ENW Strategic Options for Modelling Future Networks.

ENW MODELLING FUTURE NETWORKS

Modelling Tool Strategy and Recommendations

Table of Contents

1 Management summary

Electricity North West currently use a wide range of network modelling and other planning tools in their day-to-day operations. The tools range from products such as DINIS, to new utilities still undergoing development which automate some of the more laborious tasks necessary during planning or are being introduced to meet new regulatory or other business requirements.

This report builds on the previous where the "as is" planning landscape was documented, and critically now addresses key business stakeholders defined future planning requirements. This final project report considers the strategic pathfinder questions as to how the future planning requirement will be enabled and taken forward.

The focus of the project is on electrical modelling and analysis, with secondary reference to financial modelling. The identification and strategic assessment of functional implementation delivery pathways from both an option and delivery route-map viability perspective are considered. Detailed individual product assessment comparisons are left to a later procurement stage, but key overriding data and integration architecture questions are clearly raised with accompanying suggested solutions.

CGI has drawn on its experience from previous assignments at Electricity North West and further afield. Specific Electricity North West /CGI projects include the recent Master Data Architecture and Enterprise Service Bus projects, and the earlier LV Data Enablement and Dynamic Planning Innovation Funding Incentive project. We have engaged with key business stakeholders and those concerned with Information and Communications Technology (ICT) provision, driven by specific use cases, and maintained close coordination with the steering group to build consensus in an incremental way. CGI will also call on our experience from other DNO innovation and business-as-usual projects where appropriate such as Low Carbon London, Flexible Urban Networks Low Voltage and Flexible Approaches for Low Carbon Optimised Networks which have all involved planning tools, their data provision, integration and functionality.

This document is the project's final report and presents our overall findings and recommendations framework on which a future modelling tool strategy for Electricity North West can be based.

The project scope can be summarised as informing the Electricity North West strategy by;

- capturing the present business use of existing planning tools, and their limitations;
- collating a new future requirements roadmap;
- assisting Electricity North West in enabling new functionality through flexible ICT and data architecture decisions;
- advising how maximum benefit can be obtained from the investment Electricity North West are currently making with the new Network Management System (NMS) implementation; and
- reporting on strategic options and recommendations.

This project need can be characterised as a requirement for an Electricity North West network modelling enablement strategy for the medium and long term that does not prematurely close off any potential future options. The critical success factor for this study is to enable Electricity North West to meet the future modelling needs of the business and optimise investment in appropriate network solutions, balancing cost against outcomes.

1.1 Background

Low-carbon technologies and the smart grid are asking new questions of network design and planning. Worst-case static load analysis is no longer enough, with embedded generation, reverse power-flow, time-series data and network solution optimisation now all becoming increasingly important. The current rate of industry changes dictates that a proactive future-networks planning tool strategy is deployed to meet these challenges and stay ahead of the requirements roadmap.

This report acts as a pathfinder for strategic options, and their associated route-maps, to deliver the required planning enablement. The context is one that, until recently was relatively static, but now is increasingly experiencing and facing substantive change.

The route-maps and options put forward seek to plot an appropriate course through some major challenges that are characterised below.

External drivers include the customer adoption of low carbon technologies with their government support mechanisms, new commercially incentivised customer behaviours, the impact of new disruptive business models, and higher customer expectations. Suppliers, aggregators, the Transmission System Operator (TSO), community energy initiatives, virtual private wire developments, and peer to peer trading all have the potential to create new impacts on the distribution network by influencing local production and consumption.

Smart grid techniques as alternatives to reinforcement are migrating to business as usual. The required new functionality in the planning systems that needs to be deployed can be detailed as future use-cases.

The advent of the industry discussion as to the need for the introduction of a Distribution System Operator (DSO) function is driving the formation of new operational planning requirements. The need for greater information exchange and coordinated interactions at the transmission distribution interface have been identified. In addition, the need for a “whole system” line of sight and enhancements to investment and operational planning functionality are recognised from the implications of reports such as the Future Power Systems Architecture Project.

The planning enablement strategy chosen needs to be resilient to industry change. At this stage how the system operation roles at the distribution network level will be allocated and organised is not yet fully clear, but alternatives are gradually being delineated.

To be successful the planning enablement approach also needs to recognise the internal change management challenges. The challenges include, ease of use, training provision, user acceptance or resistance, catering for different skill-set levels, and managing business risk. All this needs to be achieved against the back-drop of minimising system disturbance, maintaining business continuity against OFGEM quotation response targets, and with user supporting documented design policy business processes and adopted use-case driven practices all of which will need careful consideration and implementation delivery response.

The approach to data and the planning system integration can be the difference that marks out success or not. Master data management and the quality of existing data is the foundation to which the new data required to enable new functionality can be added. The opportunity in the planning arena is to make a step change in productivity and system supported capability by placing the needed functionality and supporting data, at the engineer’s finger-tips, without the need for manual data preparation. The potential for digital transformation also extends to customer interactions for information provision or simple quotations through the use of on-line portals. Robotic software scripting as used in other industries may also in time be deployed to support these customer service enhancement target areas.

1.2 Structure of this document

This document is structured to guide the reader through a logical sequence of analysis carried out to support the selection of a strategic planning enhancement route map. The document should be read after reading the preceding first report entitled ENW MODELLING FUTURE NETWORKS, Modelling Tool Requirements (Current & Future).

Section 2 focuses on functional electrical modelling requirements. Existing requirements are addressed and future requirements predicted to support the smart grid and their potential timing. In addition, non-functional system requirements are assessed, as are the high-level data requirements needed to support the required functionality.

Section 3 addresses the provision of a target integration architectures within which the enhanced planning capability and consistently sourced data can operate successfully. Suggestions as to how to achieve the idealised architecture vision are put forward for consideration. Network topology and load data provision options are described for further evaluation and potential testing. Specific enhancement areas identified include the future availability of a Forecast Repository, a Load Profile Calculator, cleansing facilities for the historical SCADA data, greater automation of the process of Winter Maximum Demands production, and the use of data services.

Section 4 concisely sets out the strategic planning tool selection options by type and voltage level. The existing system landscape is taken into account with advantages and disadvantages of each option summarised.

Section 5 considers the implementation route map choices and voltage level and functional deployment sequences to support the options defined in section 4.

Section 6 evaluated the strategic options defined in section 4 against listed criteria, and also considers wider drivers for change in the industry sector.

Section 7 summarises all the preceding analysis and consolidates to form recommendations.

2 Planning enablement requirements

2.1 Functional requirements

2.1.1 Requirements – Existing and Future

The diagram below shows the main planning domains ranging through the voltage levels up to operational functions. Against these domains are listed functional use-cases the first main column being existing functionality distributed across LV Affirm, DINIS, GROND and IPSA. The use cases represent the electrical functionality applied to specific voltage levels and tasks. Each use case is colour coded to its organisational departmental home such as planning, connections, asset management and operations. The next column to the right lists the new future use-cases that are considered to be needed to enable the future planning capability irrespective of which system or route-map pathway is selected. The future use-cases are not accurately aligned to expected timescales, but more detailed consideration is given to this aspect in the table in section 2.1.2. The future use cases imply new functions that will be needed. They span short, medium and long term as to some extent it is driven by customer demand when they will be needed and any firm date would at this stage be a prediction. We do however suggest that the LV use cases and those associated with a “minimal DSO” may impact first depending on the rate of domestic low carbon technology uptake, and industry system operation model adaptation respectively.

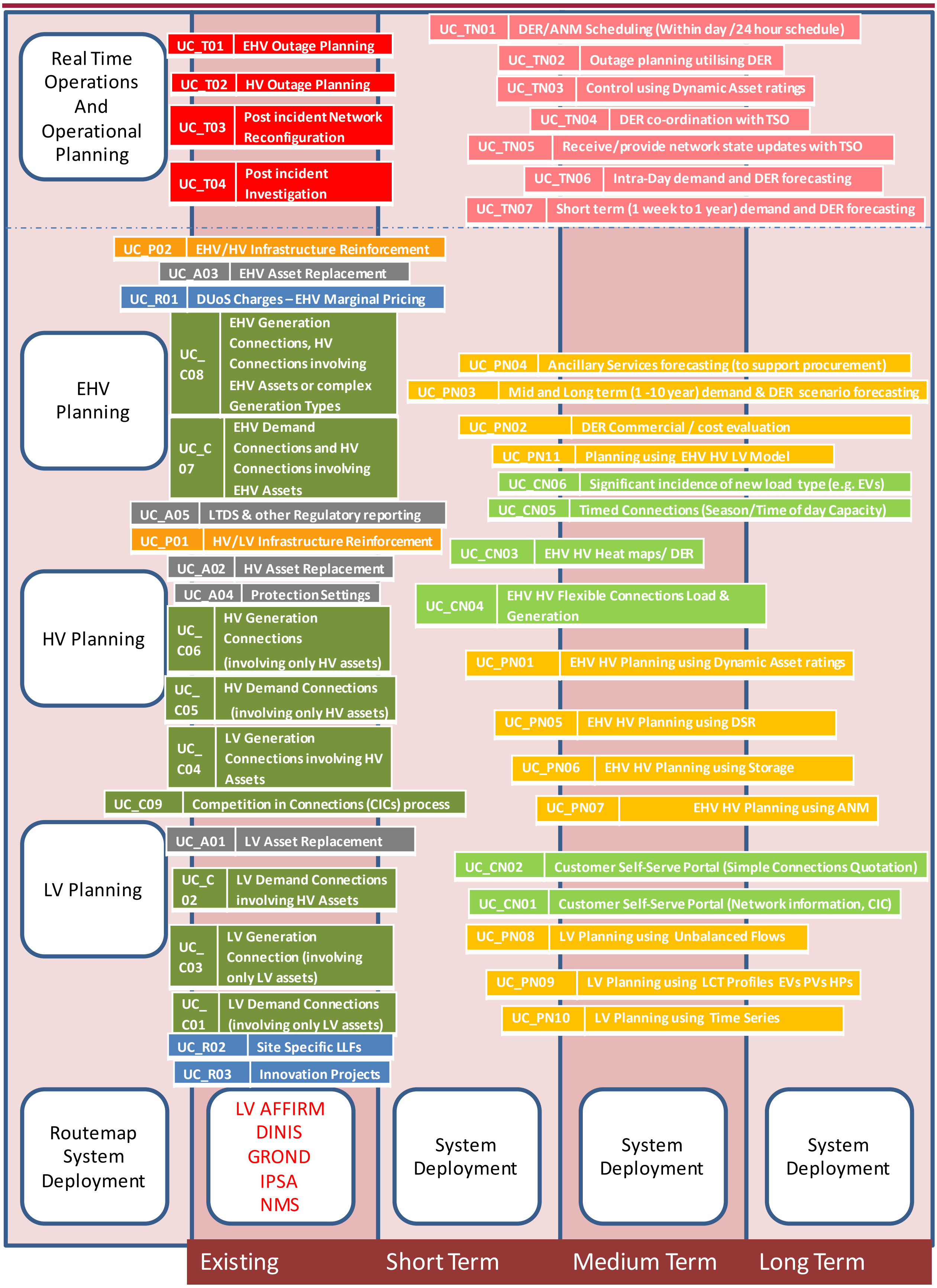


Figure 1 – Use Case positioning

2.1.2 Timing of requirements

Five main tranches relating to the timing of functionality need are envisaged. The suggested timings below are sequential, but in reality are likely to overlap driven in part by external trigger points, such as the adoption of low carbon technologies, for example an attractive EV offer and new vehicle launch perhaps supported by a government grant or "scrappage" scheme for older diesel cars.

The HV/LV Requirement
An avalanche of connection enquiries that could follow-on from Feed In Tariff (FIT) stimulated Distributed Energy Resources (DER) connections, but this time applied to Electric Vehicles (EV)s or other disruptive low carbon technologies. This could pin-point a planning vulnerability in the sense of smart functionality, and potentially dealing with the volume of enquiries within expected timescales. This situation is brought to the fore by the limited functionality and manual nature of LV Affirm, and the stage of product lifecycle represented by DINIS. Four-wire unbalanced LV analysis, ease of use, and the provision of Self-Service Portals are thought likely to be critical to meeting this challenge.

Pricing /Investment Support
Although not limited to pure power-flow functionality, the support of Distribution Use of System (DUoS) pricing and network investment has seen substantive investment to IPSA in the form of an additional EHV marginal pricing module. Any change around this area but be fully cognisant of the need to provide a viable and cost effective solution that aligns with the forward system strategy for supporting pricing and network infrastructure capital investment plans.

EHV/HV Smart Functions
As smart grid interventions are increasingly deployed as alternatives to traditional reinforcement in business as usual and not limited to innovation projects, the Business as usual planning capability must keep step with appropriate functionality and just as importantly approved procedures. Interventions such as flexible connections, Active Network Management (ANM) schemes, Demand Side Response (DSR), Real Time Thermal Ratings (RTTR), and storage are all potential examples.

