EPIC Trial Planning Process

Project Deliverable: Work Package 2 – Deliverable 1

Part 1 – Existing process review and future EPIC process design

Part 2 – EPIC Trial Plan

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1. Document purpose and associated project deliverable

This document compares the existing planning processes for the gas and electricity networks, as well as the engaged local authorities, and presents a new EPIC process approach to generating a local energy plan with local stakeholders and strategically assessing the investment options for both the gas and electricity networks.

The aim of the Energy Planning Integrated with Councils (EPIC) project is to develop a process that considers the impacts on both the electricity and gas networks and reflects the strategic ambitions of the local authority to enable better investment outcomes. This approach may result in lower overall cost to the consumer, improved risk management and also enable local partners to realise their own strategic outcomes including net zero decarbonisation, economic growth, industrial strategy and wider societal benefits.

This report is the Planning Process Report and EPIC Trial Plan which is the first deliverable for work package 2 of the EPIC project. This report includes:

- A review of the existing energy planning processes
- The design for the EPIC planning process
- A summary of the investment strategies to be modelled
- The variations within the network modelling
- The necessary data sensitivities and exchanges

2. Summary of existing planning processes

There are many different types of planning processes conducted within the energy networks, unitary authorities and West of England Combined Authority (WECA). The analysis of existing processes for project EPIC has focused specifically on those planning processes involved with the future planning of energy networks and future energy requirements that will impact on the energy networks. For example, this includes:

- Western Power Distribution's (WPD) Distribution Future Energy Scenario (DFES) and shaping sub-transmission processes
- Wales and West Utilities (WWU) network analysis and investment appraisal process
- WECA and Local Authority infrastructure master planning

This project has also considered other planning processes that will require changes to energy requirements and therefore network impacts; such as, energy efficiency deployment plans, Electric Vehicle (EV) charging and transportation and future heat strategies. The analysis of existing processes has necessarily been high level, with the intention to focus on the key points of contact between the networks and local authorities which would be enhanced or changed by the new EPIC planning process.

2.1. Electricity network processes

2.1.1. Forecasting and scenario analysis

Process overview

Distribution Future Energy Scenarios (DFES) are high granularity, primary substation level scenario forecasts which provide a projection for the growth (or reduction) of energy generation (low carbon and conventional), demand and storage technologies which are expected to connect to the GB electricity distribution networks out to 2050. DFES also includes projections for new housing growth and increase in commercial and industrial developments, energy efficiency and other network load elements. The scenarios used in the WPD DFES are aligned with those used in the Electricity System Operator (ESO) Future Energy Scenarios (FES)[1].

[1] https://www.nationalgrideso.com/future-energy/future-energy-scenarios Accessed: May 2021

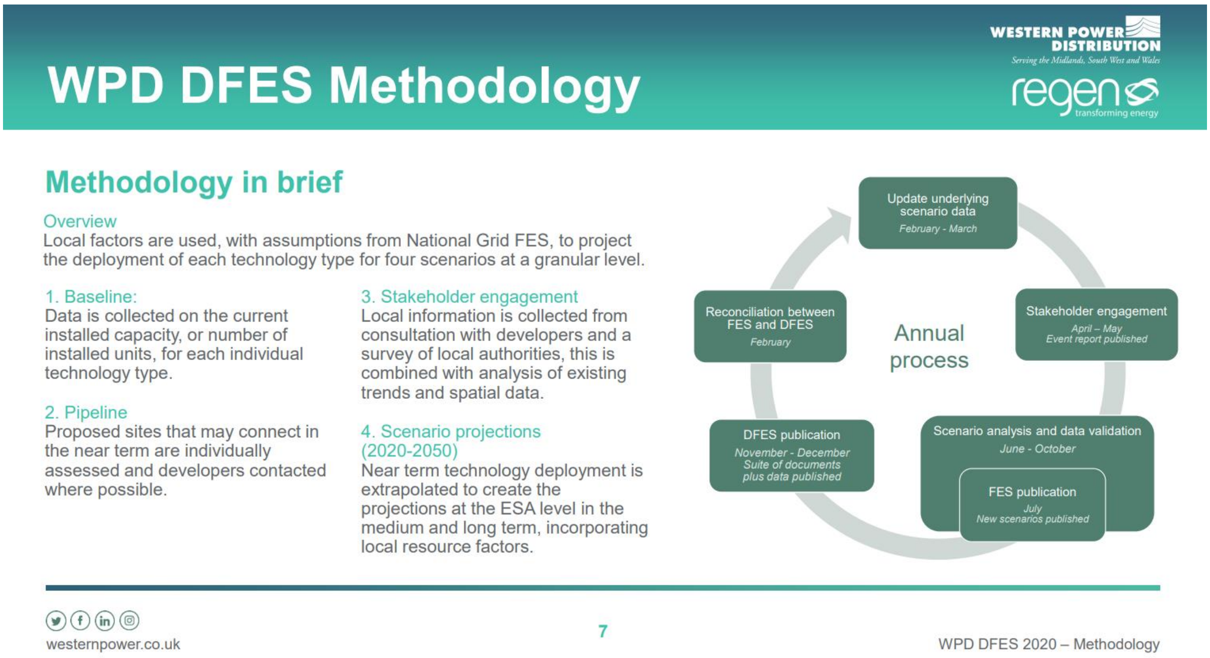

Figure 1 Overview of the WPD DFES process – taken from the 'WPD Methodology' slides[2]

Stakeholder engagement

For WPD, DFES forms part of an integrated network planning and investment appraisal process. DFES datasets, informed by stakeholder engagement, allow network planners to model and analyse different future load scenarios. They also provide a key data resource and evidence base to enable network strategy teams to appraise different investment options and develop the business case necessary to support future investment, including regulated business plans.

Stakeholder engagement is a key part of the DFES process and has been a major development over the last five years. The annual DFES cycle is major point of engagement between the networks and stakeholders and has enabled WPD to take a more proactive approach to network planning. It has also opened up the possibility of bringing stakeholders into the network planning and engagement process. Stakeholders are engaged through three main routes:

- DFES workshops and engagement events
- Bilateral discussions with project developers
- Local authority policy and new housing development data gathering

[2] https://www.westernpower.co.uk/downloads-view-reciteme/228142 Accessed: May 2021

Relationship to the ESO FES

The WPD DFES is intended to be a bottom-up analysis of a changing energy system at a regional and sub-regional level aligning with the national ESO FES framework but reflecting regional and local factors.

