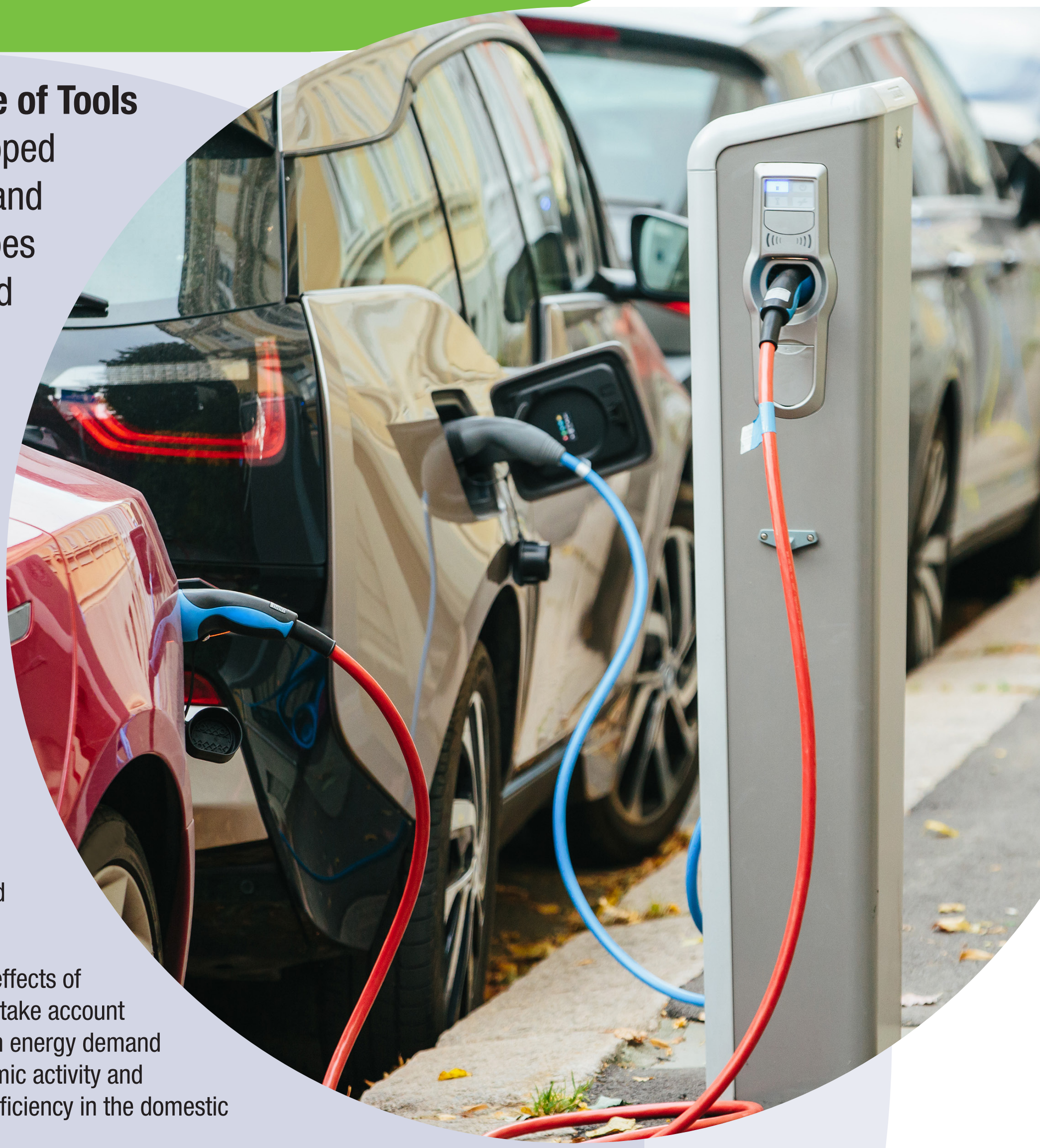
electricity north west
Bringing energy to your door

Demand Scenarios and ATLAS

Architecture of Tools for Load Scenarios

Credible scenarios of future demand and generation, which reflect the associated uncertainties, are key to efficiently planning our distribution network.