DSO Functions

The aggregated scale of embedded Distribution Network Operator (DNO) DER, and the need to further optimise the whole electricity system is driving the need for greater information exchange and coordination between distribution and transmission systems. Coordinated operational planning is core to this requirement and the local company has the distribution network operational and asset knowledge to which it needs to add the required DSO functions.

Future potential DSO Separation from the DNO?
It is far from clear at this stage how roles and responsibilities will be allocated. However, ideally the planning enablement options and route-map should be considered against the full range of potential outcomes to test their resilience to change in the industry sector.

At a more detailed level the following table lists for each future use-case business need and benefit, possible timescales, and the impact of functionality absence.

Id	Use Case/Business Process	Business Unit	Business Need/Benefit	Timing	Absence impact
UC_CN01	Customer Self-Serve Portal (Network information, CIC)	Connections	ICE Incentive OFGEM direction of travel Filtered workload	Short Term	Response timescale targets Costs Productivity
UC_CN02	Customer Self-Serve Portal (Simple Connections Quotation)	Connections	Releasing staff from simple connection assessments	Medium Term	Response timescale targets Costs Productivity
UC_CN03	Heat maps/ DER MAPS	Connections	Internal visibility Externally attracting enquiries to locations with capacity	Short Term	Reduced acceptance ration for connections. Scheme coordination more difficult.
UC_CN04	EHV HV Flexible Connections Load & Generation (ANM)	Connections	Modelling of ANM supported	Short Term	Bespoke modelling Costs Response Targets
UC_CN05	Timed Connections (Season/Time of day Capacity)	Connections	Modelling of Timed Connections supported	Short Term	Bespoke modelling Costs Response Targets
UC_CN06	Significant incidence of new load type (e.g. EVs)	Connections	Keeping up with for example EV connection requests. Driven by Diesel scrappage scheme.	Medium Term	Ability to respond in timescales and keep up with network impact
UC_TN01	DER/ANM Scheduling (Within day /24 hour schedule)	Control	DER/ANM scheduling for operational planning supported	Medium Term	Bespoke modelling Preparation Costs Schedule potentially sub-optimal
UC_TN02	Outage planning utilising DER	Control	Enhanced coordination	Short Term	Planned interruption impact minimised

Id	Use Case/Business Process	Business Unit	Business Need/Benefit	Timing	Absence impact
UC_TN03	Control using Dynamic Asset ratings	Control	Dynamic Asset Ratings fully utilised	Medium Term	Capacity release realisation
UC_TN04	DER co-ordination with TSO	Control	Increased interoperability with DSO requirements	Short Term	Control outcome conflicts eg ANM filling in released capacity from TSO turndown
UC_TN05	Receive/provide network state updates with TSO	Control	Support increased DSO/TSO interaction	Short Term	Operational planning less effective and coordinated
UC_TN06	Intra-Day demand and DER forecasting	Control	Enablement of Operational Planning Capability	Medium Term	Effectiveness of operational planning
UC_TN07	Short term (1 week to 1 year) demand and DER forecasting	Control	Enablement of Operational Planning Capability	Short Term	Effectiveness of operational planning
UC_PN01	EHV/HV Planning using Dynamic Asset ratings	Planning	Enable schemes with DAR to be modelled.	Medium Term	Capacity not released or bespoke modelling extra effort
UC_PN02	DER Commercial / cost evaluation	Planning	Value of DER	Short Term	Capacity release realisation
UC_PN03	Mid and Long term (1 -10 year) demand & DER scenario forecasting	Planning	Better quantification of combined effect of load and generation.	Short Term	Risk of underestimating the effect of latent demand
UC_PN04	Ancillary Services forecasting (to support procurement)	Planning	Reliability and availability of AS.	Medium Term	Potential shortfall of available services, or over procurement to actual requirements.
UC_PN05	EHV HV Planning using DSR	Planning	Enable schemes incorporating DSR to be modelled.	Short Term	Missed opportunities where DSR is more attractive than reinforcement, or bespoke modelling.

Id	Use Case/Business Process	Business Unit	Business Need/Benefit	Timing	Absence impact
UC_PN06	EHV HV Planning using Storage	Planning	Enable schemes incorporating storage to be modelled.	Short Term	Storage enquiries or in-house initiatives need bespoke modelling with time, cost, resource impacts.
UC_PN07	EHV HV Planning using ANM	Planning	Enable ANM scheme to be planned supported by selected tool.	Short Term	ANM schemes need bespoke modelling with time, cost, resource impacts.
UC_PN08	LV Planning using Unbalanced Flows	Planning	Accurate power-flow capability for unbalanced loads and generation.	Short Term	Inability to bulk model unbalancing impact of single phase LCT devices. Work-arounds carry under and over estimation risks.
UC_PN09	LV Planning using LCT Profiles EVs PVs HPs	Planning	Capability to model the new LCT being taken onto the network	Short Term	Inability to bulk model the impact of disruptive new LCT technologies coupled with consumer consumption behaviours.
UC_PN10	LV Planning using Time Series	Planning	Enable risk based approach rather than just worst case. Eg timed connections etc	Short Term	Inability to model time of day load/generation rather than just winter peak.
UC_PN11	Planning using EHV HV LV Model	Planning	Enable seamless through voltage level analysis.	Short Term	Fault contribution modelling and stability studies impacted.

2.2 Non-functional requirements

A non-functional requirement is something that is needed of a business solution in order for that solution to be viable for use in the business, but which is not a statement of a function or facility that the solution must be able to perform.

The following table lists the most common areas of non-functional requirements that apply to typical solutions. In this case, the overall solution architecture, including how it will integrate with other, related Electricity North West facilities, is being considered separately from the actual choice that will need to be made to select the appropriate planning tool(s) to be deployed. This table therefore indicates the relative levels of importance that should be given to each of these non-functional requirement areas when evaluating the candidate options:

Criterion	Tool Options	Candidate Architectures
Cost	important	important
Usability	important	may impact
Data Fit	important	important
IT Strategy Conformance	relevant	important
Maintainability	important	important
Adaptability	important	important
Road Map alignment (tool vendor)	important	-
Delivery (ease & risk)	important	important
Commercial risk exposure to Product Vendor	important	some relevance
Incremental ability (ability to deliver to business units)	beneficial (but probably inherent)	some relevance
Automation /self service	important	may impact
Scalability	may impact	may impact
Plug & Play ability	useful	important
Resilience	important	important
Reliability / Availability	important	important
Industry Convergence (based on available knowledge of other DNOs' plans)	important	relevant

The importance levels given in the above table can be used at a later stage to drive the definition of score weightings for these areas when carrying out formal evaluations, such as will be needed if any parts of this solution are to be put out to competitive tendering.

2.3 High-Level Data Requirements

2.3.1 Requirements

The following table describes the types of data that will be needed for the future Electricity North West planning tools:

Table 10 – Current Data Requirements

Dataset	Variant	Description	Granularity	Currency	Required quality	Study types used for	Other comments	Group	Current source(s)	Future source(s)
Network topology	**Basic**	Network components and their connectivity (including substation sites and links to the items contained at each) down to load/infeed points	Busbar-branch (plus tee nodes etc)	As-built	High, ideally "DMS quality"	Powerflow Optimisation Fault levels Common Network Asset Indices Methodology	Transformers or outgoing feeders at either end of the voltage range being studied are typically represented as infeed/load points as appropriate.	Master data	As shown on current architecture diagram	GIS/Ellipse via NMS model manager
Network topology	**With switchgear**	As above but also including significant switching points and which of these are telemetered/telecontrolled.	Busbar-branch with switchgear	As-built	High, ideally "DMS quality"	Historical studies Reliability	"Significant" switching points means those operated to energise/de-energise circuits, including "selection" isolators at large substations but excluding minor POI/CME points.	Master data	As shown on current architecture diagram	GIS/Ellipse via NMS model manager
Network topology	**Historical**	As above but backdated to past date to be studied	Busbar-branch with switchgear	Backdated	High, ideally "DMS quality"	Historical studies		Master data	Not available unless engineer manually edits as-built data	Topology: GIS/Ellipse via NMS model manager Running arrangements: NMS Historian
Network topology	**"Authorised"**	As-built topology updated by incorporation of future committed changes, eg new connections and other planned projects.	Busbar-branch (with or without switchgear)	Planned future	Should only include each potential new connection once, even if several quotes are still in validity periods for different contractors.	Powerflow Fault levels		Master data	Not available unless engineer manually edits as-built data	Approved Network Designs in GIS or in modelling tools
Conductor types and span lengths		Line and cable conductor types	Each model branch represented as spans of one or more conductor types, with lengths for each.	As for topology model	For some models may need to have separate types for different layout arrangements, as this affects impedances (especially at higher voltages)	Powerflow Optimisation Fault levels Common Network Asset Indices Methodology	Used to index a table of conductor characteristics, eg impedances, ratings, and fault probabilities. Most modern planning tools now allow a branch to be defined as a set of more than one type connected in series, with lengths given for each of these spans.	Master data	As shown on current architecture diagram	GIS/Ellipse via NMS model manager
Branch impedances		Impedances for circuits between substations or other significant nodal points	Per conductor type	Latest	High, for fault level studies. Less critical for other types eg powerflow, optimisation.	Powerflow Optimisation Fault levels Protection		Master data	Held in characteristics table in modelling tools	GIS/Ellipse via NMS model manager

CGI

Table 10 – Current Data Requirements										
Dataset	**Variant**	**Description**	**Granularity**	**Currency**	**Required quality**	**Study types used for**	**Other comments**	**Group**	**Current source(s)**	**Future source(s)**
Branch ratings		Cable/line current ratings	Per conductor type	Latest	High	Powerflow Optimisation Fault levels Reliability/ contingency	Different types of ratings are typically used for different purposes, eg seasonal ratings for OHLs, temporary/cyclic/etc for cables. In addition to these there can be separate fault ratings.	Master data	Held in characteristics table in modelling tools	GIS/Ellipse via NMS model manager
Branch fault probabilities		Probability of having a fault on a given length of conductor in any given year	Per conductor type	Latest	National/regional average used if no specific reliability data for specific assets.	Reliability	National rates are used	Master data	Held in characteristics table in modelling tools	NaFIRS
Switchgear ratings		Normal and fault ratings for switchgear	Per model of switch *(may need to be by specific plant item)*	Latest	High	Powerflow Fault levels		Master data	Ellipse / modelling tools	GIS/Ellipse via NMS model manager
Protection settings		Protection thresholds and timings	Per protection device	Latest	High	Protection	Existing project to address storage and mastering of this data	Master data	Protection database	Ellipse
Transformer characteristics		Ratings, impedances etc for transformers	See comments	See comments	High	Powerflow Fault levels Ofgem reporting in Common Network Asset Indices Methodology	For secondary Txs, it can be sufficient to have one set of values for each rating of Tx, but for primary Txs and above it may be necessary to hold separate data for each individual asset, ideally taken from its acceptance test datasheet. For Common Network Asset Indices Methodology the OFAF ratings will be used, however in other modelling activities there will be the need to consider different ratings depending upon the operational state of the network or the contingency being studied Whilst ratings are obviously crucial, it would be useful to clarify the relative importance of the other characteristic values to different study types .	Master data	Ellipse / Held against individual Txs in modelling tools	GIS/Ellipse via NMS model manager
IDNO network outfeeds		Points where IDNO networks are fed	Per IDNO outfeed	Latest	Depending on type and purpose of model	Powerflow Optimisation Others		Master data	LVFI/GIS	GIS via NMS model manager
Connected Premises	**Significant**	Premises that contain significant equipment, eg LCTs, and their points of connection to the network.	Per significant premise, eg HV customers if modelling the HV network.	Latest	Depending on type and purpose of model	Powerflow Fault levels Optimisation Others		Master data	LVFI/GIS	GIS via NMS model manager
Connected Premises	**Secondary feeders**	All customer premises and the secondary feeders they are on	All premises	Latest	Depending on type and purpose of model	Powerflow Optimisation Others		Master data	LVFI/GI	GIS via NMS model manager
Connected Premises	**LV connections**	All customer premises and their actual LV connection points	All premises	Latest	Depending on type and purpose of model	Powerflow Optimisation Others		Master data	LVFI/GIS	GIS via NMS model manager

