The Voice of the Networks

Open Networks
Workstream 1 (T-D Processes)

Product 5:
Whole System FES
Deliverable 5.1:
Review of current forecasting approaches

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Contents

1. Summary

The Whole System Future Energy Scenarios (FES) product of the Open Networks Project's Phase 2 plan for Workstream 1 (T–D Processes), seeks to establish a framework to facilitate the production of distribution level FES which are aligned to the GB FES produced by the GB System Operator (SO) in order to support whole system planning activities. This work is intended to ensure that the future scenarios used to support industry processes are produced consistently and are aligned across network operators. It will support the production and publication of scenarios to be used by network operators and stakeholders. This work is closely linked to Workstream 1, Product 1 – Investment Processes, Product 6 – Regional Service Requirements and Product 12 – TSO/DSO & DER Data Requirements.

The Whole System FES product is made up of three sub-products scheduled to be delivered over the course of 2018. These sub-products and associated deliverables are as follows: (i) P5.1 – Review current forecasting approaches (January to June 2018); (ii) P5.2 – Develop and agree guidelines/common framework to produce distribution style FES on a priority basis (April to September 2018); and (iii) P5.3 – Establish process for FES coordination across Transmission and Distribution (September 2018 to end of year). This report covers the first sub-product (P5.1) and details the evidence gathered from the Distribution Network Operators (DNOs) on the current forecasting approaches and draws some similarities and differences between the network companies' approach to forecasting.

Some of the notable observations from the DNOs' responses to the forecasting questionnaire sent out by the product team include the following:

- There are a lot of commonalities in DNO approaches to forecasting but due to different drivers for these in different DNO licence areas, there are also a number of areas where approaches are different by necessity;
- DNOs have local knowledge: In general, DNOs have a better understanding of the local resources within their licence areas compared to the SO and the host Transmission Owners (TOs) so a bottom up/top-down approach would be beneficial in future engagement with the SO on the development of the Whole System FES;
- Load characteristics are changing: Load diversity assumptions based on historic data may no longer be adequate in future forecasts which may include low carbon technologies and distributed energy resources whose operating regimes could be significantly different;
- We need to be clear on terminology around scenarios: There is need to differentiate between the use of the terms "forecasts" and "scenarios" as these are currently being used interchangeably among the DNO community.

The output from the first sub-product (P5.1) will inform the development of a common framework for the production of distribution FES in sub-products P5.2 and P5.3 as described above.

2. Introduction

As part of the Open Networks Project's Phase 2 plan for Workstream 1 (T – D Processes), Product 5 (Whole System Future Energy Scenarios (FES)) seeks to establish the framework to produce distribution level FES on a priority basis. These will be aligned to the GB FES produced by the GBSO in order to support whole system planning.

This product supports the following Workstream objectives:

1. Enable greater distributed energy resource (DER) access to networks and services by facilitating the development of mechanisms to identify and publish Distribution System Operators (DSO) service requirements for priority areas and publishing and taking forward action plans to enable the timely connection of flexible resources where these can avoid investment and unlock connection capacity;
2. Introduce whole system investment planning by developing DNO capability and establishing improved data and models to support whole system investment and operation; and
3. Provide further information to customers by collating and publishing information for DER customers to support connections and service provision. This would include future scenarios which are necessary for identifying resource volumes, service requirements and levels of curtailment.

The work is intended to ensure that the future scenarios used to support industry processes are produced consistently and are aligned across network operators. It will support the production and publication of scenarios to be used by network operators and stakeholders. This work is closely linked to Workstream 1, Product 1 (Investment Processes), Product 6 (Regional Service Requirements) and Product 12 (TSO/DSO & DER Data Requirements).

The Whole System FES product is made up of three sub-products scheduled to be delivered over the course of 2018. These sub-products and associated deliverables are as follows:

1. P5.1 – Review current forecasting approaches – January to June 2018;
2. P5.2 – Develop and agree guidelines/common framework to produce distribution style FES on a priority basis – April to September 2018; and
3. P5.3 – Establish process for FES coordination across Transmission and Distribution – September 2018 to end of year.

This report constitutes the first deliverable (P5.1) of Product 5. It details the evidence gathered from the DNOs on the current forecasting approaches and draws some similarities and differences between the network companies' approach to forecasting. The outcomes from this exercise will form the starting point for the following deliverable, P5.2.

