# Regional Breakdown

Electricity | July 30th 2018

# Overview

## About the data

The Future Energy Scenarios (FES) are intended to illustrate a broad range of credible, holistic outcomes from now to 2050. To support further analysis within the electricity industry, the scenarios are broken down to regional datasets.

The datasets include an initial draft view of gross (underlying) and net (transmission) demand for each scenario out to 2040. Each year includes three study periods, namely Winter Peak, Summer Minimum AM and Summer Minimum PM. Details of the scenarios and the study periods are provided in Appendix A and you can select the year, scenario and study period via the drop-down boxes on the Main Data worksheet.

To enable easier use by the wider industry, this year's analysis has been undertaken at a more granular regional level. The data is provided for each Grid Supply Point (GSP) and demand Direct Connect (DC). A GSP is a connection between the Transmission network and the Distribution network, whilst a DC is a connection between the Transmission network and a large energy user. To support backwards compatibility with last year's publication, we have included the major and minor FLOP zone. These are defined within the Electricity Ten Year Statement 2017[1].

## Modelling method (Active Demand)

The modelling approach is described in more detail below. At a high level we start by working out the current demand split in our start year (2017/18) at each GSP and DC. This is achieved by taking demand as metered at the transmission network and adding to this the component of demand that is supplied by non-transmission connected generating assets. The result is the total Gross demand.

This Gross demand is then split by demand subcomponents so that in our starting year (2017/18) we know what proportion of each GSP's demand is residential, industrial, commercial, heat and transport. Our FES growth rates are then applied to these sub components and therefore the change in demand at each GSP will reflect the portfolio of demand sub components seen at each GSP.

[1] https://www.nationalgrid.com/uk/publications/electricity-ten-year-statement-etys

## Your feedback

This year we have adopted many new methods and datasets and as such, this data should be considered as an initial draft which is subject to change. We welcome your views and comments on our draft regional projections. Please share your comments via our fes@nationalgrid.com email address – your feedback will be used to inform our future work.

# Current demand split

Our Future Energy Scenarios show how electricity demand will change between now and 2050. Our analysis considers the sub-components of demand. These are Residential (non-heat), Industrial, Commercial and electrification of heat and transport.

Before we can apply our growth rates, we must first understand how the current electricity demand is split regionally according to these sub-components. This is a two-step process: first we determine the gross demand at each GSP, and then we apportion this across the sub-components.

## Step 1: Gross demand

Gross demand is the total underlying consumption that you would observe if you were to add up all electricity use irrespective of which network the customer connects to or where the energy is supplied from. Until the deployment of smart meters is complete it is difficult for us to determine this demand during the study period of interest. We must make use of the metered data we have access to and apply some assumptions.

For England and Wales the starting point is Elexon Settlement data flows CDCA I030 (GSP volumes) and CDCA I042 (metered volumes for each BM unit); both available on the Elexon Portal. These represent metered Net demand as measured at the transmission network. Because we are looking at typical demand during each study periods (rather than demand at a specific historic half hour), we use the average of the data over the last 5 years. From this we calculate the percentage that each GSP typically contributes to Net demand during each study period. These percentages are then applied to the GB level Net demand calculated earlier in our FES analysis to get an energy value (in MW) for our starting year 2017/18.

For Scotland, we have continued to use Week 24[2] as the source of demand data, with the settlement data being available for benchmarking. In a few cases GSPs from the Elexon list have been replaced by an alternate list. This is generally the case for split busbar sites and both of these steps in Scotland are a transitional arrangement as we move to using Elexon data.

Once we have Net demand by GSP we can determine the underlying Gross demand[3] by GSP by adding the energy generation output of non-transmission connected power stations (Embedded and sub 1 MW) for 2017/18 financial year. Once again this is an area we have limited data for and as such we make a number of assumptions in this process.

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[2] Week 24 submissions are part of the Data Registration Code and are submitted by the DNOs. Here we use the schedule that relate to the demand on the day of GB peak demand and GB minimum demand.

[3] Note: Gross demand in this dataset does not include station demand, pumping demand or exports. We have not modelled these Direct Connects. We also do not include transmission losses at this stage.

We map each large individual (Embedded) generation site to a GSP. In many cases this mapping is per the Distribution Network Operator (DNO) or Transmission Owner (TO) data, but where gaps existed we mapped to the nearest GSP geographically. For micro-generation (sub 1 MW) the relevant Feed-in-Tariff and Renewable Obligation data was mapped to the nearest GSP. This is then scaled up to match the total micro-generation installed capacity. The installed capacity at each GSP is then converted to a generation output by multiplying with technology specific load factors. It is these generation output values that are added to the Net demand in order to give us a Gross demand for each GSP (and DC) for starting year 2017/18.

