources of income that storage assets need to secure in order to make business cases stack up. See Table 14-1.

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

	Cumulative	Baseline	2020	2025	2032
Two Degrees	Response services	10	120	160	170
Two Degrees	Reserve Services	14	196	390	435
Two Degrees	High energy commercial and industrial	1	41	106	141
Two Degrees	Domestic and community	2	6	30	60
Two Degrees	Co-location	1	10	33	103
Two Degrees	Energy Trader	10	40	80	100
	Two Degrees	38	412	798	1,008
Community Renewables	Response services	10	128	160	190
Community Renewables	Reserve Services	14	145	375	520
Community Renewables	High energy commercial and industrial	1	56	131	241
Community Renewables	Domestic and community	2	12	60	125
Community Renewables	Co-location	1	8	28	158
Community Renewables	Energy Trader	10	35	60	120
	Community Renewables	38	383	813	,353
Consumer Evolution	Response services	10	15	125	140
Consumer Evolution	Reserve Services	14	76	302	340
Consumer Evolution	High energy commercial and industrial	1	29	66	121
Consumer Evolution	Domestic and community	2	3	20	40
Consumer Evolution	Co-location	1	3	13	58
Consumer Evolution	Energy Trader	10	16	40	70
	Consumer Evolution	38	142	565	768
Steady Progression	Response services	10	20	80	140
Steady Progression	Reserve Services	14	80	148	370
Steady Progression	High energy commercial and industrial	1	15	41	56
Steady Progression	Domestic and community	2	3	12	30
Steady Progression	Co-location	1	5	12	38
Steady Progression	Energy Trader	10	20	50	60
	Steady Progression	38	142	342	693

14.1. Baseline

There are 11 electricity storage projects connected to the distribution network in the East Midlands licence area, all of which are battery storage assets of varying sizes, totalling 48.6 MW. Two of these are below 1 MW and had no location information, see summary of the remaining sites in Table 14-2.

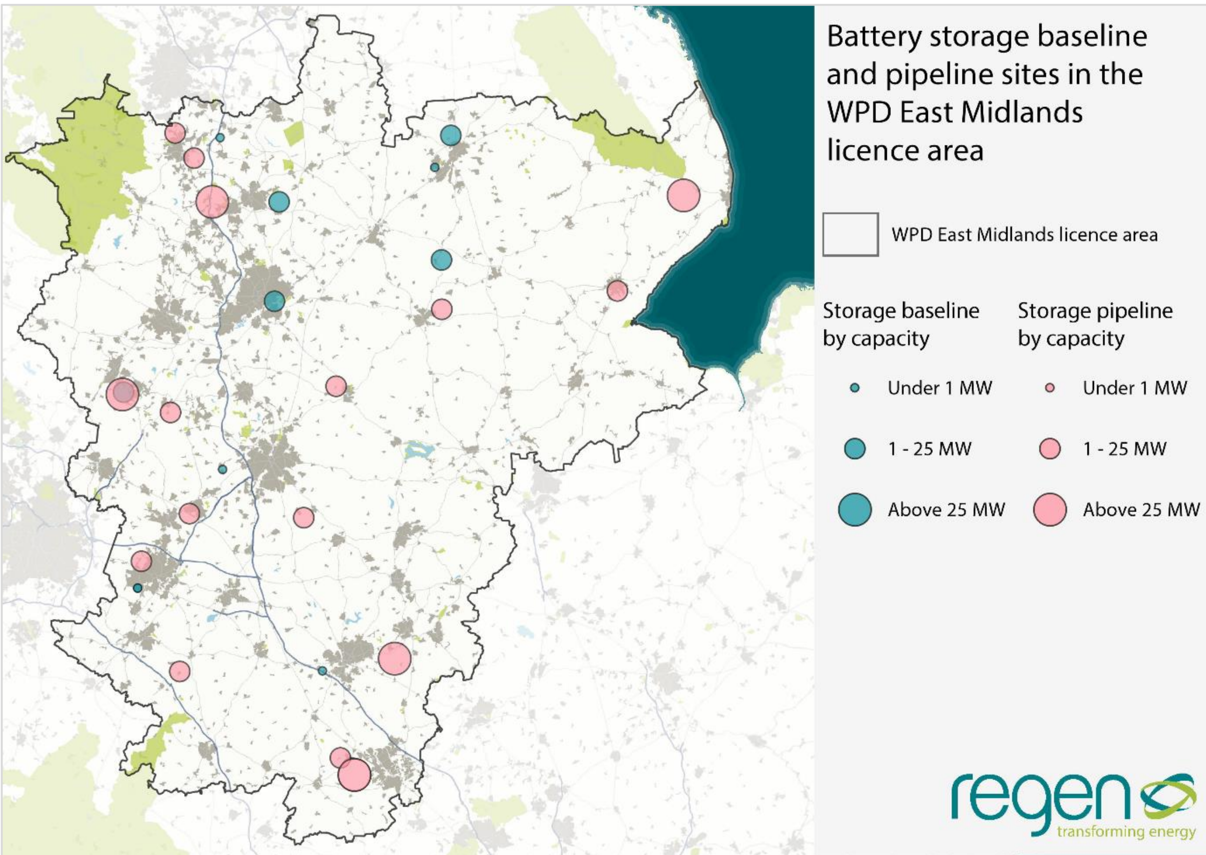
Table 14-2: Summary of connected energy storage projects in the WPD East Midlands licence area