It is, therefore, inevitable that there will be some variance between the DFES view and the national ESO FES view. Regional and sub-regional variations tend to fall under a number of factors including:

- **Resource availability** – e.g. land space for a solar farm or wind resource.
- **Historic factors** related to the uptake of technologies which, in some cases, may be a good indicator of future growth but, in other cases, may be a false friend. For example, high solar growth in the south west may not be a good indicator for the future since many of the best sites have been taken and this is reflected in a lower pipeline of projects compared to, for example, the East Midlands.
- **Political factors** such as the region's net zero ambitions, strategic plans and planning processes.
- **Stakeholder input** (including from the GDNO), local area energy plans and strategies.
- **Baseline and pipeline factors**. The DFES will pay particular attention to the pipeline of projects which are actually being developed and especially those with network connection agreements. This means that, particularly in the shorter term, DFES analysis will tend to be influenced more by the pipeline than the long term scenario. Pipeline factors are perhaps the most significant source of variation in the short term.
- **Uptake rates.** Even when the National ESO scenario is used as a benchmark we can already see variations across regions, for example, in terms of EV growth and uptake rates (especially in the short term). These variations may be expected to reduce over time.

Scope of the DFES

The WPD DFES is reported to Electricity Supply Areas (ESAs), which are defined as '*the geographical area supplied by a Primary Substation (which contains WPD-owned distribution substations) providing supplies at a voltage below 33 kV, or a customer directly supplied at 132, 66 or 33 kV or by a dedicated Primary Substation*'. These ESAs are also split by local authority boundaries meaning that the data can be viewed as local authority totals, or by primary substation totals. In the WPD DFES 2020 the forecasts are reported at yearly intervals from 2020 to 2035, and reported at 5-yearly intervals from 2035 to 2050. The technologies included in the analysis are chosen to align to the Open Networks set of standardised technology names, referred to as 'building blocks', as used in the ESO FES[3] .

3 https://data.nationalgrideso.com/future-energy-scenarios/future-energy-scenario-fes-building-block-data/r/building_block_definitions# Accessed April 2021.

Some are split into more detailed sub-categories to align with distinct demand profiles or technology types.

Figure 2 – Example of the ESAs in South Wales - From the WPD Methodology slides

Data analysis

The DFES is a mixture of a scenario analysis and a pipeline forecast. The DFES process can be summarised in three stages:

- A baseline analysis to understand historic growth and what technologies and assets are currently connected to the network.
- A pipeline analysis of identified projects and developments, mainly those that have applied for, or accepted, a connection agreement, but also including projects that have been identified in planning datasets including the BEIS Renewable Energy Planning database. The DFES also includes an analysis of all planned new housing, commercial and industrial developments, based on significant engagement with local authority stakeholders.
- Scenario analysis brings into play the scenario assumptions and future growth projects will vary between scenarios and over time.

2.1.2. Network analysis

The results of the DFES forecasting stage is then summarised in a document for the local authority stakeholders. A WPD Distribution Manager communicates these results to the local authorities to gather feedback on how the four scenarios align with the local authority plans and ambitions. The work of the Distribution Managers feeds into the single 'best view' scenario used as a baseline scenario in the network analysis stage.

The existing process is currently undergoing some changes. Up until 2020, the forecast data would be combined with asset and customer behavioural data[4] to produce a detailed study which highlighted network points that may face future constraints. This study is published as the 'Shaping Sub Transmission' process[5] and the output data feeds into flexibility and constraint management signposting, as well as network strategy forecasting models and network insights for the 132 kV, 66 kV and 33kV networks across WPD.

As an output from the shaping sub transmission process, a report detailing recommended reinforcement strategies per primary substation is produced.

Data sources for WPD network planning include:

- An appropriate network model
- The underlying demand capacity on each Bulk Supply Point (BSP) and categorisation of primary substations into a few generic types with given profiles
- The forecast capacity of each Distributed Generation (DG) asset and new demand on each BSP and primary substation
- Half-hourly profiles for each type of demand and DG
- The appropriate ratings of network components
- Existing network automation and manual switching schemes ('corrective actions')

2.1.3. Investment appraisal

The output of the network analysis is an understanding of the potential constraints on the network under different scenarios and different contingencies. This is used to determine where WPD-led flexibility services could be used to help the operation of the distribution network, or where conventional reinforcement may be required. In some cases, neither flexibility services or reinforcement are required but additional network reconfiguration prior to planned maintenance work can be sufficient to prevent a network issue. The identification of possible solutions to the network constraints identified by the network analysis does not lend itself to automation but requires the knowledge and experience of network engineers. The output from the network analysis will be used by WPD to publish a Network Development Plan in 2022.

[4] https://www.westernpower.co.uk/downloads-view-reciteme/303103 Accessed: May 2021
[5] https://www.westernpower.co.uk/smarter-networks/network-strategy/strategic-investment-options-shaping-subtransmission Accessed: April 2021

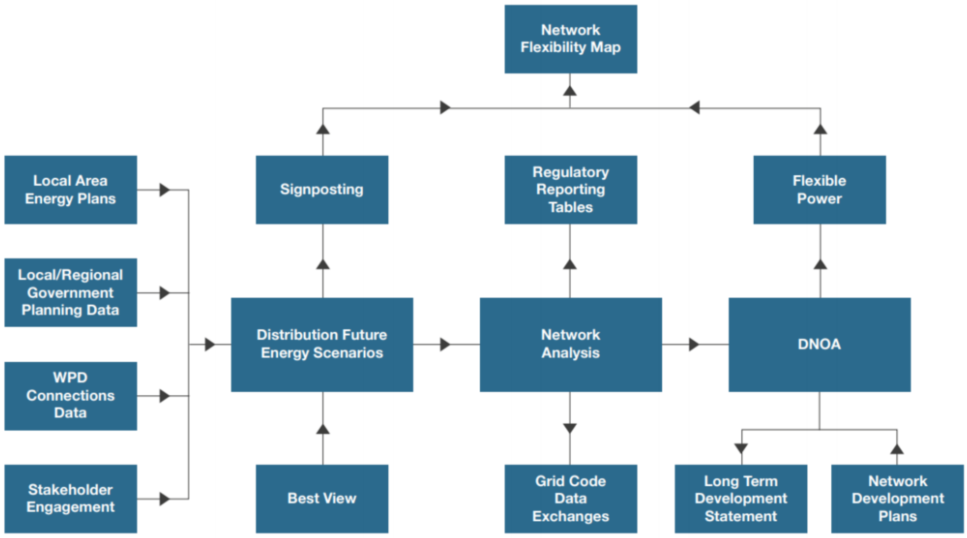

Figure 3 - WPD Publications relating to the forecasting and network analysis process for EHV and 132kV networks[6]

