NIA ENWL008
Architecture of Tools for Load Scenarios (ATLAS)

NIA Progress Report

31 July 2017

VERSION HISTORY

Version	Date	Author	Status	Comments
V1.0	12 May 2017	R Shaw		
V1.1	19 May 2017	R Shaw		Amended following comments from C Kaloudas

REVIEW

Name	Role	Date
L Eyquem	Innovation Programme Assistant	10 July 2017
G Bryson	Innovation Engineer	10 July 2017
P Turner	Innovation Manager	16 July 2017

APPROVAL

Name	Role	Date
Steve Cox	Engineering & Technical Director	20 July 2017

CONTENTS

1 PROJECT BASICS

Project title	ATLAS
Project reference	NIA_ENWL008
Funding licensee(s)	Electricity North West Limited
Project start date	October 2015
Project duration	2 years
Nominated project contact(s)	Cara Blockley (cara.blockley@enwl.co.uk)

2 SCOPE

The scope of future load analysis needs to expand from the existing focus on peak loading in MVA, based on winter peak MW loading. The expanded analysis will cover winter and summer conditions, peak loading and minimum or reverse power flow, including the effects of generation. The outputs will include indicative comparisons to thermal capacity. Future loading will be expressed with uncertainty eg scenarios and volatility measures.

This will be delivered in a consistent way across all distribution network assets – GSP, BSP, primary and secondary networks – although the implementation will differ. In particular the grid and primary analysis will be per substation, corrected for weather and generation effects, and cover the range of active power flows, reactive power flows, apparent power, power factor and load factor over a year (P, Q, MVA, pf, LF). For the secondary networks, given the lack of historic data on loading and uncertainty in local geographical spread of new technology, there will be a simpler analysis, and future scenarios will be interpreted on a volume basis ie suggesting a number of assets exceeding capacity in future. The project will deliver the methodology, prototypes and specifications for an enduring automated business solution to analysing current load, generating future scenarios and providing indicative capacity assessments.

The project builds on the analysis and tools developed in elements of the following Electricity North West innovation projects:

- Low Voltage Network Solutions (2011-2014) eg Future Capacity Headroom model of the secondary networks
- Demand Forecasts and Real Options (IFI) – 2013-2015
- Demand Scenarios with Electric Heat and Commercial Capacity Options (NIA) – 2015-2016 – developing peak demand scenarios at grid and primary
- Reactive Power Exchange Application Capability Transfer – REACT (2013-2015) with National Grid and all DNOs.

3 OBJECTIVES

The ATLAS project will develop the method to deliver historic estimates and future annual scenarios of asset loading to 2031, and make indicative comparisons of these to thermal capacity. This will provide inputs to network/business planning, information for stakeholders and help fulfil mandatory reporting requirements.

This project supports four primary objectives:

- To support efficient decisions about load-related investment in the RIIO-ED1 regulatory period (2015-2023)
- To justify the plan for efficient load-related investment in the RIIO-ED2 regulatory period (2023-2031)
- To more efficiently and accurately meet our 'Week 24' reporting obligations to National Grid, and support compliance with future restrictions on the operational envelope of GSPs
- To provide better information to stakeholders and customers, enhancing customer service.

By better understanding current and future loading, this will support the business to only provide necessary network capacity and investments, thus minimising the economic and environmental impact of the networks.

4 SUCCESS CRITERIA

- Automate correction and analysis of peak and minimum load behaviour across all grid and primary substations
- Deliver a prototype tool for annual P and Q load estimates and indicative capacity assessments across all grid and primary substations, including automated delivery of a wider scope of estimates and scenarios of GSP Connection Group loadings to National Grid in the 'Week 24' submission, and for future regulatory reporting required by Ofgem
- Amend internal policies accordingly, and specify the business-as-usual approach for grid and primary substations
- Deliver partial prototypes of load estimates and indicative capacity assessments across the secondary network, and specify the future business-as-usual system to be based on the improved load estimates expected to be available from 2018 onwards.

5 PERFORMANCE COMPARED TO THE ORIGINAL PROJECT AIMS, OBJECTIVES AND SUCCESS CRITERIA

This progress report covers the period up to 31 March 2017; the ATLAS project is on plan against the original aims, objectives and success criteria.

In the last year, the ATLAS project has moved forward from methodology development to deliver initial prototype versions of tools for data processing, weather-correction, P forecast and Q forecast for GSPs, BSPs and primary substations for the Electricity North West network. The initial versions have been delivered on a 2015/16 baseline.

In relation to the first success criterion, data processing tools have been created and applied in MATLAB software to take the half-hourly data on measured substation loading and generation export from Electricity North West's systems:

- To produce half-hourly datasets of true demand (P) and measured demand Q) for each GSP, BSP and primary substation
- To correct for data loss, spikes and switching actions to present true demand in normal operation.

