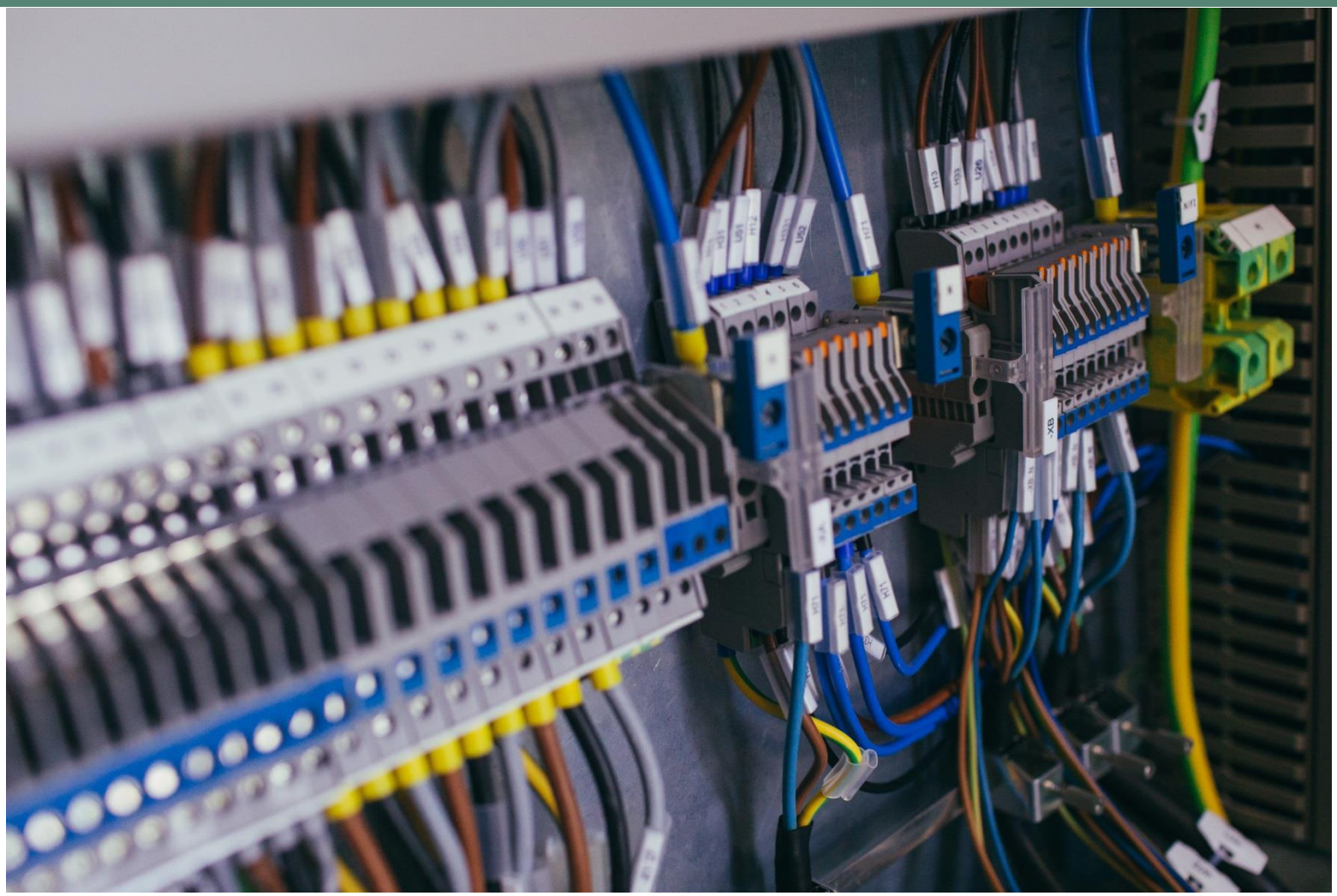
Data and Forecasting



Summary

This article highlights the need for more integrated and aligned data systems within WPD and improved interfaces within the industry. It also looks at the increased need for long-term scenarios and operational forecasting.