Table 10 – Current Data Requirements										
Dataset	**Variant**	**Description**	**Granularity**	**Currency**	**Required quality**	**Study types used for**	**Other comments**	**Group**	**Current source(s)**	**Future source(s)**
DG locations and parameters		Details of DG sites connected to the network, including types, capacities and generation parameters.	Per installation	Latest	On Application, commissioning and modification of generation.	Powerflow Optimisation Fault levels	Not all SSEG implementations are correctly notified to DNOs.	Master data	DG database (spreadsheet)	Connection Agreements
Source impedances or equivalent fault levels	**At Grid Txs**	Effective source impedances, based on quantity of generation connected	Per grid transformer	See comments	Annual or when significant change	Fault levels Protection	These vary over time according to the amount of generation connected on the grid and the grid's own running arrangements.	Historical values	NGC	NGC
Source impedances or equivalent fault levels	**At BSP and Primary Txs**	Effective source impedances, based on primary running arrangements and generation connected at EHV	Per BSP and primary transformer	See comments	Annual or when significant change	Fault levels Protection	These depend on both the grid Tx source impedances and the status of the EHV network.	Historical values	IPSA	IPSA or its replacement
Week 42 data		Data from National Grid to enable modelling of short circuit analysis		Yearly		Fault levels	At the moment this process is manual and time-consuming.	Historical values	NGC	NGC - via NMS model manager
Measurement Locations		Locations of measurement points on the network topology	Per measurement	Latest	High	Any studies that require historical or forecast data		Master data	Manually entered	NMS model manager
GSP metering		Metered GSP power flows	Per Grid Tx	Daily	As recent as obtainable	As input into G&P PDS	Received from NGC	Historical values	CLAVA	CLAVA
MDIs		Secondary substation maximum demand indicator readings	Per secondary Tx	When last collected (by Inspections process)	As recent as obtainable	HV Powerflow Input to HV load allocation process Common Network Asset Indices Methodology	Usefulness limited by the fact they give no indication of *when* the peak occurred.	Historical values	Ellipse	Ellipse
IDNO peak loads		Peak demands for IDNO network outfeeds	Per outfeed			Powerflow Optimisation Others		Historical values	CMRS/DADS	NMS historian/DUoS Billing replacement/Forecast Repository
IDNO historical metering data		Historical metered IDNO outfeed loads/exports	Per outfeed			Powerflow Optimisation Others		Historical values	CMRS/DADS	NMS historian/DUoS Billing replacement/Forecast Repository
HHly historical analogue readings		Historical VIPQ or VI readings collected by SCADA at Grid & Primary substation sites down to outgoing primary feeder currents.	Per circuit on G&P substations	history held - generally up to date unless comms or RTU failures occur	Other than for historical powerflow studies, need to filter out erroneous values from sensor failures and (usually) values collected during abnormal feeding arrangements.	HV Powerflow Input to HV load allocation process	Required filtering is currently done manually	Historical values	FLA	NMS historian
HH MPAN advances (import & export)		HHly P&Q demands from HHly metering points – AE, AI, RE, RI	Per MPAN	Last 12 months		HV Powerflow Input to HV load allocation process	MPANs of PCs 5-8 now being converted to HHly	Historical values	DADS	DUoS billing replacement[1]

1 Will be delivered as part of the Smart Metering implementation project.

CGI

Table 10 – Current Data Requirements										
Dataset	**Variant**	**Description**	**Granularity**	**Currency**	**Required quality**	**Study types used for**	**Other comments**	**Group**	**Current source(s)**	**Future source(s)**
Estimates of Annual Consumption (EACs)		Load estimates for non-half-hourly metering points.	Per MPAN	Updated after customers' meters read.		Input to load allocation process.	MPANs of PCs 5-8 now being converted to HHly	Historical values	ECOES	
NHH profile curves		Settlement consumption profiles for NHH MPAN types.	Per GSP Group/ PC/SSC/TPR combination per half-hour across the entire year	Produced daily shortly after the day in question		Input to load allocation process.	MPANs of PCs 5-8 now being converted to HHly	Historical values	ECOES	
Peak demands	**G&P**	Peak loads, derived from available SCADA measurements and HH demands. Currently identified manually for substations by Strategic Planning, but ATLAS NIA project seeking to semi-automate the production of processed HH profiles and identification of peaks	Per Tx and outgoing feeder at G&P substations. Per substation, further detail only as required for study	Yearly	As good as practicable, so as not to unduly refuse connection requests.	Powerflow	Generated in G&P PDS. Used to calculate firm capacities.	Derived data	G&P PDS	G&P PDS
Peak demands	**Secondary network**	Peak loads, derived from best information available as processed by LAS.	Secondary Tx and LV feeder level	HHly for identified peak days	As good as practicable, so as not to unduly refuse connection requests.	Powerflow Input to Future Capacity Headroom model	Used to calculate firm capacities, and by the current ARS logic.	Derived data	LAS	NMS
Firm capacities		Spare available capacities allowing for N-1 contingencies	Tx and feeder level	Yearly	As good as practicable, so as not to unduly refuse connection requests.		Key input to investment planning	Derived data	G&P PDS	G&P PDS
Fault levels		Currents that would flow if a short circuit occurred	All network components			Protection Fault levels (lower down the network)	Also used to determine where DG can be connected. Not constant quantities, they can vary depending on how much generation is running on the Grid. Appropriate values therefore need to be assumed and stored for modelling studies.	Derived data	DINIS (secondary network)	
Customer numbers		Number of customers connected to each LV Tx/feeder	Secondary feeder level	Latest		Reliability (for projected CI/CML calculations) Common Network Asset Indices Methodology		Master data	CRMS	NMS model manager
Historical outages		Historical outage details	Secondary feeder level			Reliability		Other historical data	NaFIRS	NaFIRS
Economic Forecasts by area		Growth forecasts based on DECC scenarios		Yearly		Load forecasting		Misc	CEBA	CEBA
Week 24 data		Data to be supplied by the DNO on the demand at each GSP, transfer capability between GSPS and embedded generation to allow Nati				NG's modelling studies	Created, currently in IPSA, for transmission to NG	Derived data	IPSA	IPSA

Table 10 – Current Data Requirements

Dataset	Variant	Description	Granularity	Currency	Required quality	Study types used for	Other comments	Group	Current source(s)	Future source(s)
Customer archetype categories		Customer categorisation with associated forecasting parameters			Will need better dataset in future – this is being developed in the ATLAS NIA project in our work with Element Energy	Forecasting		Misc	-	ATLAS / Forecast Repository
Scenario Inputs		Scenario inputs related to demographics, efficiency, economic activity and low carbon technologies.				Input to G&P Peak Demand Scenarios and Future Capacity Headroom Model		Misc	Various including DECC/Ofgem	Various including DECC/Ofgem
After Diversity Maximum Demands (ADMDs)		Average peak demands for premises of a given type when aggregated over a number of similar nearby premises.	Per premise type		Industry standards	Aggregated load calculations for use in powerflow models		Misc	Modelling Tools	ATLAS / Forecast Repository
Customer equipment		Relevant equipment at customer sites, eg motors, with relevant characteristics data	Per relevant equipment item	Latest	As good as practicable.			Master data	Modelling Tools	Connection Agreements
Smart Meter Inventory data		Details of installed smart meters and the configuration settings that have been downloaded to them.	Per SM	Latest		Anything that uses SM data		Master data	-	NDAG
Smart Meter readings (consumption/ export)		Half-hourly import consumption and export	See discussion	Will depend on SM solution		Powerflow Optimisation Others	See discussion - will/may require aggregation before use in planning models	Future - Historical values	-	SM solution
Smart Meter readings (voltage logs)		Each SM can buffer up to 4,320 historical voltage readings in a circular buffer	DNO can configure time interval between readings, from 1min upwards	Only collected from SM on demand	Uncertainties over meter accuracies need to be understood	Excursion investigations		Future - Historical values	-	SM solution
ANM operational details		Rules for amending demand and generation.		Latest		EHV HV Flexible Connections Load & Generation (ANM) EHV HV Planning using ANM	UC_CN04, UC_PN07	Future – network master data	-	ANM installations
ANM scenario details		Details of operational ANM scenarios. Time series data and analysis results needed.				EHV HV Planning using ANM	UC_PN07	Future – ANM characteristics	-	ATLAS / Forecast Repository
Timed Connections		Details of Timed connection contracts		Latest		Timed Connections (Season/Time of day Capacity)	UC_CN05	Future – LCT master data	-	Connection Agreements
New load type characteristics		Characteristics eg demand profiles for new load types eg EVs, PVs and HPs. Time series data and analysis needed for different types of LCT, or their values at the time of peak demands.				Connections modelling LV Planning using LCT Profiles EVs PVs HPs	UC_CN06, UC_PN09	Future – LCT characteristics	-	ATLAS / Forecast Repository

Table 10 – Current Data Requirements										
Dataset	**Variant**	**Description**	**Granularity**	**Currency**	**Required quality**	**Study types used for**	**Other comments**	**Group**	**Current source(s)**	**Future source(s)**
DAR operational details		Operating details for branches where DAR is applied		Latest		Dynamic models for relevant Branches.	UC_PN01	Future – network master data	-	NMS
Weather condition/ scenarios		Weather condition/scenarios for modelling consumer and DAR scheme behaviour. Time series data and analysis results needed.				Dynamic models for relevant Branches.	UC_PN01	Future – weather conditions	-	ATLAS / Forecast Repository
DER scenario details		Details of operational DER scenarios. Time series data and analysis needed.				Mid and Long term (1 -10 year) demand & DER scenario forecasting. Ancillary Services forecasting (to support procurement)	UC_PN03, UC_PN04	Future – LCT characteristics	-	ATLAS / Forecast Repository
Storage scenario details		Details of operational storage scenarios. Time series data and analysis results needed.				EHV HV Planning using Storage	UC_PN05	Future – LCT characteristics	-	ATLAS / Forecast Repository
Phase imbalance data		Phase allocation of connections or phase imbalance scaling for each LV feeder.				LV Planning using Unbalanced Flows	UC_PN08	Future – network-premise connectivity details	-	GIS
Load and Generation Time series data		Historical time series for key loads and generation sites				LV Planning using Time Series	UC_PN10	Future – historical load data	-	Smart Metering Market systems

Though smart meters can provide half-hourly per-premise consumption data, this is regarded as personal data belonging to the customer of the premise and therefore has to be tightly secured. Some level of aggregation of this data must therefore be carried out before it can be obtained for use in modelling tools.

2.3.1.1 Current architecture

The following diagram shows the current modelling tools and associated data source architecture:

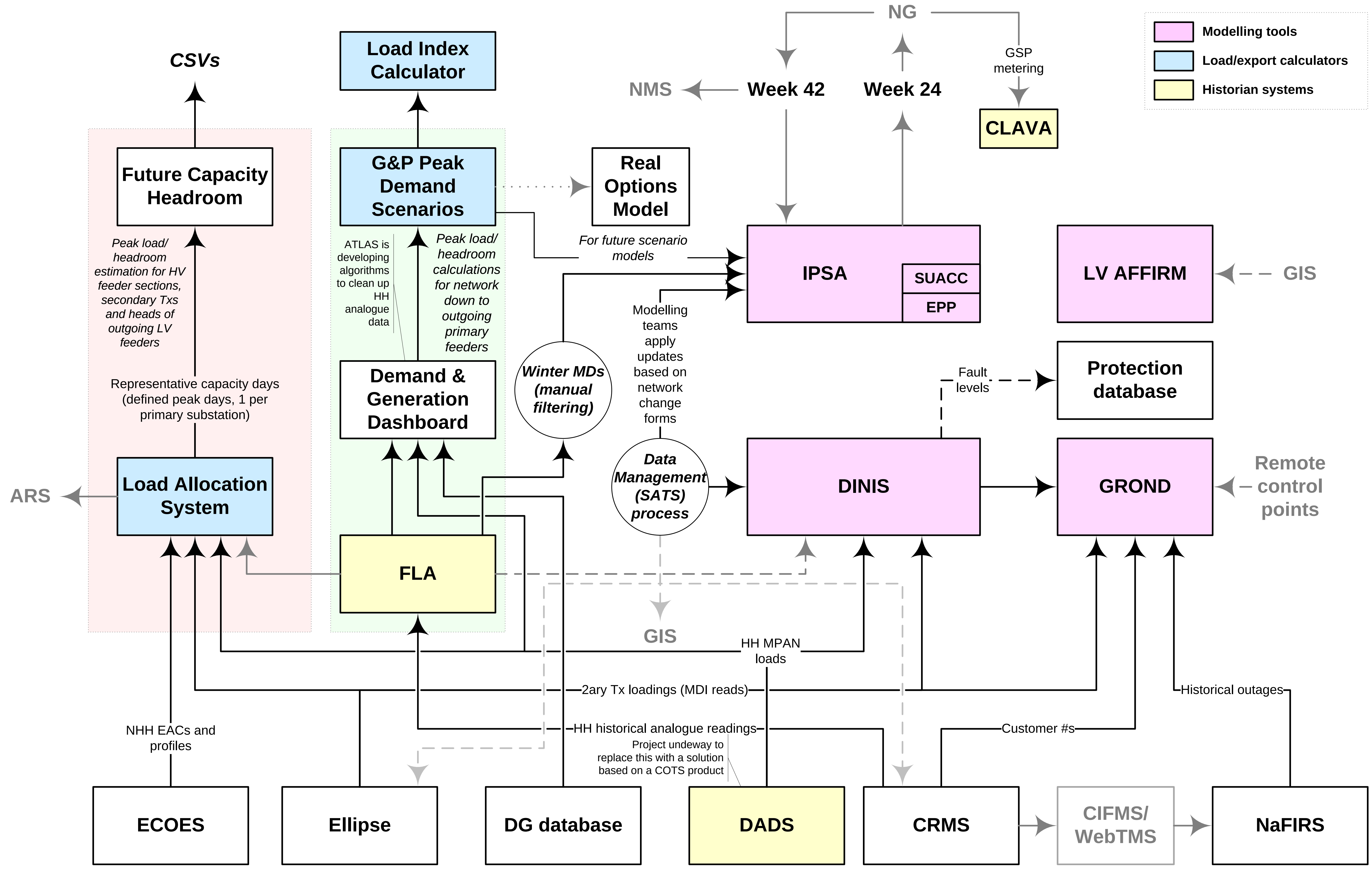


Figure 2 – Current modelling tool and data source architecture

3 Target integration architectures

On-going changes to Electricity North West's IT landscape have a number of implications for how modelling tools can be supported in future.