3. Scope

3.1 Inclusions

The scope for deliverable P5.1 focuses on reviewing current forecasting approaches among the DNOs in order to identify similarities and differences, understand the key factors and drivers in the

development of forecasts, how the forecasts are used and the challenges faced by the network companies in the development and use of the forecasts. The scope includes the following:

- Review of current forecasting approaches by the DNOs
- Literature review of forecasting approaches
- Learning from Distribution FES to-date
- Drivers for current approaches
- Challenges to current and desired forecasting approaches

3.2 Further work

The scope covered in this version of the report only covers deliverable P5.1. Learning from this deliverable will inform the development of deliverables P5.2 and P5.3. These will focus on the development of a consistent whole system framework for FES production among the DNOs and how this is done consistently with the national FES produced by the SO. Best practice, and gap analysis will also be undertaken for these deliverables, including development of proposals for any process modifications that may be required to facilitate consistency of FES between Transmission and Distribution. The scope of the entire P5 product does not include the implementation of the proposed framework to produce scenarios.

4. P5.1 Methodology

A forecasting questionnaire was prepared and circulated to all GB DNOs to gather their responses to key questions. The questions were designed to help understand the current forecasting approaches used by the DNOs. The questionnaire is one of the key activities for this deliverable, and allowed the Product 5 team to understand what forecasting activities are currently being carried out by the DNOs, what they are used for, similarities and differences between DNOs' approaches and the drivers behind these, challenges faced and the direction of travel within the DNO community. This information, together with the desired forecasting outcomes, will allow the Product 5 team to carry out a gap analysis which will be one of the key activities in P5.2 – Development of a common framework to produce distribution style FES on a priority basis. By carrying out a gap analysis, the areas that need addressing will be identified.

For deliverable P5.1 specifically, the following activities were undertaken:

- Requested information from all DNOs. A questionnaire was prepared by the Product 5 team and peer reviewed by WS1 subject matter experts (SMEs) before being sent to DNOs in early March 2018. Responses were received from all DNOs by mid-March 2018.
- In April 2018, the Product 5 team reviewed the questionnaire responses and identified similarities and differences in forecasting approaches. The findings were presented to the WS1 group and a summary of these is provided in Appendix 1.
- This report documents the findings and observations made by the Product 5 team on the overall approach and current direction of travel within the DNO community.

5. Forecasting questionnaire

The forecasting questionnaire consisted of 12 questions covering the following areas:

- The forecasting activities undertaken by the DNOs in their licenced areas beyond the Grid Code Week 24 requirements, the techniques used and to what degree active and reactive power are forecasted;

- Types of resources explicitly considered in forecasts, level of data clustering and aggregation used and how diversity is taken into account;
- What the forecasts are used for and time horizon for forecasts;
- Whether multiple scenarios are considered and, where this is the case, the objectives for creating multiple scenarios and whether the scenarios would be aligned to any of the National FES produced by the SO;
- Whether some distribution connected generation are excluded in forecasts, e.g. large generation (defined as per Grid Code) and whether network limitations are considered to restrict the forecast volumes;
- What type of parameters are forecasted, e.g. peak, minimum, average for particular days or time of day etc;
- How the information used in developing the forecasts is obtained and whether there is collaboration with other network owners in the production of forecasts particularly where there is a common interface; and
- Key challenges in producing the forecasts.

The questionnaire was sent to all 6 DNOs covering the 14 licenced DNO areas in GB. All DNOs responded to the questionnaire.

5.1 Review of DNO Responses

A review of the responses was undertaken by the Product 5 team. A high level summary of the responses is given in Appendix 1 where the similarities and differences are drawn from the responses. Overall, the responses provided a good understanding of the current forecasting approaches undertaken by the DNOs. This forms a vital input into the gap analysis exercise that will be undertaken in the development of a common forecasting framework in P5.2. Observations from the responses are presented below.

5.2 Observations

5.2.1 General

All DNOs carry out load forecasting to support the development of the Grid Code Week 24 submission, the Long Term Development Statement (LTDS) publication and regulatory submissions of load indices. Beyond this, there are various levels of forecasting activities to different levels of detail and horizons across the DNOs depending on the specific challenges faced in the DNO licenced areas.