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Note: a glossary and diagram key can be found in the DSOF introduction document on our website

Background

Data Systems

The majority of the data systems within WPD have been in place for many years and have worked effectively throughout. The systems are predominately independent from each other and are kept up-to-date with the primary data that they were designed to store. There are limited interactions and relationships between the Distribution Network Management System (DNMS), geographic mapping software and the asset database, as this has not been required in the past. Where there was a need to integrate data from multiple data sources, a largely manual process was used due to the lack of relationships between systems.

A good example of this is modelling for network design analysis, as inputs from multiple data systems are required to create and update a model. This is not time critical and means human validation and verification of data can be undertaken to ensure the data from separate systems is correctly integrated. In the past, the complexities of linking the main systems were not worth the resource and inevitable issues that would arise.

The growing need for operational and real-time analysis is having a greater impact on the data systems within WPD. Not only will the data need to be stored in an effective manner within the given data system, but the systems will need to be more integrated, so these real-time systems can automatically interrogate the data to get the inputs to the analysis, in the timeframes required. The type of information that these systems will need are:

- Network impedances;
- Network topology;
- Installed assets;
- Ratings and limitations; and
- Geographic layout.

Data Exchange

There is a need to share data between WPD's internal systems, and a growing need to share data with the GBSO, customers and third parties. This section looks at a standard that could help data exchange in an unambiguous and consistent format.

Forecasting Data

The network has been designed using the knowledge of what is currently connected to the network and a committed model, based on all connected and accepted-not-yet-connected demand and generation. With the issues discussed in the previous sections, there is a growing need to have better long-term forecasting to predict how the network will look beyond the committed model. This is due to the complexities and timescales of reinforcing a network when there are Low Carbon Technologies (LCTs) that can significantly change the loadings on the network in a relatively short period of time.

As we move away from operating a passive network, there is also a need for more operational forecasting, to predict how the demand and generation will operate in the shorter term (minutes to weeks). This can be used to better actively manage the network.

Network Impact

Data recording and interpretation is the key link between network visibility and being able to accurately represent the network in a model. Effective data systems that can record data in a format suitable for the end use will be crucial.

Better relationships between systems are an essential precursor to implementing a number of the proposed Distribution System Operator (DSO) smart solutions. The real-time and operational planning systems that need information from multiple data sources will have to be able to automatically collate and validate the data prior to making network critical decisions. The data will need to be unambiguous, accurate and consistent, so the model analysis will provide correct and meaningful results.

Better short-term forecasting will allow operational modelling and analysis more information on how best to operate the network. The scenarios discussed in this section will enable network issues (such as constraints) to be identified earlier. This will allow them to be resolved by conventional reinforcement or smart solutions.

Detailed Assessment

Data Alignment

WPD's asset, operational and spatial data are not currently aligned. There are three primary systems that store the majority of the data required to design and operate a network. These are detailed in Figure 1. This data architecture was designed for a passive network and has worked effectively for many years.

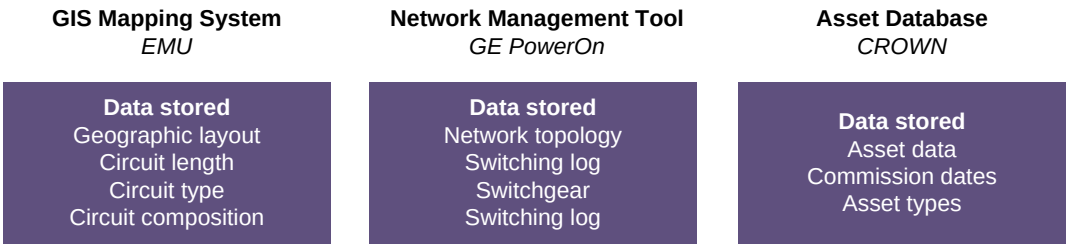

Figure 1: Summary of existing data structure within WPD

There are currently limited data relationships between these systems. A smooth transition to being an effective DSO will require a more integrated data structure with appropriate relationships between systems. This will involve significant work to ensure there is sufficient integration between these systems.