2.2. Gas network processes

2.2.1. Forecasting

WWU have conducted a Regional Future Energy Scenarios (Regional FES)[7] innovation project which aligned with the ESO FES scenarios and building blocks where possible, and run 'High Growth' and 'Low Growth' demand forecasting scenarios which feed in to the gas network long term development strategy and informed aspects of the RIIO-GD2 business plan.

The 'High Growth' scenario is based on continued growth of flexible generation, and linear growth of domestic market. Whereas 'Low Growth' accounts for the uncertainty surrounding gas in new homes post 2025 and the possibility of a re-direction away from gas-fired flexible generation.

The outcomes of the Regional FES project are used as the basis for producing joint GDN/DNO scenarios for the regions where networks have the same geography. For the Regional FES innovation project, the network was disaggregated into 63 Gas Supply Areas (GSAs) within WWU south West Local Distribution Zone (LDZ) and 37 GSAs within WWU Wales N&S LDZs.

[6] https://www.westernpower.co.uk/downloads-view-reciteme/303103 Accessed: May 2021
[7] https://www.wwutilities.co.uk/media/3868/regional-growth-scenarios-for-gas-and-heat.pdf Accessed: May 2021

For the WWU Regional FES, four workshops were held in Exeter, Bristol, Cardiff and Llandudno with over 150 delegates representing industry, DNOs, consumers, academia, Welsh Government, local authorities and community organisations attending. The project also engaged directly with other key organisations and WWU's connected customers and collated data and information from several regional sources including, for example, local development plans.

Regional and local factors are used in the Regional FES to inform the uptake and location of new customer connections. These include resource and feedstock availability, uptake of domestic heating technologies, planned new housing and C&I developments, local authority policies and planning permission records.

2.2.2. Network analysis

Long term demand forecasts are developed and fed into network modelling to determine the gas storage requirement and therefore to identify constraints.

Data sources for WWU network planning include:

Distribution (<7bar):

- Annual demands (AQs) for each meter point from Xoserve are used to derive a peak 6 minute demand for each meter point through aa Demand Derivation System (DDS).
- Connected System Exit Point demands are modelled where Independent Gas Transporters connect to the network.
- Postcode data is used to apply these demands to relevant nodes in analysis models, where numerous demands are aggregated together.
- Set pressures at Pressure Reduction Installations (PRIs) and District Governor outlets.
- Pipeline data from a GIS mapping system (diameter, wall thickness, material etc).
- Several supply and demand types such as power generation, CNG fuelling stations and biomethane are modelled manually when the connection agreements or grid capacity arrangements are formed.
- Information from engagement with local authorities is used to model potential future demands on 5-year forecast models.

Local Transmission Systems (LTS):

- Peak 1-in-20 demand values (output from forecasting process).
- Hourly demand profiles for a range of demand levels (eg. >19mcm/d, 18-19mcm/d etc), to reflect how within-day profiles change at or away from peak demand.. These are based on several years of telemetered data..
- Non-daily metered (NDM) demand data is uplifted from the distribution system models to establish how forecast 1-in-20 demand is split across Pressure Reduction Installations (PRI).
- Daily metered demand data from Xoserve, which is added to the NDM demand.
- Pipeline data from GIS system (diameter, wall thickness, material etc).
- Pressure data (maximum operating pressure) to impose limits on pressure cycling to drive line pack storage.

- Offtake and PRI capacities are stored separately, component-by-component, and compared with peak-hour demand to identify constraints.
- Several supply and demand types such as power generation, Compressed Natural Gas (CNG) fuelling stations and biomethane are modelled manually as per the distribution networks.

Several tools are used by WWU in the forecast and investment option appraisal process. These include the Asset Investment Optimisation tool which was used to derive the GD2 plans, and the Pathfinder Plus tool, which analyses current energy data and future options, assessing the viability of any decarbonisation approach and its impact on gas network capacity and storage requirements. The Pathfinder Plus tool also defines the implications of energy investment plans, showing their impact on energy reliability, and the resultant carbon emissions. This tool is used by WWU in support of the Zero 2050[8], HyHy[9] and Gas Goes Green projects[10].

2.2.3. Investment appraisal

Once network constraints have been identified by the network modelling, the reinforcement or interruption requirement is determined. Reinforcement for new demand connections (i.e. specific reinforcement), and reinforcement driven by constraints found in network models during updates (general reinforcement) is typically approached on a 'just in time' basis to avoid uneconomic investment, although the funding for this is pre-arranged for each price control period based on WWU's forecasts.

However, in each instance the reinforcement is reviewed to identify enhancement opportunities; for example, if further local demand increase is expected or future mains replacement schemes are planned then this could be considered 'one-touch'. When designing reinforcement for a power generation site in Ebbw Vale recently, for example, WWU became aware that numerous other large demand customers were planning to connect and so the final design took those sites into account.

'Strategic' investment approaches typically only apply to planned work such as mains replacement and maintenance activities, where whole-life cost (WLC) and cost benefit analysis (CBA) approaches can be applied to deliver work as economically as possible.