There is currently some collaboration between the System Operator (SO) and DNOs, and among neighbouring DNOs, and between DNOs and IDNOs, in the production of their respective energy scenarios and forecasts. This collaboration is however limited, and mainly dictated by specific needs that arise on specific parts of the network. A wide range of distributed energy resources (DERs) and low carbon technologies (LCTs) have been identified for consideration in, and development of forecasting tools and methodologies to varying degrees by some DNOs. In

general, the DNOs have a better understanding of the local resources within their licenced areas compared to the SO and the host TOs, therefore a bottom up/top-down approach would be beneficial in future engagement with the SO on the development of the Whole System FES. This will drive a more accurate picture of the national scenarios when considering the regional spatial disaggregation.

Some of the resources identified in forecasts include wind, photovoltaic (PV), heat pumps, electric vehicles (EV), demand side response (DSR), flexibility services from domestic time of use tariffs (ToUT), industrial and commercial (I&C) DSR, smart charging of EV, domestic energy storage, enhanced frequency response (EFR), behind-the-meter commercial storage, storage co-located with large scale distributed generation, industrial and domestic combined heat and power (CHP), air conditioning, active network management (ANM), biomass, biogas, landfill gas, flexible/peaking plant, hydro, etc. Some DNOs are beginning to consider how they could better understand the potential for non-build solutions from their forecasts.

Generally, DNOs have a good understanding of what generation will connect but there is greater uncertainty as to exactly when it will connect and how it will be used (profiles). This is in relatively shorter time scales (~ 5 years) compared to timescales for large transmission connections.

5.2.2 The need for a whole system forecasting framework

In order to develop a consistent forecasting approach between the SO and the DNOs, the forecasting work within the DNOs needs to progress significantly before meaningful alignment can take place. Development of a common forecasting approach (P5.2 deliverable) among the DNOs should accelerate the work to establish a consistent approach between the SO scenario work and the DNO forecasting to achieve Whole System FES.

The purpose of developing consistent future energy scenarios by all network companies, including the SO, is to facilitate the identification of system needs and to support the future energy landscape. The FES are seen as different and equally plausible future outcomes, and that the constraints for these scenarios (cost, lead time, technology, network capacity, etc) are not considered at this stage.

Challenges arising from the use of multiple scenarios will require a common approach to ensure that the different solution options under the different scenarios can be considered appropriately in arriving at investment decisions, e.g. least regret approach adopted by the SO for the NOA cost benefit assessment or other approaches based on probability weightings for different scenario outcomes. These challenges are out of scope for this product but will be covered under Product 1 – Investment Processes.

5.2.3 Forecasting horizon and uncertainty

Load forecast data forms the basis of network planning and development and, going forward, it is clear that the increasing number of DER and LCT which have many possible operating regimes is greatly increasing the level of uncertainty in network planning and development activities. This will also affect network operation and maintenance activities. Increasingly, DNOs are producing more data forecasts than the minimum requirements based on their licence obligations. This trend is likely to continue as the penetration of DER and LCT increases as well as the DSO and potential new markets emerge in the new flexible smart world. Up until recently, the level of certainty within the 5-year horizon has been relatively high and it is acknowledged that with increased uncertainty, it may be beneficial to consider a scenario based approach even for this near-term time horizon. For horizons longer than 5 years, a FES approach will be required in order to address uncertainty meaningfully within the investment frameworks.

There is need to differentiate between the use of the terms "forecasts" and "scenarios" as these are currently being used interchangeably among the DNO community. It is important to distinguish that one approach to forecasting can be a scenario-based approach. The scenario definitions are not forecasts, but the application of the scenario assumptions can be used in various combinations to form either one forecast or a range of possible forecasts with varying levels of confidence or probabilities. It is acknowledged that different business activities may require different types and levels of forecasts.

5.2.4 Forecast parameters

In addition to power or resource capacity forecast parameters (for example, installed MW capacity for a given technology, number of EVs, heat pumps, etc), it may also be necessary to forecast other parameters such as energy or load factors associated with these resources which could represent load profiles or behaviour of the underlying resources. While it is reasonable to assume that these behaviour parameters may be dictated mainly by market arrangements, the assumptions made on these and the utilisation of flexible solutions can have a significant impact on the network capability and performance. These assumptions therefore need to be considered carefully, for example, consumer behaviours around EV charging could be disproportionately disruptive if not modelled appropriately.