Impact on Operability

By putting these data systems in place ahead of need will ensure WPD can:

- Effectively share data with National Grid, customers and third parties;
- Run real-time analysis where there is a high data requirement, this will include load-flow analysis within the DNMS; and
- Safely implement and manage new flexibility services using operational and real-time analysis.

We will need appropriate procedures to deal with data failures. For example, if a certain data point (e.g. transducer) fails and this is critical to the operation of an Active Network Management (ANM) scheme or "real-time analysis" system we will need to repair / resolve this as a matter of urgency.

Data exchange

As stated above, the need to share data internally and externally will increase as the growth in distributed generation, storage and smart solutions makes closer coordination with National Grid, customers and third parties a necessity. The CIM format is routinely used for joint studies in Europe and is being used increasingly in the UK.

National Grid Data Exchange

The Grid Code [1] allows National Grid to share a two week in advance model for operational or design purposes, which can be utilised to inform WPD's operational support about how best to operate the network. This is not extensively utilised due to the lack of a common interface between power system software packages. Without a standard data format to convert to WPD systems it cannot be fed into operational planning in realistic timescales.

The yearly Week 24 and Week 42 data exchanges between Distribution Network Operators (DNOs) and National Grid is no longer frequent or detailed enough to design and operate an increasingly complex network. For data to be shared more efficiently, these data sharing processes need to be streamlined.

Customer and Third party Data Exchange

Customers, consultants and third parties are also requiring more network data. WPD have a number of online tools and data sources available to customers:

- **Data Portal 2** – This has two main features: a facility to download WPD asset data and EMU online, a new facility giving a web browser based Geographic Information System (GIS);
- **Customer Internet Routing and Tracking (CIRT)** – A web portal for ICPs to make connection applications;
- **Technical Information Website** – This provides technical specifications and policy documents for connections providers working within the WPD area; and
- **Long Term Development Statement (LTDS)** - Currently the main way network data is available to customers is the LTDS, which gives the network data in Excel format similar to the week 24 data. Producing the LTDS is a largely manual process which happens once a year.

Data Portal 2, CIRT and the technical information website are proving to be effective methods of sharing data. The LTDS is a licence condition that was designed before the uptake of distributed generation. There is a growing need for a new way of updating customers on our network arrangement more regularly and effectively.

Common Information Model (CIM)

The need to quickly, reliable and securely exchange data internally and externally is becoming technically challenging as no standard has been universally adopted in the UK. One option is to utilise the IEC Common Information Model (CIM) standard, which is defined in British Standard (BS) EN 61970 [2] and BS EN 61968 [3]. This standard is an abstract model that represents all of the major objects in an electricity utility enterprise. It is human readable and machine readable. The data includes parameters common to breaker orientated applications. The standards associated with CIM define profiles and CIM/Extensible Markup Language (XML) model exchange formats.

An example of the data transfers that will be required are given in Figure 2. The quantity, frequency and detail of network data means there will be a greater need to share model data in an easy to access, consistent and reliable format.