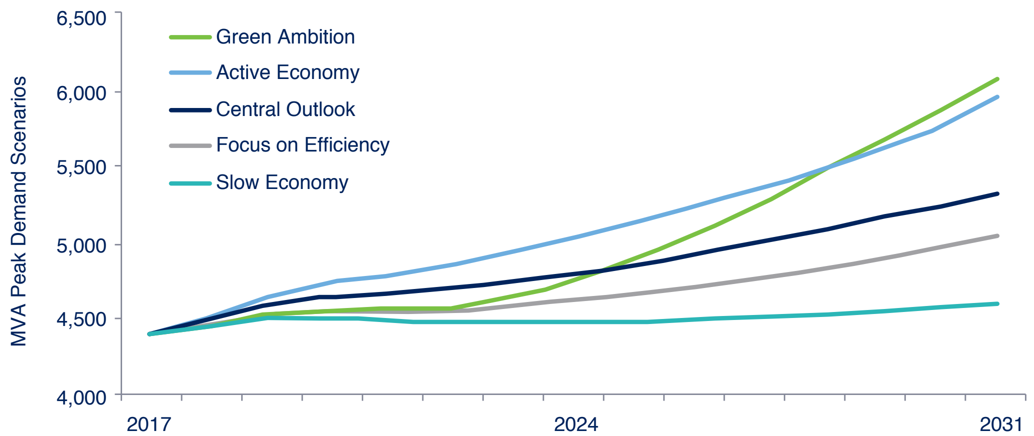
Our ATLAS project (**Architecture of Tools for Load Scenarios**) has developed methodologies, prototype tools and specifications to develop the types of detailed loading scenarios and comparisons to capacity which are needed by distribution network operators (DNOs) to plan for future customer needs.

The ATLAS project builds on the work from another project 'Demand Scenarios with Electric Heat and Commercial Capacity Options', which closed in April 2017. Both projects are funded under the Network Innovation Allowance (NIA).

The Demand Scenarios project developed and implemented a revised methodology for producing annual peak demand scenarios per substation for our region, for use in planning and reporting.

Historic measured demand is corrected for the effects of metered exporting generation. Future scenarios take account of econometric modelling of underlying trends in energy demand including the effects by local authority of economic activity and population, and the differing effects of energy efficiency in the domestic

Figure 1: Scenarios for winter peaks – sum across all bulk supply points



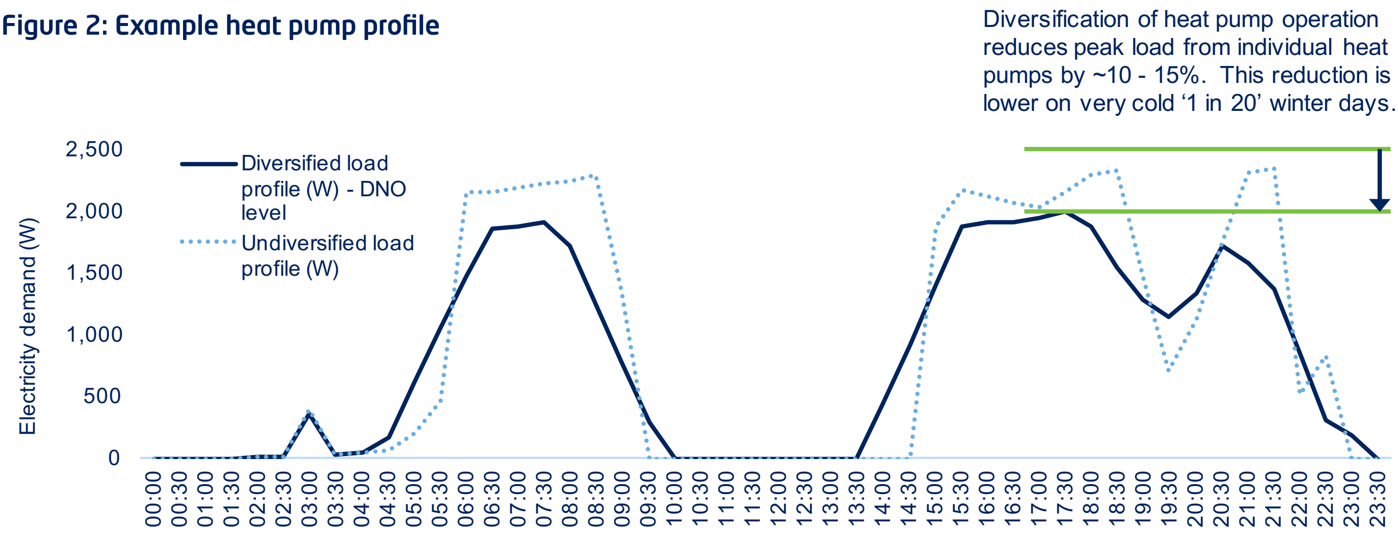
and non-domestic sectors. They include the incremental effects on peak of those load types which are likely to be more important in future, such as electric vehicles.