Project / Location	Storage Business Model	Capacity (MW)	Voltage
Oxcroft Solar Farm	Generation Co-location	**3.5**	33kV
Rufford Battery Storage	Reserve Services	**7.37**	11kV
University of Warwick	C&I High Energy User	**4**	11kV
University of Warwick	C&I High Energy User	**4**	11kV
Leverton Battery Storage	Response services	**10**	33kV
Project Scene Energy Centre	Domestic and community	**2.1**	11kV
Swadlincote Breach Farm	Energy Trader	**10**	33kV
Mill Farm Battery Storage	Reserve Services	**7**	33kV
Lincoln Sadler Road	C&I High Energy User	**0.5**	11kV

Apart from two battery storage assets installed at the University of Warwick in spring 2014, all these storage assets have come online within the past 3 years. Many of the projects have communicated and/or recorded activity in National Grid ancillary service markets/commercial programmes such as Firm Frequency Response, the CM and the Balancing Mechanism.

The location of the connected projects is shown in Figure 14-1.

Figure 14-1: Connected and pipeline battery storage in the East Midlands licence area



14.2. Pipeline

There are 21 projects, totalling 330 MW, with accepted-not-yet-connected status in the East Midlands licence area. These are of varying size, with three projects sized specifically to fall just below the requirements of the Nationally Significant Infrastructure Projects (NSIP) regime threshold of 50 MW. There have been recent developments in the form of BEIS consulting[86] to permit co-located generation and storage assets to independently connect 50 MW each before falling under the NSIP requirements. Regen's analysis[87] of this consultation suggests that this change could promote development of more energy storage co-located with energy generation.

The storage pipeline in the East Midlands is a mixture of business models. The largest sites are summarised in Table 14-3.

Table 14-3: Summary of pipeline energy storage projects in the WPD East Midlands licence area

Pipeline Project Location	Storage Business Model	Capacity (MW)
Newton Wood Farm, Newton, Alfreton	Response service	50
Grendon Lakes, Land Off Station Road, Northampton	Reserve services	49.9
Land at Potash Farm, Nash Road, Beachampton	Reserve services	49.99
Manor Farm, Wainfleet Road, Skegness	Reserve services	25.6
Land at, Newgate Lane, Londonthorpe	Response services	25
Breach Farm At 132, Swadlincote	Reserve services	20
Asfordby STOR B, Plot 10 Asfordby Business Park, Leicestershire	Reserve services	20
Sheepbridge Lane, Chesterfield	Response services	20
Back Lane, Chesterfield	Reserve services	20
Walworth Farm, Southam	Reserve services	15
Hill Farm, Spring Lane, Leicestershire	Reserve services	10
Land off, Battery Lane, Boston	Energy Trader	10
Hydes Lane ESS, Watling Street, Leicestershire	Reserve services	5
Deanshanger Road, Milton Keynes	Response services	5
SMEETON ROAD, LEICESTER	Reserve services	4.23

Projects without any location information and those with zero capacity were removed.

Each of the remaining projects were then assessed under the following three areas:

- Activity in the CM (registration, pre-qualification and Capacity Agreements)
- Planning application activity in local planning portals
- Any relevant news articles around project or project developers

Using this information, the methodology to assign whether a project was to go ahead, in which scenario and the year it is to come online is summarised as follows:

Which projects in which scenario

[86] See BEIS, *Consultation on Proposals Regarding the Planning System for Electricity Storage*, March 2019: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770703/electricity-storage-planning-consultation.pdf
[87] See Regen article, 15th January 2019: https://www.regen.co.uk/reforming-the-planning-regime-for-storage/

1. IF lost a T-1 CM auction, assume will win 2019 T-1 auction (deliver 2020) under TD and CR.

2. IF lost a T-4 CM auction but has evidence of planning, assume will win T-1 auction after next (deliver 2021) under TD and CR.

3. IF lost a T-4 CM auction and nothing in planning applications, assume will win next T-4 auction (deliver winter 2022) under TD and CR.

4. IF no CM auction but evidence of planning, assume 2022 delivery for TD and CR, half capacity delivery for CE, no delivery for SP.

5. Other information (i.e. Amazon warehouse has timescales online) discretionary.

6. No CM bid and no planning: assumed response services, start 2021 under TD and CR

7. Withdrawn planning permission: goes ahead in CR only.

8. Pending planning permission: goes ahead in TD and CR.

When does the project come online?