The main areas in which the Electricity North West IT landscape impacts modelling tools is in the areas of

- provision of existing network topology data that is suitable for use as the starting points for specific modelling tasks;
- provision of load data, whether historical or forecasts, for use in these models, and
- where, and to what extent, modelling systems will be provided as an integral part of systems currently in the pipeline, most notably the new Electricity North West NMS implementation.

Traditionally, each Electricity North West planning tool has had its own database of network topology and asset characteristics data, which has been maintained manually and separately from the data mastered in the main operational systems (GIS, Ellipse, CRMS etc), either by the Data Management team or by the planning team themselves.

A key objective of Electricity North West's Master Data Management strategy is to avoid the need for the same data to be entered separately into multiple systems. For the future, therefore, rather than each planning tool having a separately maintained copy of the as-built network dataset, this network topology data will be made available from the operational master systems via automated interfaces to the planning tool(s)' main data repositories. Planners will then extract the portions of network required for each of their sets of studies from this repository. Committed future planned network changes will also be propagated to the tool(s)' main repositories, appropriately differentiated from current live network.

The NMS project is therefore consolidating the mastering of network topology and static asset data into GIS and Ellipse. As it also requires all of the same information, it is envisaged that a Data Virtualisation layer may be built around the cleansed source databases (GIS and Ellipse) so this data can be obtained to maintain the NMS' own topology and connectivity model. Typically, when a change to the network is about to be commissioned, the following things will happen:

i. the topology changes for each stage of commissioning will be entered beforehand into an "alternative" layer in GIS;

ii. these alternatives will be transmitted to the NMS QA environment, where they will be validated and be supplemented with any relevant SCADA configuration information (the latter will continue to be mastered in NMS); and

iii. the completed and validated NMS "changesets" (which correspond to what would previously have been called "patches") will then be applied to the live NMS network topology model at the appropriate time during commissioning, just as done today in CRMS.

It is not yet clear how future, committed network change plans should best be incorporated. There is an aspiration to populate these into a "planning layer" within GIS, which could also make them available to the NMS' planning functions. If this is implemented then the GIS could also act as a master repository for them for the "offline" planning tools.

A further Service Termination project is also now underway to define a storage and mastering strategy for all the information that Electricity North West holds about customer premises and any relevant equipment installed therein, such as DG, electric vehicle charging posts or other LCTs. If the solution it arrives at identifies the need for any additional master data systems, these will need to be incorporated into the Data Virtualisation provided for NMS, as the latter will also require this data.

NMS will also incorporate a Common Information Model (CIM)-compliant model export facility which will allow network model selections to be made available in this industry-standard format. NMS also automatically keeps copies of all historical network topology versions in its Historian, and these can also be exported if requested.

The chosen planning tool data architecture should aim to take maximum advantage of the mechanisms above that are already being developed as a key foundation for the new NMS. There are one or two small devils in the detail – see 3.3 below – and some areas in which a choice of architectural options is possible, such as whether to obtain master network data from GIS/Ellipse directly or via NMS, but this offers an attractive mechanism for making network topology data available for "offline" planning tools as and when required.

3.1 Idealised architecture vision

To inform the process of assessing the candidate integration architectures, the diagram on the following page shows an idealised view of a future Electricity North West modelling tool architecture, with the principal information flows between the various components.

The systems shown at the bottom are existing systems, or ones in development, from which modelling tools can be fed with the data needed for their studies. As previously noted, the majority of this data falls into two main categories:

1. network topology data, including relevant asset information such as nameplate/ratings data and associated electrical and thermal characteristics; and
2. load data, such as historically metered or forecast values for each load point in the area of network to be studied.

For each of these categories, the available data is mastered across a range of separate Electricity North West systems. Network topology and asset data is mainly mastered in GIS and Ellipse. Various types of historical load data are mastered in appropriate repositories:

- the NMS Historian for historical metered SCADA data and NMS study results,
- the DUoS billing system for HH Meter Point Administration Number (MPAN) advances,
- CLAVA for historical metered Grid Supply point (GSP) values provided by NGC, and
- the future Smart Metering systems for historical load and voltage readings.

In this ideal world view, a set of data services would be provided for each of these two categories, providing easy-to-use facilities for planning tools or engineers to obtain whatever load data they need to use in their models. These data services would then request the available data from the appropriate source systems according to what has been requested, collate the responses, and finally pass the combined dataset back to the original requestor.

Two additional facilities related to load data provision are also included in the ideal architecture:

a. A Forecast Repository, where previously prepared load forecasts can be filed for future use when modelling.
b. A Load Profile calculator that can produce location-specific load profiles from generic profile curves and notional demands or characteristics for each location. A prototype facility of this nature is currently being trialled on the FUN-LV project, where Estimated Annual Consumption (EAC)s for individual MPANs were combined with the appropriate Elexon profile curves to generate deemed HH historical load profiles for use in LV powerflow studies.

The component described as "Smart Contracts" is also likely to be a key facility that will be needed. This would be a system that holds (or a data service that makes available) the technical information on contractual arrangements that have been agreed with third-party DER operators, such as the number of times a particular DSR facility can be called upon and the charges payable for doing so. This information will increasingly be needed for planning studies as the move to a DSO role takes place.

The following diagram presents an ideal-world view of a future Electricity North West modelling tool architecture, items in red being potential future additions:

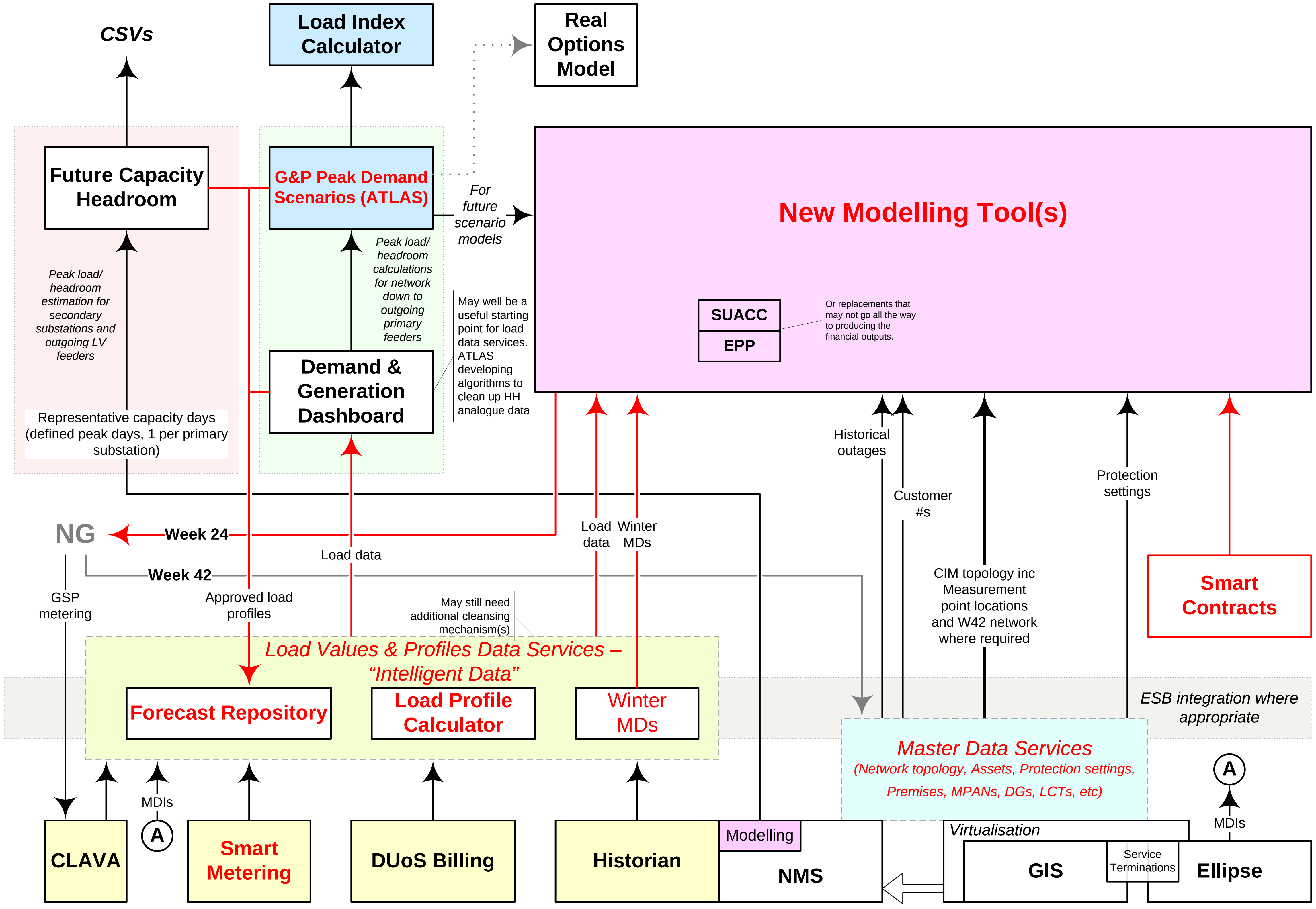


Figure 3 – Idealised future modelling tool architecture

A set of Master Data Services will be needed to maintain the new modelling tool(s)' copy of the as-built and, ideally, planned, network topology. Some possible options for how this might be provided are described in 3.3 below.

After network topology, the next most important type of data required for planning tools is load data. Though sets of anticipated peak demands are generally used at present, in the future there will probably be a need to 'play though' sets of half-hourly worst case profiles. At present the provision of this data is a highly manual process, with much of this data managed outside of the core IT estate using spreadsheets and other desktop tools. A more automated solution would provide a set of Load Values & Profiles Data Services so that planners can easily locate and load the data required for their models. This is likely to involve facilities such as the following:

- A Forecast Repository would provide a controlled data repository for approved planning forecasts and load profiles, such as the data produced by the Future Capacity Headroom model and the Demand & Generation Dashboard/G&P Peak Demand Scenarios (for which ATLAS is currently prototyping some key enhancements).
- A Load Profile Calculator would make estimated half-hourly load profiles available for customer endpoints based on existing, metered settlement data and appropriate allocation profiles such as the Elexon ones. Much of the source data for this is available from the DUoS Billing solutions.

Appropriate Smart Metering data, after aggregation, could also be fed into these data services.

Options for future load data provision are discussed further in section 3.4 below.

As the transition from DNO to DSO unfolds, planners will need to take increasing account of contracted smart grid services such as DSR. It is likely that a time will come when each DNO will need a Smart Contracts solution to track all the agreements that are in place and under what circumstances they can be called upon.

It may not be practicable or cost-effective to implement everything shown in the above figure, but it provides a guiding vision for the future tool and IT landscape.

3.2 Options for realising the vision

There are three main aspects of this architecture for which different candidate options are available:

1. The selection of modelling tools to be used, including the selection of modelling use cases that can be carried out using the new NMS modelling facilities, whether one or several additional, "offline" modelling tools are needed, and whether or not one of these should be IPSA. See section 4.
2. The precise mechanism by which network topology data will be made available to planning tools other than those hosted in NMS from the operational master systems. See 3.3.
3. The facilities that will be provided to facilitate the management and provision of load data for planning models, thus reducing the amount of manual effort required to populate this data into study datasets. See 3.4.

The available options for these aspects, with their respective merits and de-merits, are discussed in greater detail in the following sections.

3.3 Network topology data provision

Assuming it is decided that the new NMS is not the appropriate platform for supporting all of Electricity North West's future modelling requirements, and that therefore one or more additional network planning tools will be required, a robust architecture will also be needed to enable these additional new planning tools to obtain the network topology data they need from the existing Electricity North West systems in which this data is mastered.