## Step 2: Gross demand subcomponents

This year was the first time that we used the following method to better understand the type of demand that we have in each GSP (residential, industrial, commercial, heat and transport). We are therefore keen to hear your feedback.

To estimate the split of domestic and non-domestic demand to be used per GSP in our analysis start year (2017/18), electricity consumption data from BEIS was used[4]. This data provides the breakdown of 2016 electricity consumption by output area. The output areas are: Middle Super Output Areas (MSOAs) for England and Wales; and Intermediate Geography Zones (IGZ) for Scotland.

We map these output areas to our Grid Supply Points according to a nearest neighbour approach. That is, we assumed that the electricity demand of each IGZ and MSOA is supplied by the closest GSP. This is a process that we are keen to approve on and welcome your feedback on how we can improve it.

Once we have allocated each output area to a GSP we can use the BEIS data to calculate a percentage split of domestic and non-domestic demand in each GSP. This percentage was then applied to our start year (2017/18) GSP gross winter peak to estimate the current domestic and non-domestic demand of each GSP.

For the summer minimums, some scaling was required so that the regional data reflected the FES GB dataset. This is required because the BEIS data gives an annual split and, whilst this annual split is reflective of the Winter peak split, it is not reflective of Summer Minimums.

The BEIS data does not split non-domestic demand down into its constituent parts. Therefore, to obtain commercial and industrial demands, we split the non-domestic component according to the Great Britain split as published in the Future Energy Scenarios.

This process produced the gross demand of the GSP for each demand component in our starting year 2017/18 (for electric transport treatment, please see below).

[4] https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption

# Forecasts

## Demand

Having determined the demand sub components for each GSP (and DC) in our starting year (2017/18) we are now able to apply our forecasts to calculate the demand by GSP out to 2050.

### Residential, industrial and commercial

Our residential demand trends for each scenario were applied to the starting year residential demand at each GSP. This gave a GSP level residential forecast for every scenario and year. The same process was applied to commercial and industrial trends.

It should be noted that our industrial demand forecasts also include electricity demand for hydrogen production (via electrolysis). As such we are assuming that hydrogen is produced via electrolysis in alignment to current industrial demand across the country.

### Heat demand

We understand that heat pumps uptake is dependent on many factors such as type of house; ground and environmental conditions, existence of garden (for GSHP), noise considerations (for ASHP) and heat pumps installations are also subject to planning permissions.

Our modelling does not go into all these details which are not part of the current scope. To forecast heat pumps in each scenario, we assumed that heat pumps demand will follow residential demand trends. We therefore allocate heat pumps demand in each GSP based on each GSP's contribution to total residential demand.

The same process used for heat pumps was also applied to our district heat demand forecasts.

In our Two Degrees scenario, we restrict the deployment of heat pumps in cities which deploy hydrogen as a fuel for heat decarbonisation. That is, in this scenario, cities that have undergone a conversion to hydrogen by 2040, or will switch to hydrogen between 2040 and 2050, do not see a growth in heat pumps. These cities are listed in Appendix B.

### Transport demand

We model domestic electric vehicles according to the following process. Electric vehicles used in commercial or industrial processes are covered by the general process set out above for those sectors.

Our start year split is based upon the DVLA[5] values for "vehicle registration by postcode and body type and propulsion in 2015". When the scenario reaches 5 million cars the locational split is based on whole fleet numbers from Department for Transport (DfT) Statistic table VEH0122. By moving to whole fleet numbers, we solve potential population growth issues that occur when creating splits based on just today's EV registration locations. The period in between the two split methods is calculated as a smooth curve (not a straight line) between the two splits.

[5] Driver and Vehicle Licensing Agency (dval.gov.uk)

### Direct Connects

Rail network direct connects follow the growth of rail as assumed in GB FES. The demand of the other types of direct connects stays constant across the years. This is an assumption that will be revised in FES 2019 using the Elexon data at that stage in the process.

Our Two Degrees scenario includes a conversion to hydrogen for heating. The electricity demand required to operate the steam methane reformers (used to produce hydrogen) has been modelled as a number of new demand direct connects.

## Supply

The Embedded and Sub 1MW Generation forecasts are apportioned according to the existing geographical distribution for all technologies except solar. Our solar spatial forecast is designed to reflect the fact that as solar installed capacity increases it will spread across the country. Today solar is most prevalent on the south coast and east coast.

For storage, the existing capacity and new sites with a known location were allocated to a GSP using a nearest neighbour approach. Future growth that does not yet have a known location is split out to GSP level based upon the year by year increase in wind and solar by GSP.

# Reactive power

## Current view

For England and Wales the starting point of the net reactive power (Qnet) is the National Demand Data (NDD)[6], due to resolution of reactive power metering in Elexon datasets not aligning with the active demand datasets we have used. These represent metered Net reactive demand as measured at the transmission network. Where NDD was missing metering for certain GSPs or DCs, Week 24 data was used.