TD & CR: CM delivery year if known. Otherwise estimated year from acceptance date.

CE: CM delivery year if known. Otherwise + 2 years of TD/CR estimate.

SP: CM delivery year if known. Otherwise + 5 years of TD/CR estimate.

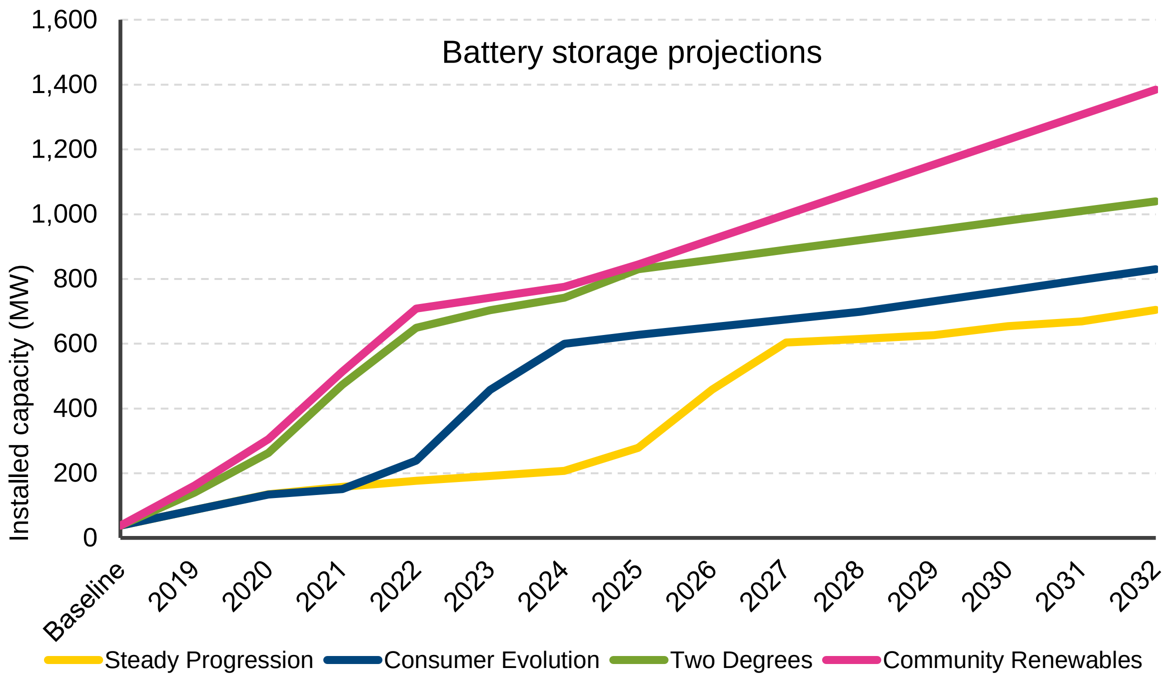
The outcome of this analysis primarily resulted in staggering the deployment of some of the pipeline capacity between the scenarios. However, there were a couple of projects that provided some specific allocations, off the back of information gleaned through local planning portals.

Table 14-4: Pipeline projects with specific allocations

Pipeline Project	Capacity (MW)	Planning & Market Consideration	Action Taken
Walworth Farm, Southam, CV47 2QT	15	Gained permission with conditions on 03/08/16, withdrew application in 09/05/18 after variations were refused.	Allocated to only go ahead in **Community Renewables** scenario
Breach Farm, Swadlincote, DE12 6RJ	40	Project won T-4 2016 auction for 10 MW and a further 10 MW for turn-down services in T-1 2018 auction (but also lost a 10 MW energy storage bid). 40 MW bid in T-4 2017 auction failed. Planning permission granted in full on 16/04/18.	Opted to downrate capacity to 20 MW in all scenarios, due to total of successful CM bids.

14.3. Battery storage scenarios

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



Scenario summary

The capacity of battery storage increases significantly in all scenarios, but the highest growth is seen in Community Renewables and Two Degrees as back up and peaking power is more important to provide balancing in a high renewables electricity system.

Relationship to other scenarios

The battery storage model is built using the FES 2018 as the basis for the top down analysis and the findings are broadly in line with the levels of storage expected at distribution level in FES 2018.

There are now 11 operational storage sites totalling almost 50MW, compared to none in the study completed two years ago. The storage growth potential is significantly higher across all scenarios, with the highest 2030 growth scenario from 2017 (Gone Green) is now 451 MW lower than Community Renewables in FES 2018.

Distribution of technology across ESAs

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

Table 14-5: 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	**This is weighted towards numbers of high energy usage industrial and commercial property locations.**

Domestic and community	**This is weighted towards domestic properties with solar PV, incorporating the rooftop solar projections.**
Generation co-location	**This is weighted by the scenario specific projections for ground mounted solar PV and onshore wind.**