5.2.5 Diversity

Diversity assumptions based on historic data may no longer be adequate in future forecasts which may include LCT, DER, etc whose operating regimes could be significantly different. More detailed forecasts based on the constituent energy elements at a higher time resolution than the traditional seasonal approach would be valuable in informing diversity assumption going forward. e.g. the interaction between wind, solar, storage, ANM, DSR would give more insight into credible assumptions on diversity. Similarly, load growth assumptions would significantly benefit from this approach.

5.2.6 Source of forecasting data

A wide range of sources needs to be considered in the development of credible FES. Current practice considers connected resources, metered and SCADA data, Government and Local Authority policies, plans, projections and targets, gross value added (GVA) and social demographic information from sources such as Experian Mosaic, EV registrations from the DVLA and stakeholder engagement. All these sources are currently being used to different degrees by different DNOs.

5.2.7 Collaboration

There will be need for improved collaboration between network companies to ensure consistency in the way the scenarios are produced in order to allow coordinated network/system development across different network ownership boundaries. The relationship between FES and DNO forecasting cycles will need to be defined to ensure that the Whole System FES are produced in a consistent and timely manner, to feed into the various investment decision making processes, publications and reports.

Appendix 1 Summary of forecasting questionnaire responses

Q1 What forecasting activities do you undertake in your licenced area beyond the Grid Code Week 24 requirements? Can you describe the forecasting techniques? To what degree do you forecast active and reactive power?

In common

Basic distribution planning load estimates using historical load growth, SCADA data, known demand and generation connections requests. Used by most DNOs for short term forecasts (5 years) using standard growth rates. All network owners considering more sophisticated forecasting methods for RIIO-ED2 readiness. Reactive power studies carried out as and when required.

Different

There are varying levels of detail in the constituent forecast elements between DNOs depending on need. Applies to reactive power forecasting, forecasting beyond the GC Week 24 timescales in general and types of Demand, DSR, LCT, DER, DG, etc considered. ENWL are the only DNO who forecast reactive power.

Q2 ***What types of resources do you consider explicitly in your forecasts e.g. generation technologies, demand types, storage, electric heating, heat pumps, electric vehicles, DSR, etc?***

In common

All network companies consider the resources listed in the question, but some DNOs are at an early stage with regards to LCT forecasts. This is due to the fact that there is a lot of variations in LCTs and EVs uptake in different DNO areas. Generation connections and I&C demand are considered explicitly. All network companies are looking to increase the number of resource types they model in their forecasting activities.

Different

For some network companies, consideration of flexible non-build solutions is at early stages, where they are looking to model their potential. There is need to look at the network implications of these resources in more detail. Other companies do not consider/model flexible solutions at the moment.

Q3 What level of data clustering do you use; regional? GSP? Primary/Secondary substation? Do you aggregate substation forecasts to achieve a high-level regional forecast; and if so, how do you account for diversity?

In common

Most DNOs determine growth rates from historic load data and apply these to primaries and GSPs, with adjustments made for known developments. There is a general shift towards improving the approach to aggregation through more detailed representation of the underlying energy components.

Different

There are various approaches in use by the DNOs in terms of the level of the data forecasted and how diversity assumptions are applied. ENWL decompose underlying demand and then independently project each demand component based on available information on the factors that are correlated with and affect these components. The aggregation of these demand components can be used to define the load growth rate for peak/average/minimum demand. . This is similar to UKPN's methodology. NPg, ENWL and UKPN use a Bottom up/Top down approach. WPD forecast at "electricity supply area" level, aggregated to 132kV.

Q4 What do you use the forecast data for? E.g. System development plans, publications, etc. What is the time horizons of such plans and publications?

In common

All DNOs produce GC Week 24 forecasts which are used in the production of the LTDS – 5-year forecast. Regulatory submission of Load Index (up to 8 years at the start of RIIO-ED1). For forecasts used to inform load related reinforcement plans and RIIO 2, scenario timescales longer than 5 years are being considered by all. DSO Transition decision support (extent and feasibility of flexibility services and operational technology requirements)

Different

Strategic, short term and long-term planning horizons vary across network companies. NPg forecasts up to 20 years depending on specific need. UKPN forecasts up to 2050. WPD publishes reports on Strategic investment planning to the end of 2031 (assumed end of RIIO ED2). ENWL's central outlook scenario has a horizon of 45 years. WPD and UKPN use these for RDPs. SHEPD use the forecast data for external stakeholder communication on available connection capacity via an online interactive tool.