For Scotland, we have continued to use Week 24 for the net reactive power as the source of demand data, with the NDD being available for benchmarking.

The gross reactive power (Qgross) in each GSP includes the metered net reactive power with the additional network's losses and gains (including DNO network).

## Reactive power forecasts

To understand the trends of the gross reactive power, power factors were applied to the active demand of each demand sub- component. These trends were then applied to the starting point of the gross reactive power and produced the gross reactive power forecast for the 4 scenarios.
The power factors for each subcomponent were produced based on literature reviews and in-house modelling.

The net reactive power was modelled, using Pgross, Qgross, Embedded Generation and Sub 1 MW Generation and network characteristics.

[6] NDD is part of National Grid's operational demand metering.

# Appendix A

## The scenarios

Our spatial modelling follows on the GB analysis undertaken as part of our Future Energy Scenarios. This year we have adopted a new 2 x 2 matrix resulting in 4 scenarios. These are described in more detail in our Future Energy Scenarios publication. The following provides a high level summary.

The **speed of decarbonisation** axis combines policy, economics and consumer attitudes. All scenarios will show progress towards decarbonisation from today, with the scenarios on the right of the matrix meeting the 2050 target.

The **level of decentralisation** axis indicates whereabouts on the energy system solutions are physically located, moving up the axis from large scale central, to smaller scale local solutions. All scenarios will show an increase in decentralised energy compared with today.

This approach allows two of the scenarios to meet the 2050 target, but via different routes. The other two scenarios allow us to explore different levels of decentralisation in a world where 2050 targets are not met.

- **Community Renewables:** A world where people are engaged and able to invest in local innovative solutions to meet their energy needs. This allows the 2050 target to be successfully met.
- **Two degrees:** A world where there is the money and a collective will to invest in large scale ground-breaking energy solutions for GB. These allow the 2050 target to be successfully met.
- **Steady Progression:** A world where current advances continue in the energy sector. There is muted investment in large scale solutions. Ultimately heating stalls the movement towards the 2050 target.
- **Consumer Evolution:** A world where advances continue in the energy sector. There is more take-up in small scale solutions. These prove insufficient, particularly for green transport, and thus the 2050 target is missed.

## Study periods

- Winter Peak is a view of peak demand between the hours of 17:00 and 18:00 – typically November-February on a week day.
    - The peak demand is Average Cold Spell (ACS) – a high demand condition, which has a 50% chance of being exceeded
    - Electric vehicles are a demand – smart charging behaviour assumed.
    - Some vehicle to grid considered as supply
    - All storage considered as a supply
    - This period is of interest as these are the maximum demands on the system
    - Note EV smart behaviour is an assumption but demands could be higher or lower under certain circumstances.

- Summer Minimum AM is a view of demand between 0500-0600, typically in June-August on a Summer Sunday morning.

- Electric vehicles are a demand – no smart behaviour assumed (people charge how they would charge assuming todays behaviour)
- All storage considered as a demand – spread over 4-6 hours to avoid creating a new low demand point
- This period is of interest as these are the currently minimum demands on the system

- Summer Minimum PM is a view of demand between 13:00-1400, typically June-August, Summer Sunday afternoon.
  - Electric vehicles are a demand – no smart behaviour assumed (people charge how they would charge assuming todays behaviour)
  - All storage considered as a demand – spread over 4-6 hours to avoid creating a new low demand point
  - This period is of high interest due to solar PV which peaks at this time and reduces transmission demands – but flows around the system may still be high.

# Appendix B

Our Two Degrees scenario includes a conversion to hydrogen for heating. As discussed in our Future Energy Scenarios document, hydrogen could heat one third of homes by 2050. This would require coordinated action to develop city and regional hydrogen networks. All of this hydrogen is initially supplied from steam methane reforming.

It is highly uncertain where these steam methane reforming plant will be located or, in deed, which regions will convert to hydrogen use. For the purpose of this regional modelling we have selected locations where this is a high demand for heat and good network infrastructure (in alignment with other industry publication on hydrogen networks).

## Cities with hydrogen

Aberdeen (City) – post 2040
Birmingham (GA)
Bristol (City) – post 2040
Cardiff (City) – post 2040
Edinburgh (City)
Glasgow (GA)
Hull (City)
Leeds (City)
Leicester (City) – post 2040
Liverpool (GA)
London (GA)
Luton (City) – post 2040
Manchester (GA)
Newcastle (GA)
Oxford (City) – post 2040
Sheffield (City)
Teesside (GA)

## Steam methane reformers

Indicative locations of plant:
North East Scotland
North East England
Cheshire/Merseyside
Yorkshire
South East England