We identified key contributors to future growth in peaks as being heat pumps and air conditioning, so the project developed and integrated additional analysis of the impact of these technologies. This enabled us to analyse both winter and summer peaks on our network.

Project partner, DELTA EE used building physics modelling to develop diversified half-hourly load profiles of key ‘heat pump-house type’ combinations, to understand how load would vary significantly with temperature by type eg comparing an average and a very cold winter, and validated these profiles with manufacturers.

The heat pump work also developed uptake scenarios and investigated the impact of heat pump load on the secondary network, how potential interventions with customers could mitigate these problems and how profiles would vary with market signals encouraging flexible operation of heat pumps.

Figure 2: Example heat pump profile



To improve analysis of summer peaks, the Tyndall Centre at the University of Manchester explored the scale and drivers of future increases in summer air conditioning load, informed by their work on the RESNET project.

In terms of future peak load growth, air conditioning load is potentially as significant as heat pumps for future load growth, and summer peaks could plausibly exceed winter peaks in urban areas in high-temperature scenarios.

Figure 3: 2030 summer peak air-conditioning load on Electricity North West network in median temperature scenario

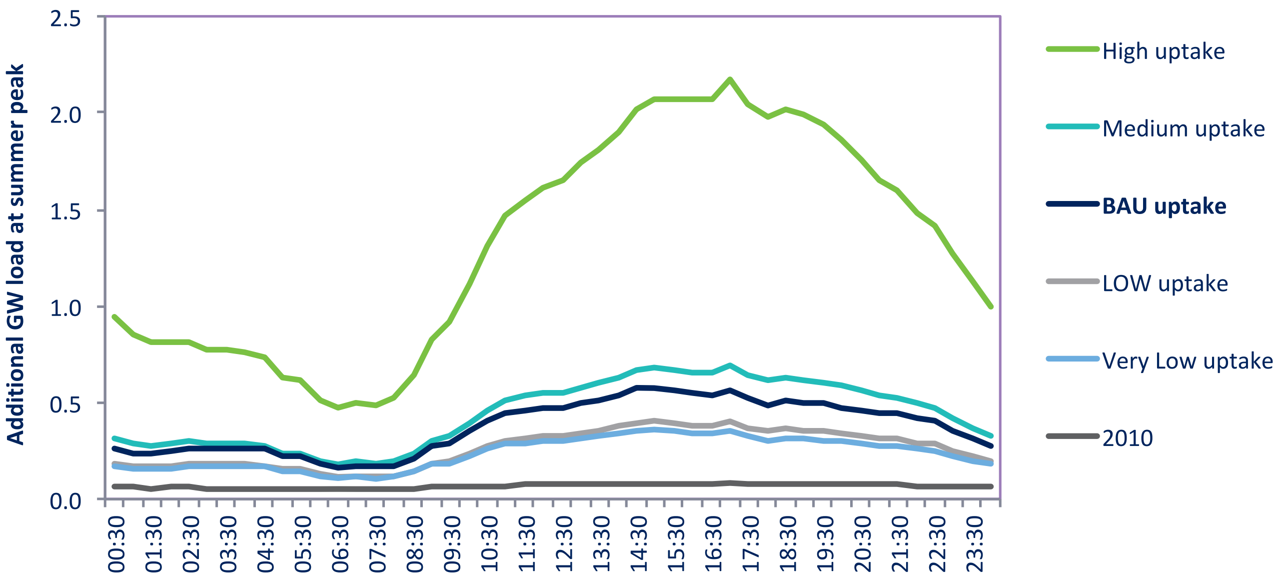


Figure 4: 'Real options' cost benefit analysis model

Inputs	Calculations	Summary metrics
Future demand scenarios Framework inputs Strategy A inputs Strategy B inputs	Strategy A Strategy B (repeated structure)	Cost and risk distributions Least regret cost and risk analysis Capacity output per demand scenario Cash flow output per demand scenario

We use our peak scenarios to judge when it is efficient to use a traditional or smart solution to deliver network capacity. We developed a prototype 'real options' cost benefit analysis model to support decisions on whether to provide network capacity in a particular location by traditional reinforcement and/or by purchasing post-fault demand side response (a technique developed in our Capacity to Customers project). A decision support model is required because these two strategic options provide different amounts of capacity and have different cost and risk profiles, so the efficient decision depends on a view of uncertain future demand. The prototype model has already been used to support real business decisions to purchase demand side response and choose the appropriate size of new and replacement primary transformers.