Though GIS and Ellipse will become the master systems for the as-built network topology, connectivity and asset master data, we have also identified that some additional data that will be mastered by the new NMS, for example, linkages between network topology elements and historical SCADA powerflow measurement streams, or information on which switches are telecontrollable (for reliability studies, etc), will be needed by these additional planning tools. This implies that, somehow, the planning tools databases must be maintainable automatically from the versions of data mastered in all three of these key operational systems.

The data initially provided to NMS is a subset of the GIS and Ellipse; the modelling tools may need to enhance the NMS data to include further attribution or add NMS-sourced data to GIS and asset data direct from GIS and Ellipse.

Three technically credible options have been identified for making the network topology and asset master data available to additional planning tools. It is beyond the scope of the current project to assess these options in complete detail, and in view of the fact the NMS project is still in progress a number of technical uncertainties in these areas remain.

These three options, and their key advantages, disadvantages and current uncertainties, are outlined at a high level in the table below. In view of the level of trade-offs and uncertainties, we recommend that Electricity North West's solution and data architects conduct a more detailed assessment of these options in order to identify which is the most advantageous.

Network topology data provision				
No	**Option**	**Advantages**	**Disadvantages**	**Uncertainties**
1	Obtain data from NMS using its CIM topology exporter	NMS has been designed to do this Data readily available in CIM format Historical, and potentially future authorised, models also available Will include linkages to available historical SCADA data (CIM Measurements) Selection of network extents by voltage level(s) and feeder(s) included in core facility.	Data available only in CIM format NMS is not the master system for most of this data Does not support provision of any diagram coordinates (CIM GML)	Version and extent of CIM support Export process has not yet been tested Exact extract selection parameters available Scope of facilities available in initial NMS implementation

Network topology data provision				
No	**Option**	**Advantages**	**Disadvantages**	**Uncertainties**
2	Obtain data directly from GIS, Ellipse etc by making calls to the Data Virtualisation facilities implemented for NMS	Decouples model data extract process from operationally critical NMS Data could be made available in formats other than CIM Extraction facilities could incorporate whatever selection criteria needed Obtains data directly from master systems Mechanism could feed other applications, not just modelling tools	Requires additional development of extraction facilities. Extracts will run directly against live systems, so in large numbers may degrade performance Duplication of functionality with NMS Cannot include the following (unless additional NMS DV facilities are added): • Any topology corrections made directly into NMS only • EHV schematic or substation internals diagram coordinates • historical modelling datasets • available SCADA linkages	
3	Implement an additional, actualised copy of the as-built network topology to serve this data up for planning tools etc *	Decouples model data extract process from operationally critical NMS Scalable, avoiding potential performance impacts to master systems Data could be made available in formats other than CIM Extraction facilities could incorporate whatever selection criteria needed Obtains data directly from master systems Mechanism could feed other applications, not just modelling tools Could also incorporate Data Quality Management facilities	Requires additional development Duplication of functionality with NMS Cannot include the following (unless additional NMS DV facilities are added): • Any topology corrections made directly into NMS only • EHV schematic or substation internals diagram coordinates • historical modelling datasets • available SCADA linkages	

Where disadvantages listed relate to data unavailability, the most significant of these is likely to be topology corrections that are made directly into NMS. Unless GIS and Ellipse are subsequently updated into line manually, a lack of access to this data would prevent the modelling tools from having correct network topology. Unavailability of schematics or diagram coordinates will make the modelling tools harder to use (the precise impact is likely to depend on the tool(s) chosen. Lack of access to SCADA point linkage may require modellers to enter these linkages manually when they need to use historical SCADA data for their models.

The Data Governance implications of the options should also be given further consideration by Electricity North West. In particular, if the processes and systems that are providing data for the crucial network operations functions that the NMS support are extended so as to also provide the equivalent data for additional planning tools, then the governance systems and processes that oversee this data provision may need to be extended or refined to take account of the planners becoming additional key stakeholders in this data provision.

It has been assumed that committed future network topology changes will, at a future time, be mastered in the GIS. When this is done these topology versions will also need making available to the planning tools by one of the above mechanisms.

* Option 3 is termed an “Integrated Network Model” by CGI and has been a component within a number of successful innovation projects.

3.4 Load data provision

We have used the term *load data* to mean demand and generation data computed by engineers based on available empirical data.

3.4.1 Background

Currently, most studies use future forecast peak demand load values that have been created using forecasting tools from appropriate inputs such as historical SCADA readings and/or secondary substation maximum demand indicators (MDIs). For the future, however, it is envisaged that more use will need to be made of half-hourly worst-case load forecasts, such as for specific types of scenario day such as cold winter weekdays.

Any load forecast data, however, is currently subject to some degree of uncertainty as a result of the limitations of the source data. For example, the MDI readings do not have timestamps to identify the actual date and time at which the peak demand occurred. When using historical SCADA readings, it is also necessary to filter out readings that correspond to times when abnormal feeding arrangements were in force. For example, if the NOP at the far end of an 11kV feeder has been closed to back-feed a portion of network beyond it in order to achieve a fault restoration, then the currents measured at the head of this feeder will not be representative of the current or peak demands of this feeder in normal running. The ATLAS project is currently investigating what methods and algorithms should be applied to the source data in order to produce more reliable load forecast baselines for use in modelling studies.

A further issue with load data in the current environment is that it generally has to be copied manually between its sources and the modelling tools, which is time-consuming for the planning engineers.

In the following subsections, therefore, we have considered a number of new candidate facilities that would assist in reducing this manual workload, and would enable the future forecasting tools and methods recommended by ATLAS to be embedded within a controlled data management environment.

3.4.2 Candidate improvements

There are three main types of load data that can be used by planning studies and/or forecasting tools:

i. current SCADA and other metered values;

ii. actual historical values, such as SCADA or MDI readings, GSP metering, HH MPAN advances, and in future potentially also smart meter consumption/export readings; and/or

iii. future forecast values produced by engineers using forecasting tools.

The first of these categories is only really relevant to near-real-time operational planning models for which the new NMS is the obvious platform of choice, as it is specifically designed to support these. To improve the management and orchestration of the other categories, though, the following potential improvements can be identified:

- A Forecast Repository into which approved sets of load forecast data can be published so that they can then be made available to other facilities, essentially at the click of one button after selecting the specific forecast dataset to be used.
- A Load Profile Calculator which would automate the calculation of deemed load profiles by combining generic half-hourly profile curves with an appropriate total load value for the customer premise or network location in question.

- General cleansing facilities for the historical SCADA data, eg for removing readings affected by sensor or communications failures.
- Greater automation of the process of Winter Maximum Demands production, such as automatically flagging up readings collected when abnormal running arrangements were in force.
- Data services to act as a broker for historical data requests and perhaps also do some marshalling of the various data types.

Other than for a small number of interdependencies that are identified in the following subsections, these improvement options are potentially independent, so Electricity North West could choose to do some but not all. The decision on whether or not, and if so how, to implement one of these candidate improvements would depend on whether the business benefits it offers, in terms of reduced manual data handling by planning engineer and other data quality/management benefits, are sufficient to justify the implementation costs.

The following subsections consider each of the above candidate improvements in greater detail.

3.4.3 Do Nothing

Do Nothing	
Pros	**Cons**
No additional cost	No benefits Over time this option will impact negatively on productivity and functional capability.

3.4.4 Forecast Repository

A forecast repository would act as a kind of librarian, allowing approved sets of load forecasts to be filed by engineers and then enabling (all or parts of) these datasets to be provided easily for using in planning models when required. This would include forecasts compiled using existing and in-development models such as the ATLAS G&P Peak Demand Scenarios, and the ATLAS secondary networks load scenario tools (which will need to be specified) as shown by the red arrows on Figure 3 above.

Each forecast dataset would comprise a set of load profiles for each relevant network location (eg customer premise or any other appropriate point within the network topology), plus a number of "metadata" fields that define its contents and applicability, such as

- a forecast name
- the base forecasting scenario or the assumptions it embodies
- year of validity (or applicability date range)
- scenario day type, eg cold winter weekday.

The repository database would basically be a hypercube of forecast values with dimensions such as the above plus:

- half hour within the scenario day
- the network/premise location (may be generic eg "secondary Txs feeding middle-class housing estates")
- the determinand of this particular (eg P, Q, S, V, etc) – this allows forecast datasets to contain multiple measurements at each location, such as P and Q values.

The repository would then service incoming data requests for subsets of this forecast data. For example a planning tool could prompt the engineer for the forecast dataset, a set of scenario days and set of determinands to be obtained and then transmit a request to the repository for this data, including a list of the relevant network/premise locations based on the topology previously loaded for the study.

Some initial data modelling work around how to structure a load forecast repository was done on the WPD FALCON project for its Energy Model. The data model requirement for a forecast repository here, though, is thought quite similar to that.

A slightly more advanced version could also support a basic data management workflow to manage lodging, approvals and replacements of datasets.

Forecast repository	
Pro	**Cons**
Provides well-managed home for this data	Cost - probably no existing COTS product available
Facilitates loading (location-specific) data into models	
Supports Load Profile Calculator	

3.4.5 Load Profile Calculator

The load profile calculator would allow historical half-hourly load profiles to be calculated automatically on request from generic profile curves and location-specific consumption/export totals, and forecast future profiles to be made available from these using simple extrapolations. This is primarily focussed on manipulating data from customer end points, such as industry settlements readings or aggregated smart meter reads.

The calculator would hold a list of known measurement locations such as NHH MPAN numbers and/or network locations, and would be populated with appropriate overall load values for each, such as EACs or Annual Advances (AA)s for MPANs or Maximum Demand Indicator (MDI) readings for secondary Transformers. It would then field data requests from planning tools or other applications similar to those envisaged for the Forecast Repository and respond with calculated HH load profiles for the network/premise locations sent in the request.

A prototype facility of this nature is currently being trialled on UKPN's Flexible Urban Networks – Low Voltage (FUN-LV) project, where it computes estimated HH load profiles for NHH MPANs by combining their EAC values with the corresponding Elexon profile coefficients.

The profile calculation principle could also be extended to cover different types of data provision, such as compiling secondary Transformers/LV way profiles from source data such as premise types/numbers using After Diversity Maximum Demand (ADMD) values or other generic profiles.

For best results the calculator would work in conjunction with a Forecast repository as it could use some of the latter's data.

Load Profile Calculator	
Pro	**Cons**
Further automates modelling tool data provision	Cost – ideally needs Forecast Repository to work with
Feasibility established on FUNLV	

3.4.6 Cleansing facilities for historical SCADA data

This would be a facility to automatically cleanse/remove bad values affected by sensor or Remote Terminal Unit (RTU) communications failures etc. ATLAS is already developing prototype methods for processing half-hourly G&P substation data including measured P and Q values at primary, BSP and GSP substations and identifying seasonal MDs (not just winter). The correction methods are tailored to the types and scales of errors found in substation P and Q data (but not feeder data).

One of WPD's NIA projects has also looked at correction process for feeder data.

It may well be appropriate to implement some or all parts of these processes this within the framework of the new NMS, which will probably have useful facilities to support it.

Cleansing facilities for historical SCADA data	
Pro	**Cons**
Eliminates or reduces manual task	Cost – unknown and would depend how easily or not this could be done in NMS
Enables greater automation of Winter MDs production	

3.4.7 Greater automation of Winter MDs production

This is possibly an extension of the historical SCADA data cleansing facilities described above. With access to historical switch states, which will be available in the new NMS historian, it could flag or eliminate readings for periods when there had been abnormal running arrangements that would have affected the values in question.

Again, it may well be appropriate to implement this within the NMS framework where the historical switch states will be readily available in its Historian.

Greater automation of Winter MDs production	
Pro	**Cons**
Eliminates, or significantly reduces, labour-intensive manual task	Cost – unknown and would depend how easily or not this could be done in NMS
	May depend on historical data cleansing

3.4.8 Load data services

It can be seen from the preceding subsections that several distinct facilities could be employed for managing the technical aspects of specific facets of load data provision, and the available historical data will also spread across a number of other discrete systems including

- the NMS historian (historical SCADA and NMS study values),
- CLAVA (historical GSP metering),
- Ellipse (holds historical MDI readings),
- the DUoS billing system (HH MPAN advances), and
- the Smart Metering solution (historical consumption/exports, though this data may only be made available in aggregated forms)

A data services facility would act as an overall integrator and orchestrator of these facilities. Its core data provision mechanism would basically work as follows:

i. A planning tool or other application would submit a request for a set of load data, of a particular type and covering a specified set of network/premise locations.

ii. The data services layer would field this request and, by accessing information detailing what types of load data can be provided by each of the available facilities, would submit appropriate requests to each one for the relevant portions of the originally requested data.

iii. As each facility responds with the data requested in (ii) above, the data services layer would combine these into a single response dataset.

iv. When all of the load data provision facilities have responded as requested, the data service layer would return the integrated dataset to its original requestor.