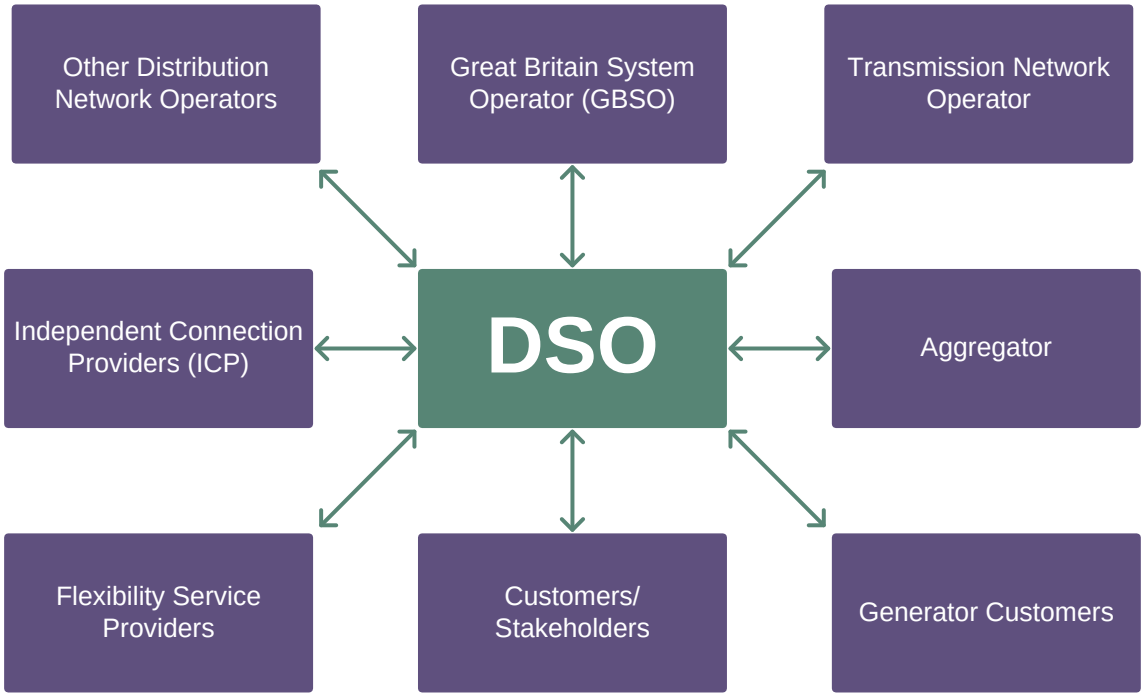

Figure 2: Example of data exchange required between DSO and third parties

Using the CIM standard internally and for data exchange with National Grid, customers and third parties will be reliant on relevant software packages adopting the standard in a way that is compatible with other formats. A number of the main power system software packages and data management tools have recently implemented CIM importer and exporters, suggesting there is a general trend within the industry to adopt this standard.

Impact on Operability

Being able to share data effectively, on an increasingly complex network using a standardised format will help with the rollout of smart solutions. It will mean significantly less manual data manipulation is required, which will be less resource intensive and will reduce software and data incompatibilities.

Operational Forecasting

Short-term forecasting is the minute to week(s) ahead forecasting that can be used to determine the likely network conditions based on key factors.

Determining non-intermittent generation running can be done through effective data sharing and monitoring of market and price signals that will impact demand and generation. To forecast intermittent generation for PV and wind requires monitoring irradiance and wind level. Forecasting this information will enable a better understanding of how the network will look in the following 24 hours.

Impact on Operability

Implementation of more operational planning forecasting will help:

- Ensure the network is compliant for credible network events, typically a fault;
- Determine network loadings through demand and generation forecasting, this will help with outage planning; and
- Operate the network in a way that will reduce losses, without compromising on network security.

Without this type of forecasting, conservative assumptions are used when configuring the network or taking outages. This will mean the network cannot be utilised as effectively.

Scenarios

WPD need to know what generation and demand is likely to connect to make low regret investment decisions. Currently this is done on a committed model, based on connected and accepted-not-yet-connected offers. This model gives a reasonably accurate view of the network about 3 years ahead, which is used to make investment decisions.

Better long-term forecasting can help reduce network constraints and enable customers to get a better connection. WPD have commissioned Regen to forecast generation and demand growth for all licence areas out to 2030 as part of WPD's *Shaping Subtransmission to 2030* studies. These forecasts are used to undertake detailed subtransmission power system studies to determine under what scenarios network constraints will arise. An example of the forecast data for the South Wales licence area can be seen in Figure 3.