This allows diurnal behaviour, trends and seasonal peaks/minima to be automatically identified. Furthermore, algorithms developed in MATLAB are used to automate estimation of the output of non-monitored generation per substation, in order to give a full view of the underlying true demand.

The initial version of the data processing was applied in May/June 2016 to streamline manual work identifying peak demands in 2015/16 and to generate a five-year history of true demands at BSP and primary substations. A description of the initial version of the data processing methodology was published at www.enwl.co.uk/atlas in autumn 2016. The tool was then further developed to produce an updated data set for GSP, BSP and primary true demands in February 2017.

In relation to the second success criterion, a draft forecast methodology was defined for development of P and Q scenarios by substation.

For the P scenarios, this set out a structure to forecast diurnal profiles of true and latent demand (distribution generation – DG) per month in a consistent way for each GSP, BSP and primary substation in a DNO network. The ATLAS project is building here on the learning from the 'Demand Scenarios with Electric Heat and Commercial Capacity Options' (NIA) project, by considering demographic and economic differences per local authority and the way that domestic heat pumps and air conditioning will affect winter and summer peak loads. However that project was focused on **peak** demands.

To achieve monthly diurnal views and to extend to latent demand, the ATLAS project identified the potential for the substation load growth models developed by Element Energy for UKPN and NPG in other innovation projects to be adapted and extended. The ATLAS form of the Element Energy model uses the learning from the 'Demand Scenarios' NIA project and also meets the wider scope of ATLAS ie using the outputs of the data processing methodology, and producing maximum, minimum and average scenarios of true demand and of latent demand met by DG per substation each month to 2050.

Since May 2016, Element Energy has worked with Electricity North West on ATLAS to produce an Excel-based load growth model which can demonstrate a wide range of scenarios. Scenarios of true demand are linked to characterising demand in a set of 'customer archetypes' linked to external geographic datasets. The initial P scenario model was delivered in December 2016, and then recalibrated in March 2017 including a region-specific weather-correction of true demand.

In contrast, the Q scenario methodology has been developed internally by Electricity North West using IPSA power systems analysis tool together with Python and MATLAB software platforms, building on the approach developed in the REACT project. The approach to forecast measured Q at primary substations combines the initial P forecast from the Element Energy model with historic seasonal trends in measured Q/P ratios at the primary substations.

Between primary substations and GSPs, time-series network modelling in IPSA is used to model the interactions between power flows and the detailed characteristics. A significant achievement for the ATLAS project this year was the set up and validation of this network modelling against monitored Q demand at GSPs. The draft Q forecast models were then completed in March 2017. The implementation and practical benefits of the proposed Q forecast methodology are demonstrated in a paper accepted for the June 2017 CIRED conference in Glasgow.

Using the minimum demands and installed/accepted DG capacity values gathered as part of the ATLAS project, work has begun on delivering a metric of available thermal capacity for DG by BSP substation.

The final two success criteria – on amending policies and defining the business-as-usual approaches for load scenarios for GSP, BSPs, primary substations and the secondary network – will be addressed in the remaining months of the project.

6 REQUIRED MODIFICATIONS TO THE PLANNED APPROACH DURING THE COURSE OF THE PROJECT

No change to the planned approach has been made, but the timeframe of the scenarios has been extended, beyond 2030 on an indicative basis to 2050. This longer timeframe is required when considering Ofgem's CBA framework and for impact assessments for innovation funding.

7 LESSONS LEARNED FOR FUTURE PROJECTS

The ATLAS project has so far demonstrated that it is feasible (but challenging) for a DNO to implement half-hourly data processing for GSP, BSP and primary P and Q, to weather-correct true P demand, and to use those inputs as the basis of well-justified P and Q scenarios for the purpose of strategic planning. The rest of the project will test this by updating with an improved data set and seeking to use the ATLAS approaches on a 2016/17 baseline for analysis and reporting of loading on the grid and primary network in 2017.

To enable automated approaches to data analysis and forecast scenarios, for consistency, changes have been made to substation naming in multiple reports and datasets.

Modelling challenges in time-series modelling of extended 132 to 33kV networks, as well as analytics on big data (ie, half-hourly demand data across all GSP, BSP and primary substations) were also revealed. A significant lesson learned was that special concern needs to be taken into account to deal with issues around computational cost, memory limitations and practical aspects in modelling.

8 THE OUTCOMES OF THE PROJECT

Not applicable for a progress report

9 PLANNED IMPLEMENTATION

Not applicable for a progress report

10 OTHER COMMENTS

The ATLAS and Demand Scenarios NIA projects were presented together at the Low Carbon Networks Innovation conference in Manchester in October 2016 – see www.enwl.co.uk/atlas for the presentation.