Load data services	
Pro	**Cons**
Eliminates, or significantly reduces, work required to incorporate load data into models	Depends on Load Profile Calculator and Forecast Repository

3.4.9 Impact on core modelling tools strategy

- To achieve effective automation of load data provision it will be crucial for the network topology models that are provided to planning tools to include Measurement points at all of the locations for which modelling studies will need to apply these. These points will need to be included, at a minimum, at
    - customer premise exit points,
    - DER locations (according to the type of DER)
    - other network outfeed points, eg Independent Distribution Network Operator (IDNO) in-feeds,
    - outgoing primary and secondary LV feeders, and
    - at all transformers.
- Modelling tools will then need to be able to submit load data requests, following an appropriate user dialogue, in a form compatible with the facilities described in 3.4.4, 3.4.5 and/or 3.4.8 above.

4 Strategic options

4.1 Options for incorporating modelling tools

The options described apply to functions outside the remit of real time operations and operational planning which will naturally be assigned to the NMS.

Option A	**NMS (all voltages)**
Option B	**New Single Tool (all voltages)**
Option C	**Enhanced IPSA (all voltages)**
Option D	**IPSA (EHV/HV)** **New Tool 2 (HV/LV)**
Option E	**New Tool 1 (EHV/HV)** **New Tool 2 (HV/LV)**
Option F	**NMS (EHV/HV)** **New Tool 2 (HV/LV)**

For Options D and E there are some additional options on the position and extent of the overlap between the EHV/HV network and HV/LV network. Bespoke decision support applications excluded, but may feed into the development cycle of the main tools deployed over time.

CGI

4.1.1 Existing context without NMS

This section benchmarks the current situation against the above criteria, as a reference point for comparison with the future options described in the following sections:

	EHV	HV	LV
Real Time Operations	IPSA		
Operational Planning	IPSA		
Connections Planning	IPSA	DINIS, GROND	LVAFFIRM
Investment Planning	IPSA	DINIS, GROND	LVAFFIRM
Scheme Planning	IPSA	DINIS, GROND	LVAFFIRM
DUoS Billing	IPSA	500MW model	500MW model
Site Specific LLFs	IPSA	500MW model	500MW model

Existing without NMS	
Pros	**Cons**
Low initial cost	Multiple Masters
Bespoke elements already built	Maintainability (manual updates)
	Some older products
	Functional Gaps
	Vendor Risk
	Lots of manual data copying required
	Some key data held in spreadsheets etc, outside supported systems

4.1.2 Initial context with NMS

	EHV	HV	LV
Real Time Operations	NMS	NMS	NMS
Operational Planning	NMS	NMS	NMS
Connections Planning	IPSA	DINIS, GROND	LVAFFIRM
Investment Planning	IPSA	DINIS, GROND	LVAFFIRM
Scheme Planning	IPSA	DINIS, GROND	LVAFFIRM
DUoS Billing	IPSA	500MW model	500MW model
Site Specific LLFs	IPSA	500MW model	500MW model

Initial context with NMS	
Pros	**Cons**
Planning functionality in NMS	Multiple Masters
NMS to feed CIM datasets	Maintainability (manual updates)
	Some older products
	Functional Gaps
	Vendor Risk

4.1.3 Option A - NMS (all voltages)

	EHV	HV	LV
Real Time Operations	NMS		
Operational Planning			
Connections Planning			
Investment Planning			
Scheme Planning			
Site Specific LLFs			
DUoS Charges	NMS	500MW Model	

Pros	Cons
Planning functionality in NMS	Reliance on one vendor/system
NMS to Tool network alignment	Potential system performance risk
Top to bottom multi-voltage level analysis	Future authorised network needs incorporating
Larger user group/shared development costs	SUACC/EPP re-implementing
Maximise NMS investment	Timing of functionality availability
Separate DMZ environment	Bespoke requirements/ “UK-isation”
	Users will require training in a new system/ IPSA replacement disturbance

4.1.4 Option B - New Single Tool (all voltages)

	EHV	HV	LV
Real Time Operations	NMS		
Operational Planning			
Connections Planning	New Single Planning Tool (NSPT)		
Investment Planning			
Scheme Planning			
Site Specific LLFs			
DUoS Charges	NSPT	500MW Model	

Pros	Cons
Select best of breed Tool (Best Functionality)	SUACC/EPP re-implementing
Flexible implementation of new technology models	Users will have to learn a new system
Top to bottom multi-voltage level analysis	Disturbance of IPSA replacement
Early step enhancement in LV capability	

4.1.5 Option C – Enhanced IPSA (all voltages)

	EHV	HV	LV
Real Time Operations	NMS		
Operational Planning			
Connections Planning	IPSA		
Investment Planning			
Scheme Planning			

Site Specific LLFs		
DUoS Charges	IPSA	500MW Model

Pros	Cons
Flexible implementation of new technology models	Timing of functionality availability
Top to bottom multi-voltage level analysis	Existing Unbalanced LV
Users already familiar	Potential Scaling effort
SUACC/EPP investment retained	

4.1.6 Option D - IPSA (EHV/HV), New HV/LV Tool

	EHV	HV	LV
Real Time Operations	NMS		
Operational Planning			
Connections Planning	IPSA	New HV/LV Tool (NHVT)	
Investment Planning			
Scheme Planning			
Site Specific LLFs			
DUoS Charges	IPSA	500MW Model	

Pros	Cons
Flexible implementation of new technology models	Cost of new tool and implementation
SUACC/EPP investment retained	Ease of Top to bottom multi-voltage level analysis
Best of breed HV/LV Tool added	Users learning curve/training on new tool

Existing IPSA investment retained	
Planning capability resilience	
Ability to flex between NMS, IPSA & New HV/LV tool	

4.1.7 Option E – New EHV/HV Tool, New HV/LV Tool

<table>
<tr><th></th><th>EHV</th><th>HV</th><th>LV</th></tr>
<tr><td>Real Time Operations</td><td colspan="3" rowspan="2">NMS</td></tr>
<tr><td>Operational Planning</td></tr>
<tr><td>Connections Planning</td><td colspan="2" rowspan="4">New EHV/HV Tool (NEHVT)</td><td rowspan="4">New HV/LV Tool</td></tr>
<tr><td>Investment Planning</td></tr>
<tr><td>Scheme Planning</td></tr>
<tr><td>Site Specific LLFs</td></tr>
<tr><td>DUoS Charges</td><td>NEHVT</td><td colspan="2">500MW Model</td></tr>
</table>

Pros	Cons
Best of breed HV/LV Tool added	Cost of two new tools and implementation
Best of breed EHV/HV Tool added	SUACC/EPP investment not retained
Planning capability resilience	Existing IPSA investment not retained
Flexible implementation of new technology models	Ease of Top to bottom multi-voltage level analysis
	Users learning curve/training on new tool
	Disturbance of replacing IPSA

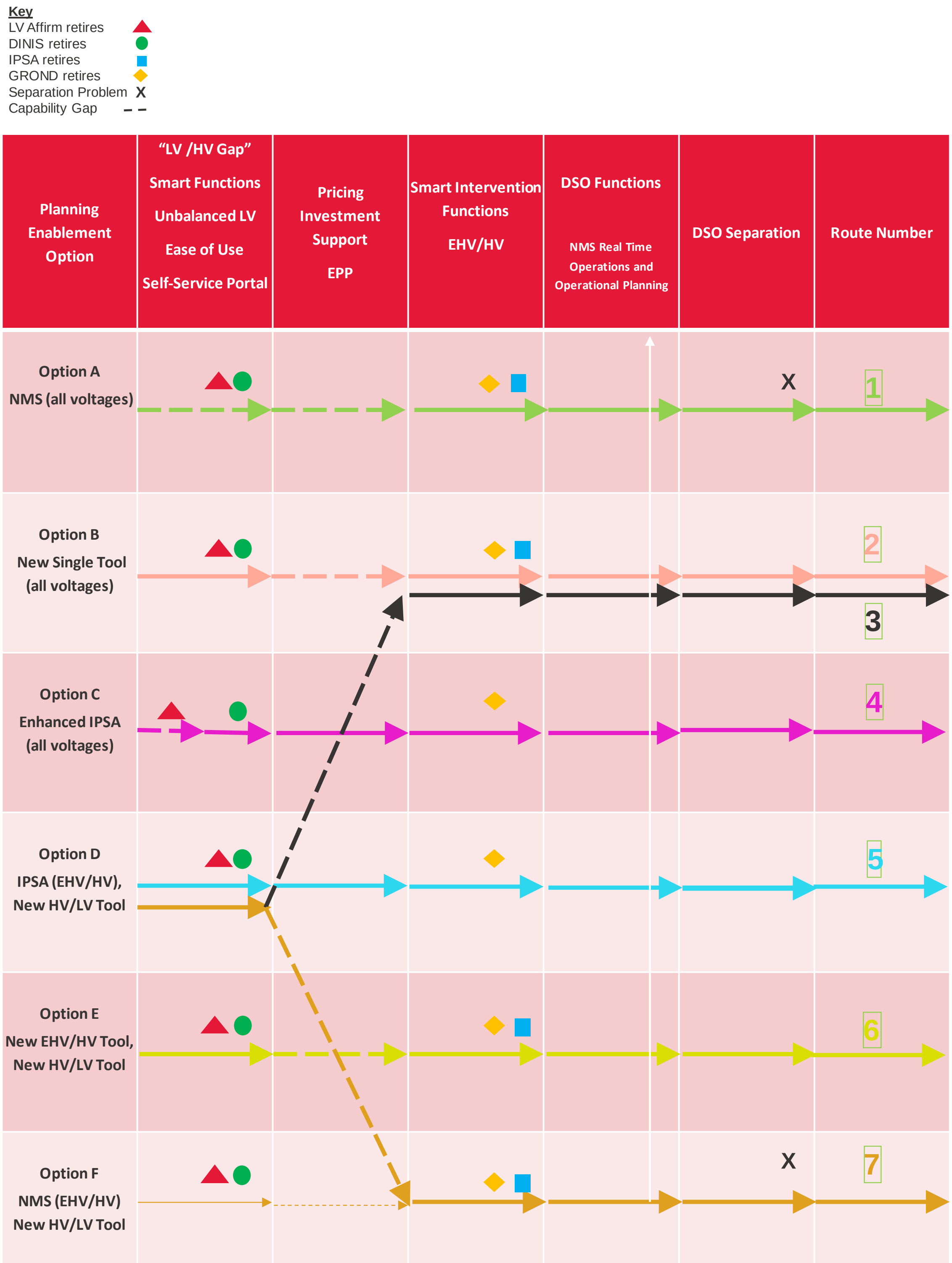
4.1.8 Option F - NMS (EHV/HV), New HV/LV Tool

<table>
<tr><th></th><th>EHV</th><th>HV</th><th>LV</th></tr>
<tr><td>Real Time Operations</td><td colspan="3" rowspan="2">NMS</td></tr>
<tr><td>Operational Planning</td></tr>
<tr><td>Connections Planning</td><td rowspan="4">NMS</td><td colspan="2" rowspan="4">New HV/LV Tool</td></tr>
<tr><td>Investment Planning</td></tr>
<tr><td>Scheme Planning</td></tr>
<tr><td>Site Specific LLFs</td></tr>
<tr><td>DUoS Charges</td><td>NMS</td><td colspan="2">500MW Model</td></tr>
</table>

Pros	Cons
Best of breed HV/LV Tool added	Cost of new tool and implementation
Maximise in part NMS investment	Ease of Top to bottom multi-voltage level analysis
Planning capability resilience	Users learning curve/training on new tool
Reduces NMS users/transactions	SUACC/EPP investment not retained
	Existing IPSA investment retained

5 Implementation delivery route-maps

Implementation assumptions The applications LV Affirm, DINIS, and GROND are all to be retired due to product lifecycle and functionality considerations. The following table develops implementation potential route-maps based on a sequence of predicted challenges listed as column headings. Each planning enablement option is considered in turn with the flexibility to move between options also considered.