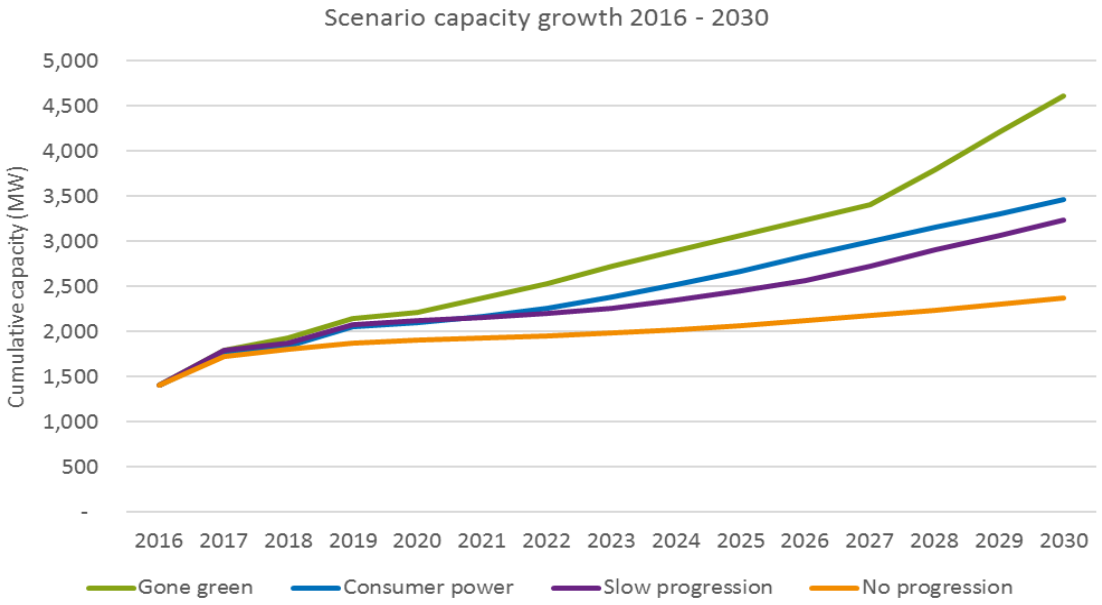

Figure 3: Distributed renewable generation capacity growth by scenario in the South Wales licence area

This forecasting methodology is aligned with National Grid's Future Energy Scenarios (FES) [4]. This approach is based on different levels of economic prosperity and green ambition. By assessing a number of different scenarios increases confidence in the best low regret investments.

Impact on Operability

The challenge is where major reinforcement on the EHV or transmission network is required, as the lead times on such works can be up to 10 years. This can lead to generators not being able to connect or having heavy curtailment under certain network conditions.

Short Term Mitigation and Solutions

Data Alignment and Exchange

The need for high-quality data alignment is essential and WPD are proactively investigating ways to improve data system integration through a number of active and completed innovation projects:

- **Time Series Data Quality** (Active) – This project aims to better understand data quality and identify trends and issues which would be difficult to spot via human intervention. The outputs from this project will identify how to improve time series data quality.
- **FALCON** (Completed September 2015) – This project looked at aligning the data of our 3 main systems at 11kV into an integrated network model.
- **Common Information Model** (Active) – Building on the FALCON project this is looking at creating a comprehensive, accurate and portable network model in CIM format.

The WPD CIM project is investigating the potential of using the international standard to support exchange of electrical information and how it could be used to support the information layer of the smart grid architecture model. The benefits of having data in CIM format will be tested to determine whether there is a business case to convert and maintain data in this format as a future requirement for our software. The benefits from having data in a CIM format will be evaluated by:

- Exchanging data with third parties;
- CIM software importing and exporting ; and
- Supporting the development of a system interface.

Operational Forecasting

The most notable operational forecasting project trialled within WPD is the Advanced Planning Tool (APT), as part of the Low Carbon Network Fund (LCNF) Network Equilibrium project. The aim of the project was to create a tool for operational support and control engineers for proactive and reactive modelling using profile data. The aim of this is to give better information on the expected power flows and voltage profiles under both normal and abnormal operations.