The ATLAS project significantly extends the scenario analysis in the Demand Scenarios project beyond peaks to half-hourly historic and scenario analysis covering:

- Seasonal peaks and minima
- Active power (P), reactive power (Q) and their combination in apparent power (S)
- Analysis of measured, latent and true demand (now including the effects of metered and non-monitored generation)
- Indicative comparisons to capacity.

ATLAS has delivered methodologies and prototype tools for the grid and primary network which we have used for demand forecasting in 2017. We will also deliver a consistent methodology and specification for a tool for the secondary networks. This will be implemented later to take advantage of ongoing data cleanse and improvements in load estimation at these voltages, associated with the introduction of a new network management system.

A key initial project deliverable in ATLAS was to develop and implement a prototype tool for data processing in MATLAB. This takes half-hourly data for the 'monitored component of true demand' and corrects it for network switching, data loss and spurious spikes. This allows us to carry out the year-round half-hourly analysis, including automatic identification of seasonal peaks, minima and load factor.

We have successfully applied this to five years of our bulk supply point (BSP) and primary substation data. We have also made estimates of the output of non-monitored generation, and the effect on suppressing measured substation demands.

This work is described in our data processing report at **www.enwl.co.uk/atlas**.

This dataset has allowed us to derive asset-specific weather correction of historic demand, as the baseline of our P scenarios. The ATLAS P scenarios of half-hourly true demand and latent demand (generation) were delivered per substation using a new 'customer-archetype' model built by project partner Element Energy. This expands on their previous load models with other DNOs and incorporates key learning from our Demand Scenarios project (such as on heat pumps, air conditioning, population and economic activity) to indicate, on a monthly basis, daily profiles of maximum, average and minimum load, and increasing representation of distributed generation and storage.

Our work on Q scenarios builds on the work of the Reactive Power Exchange Application Capability Transfer (REACT) project which investigated increasing Q exports at the transmission-distribution boundary.

ATLAS extends the analysis from just periods of minimum demand at certain GSP substations to deliver an integrated year-round approach for the whole of a DNO's grid and primary network. Key inputs to the Q scenarios are a) the P scenarios for demand and generation; b) the historical Q/P ratio trends at primary substations; and, c) crucially the interaction of future mixes of demand and generation with the DNO's network above primary substations. The latter aspect has been explored in two ways – via detailed time-series network modelling in IPSA2 with Python scripting and via an empirical spreadsheet approach that involves simplified network equivalent modelling. Our comparison of these approaches revealed practical GSP group cases where a detailed time-series network approach is the only way to adequately mimic the Q exchange behaviour of transmission-distribution interfaces. Benefits of this detailed approach were disseminated in a paper presented in CIRED 2017 conference (Glasgow, June 2017, available online at: **www.enwl.co.uk/atlas**).

ATLAS delivers richer loading scenarios across the DNO network, providing the platform for smart management of the network, and enabling informed discussions with National Grid and other stakeholders about future investments and solutions.

Figure 5: Issues addressed by ATLAS data processing

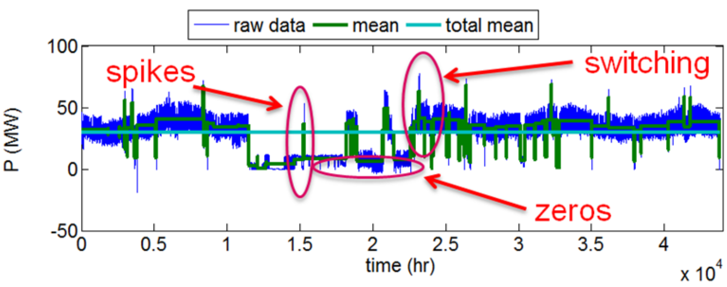
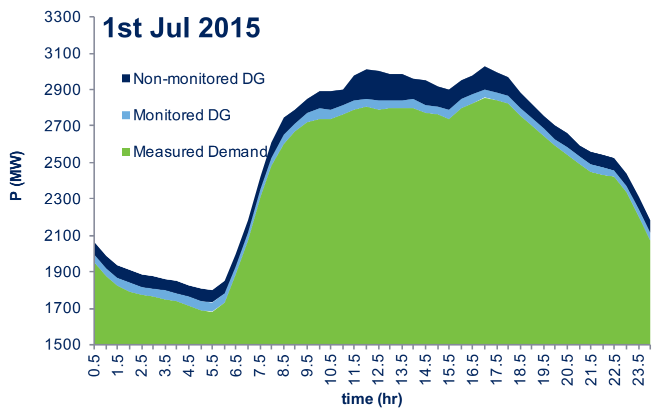


Figure 6: Aggregate demand at primary substations on a summer day



www.enwl.co.uk/atlas
www.enwl.co.uk/demandscenarios