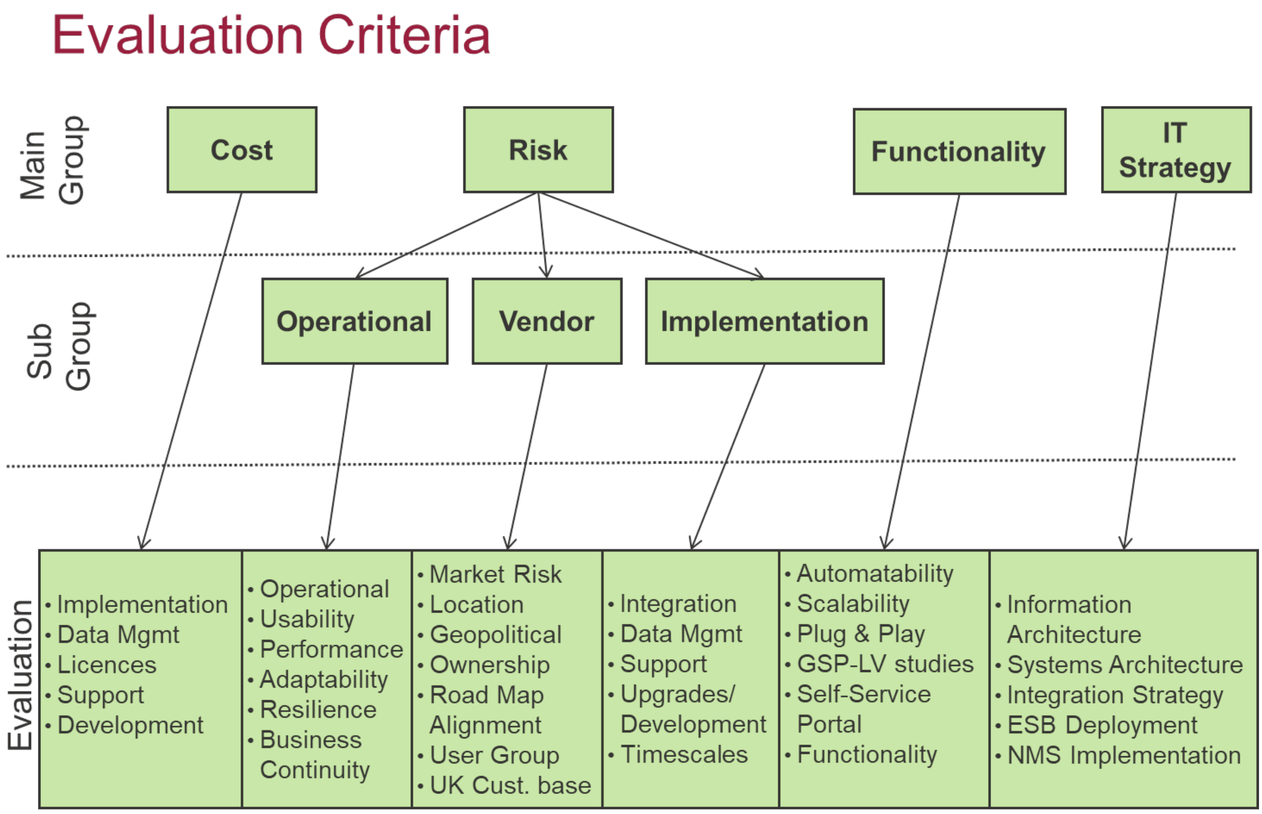
Route Map	Advantages	Challenges
Route 1 All NMS	Single system	Down voltages roll out mismatch to LV gap. DSO separation challenge. Functionality timing. IPSA replacement, SUACC/EPP.
Route 2 New Single Tool	Independent best of breed	Disruption. IPSA replacement, SUACC/EPP.
Route 3 New LV/HV Tool then expand to replace IPSA	Staged replacement Independent best of breed	IPSA replacement, SUACC/EPP.
Route 4 IPSA	Existing user-base familiarity licences.	LV Gap, unbalanced 4w, portal, ease of use questions.
Route 5 New LV/HV Tool and IPSA	Retains EPP Less disruption.	Multiple Tools and their management, interfacing.
Route 6 New LV/HV Tool and New EHV/HV Tool	Best of breed systems	Cost, multiple systems, IPSA replacement, SUACC/EPP.
Route 7 New LV/HV Tool with IPSA and then switch EHV/HV to NMS	Staged replacement of IPSA. LV gap addressed	Multiple tools and their management and interfacing. IPSA replacement, SUACC/EPP.

6 Evaluation of strategic options

6.1.1 Evaluation Summary

The strategic options have been evaluated below against a broad list of criteria to position them relative to each other. The criteria breakdown structure is shown below and applied qualitatively in the following table. Detailed functional analysis against all candidate products is not presented at this stage and may be the subject of a forthcoming procurement activity.

Criteria for assessment:



The strategic options are shown in the evaluation table below with types of solution, rather than comprehensively listing individual products, rated against criteria and sub-criteria. Green indicates a good rating with yellow and red respectively less so. This analysis will require regular updating and confirmation in increasing levels of detail and quantification.

Criteria		Sub-Criteria	NMS (all voltages)	New Single Tool (all voltages)	Enhanced IPSA (all voltages)	IPSA (EHV/HV) New (HV/LV)	New (EHV/HV) New (HV/LV)	NMS (EHV/HV) New (HV/LV)
Cost		Implementation	M	H	H	M	H	M
		Data Management	L	M	M	H	H	M
		Licences	L	M	L	M	H	M
		Support	M	M	L	L	L	M
		Upgrades/ Development	H	M	L	M	M	M
Risk	Vendor	Vendor (Market Risk)	L	L	H	M	M	L
		Vendor location / geopolitical	M	M	L	L	M	M
		Vendor (ownership)	L	L	H	H	M	L
		Road Map alignment	L	L	L	L	L	L
		User Group	L	L	L	L	L	L
		UK Market customer base	H	M	L	L	L	M
	Operational	Operational	L	L	L	L	L	L
		Usability	M	M	M	L	L	L
		Performance	H	M	M	L	L	M
		Adaptability	M	L	L	L	L	L
		Resilience / Business Continuity	L	L	L	L	L	L
	Implementation	Implementation/ Integration	H	H	M	M	H	H
		Data Management	L	M	M	M	M	M
		Support	L	M	L	M	H	M
		Upgrades/ Development	L	M	M	M	M	M
		Timescales	H	L	M	L	L	L
Functionality		Automatability	M	M	L	M	M	M
		Scalability	L	L	L	L	L	L
		Plug & Play Ability	M	M	L	M	M	M
		End to end network studies	L	L	L	M	M	M
		Self-Service Portal	M	M	M	M	M	M
		Functionality	M	M	M	L	M	M
IT Strategy			L	L	L	L	L	L

6.2 Tool Option Resilience to DSO Role

The decision of how to allocate DSO roles and responsibilities has a number of potential outcomes against which planning enablement strategic options can be tested. The following potential outcomes are suggested with none excluded on the basis of likelihood to actually be implemented. The range suggested is put forward in the knowledge that a Transmission Owner/Transmission System Operator (TO/TSO) organisational or ownership split is being considered for National Grid, and on that basis a more radical DNO impact might be delivered. Outcomes considered with categories taking into account the recent SPEN consultation are:

- The DNO establishes an in-house DSO, with variants for (Total DSO, DSO Manager, DSO Transmission Support).
- DNO Functionally split from DSO (co-owned but ring fenced), with variants for (Total DSO, DSO Manager, DSO Transmission Support).
- DNO Company split into Asset Owner and Operator, (DSO included in Operator), with variants for (Total DSO, DSO Manager, DSO Transmission Support).
- Total TSO (Includes regional DER aspects)
- Total ISO (Includes regional DER aspects)

Under all the outcome options above Real Time Operations and Operational Planning Functions are assumed present in the NMS. The table below attempts to predict system separation issues, or functionality access challenges, depending on which DSO model is implemented.

	1 DNO-DSO	2 Ring-Fenced DSO Function	3 Separate DNO and DSO	4 Total TSO Or ISO
Option A - NMS (all voltages)	OK	Ok If shared system access arrangements with DNO -	Separation problem	NMS System arrangements tbc
Option B - New Single Tool (all voltages)	OK	OK	OK	OK
Option C – Enhanced IPSA (all voltages)	OK	OK	OK	OK
Option D - IPSA (EHV/HV) , New HV/LV Tool	OK	OK	OK	OK
Option E – New EHV/HV Tool, New HV/LV Tool	OK	OK	OK	OK
Option F - NMS (EHV/HV) New HV/LV Tool	OK	Ok If shared system access arrangements with DSO -	Separation problem	NMS System arrangements tbc

The following table summarises each option from a risk assessment point of view. Seven risk domains are considered ranging from functional gaps, data provision, ease of use, DSO separation aspects, the business being dependent on a single system, SUACC/EPP, and finally vendor risk.

Risk assessment Overview	**Functional Gaps**	**Data Provision**	**Ease of use**	**DSO Separation**	**Single System Dependency**	**Pricing & Investment Solution**	**Vendor Risk**
Option A - NMS (all voltages)	LV being developed	LV 2018 target date	Needs develop ment	Potential Issue	Potential Issue	New Solution Needed	Low
Option B - New Single Tool (all voltages)	Low Risk	See Section 2&3	Low Risk	Low Risk	Low Risk	New Solution Needed	Low Risk Subject to confirmation
Option C – Enhanced IPSA (all voltages)	LV needs to be developed	See Section 2&3	Needs develop ment	Low Risk	Low Risk	Low Risk	Medium
Option D - IPSA (EHV/HV) , New HV/LV Tool	Low Risk	See Section 2&3	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk Subject to confirmation
Option E – New EHV/HV Tool, New HV/LV Tool	Low Risk	See Section 2&3	OK but Multiple voltage level issue	Low Risk	Low Risk	New Solution Needed	Low Risk Subject to confirmation
Option F - NMS (EHV/HV) New HV/LV Tool	Low Risk	See Section 2&3	OK but Multiple voltage level issue	Potential Issue	Potential Issue in part	New Solution Needed	Low Risk Subject to confirmation

7 Recommendations

There are three main planning enablement decision areas available to Electricity North West:

1. The extent to which network planning models can be executed within the new NMS platform (extended if necessary to incorporate appropriate additional hardware and/or software module licences), and what if any modelling functions are better carried out in one or more separate planning tools.
2. If additional planning tools are required, then how best to integrate these with Electricity North West's main operational master systems – GIS, Ellipse and NMS – for automated network topology and asset master data provision.

7.1 Overall planning tool landscape

The options described fall into three strategic categories namely expansion of existing or already committed to be deployed systems, hybrid solutions containing existing and new systems, and completely new alternatives.

Expansion Paths

There is a natural interest in focusing on the potential of existing investments before considering alternatives.

Option A NMS and Option C IPSA expansion to all voltage levels fall into this category.

Hybrid Solutions Paths

These paths are characterised by using more than one solution across the voltage ranges.

Option F sees the NMS at EHV, and a new tool at HV/LV. Option F does not satisfy the single planning tool objective but may usefully come into play in its own right, or as a contingency, depending on the NMS full voltage range capabilities, their availability timing, and ease of use at lower voltages.

Option D sees IPSA retained at EHV, with a new tool at HV/LV, and represents an option with a potentially low impact on the current solution landscape.

Alternative Options

In the ENW context less favoured options due to likely cost and disruption include Option B a new single Tool for all voltages, and Option E two new tools deployed at EHV and HV respectively.

Overall Option Comparison

The table below shows an overall estimation of the current status of attractiveness, readiness and risk of each option in the ENW context. The timing of business need against functionality availability needs to be considered when determining which option to select, along with all the factors mentioned in this report.

On the basis of overall option attractiveness viewed as an aggregate of the preceding analysis, and readiness viewed in terms of the current availability of the required functionality, and taking into account overall risk the options are compared below. The following table summarises the possible options.

Three front runner options are represented by Option A NMS (All Voltages), Option C Enhanced IPSA (All voltages) and Option F (NMS EHV/HV and a new HV/LV system) emerge from the group of six.

Option A is logically attractive, but is moderated by level of readiness and ease of use and development needed at LV. The potential impact of DSO separation, and a requirement to replace EPP are also considerations, as are the potential need for results validation and the business risk of single system reliance.

Option C would entail substantive development at LV.

Option F has merit in securing an already developed best of breed HV/LV tool and using the NMS at EHV/HV, but has the challenge of coordinating two tools when conducting multiple voltage level studies and the cost of the additional tool.

Option D retains IPSA at EHV, but sees a new HV/LV tool and in doing so moderates potential user base disruption and readiness and implementation risk, but delivers multiple tools.

Key.

Strategic Category	Option	Planning Enablement Option	LV	LV/HV	HV/EHV	EHV
Name	**Letter**	**Option Title**	Tool Name Attractivene / Readiness / Risk	Tool Name	Tool Name	Tool Name

Strategic Category	Option	Planning Enablement Option	LV	LV/HV	HV/EHV	EHV
Expansion	**A**	**NMS (all voltages)**	NMS	NMS	NMS	NMS
Expansion	**C**	**Enhanced IPSA (all voltages)**	IPSA	IPSA	IPSA	IPSA
Hybrid	**D**	**IPSA (EHV/HV), New HV/LV Tool**	New HV/LV Tool	New HV/LV Tool	IPSA	IPSA
Hybrid	**F**	**NMS (EHV/HV) New HV/LV Tool**	New HV/LV Tool	New HV/LV Tool	NMS	NMS
Alternative	**B**	**New Single Tool (all voltages)**	New Single Tool	New Single Tool	New Single Tool	New Single Tool

Strategic Category	Option	Planning Enablement Option	LV	LV/HV	HV/EHV	EHV
Alternative	**E**	**New EHV/HV Tool, New HV/LV Tool**	New HV/LV Tool	New HV/LV Tool	New EHV/HV Tool	New EHV/HV Tool

7.2 Topology data provision for additional planning tools

Three different solution architectures are possible for delivering automated provisioning of current and future network topologies, including the associated asset nameplate and other master data, to additional planning tools (other than NMS):

1. Obtain data from NMS using its CIM topology exporter.
2. Obtain data directly from GIS, Ellipse etc by making calls to the Data Virtualisation facilities implemented for NMS.
3. Implement an additional, actualised copy of the as-built network topology to serve this data up for planning tools etc.