Q5 Do you consider multiple scenarios? If so, how many scenarios and what are the objectives in creating multiple scenarios?

In common

WK24 forecasts are based on single forecasts (best view). Some DNOs use a variety of scenarios developed with bespoke approaches to inform their various activities ranging from investment planning decision making to stakeholder engagement. The direction of travel for all DNOs is to develop and use multiple scenarios in the future.

Different

There are different approaches to scenarios among the DNOs with some currently not using scenarios and others considering 4 main scenarios aligned to National Grid and others have more than 4 scenarios. WPD, UKPN and ENWL use multiple scenarios, other DNOs do not use multiple scenarios.

Q6 Do you align your forecasts to any of the National FES produced by the SO?

In common

Most DNOs do not align their scenarios with the National Grid FES.

Different

WPD align their scenarios with the National Grid FES. UKPN, SEPD and ENWL carry out various activities to gain insights from FES into their forecasting assumptions, while NPg uses the National Grid FES as an input into its own scenario forecasting.

Q7 Do you exclude some distribution connected generation in your forecasts, e.g. large generation (defined as per Grid Code), and if so, why?

In common

All DNOs exclude large generation from Week 24 submissions as per the Grid code. However, all generation is included for network planning purposes, including for reactive power and voltage assessment.

Q8 Do you consider network capacity limitations in your forecasting activities? i.e. to what extent do you restrict the forecast volumes due to network capacity limitations?

In common

All DNOs do not apply network limitations to their forecasts. It was noted that the SO takes a similar approach in their FES production work.

Q9 How do you obtain the information you use in developing the forecasts, e.g. stakeholder engagements, customer applications, etc? Can you describe the process?

In common

All DNOs use the current connected resources as baseline, which is modified going forward by considering contracted schemes. Historical trends, obtained from measured data, stakeholder input and other data are used to inform future projections.

Different

Beyond the baseline and contracted pipeline, there are varied approaches although the principles remain broadly the same across all DNOs. The breadth of sources for determining projections differs by DNO with some DNOs using detailed models at post code level and also using DVLA registrations for EVs for example, government projections and targets, local authority projections, GVA, customer engagement activities, etc.

Q10 What type of parameters do you forecast, e.g. peak, minimum, average, particular days, what time of day etc? What is your forecasting horizon in years?

In common

All DNOs forecast the traditional winter and summer peak demands and installed generation capacities. With varying degrees of detail, the DNOs also consider additional parameters as required for the activities and these are forecasted beyond 5 years in most cases

Different

ENWL forecast half hourly active and reactive demand from which daily, seasonal or annual peak data can be derived, active power is forecasted up to 45 years while reactive power is forecasted up 8 years. WPD uses a 'representative days' model on a half hour resolution for active and reactive power, from which seasonal peak power flows can be derived, and forecasts up to 2031 (assumed to coincide with end of RIIO ED2). Forecasting years vary from 5 years to 45 years across the DNOs.

Q11 Do you collaborate with other network owners in the production of forecasts particularly where there is a common interface?

In common

There is generally limited collaboration between network owners in addition to the mandated bilateral meetings between the DNOs and the SO. There is however increasing collaboration in terms of industry initiatives to improve the whole area of forecasting, with a number of consulting firms, e.g. Regen and Element Energy working with some DNOs on forecasting approaches and tools.

Different

WPD collaborates with SEPD, UKPN and National Grid. ENWL, SSEN, NPg, SPEN and UKPN also collaborate with the National Grid FES team

Q12 What are your key challenges in producing forecasts?

In common

Most of the challenges faced by DNOs relate to the volume and rate of penetration of LCTs, DER and other new technologies. All DNOs are faced with the challenge to disaggregate the load on the distribution networks into the constituent components in order to allow the true demand to be separated from e.g. DSR, impact of other flexibility services and distributed generation. With the changes in load, DER and LCTs, it is increasingly challenging to forecast the reactive demand of the system. This challenge is around understanding both deployment and operating regimes of these resources. Modelling consumer behaviour/use of flexibility and how assumptions on these are arrived at is currently not consistent between the DNOs and the SO. Another challenge is how to make investment decisions when there are different possible outcomes from these scenarios.

Different

For those DNOs attempting to align their forecasts with National Grid FES there is the challenge that the timing of the scenario development timelines is not aligned. In time, this may become a common challenge for all DNOs.