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[8] https://www.regen.co.uk/project/net-zero-south-wales/ Accessed: May 2021
[9] https://www.smarternetworks.org/project/nia_wwu_060 Accessed: May 2021
[10] https://sgn.co.uk/about-us/future-of-gas/gas-goes-green Accessed: May 2021

2.3. Local authority master planning processes

2.3.1. Master planning process overview

The West of England Combined Authority (WECA) is made up of Bath & North East Somerset, Bristol and South Gloucestershire Councils. Working with their partners including the West of England Local Enterprise Partnership (LEP) and North Somerset Council, WECA's primary objective is to drive economic growth within the region and part of their investment fund is allocated towards master planning in areas of the region which have been identified as requiring significant infrastructure investment.

WECA are currently undertaking two strategic master planning projects; one for South West Bristol and one for the North Fringe area in Filton. The infrastructure in scope for these master planning projects primarily comprises transport (including walking and cycling), utilities, green infrastructure and any health, education or training infrastructure needs that have spatial implications.

The overarching aims of the infrastructure master planning projects are similar but the specific objectives for the North Fringe area are described below as an example:

- To provide an evidence-based programme of proposed infrastructure investments and interventions that enable transformational change
- To provide a blueprint for high-quality, well-connected and environmentally sustainable housing growth
- To deliver the future spatial growth and strategic priorities of the Local Industrial Strategy
- To consider how 'net zero carbon' could be achieved through infrastructure investment to match Local Political declarations and those of Central Government
- To integrate sustainable travel solutions

The methodology that is being employed for the North Fringe area to create the infrastructure masterplan can be divided into three main phases:

- Phase 1: Produce the baseline report. This phase involves the development of a baseline evidence base, which provides a review of the existing infrastructure provision and capacity within the area and establishes a housing and economic development baseline.
- Phase 2: Develop vision and objectives, engage stakeholders, develop options and consider suitability for business case development. This phase builds upon the baseline report and considers the range of possible infrastructure interventions.
- Phase 3: Reach agreement on the infrastructure masterplan proposal(s) that will inform the Local Plan.

Producing the business cases for interventions takes place after the content of the infrastructure masterplan has been created and agreed by the stakeholders.

It should be noted that strategic master planning projects are not part of the usual planning process but are one-off projects commissioned for specific areas (usually as a result of an area being identified as requiring significant infrastructure investment). If the EPIC process is to be used in other areas that are not part of a strategic master planning project then it will be necessary to refer to the regular planning processes; for example, local plans develop by local and unitary authorities and, for other WECA areas, the Spatial Development Strategy (SDS). These local policies set the framework for the master planning process and some of the wider WECA policies that are likely to have an impact on the energy network are summarised in Appendix 1: WECA policies summary.

If the EPIC process is found to have the greatest benefit when applied to strategic master planning projects then this would result in there being two complementary planning processes. The existing network led process would continue which focusses on EHV and 132kV networks and uses local authority data for the entire licence area combined with the complete DFES data set. The EPIC process could be applied where the local authority has identified specific infrastructure growth and/or low carbon policies that may have a significant network impact. For example, as more detailed greater detail information was available from the master plan or greater detail results in greater detail were required (e.g. additional use case and sensitivity analysis or a greater view of the local impacts at HV and LV.).

2.3.2. Engagement with network operators

As local authority stakeholders develop policy, there may be engagement with the energy networks where DNO \ GDN approval is needed. However, for many wider decarbonisation policies, such as improving building efficiency, there may be no engagement with the network operator.

As part of the long term planning processes, the DNO and GDN collects data on new housing and C&I developments and seeks to validate this with local authority stakeholders. Furthermore, high level information on decarbonisation planning is included in these processes.

2.4. Comparison of planning processes

2.4.1. Timelines

Both WPD and WWU have an annual cycle of forecasting demand and generation on the network and use this to inform either investment in the network or in flexibility services. The Open Networks WS4 P5 'Coordinated Regional Data Gathering' Final Report (May 2020)[11] states:

[11] ENA Open Networks Template (energynetworks.org) Energy Networks Association – Published May 2020, accessed April 2021.

"as there is no alignment for when regional data is updated by Local Authorities or used by networks, it is challenging to standardise a process such that the same regional data is used by networks without the risk of updated information being available."

Based on this finding, the standardised process for EPIC is not proposed to have a regular timeframe, but to take the most recent local authority data regarding policies and new housing and C&I development at the point of producing the local energy plan.

2.4.2. Data inputs

There are some areas of commonality between the data requirements by the energy networks for their forecasting and network analysis processes. Both networks require connection forecasts, paired with profiles for demand and generation, as well as asset data such as pipeline diameter or substation headroom.

The energy networks have existing profiles, however consistent assumptions and profiles between the energy networks may need to be developed where the technologies connect to both networks, as is the case with hybrid heat pumps.

The technology building blocks are used to inform the technology types used by WPD in the DFES, however in some places the DFES splits the technology types into more detailed categories than the standard building blocks. Several technology types are not currently defined within the building block technology list for many gas network connected technologies, for example domestic gas-networked boilers.

Both WPD and WWU have used the same scenarios as used in the ESO FES, though these can change between years and the regional DFES process for WWU is not an annual process. WPD use the four DFES scenarios, but also combine these to create a single 'best view' scenario.

The geographic areas analysed in the forecasting process by both networks do not align with each other as these are informed by the pipes and wires constituting the energy networks. However, both geographic area systems in the WWU Regional FES and WPD DFES 2020 included a local authority split running across the network-informed areas, providing some comparative capabilities for stakeholders.

2.4.3. Stakeholder engagement

Both WPD and WWU engaged with local authority stakeholders as part of the DFES and Regional FES processes. This is done on a per-licence area basis, often through full-day workshops or webinars. WWU also engages with major gas users to inform pre-forecast demand figures as part of the process set out in the Uniform Network Code.

Both WPD and WWU analyse local authority new development data as part of the DFES and Regional FES processes. This is completed on a per-local authority basis, and involves analysis and validation of new development data with the local authority.

3. Overview of future EPIC planning process

3.1. Introduction and objectives

The EPIC project seeks to test the hypothesis that developing an integrated local energy requirements plan at a lower level of granularity, which considers the impacts on both the electricity and gas networks, and reflects direct input from local authority development and master plans, will enable better investment outcomes for both the networks and regional stakeholders.