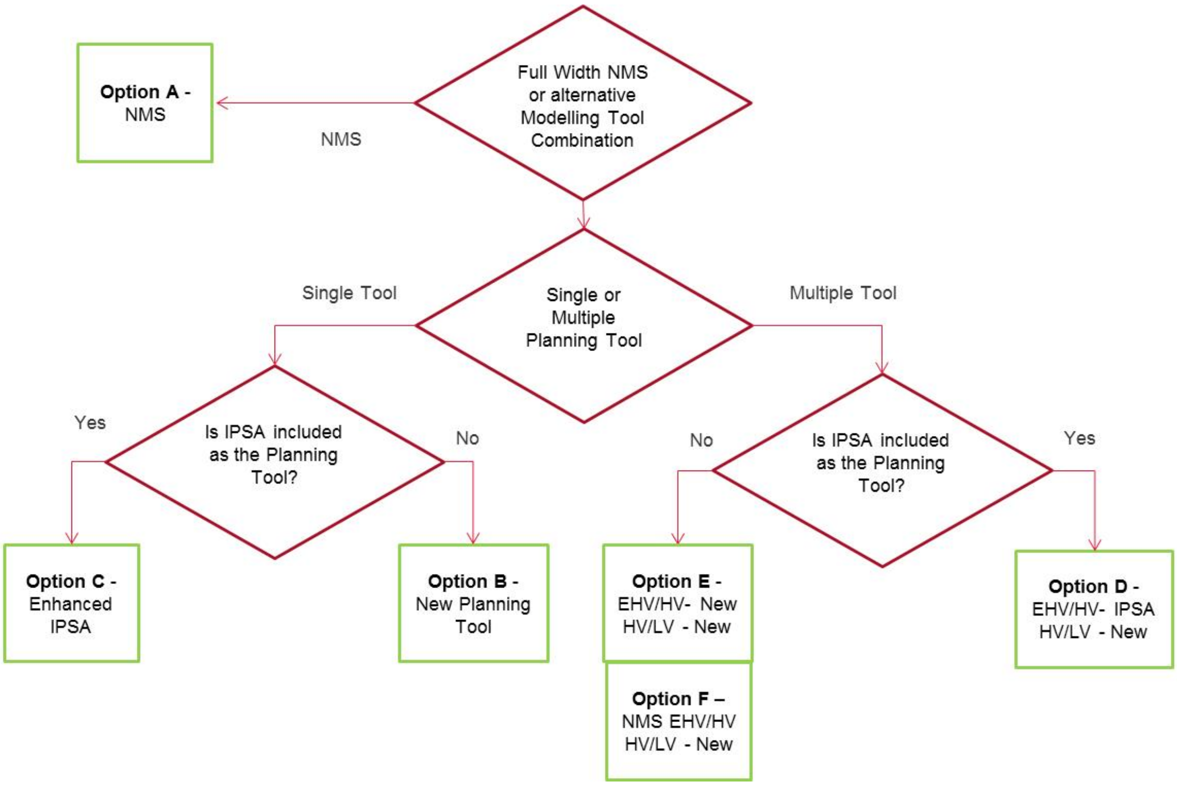
It has not been possible within the scope of this project to exhaustively assess the merits and de-merits of these options, so further consideration of this area is still needed.

7.3 Solution Option Decision

The following diagram depicts an option decision tree predicated on the key questions as to the viability of the NMS to host all voltage modelling, and then if this is not the case the potential for a single, or multiple alternative planning platform.

In order to provide additional validation to the options put forward the following next steps are suggested.

- Confirm from the NMS implementation the timing of specific voltage level data and functionality.
- For IPSA confirm the timing of availability of 4w unbalanced LV analysis, and ease of use for high volumes of connections.
- Maintain an updated view of the business need timing for new use-case functionality.
- At an appropriate stage in a future procurement process;
    - Conduct timed user tests to confirm ease and speed of use.
    - Conduct system performance testing.
    - Prove functionality with scripted screen-shot validation.
- Conduct business performance risk assessment against any implementation plan.



7.4 Next Steps

7.4.1 Candidate tools

- Through procurement, verify the functionality and capability matrix for A, C, F, D.
- Test ease of use of candidate tools with specific connection and use-case scenarios.
- Check timing and availability within candidate tools of functionality and data.

7.4.2 Candidate architectures

Further internal work by IT&T is required, taking account of the emerging NMS integration design, to

- confirm the future architectural vision, and
- assess the candidate topology data provision options (section 3.3) and determine the actual architecture that will be implemented to underpin any solution.

In parallel with the above, we recommend that further analysis is carried out to

- quantify the business case (based on elimination of manual data manipulation by the planners) for provision of more automated load data provision facilities (section 3.4), and then
- identify an appropriate solution architecture for the provision of those for which sound business cases exist.

Appendix A – Glossary of terms

Term	Definition
AC	Alternating Current
ADMD	After-Diversity Maximum Demand
ADMS	Advanced Distribution Management System
AFFIRM	Approved Flicker, Fusing & Impedance Regulatory Model
ANM	Active Network Management
ARS	Automated Restoration System
BAU	Business As Usual
BETTA	British Electricity Trading and Transmission Arrangements
BSP	Bulk Supply Point – a substation that typically transforms 132kV down to 33kV
CB	Circuit Breaker
CBRM	Condition-Based Risk Management
CDCM	Common DUoS Charging Methodology
CGI	Consultants to Government and Industry
CI	Customer Interruptions
CIFMS	Electricity North West's unplanned outage management system, also known as WebTMS
CIM	Common Information Model
CLAVA	A system which holds measurements taken at GSPs and provided by National Grid
CML	Customer Minutes Lost
CNAIM	Common Network Asset Indices Model
CRMS	Control Room Management System
DADS	Electricity North West's DUoS billing system
DC	Direct Current
DER	Distributed Energy Resource
DG	Distributed Generation
DINIS	Distribution Network Information System – a network planning system
DMS	Distribution Management System
DNO	Distribution Network Operator
DS	Distribution Substation, aka a Secondary Substation
DSO	Distribution System Operator
DSR	Demand-Side Response

Term	Definition
DUoS	Distribution Use of System
DV	Data Virtualisation
EAC	Estimate of Annual Consumption
ECOES	Electricity Central Online Enquiry Service
EHV	Extra High Voltage
EPP	Expansion, Planning & Pricing (IPSA module)
ESB	Enterprise Service Bus
ETL	Extract, Transform and Load
EV	Electric Vehicle
FALCON	Flexible Approach to Low Carbon Optimised Networks
FACTS	Flexible Alternating Current Transmission System
FCH	Future Capacity Headroom
FLA	Feeder Load Analysis (SCADA historian)
FLISR	Fault Location, Isolation and Service Restoration
FUNLV	Flexible Urban Networks Low Voltage
GIS	Geographical Information System
GML	Geographical Markup Language
G&P	Grid and Primary
GROND	A network planning system
GSP	Grid Supply Point
HH	Half-Hourly
HV	High Voltage
I	Current
ICP	Independent Connection Provider
ICT	Information and Communications Technology
IDNO	Independent Distribution Network Operator
IFI	Innovation Funding Initiative
IPSA	A network planning system
ISO	Independent System Operator
LCL	Low Carbon London
LLF	Line Loss Factor
LRIC	Long Run Incremental Cost – one of the EHV charging mechanism defined in the Distribution Connection and Use of System Agreement
LV	Low Voltage
LV Affirm	A low voltage network planning system

Term	Definition
LVFI	LV Fault Inferencing – the system which infers network-premise connectivity from the premise and network locations
OFGEM	The Office of Gas and Electricity Markets
OMS	Outage Management System
MDI	Maximum Demand Indicator
MDM	Master Data Management (can also mean Meter Data Management or Mobile Device Management, but not used in either of those senses in this document)
MPAN	Meter Point Administration Number
MPRS	Meter Point Registration System
NaFIRS	National Fault & Incident Reporting System
NGC	National Grid Company
NMS	Network Management System – a new operational control platform that will include DMS, OMS and SCADA components
OASIS	Data repository for oil results and Rodgers ratio calculator
OHL	Overhead Line
ORM	Outage Risk Model
P	Real (Active) Power
PC	Profile Class
PN	Physical Notification – as defined in the Balancing & Settlement Code
PQ	Real and Reactive Power
PV	a. Photo-Voltaic (solar panels b. Real Power and Voltage
Q	Reactive Power
R	Resistance
RIIO	Revenue = Incentives + Innovation + Outputs – the new performance-based model for setting energy network companies' price controls
RIIO-ED1	The regulatory DNO price control period from 1/4/2015 to 31/3/2023
RMU	Ring Main Unit
RTTR	Real Time Thermal Rating
RTU	Remote Terminal Unit
S	Apparent Power
SAP	A major ERP product used by Electricity North West for Financials, HR, Procurement and Connections work management.
SATS	System Amendment Tracking System (Access database)
SCADA	Supervisory Control And Data Acquisition
SLA	Service Level Agreement

Term	Definition
SLC	Standard [Electricity Distributor] Licence Condition
SM	Smart Meter
SOP	Soft (Normally) Open Point
SSC	Standard Settlement Configuration
STATCOM	Static Synchronous Compensator
SUACC/EPP	Sole Use Asset Cost Calculation / Expansion Planning & Pricing (IPSA module)
SVC	Static Var Compensator
TO	Transmission Owner
TOGA	Transmission Outage and Generator Availability – the system used by National Grid and its customers to log outage information
TPR	Time Pattern Regime
TRS	Transmission Restoration System
TSO	Transmission System Operator
Tx	Transformer
V	Voltage
VIPQ	Voltage, Current, Real and Reactive Power
VT	Voltage Transformer – used to measure voltages on the network
WebTMS	See CIFMS
WJBP	Well Justified Business Plan
X	Reactance

Appendix B Evaluation Criteria Descriptions

Group	Sub-Group	Criteria	
Cost		Implementation	Cost of system integration, testing, commissioning, hosting set-up.
		Data Management	Effort to orchestrate data to service application.
		Licences	Product vendor concurrent/ or per user fee for the application or modules.
		Support	Cost of 3rd line support to fix system issues.
		Upgrades/ Development	The cost of incremental system updating upgrades, and where requested additional functional development.
Risk	Vendor	Vendor (Market Risk)	Is the vendor exposed to undue market risk by being limited to a narrow market segment?
		Vendor location / geopolitical	Is the vendor based in an economically and politically stable location?
		Vendor (ownership)	Business continuity likely with a secure stable owner
		Road Map alignment	Is the product road map defined and aligned to the clients requirements
		User Group	Is there a broad well represented user group
		UK Market customer base	Is the vendor active in the UK, with a UK client base, and UK market specific adaptations?
	Operational	Operational	Does the system choice for planning pose an operational risk?
		Usability	Can the full range of users across the voltage levels and skill-sets, access and operate the system effectively maintaining their personal productivity without undue learning curves and difficulty.
		Performance	Does the system respond to the user within business timescales and the required accuracy of analysis?
		Adaptability	Can the system be adapted to cater for new situations requiring network analysis to be tackled differently?
		Resilience / Business Continuity	Is the system resilient and capable of high availability in order to support the client's business continuity under heavy workloads and system events?

Group	Sub-Group	Criteria	
	Implementation	Implementation/ Integration	Is the applications integration of particular technical difficulty?
		Data Management	Does the application require particular approaches to data types, management or availability that will be difficult to provide.
		Support	Is the required level of technical support for the application likely to be available through the implementation phase.
		Upgrades/ Development	Is there a risk that upgrades are particularly disruptive or even require re-implementations rather than upgrades?
		Timescales	Are there risks that implementation timescales are behind the business requirement?
Functionality		Automatability	Can the system support process and analysis automation i.e. the fast-tracking of more straight forward analysis cases, or multiple scenario computation?
		Scalability	Can the application scale to the enterprise level of users, and is it able to respond to industry change or company expansion through mergers and acquisition.
		Plug & Play Ability	Is the application easily connected to, and transfer data with other applications.
		End to end network studies	Does the application and implementation route-map lead to a holistic solution across voltage levels?
		Self-Service Portal	Does the application support the use of portals were customers can gain information and/or provisional quotations.
		Functionality	Specific functionality is addressed in a separate spreadsheet.
IT Strategy			Consistent with: • Information Architecture • Systems Architecture • Integration Strategy • ESB Deployment • NMS Implementation