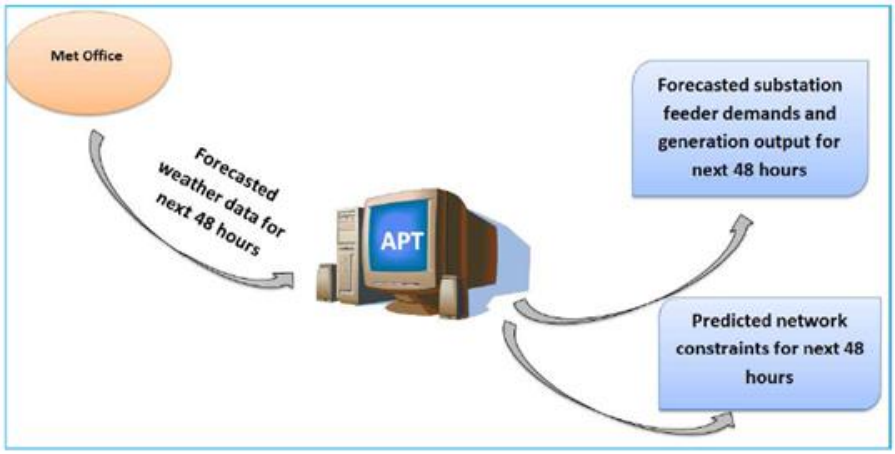

Figure 4: Diagram showing APT data forecasting

One of the other functions was to determine expected network constraints for the following two days. The forecasting functionality of the APT is based on the usage of 48-hour weather forecasts to produce forecasted demand and generation profiles for the following two days. As shown in Figure 4, the Met Office provides the weather forecasts to the APT (on a daily basis) and then the APT produces the forecasted feeder demands of all substations and the forecasted output of generation connections. These forecasts are then used in the load-flow calculations which produce the expected network constraints for the next 48 hours. Network Equilibrium is ongoing, but development of the APT was terminated due to the limited success of the forecasting.

Scenarios

Scenarios have been developed as part of WPD's strategic reports. All four licence areas have been published and currently the forecasts are being undertaken for the second iteration of each licence area. These scenarios are used to guide low regret investment decisions on the subtransmission network.

The same forecast data has also been used as part of Regional Development Plan (RDP), which is part of the ENA's Open Networks project. This is a joint study between WPD and National Grid, using scenarios to compare build and non-build solutions across the transmission/distribution boundary.

Long Term Solutions

Data Alignment and Exchange

Using the outcomes from these innovation projects will help guide us on how to further integrate our data systems to meet the requirements of a changing network.

If CIM proves to be a viable method of integrating systems, the long-term solution will be a rollout of CIM where possible to improve the ease of data sharing and data quality.

Whilst integration of WPD's existing systems is being actively investigated, consideration is also being given to where data should be stored in the longer term. This includes the possibility of moving to a single system that is more suited to the requirements of a DSO.

Operational Forecasting

WPD will continue to investigate how operational forecasting can be utilised to assist in network operation. Areas of interest could include dynamic asset ratings (DAR) and weather-based demand and generation forecasts.

Scenarios

WPD will continue to assess the need for long-term forecasting to ensure the network can be designed and operated effectively. This will include further collaboration with National Grid, like the work currently being done as part of the Open Networks project. WPD will continue to run stakeholder events to get valuable inputs from all parts of the industry; these will also be used to disseminate study outputs.

Bibliography

[1] National Grid Electricity Transmission plc, "The Grid Code, Issue 5, Revision 21," 21 March 2017.

[2] The British Standards Institute, "BS EN 61970: Energy management system application program interface (EMS-API)".

[3] The British Standards Institute, "BS EN 61968: Application integration at electric utilities – System interfaces for distribution management".

[4] National Grid plc, "Future Energy Scenarios," July 2017.