As part of the current process to create the DFES, gas and electricity utilities reflect local and regional factors as well as information from local authority development and decarbonisation plans. However, although local authorities are consulted and input data into the DFES process, such as new development data for housing and commercial sites, the DFES scenarios are based largely on national future energy scenario projections and do not wholly adopt or incorporate the details of local authorities' development plans for specific areas. There is also a practical limitation that the DFES is conducted for entire licence areas, and for the electricity networks this is done within a tight window of three to four months after the publication of the annual FES.

It is therefore recognised that, while the DFES process provides an overall basis for network planning, it may not provide the necessary detail for specific investments and may not reflect the local authority plans and expectations of future energy requirements for specific areas, such as, for example, an enterprise zone or strategic development area. Similarly local authorities may benefit from a different selection of use cases being modelled focussing on variations to the assumed "best view" scenario rather than modelling scenarios that are not considered likely by the local authority, and providing a view of investments at HV and LV is expected to provide additional value.

This document sets out the EPIC project's proposal for a new process and a new way of working for electricity and gas distribution networks to work with local authorities to create a more granular local energy requirements that can be then be incorporated into the DFES and network analysis.

The objective of this new, standardised process is to enable the development of an energy requirements and network investment plan for the selected Strategic Planning Area (SPAs). SPAs are intended to be small enough to allow detailed analysis within a limited timeframe, but large enough to contain a number of development sites and a variety of future (multi-vector) energy opportunities that would allow the appraisal of different investment strategies, as well as non-network solutions. It is envisaged that these areas would already be of strategic interest to local authority partners, perhaps as part of a master planning area, enterprise zone or strategic development area. It is not intended that the EPIC process would attempt to cover entire local authorities, or be used in areas which are not subject to strategic development, and which would be better covered by the existing network planning processes.

A key objective of the EPIC process is to enable a joint planning and network investment appraisal exercise to be conducted with limited resources within a short time period, with engagement lasting from weeks to a couple of months. This requires a high degree of process and data automation and, if the trial is successful, could enable the EPIC process to be adopted as a business as usual activity for gas and electricity networks, and potentially a new form of customer service for local authorities and regional bodies.

The data and analysis produced by the EPIC process should be of sufficient detail and robustness to be used as part of an investment appraisal process, and potentially to justify investment in network assets or non-network solutions.

3.2. EPIC Process overview

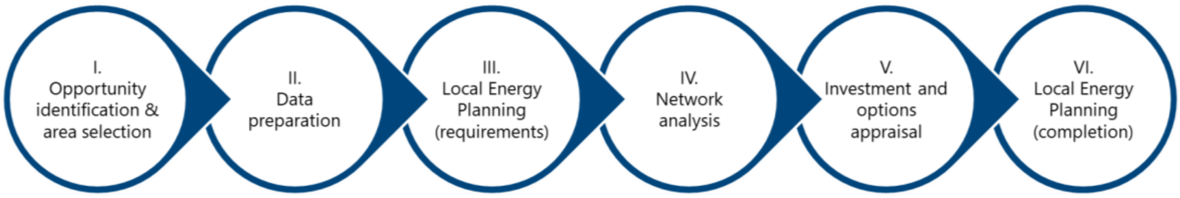
The starting point for the EPIC process is to use the existing DFES, and other sources of network data, to create a strawman or "best view" plan that is disaggregated to a lower level of granularity on the low voltage network. This "best view" plan is then used as a starting point to engage with local authority partners, and to incorporate local authority planning data and other inputs to create a strategic area energy requirements plan. The strategic area requirement plan, including any sensitivities and scenarios, is then subject to network analysis, using a new set of automated analysis tools and use of the ENA's whole system Cost Benefit Analysis (CBA) tool, to conduct an options appraisal exercise and to create a network investment plan.

The EPIC integrated planning process therefore differs from, and is not intended to replace, the concept of a Local Area Energy Plan (LAEP)[12], both in terms of its starting point, scope, resource commitment and timescales. For example, the EPIC process is a detailed review of an area within a local authority, whereas a LAEP process may involve a wider review of a local authority area. The EPIC integrated planning process also differs from the investment planning product produced as part of Open Networks Workstream 4. Although the EPIC process also involves gathering local authority data to update network investment plans, the scale and scope is different, with a much more granular area of focus as part of Project EPIC. The EPIC process does not cover all of the recommended elements of a LAEP process, but could run alongside, or follow, the development of a LAEP, using LAEP data as a key input. This would allow the networks to efficiently respond to LAEP's at a network level and to incorporate LAEP inputs into their network analysis processes.

[12] Local Area Energy Plan methodology developed by the Energy System Catapult and CSE see https://es.catapult.org.uk/reports/local-area-energy-planning/ Accessed: April 2021

There are six core EPIC process stages as illustrated below and described in the rest of this report:

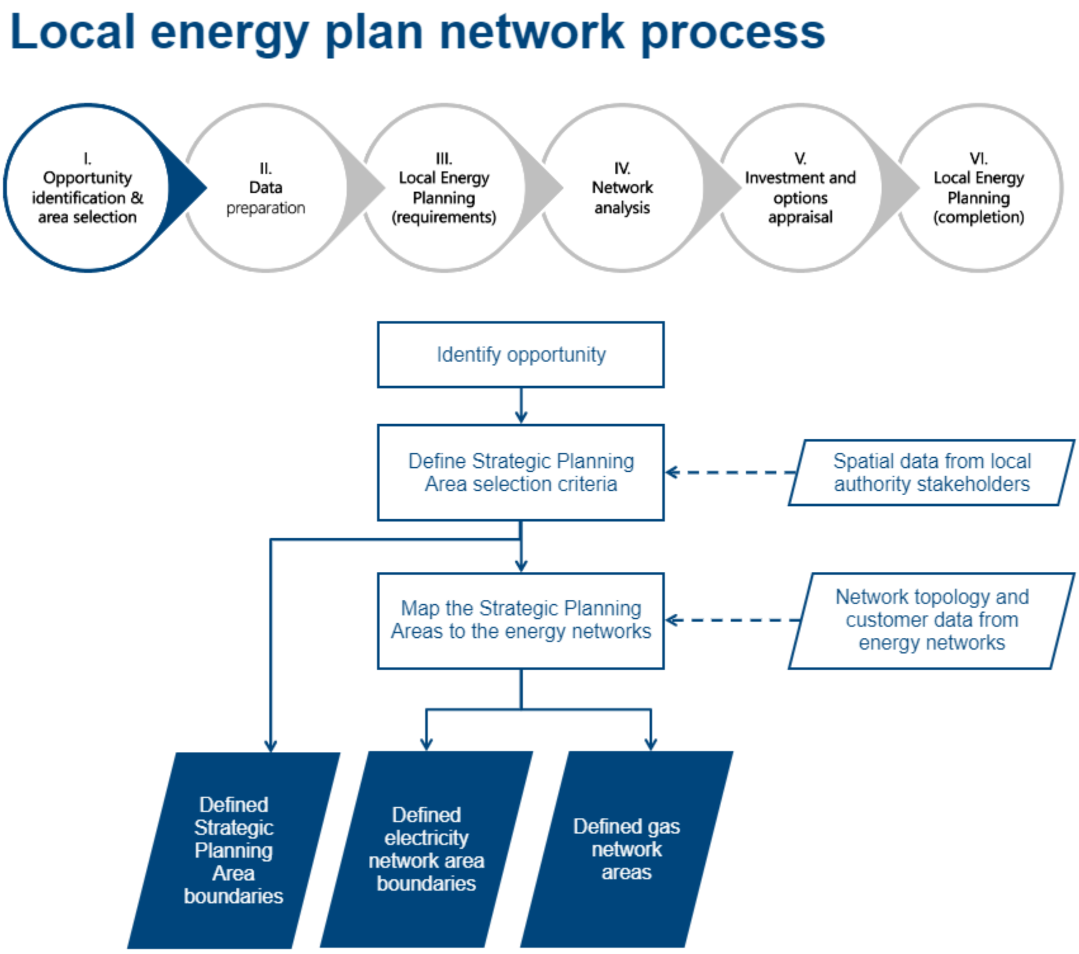
I. Opportunity identification and area selection
II. Data Collection
III. Local Energy (requirements) Planning
IV. Network analysis
V. Investment and options appraisal
VI. Local Energy Planning (completion)



There are four key stakeholders whose input, feedback and review is required throughout all the process stages to ensure a successful outcome. For the purposes of this document, these roles are generically described (local authority stakeholder(s), DNO network planner, GDN network planner and a new process analyst role) and will need to be assigned appropriately prior to commencement of the process. Other roles including those of distribution and area managers are also described throughout the process.

The following sections in this report focus on each of these process stages and detail the sub-process steps within the stage, step through the roles and responsibilities for each of the four key stakeholder groups and the required data flows and, finally, summarise the outputs for each of the process stages.

4. Trial Process Stage I: Opportunity identification and area selection



4.1. Identify the opportunity

It is envisaged that the starting point for the EPIC process would be the identification, either by the networks or by a local authority partner, of an opportunity to work together to create an integrated energy plan for a particular area. Identification of an opportunity could also come from engagement with wider regional bodies such as a combined authority, local enterprise partnership or work done by an regional Energy Hub.

The identification of the opportunity could come from a variety of sources

- Engagement during and following the annual DFES and network planning process
- The results and recommendations from a LAEP
- Local authority infrastructure master planning
- A local heat and energy efficiency strategy
- Transport planning

Opportunities to conduct an EPIC joint plan could also come from the identification that an area is network constrained and/or is subject to a number of new development projects.

Once an opportunity has been identified the first step in this process is the selection of one or more Strategic Planning Areas (SPAs). The selection and definition of the SPAs should ideally be undertaken in partnership with the local stakeholders, other networks and councils, allowing the rationale of each party to be considered. Collaboration will also improve the tailoring of the SPA, potentially mapping it more closely onto network supply areas.

4.2. Define Strategic Planning Area selection criteria

A SPA should be designated in an area where it can deliver significant impact on energy demand, generation and required infrastructure. Other considerations may include:

- Diversity of specific geography and land use, for example, industrial, domestic, urban and rural settings
- A range of energy requirements including those for new developments
- Planned energy efficiency measures
- Opportunities for energy generation and green gas
- Opportunities for heat networks
- Current and future transport infrastructure and requirements
- Opportunities for flexibility and energy storage

By the end of the SPA selection process, the boundaries of the SPA(s) should be signed-off by the relevant local stakeholders and energy networks.

4.3. Map the Strategic Planning Areas to the energy networks

The boundaries of the SPA as agreed with the local stakeholders are unlikely to align directly with either gas or electricity network areas. Therefore, a larger area than the SPA will be defined for the process of networks analysis i.e., incorporating full primary substation areas or ESAs.

Entire network areas which intersect the SPA are required to be analysed, though the data gathering should be done at a level as to be potentially aggregated either to network area or SPA. For the gas networks, this high granularity is important as household connection projections will be analysed at a postcode level. Injections into the gas network from outside the SPAs will also have an impact on the assets using the gas network inside the SPAs, at a range of pressure levels.

Network topology data from the energy networks DNO is required for this process, as well as a count of customers to postcode level. This network mapping process may become iterative as the original SPA boundaries may be 'fuzzy' and therefore could be altered slightly to include or exclude certain developments or network areas that only partially fall within the SPA. The network areas should be shared in a widely accessible format, as not all project partners will have access to GIS software.

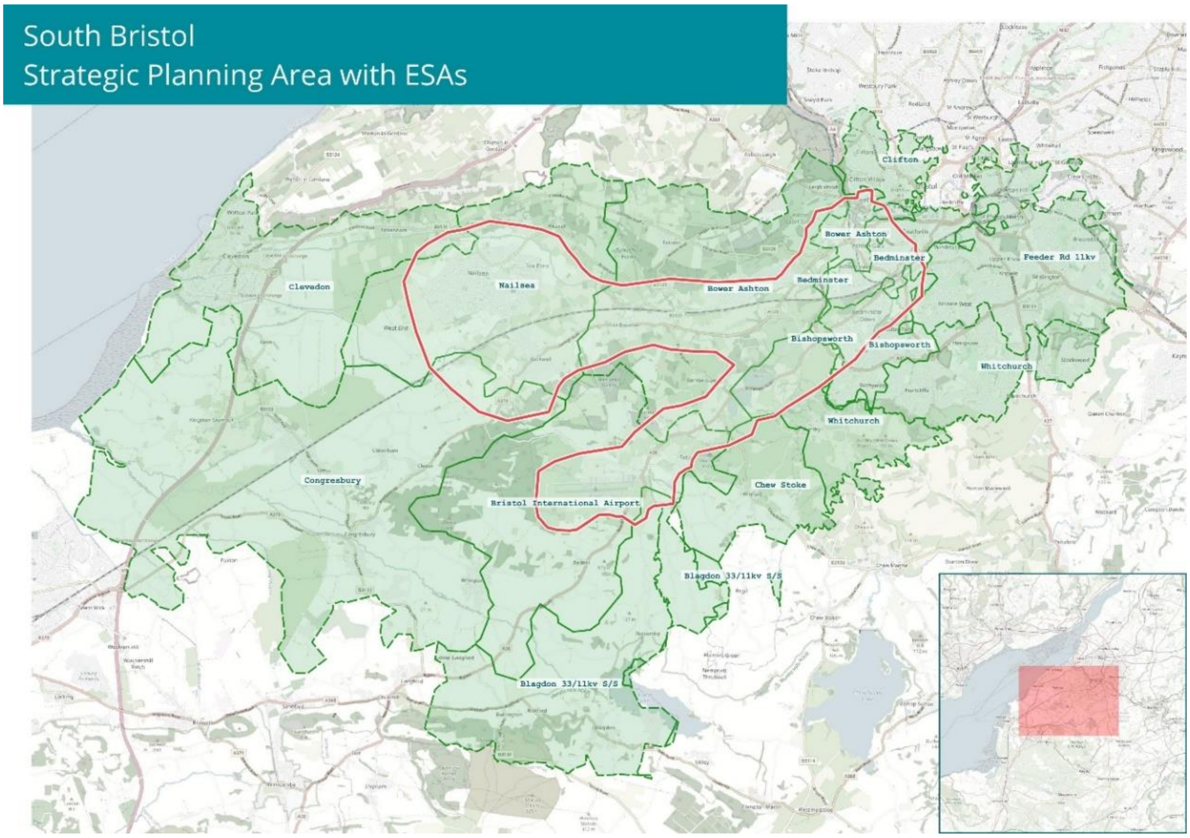


Figure 4 Illustration of ESA and SPA boundaries: the green areas are the complete ESAs that need to be analysed for the specific SPA outlined here in red.

4.4. Stage I – outputs, roles and processes overview

4.4.1. Outputs for this stage

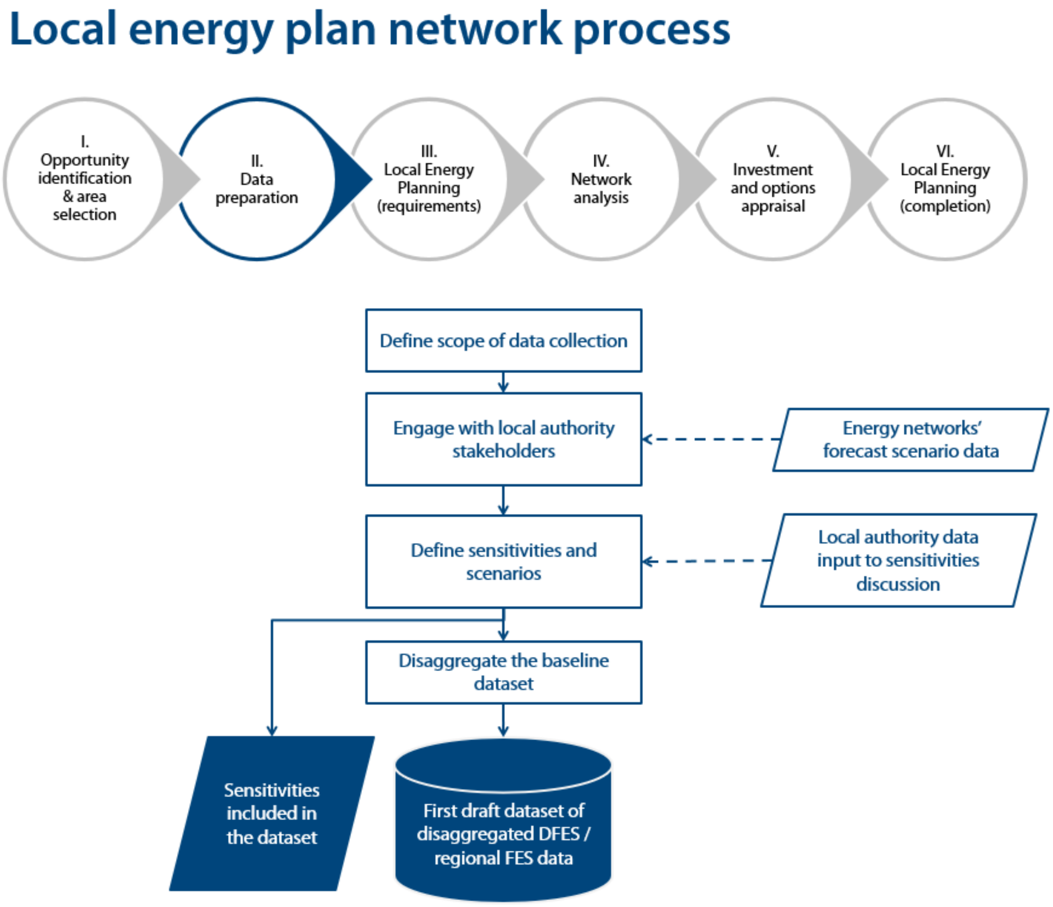
The outputs that need to be agreed and signed off at this stage are:

- The rationale for selecting the SPA and consensus on why the area would benefit from undertaking the EPIC process
- The SPA boundaries
    - Data type: GIS-readable file, such as a geopackage or shapefile
- The wider SPA boundaries for the energy networks
    - Data type: GIS-readable file, such as a geopackage or shapefile or could be a list of primaries or postcodes which are within the network areas for assessment.

4.4.2. Stage I – roles and processes overview

Stage I
Roles and responsibilities
Local authority stakeholder(s)
The role of the local authority stakeholder(s) is to review the SPA specification process to ensure that it is adequate for the needs of local stakeholders in realising their own strategic aims.
DNO network planner
The role of the DNO network planner is to provide the electricity network perspective in reviewing the SPA process to help define the boundaries of the SPA This involves providing network hierarchy data so that the wider network-informed SPA borders can be produced.
GDN network planner
The role of the GDN network planner is to provide the gas network perspective in reviewing the SPA process. This involves providing network hierarchy data so that the wider network-informed SPA borders can be produced.
Process analyst
The local energy plan process analyst is not a role that currently exists within network planning. However, the role of a process analyst could be completed by the networks as part of this approach and there are accountabilities for local area energy planning within WWU's net zero team structure, for example.. The role of the process analyst at this stage is to combine the input from the local stakeholders and network stakeholders and produce draft and final SPA boundary files.
Data flows
Local authority stakeholder(s)
Could provide the initial area selection boundaries, otherwise no data input required at this stage. Shapefile data received for draft and final SPA boundaries.
DNO network planner
Needs to provide network topology data to create the wider SPA boundaries. Shapefile data received for draft and final SPA boundaries.
GDN network planner
Needs to provide network topology data to create the wider SPA boundaries. Shapefile data received for draft and final SPA boundaries.
Process analyst
The role of a process analyst can be completed by the networks as part of this approach. The process analyst receives network topology data from the DNO and GDNO network planners.

5. Trial Process Stage II: Data preparation



5.1. Define the scope of data collection

The initial data collection period is completed with a signed off version of the full list of building blocks, the starting scenario from regional DFES data, and an agreed timescale.

5.1.1. Building blocks scope

The forecast datasets produced are designed to reflect what is used in current network planning processes by both the gas and electricity networks. The 'building blocks' as defined by the ENA Open Networks project and used in the National Grid ESO FES[13] are

[13] https://data.nationalgrideso.com/future-energy-scenarios/future-energy-scenario-fes-building-block-data/r/building_block_definitions# Accessed April 2021.

proposed to be used as the technology types, plus several gas-network relevant technologies such as gas boilers and gas network injection. These are also consistent with the technology building blocks in the existing forecasting processes for WWU and WPD.

Additional building blocks or factors may be included with the agreement of all parties, such as energy efficiency demand reduction factors. Of the full list of building blocks, many may only connect to the energy networks in some areas of the country. For example, marine technologies or offshore wind may not be relevant for a local energy plan in Birmingham. However, a full building block list is used to allow for best replicability.

As part of the data collection stage, the full list of building blocks and their details should be signed off by the project partners. A summary table of some of the building blocks is shown in Table 1 below, and a complete list of the building blocks used as part of Project EPIC is included in **Appendix 2: Building blocks summary**.

Table 1 – Summary of some of the building blocks used in the National Grid ESO FES

Category	Vector	Examples of building blocks included
Demand	Heat	Including: • Air conditioning • Heat pumps • Hydrogen boiler • Night storage heating • Primary gas boiler • Hybrid heating systems
	New developments	• New C&I development • New domestic housing development
	Transport	• CNG vehicles • Electric vehicles • Electric vehicle charge point • Hydrogen vehicles
	Fuel manufacture	• Hydrogen electrolysis • Hydrogen SMR/ATR
Generation	Electricity generation	Including: • Solar Generation • Waste Incineration (including CHP) • Wind (Onshore) • Biomass & Energy Crops (including CHP) • CCGTs (non CHP) • Hydro • Non-renewable CHP • Non-renewable Engines (non CHP) • OCGTs (non CHP)

		• Renewable Engines (Landfill Gas, Biogas)
Injection	Fuel injection	• Biomethane/bioSNG injection • Hydrogen injection
Electricity storage	Electricity storage	• Energy storage

5.1.2. Starting database scope

The starting point for network analysis will be the energy networks' regional scenarios and DFES documentation, projecting the growth of supply and demand building block technologies. Rather than repeating four scenarios in the local energy plan, a single "best view" scenario should be considered, reflecting the network analysis process of the DNO / GDN. An alternative view may also be used, to show a secondary scenario in the options appraisal stage.

5.1.3. Timescale scope

The local energy plan projections can be taken out to 2050 to reflect the ESO FES. However, a focus can be placed on the nearest network planning periods, ED2 and ED3. The DFES data from WPD is produced yearly to 2035, and in five year stages from 2035 to 2050.

It is envisaged that the EPIC process will be most useful looking at energy requirements and network impacts over the period of 10 to 15 years. This will allow sufficient horizon scanning to consider anticipatory and strategic investments, but within a timeframe where very local and specific data can be used to evidence and justify investment.

5.2. Engage with local authority stakeholder(s)

Several datasets from local authorities are collected as part of the Regional FES and DFES processes but may be updated with supplementary data or reviewed as part of an additional validation stage as part of this process. The data collected includes:

- New domestic and commercial & industrial developments within the SPA boundaries:
    - Including the location, scale, and expected build timeline.
- Plans for new heat networks within the SPA boundaries.
- Plans for energy efficiency improvement schemes.

The outputs of this stage cover evidenced local policies and a database of planned new developments in the SPAs. These will be used to inform data decisions in later stages of this process, or used to directly update the forecast database.

5.3. Outline the use-cases to be used in the cost benefit analysis stage

Rather than model multiple scenarios with widely varying datasets, a limited number of use-cases should be defined. These use-cases are used to test the network implications of specific decisions made by local authority stakeholder(s) creating local policy, of energy networks choosing investment options, or are included to incorporate future uncertainties in the projections.

These use-cases should be informed and led by engagement with the local authority stakeholder(s), and agreed before the data disaggregation process. Examples of the use-cases could be heat pump uptake in new build homes with or without energy efficiency improvements.

5.4. Define the data required to test the use-cases (sensitivities and scenarios)

To include the data required to test the use-cases, various scenarios or sensitivities are included in the input dataset which may be used as part of the cost benefit analysis process.

1. Differing 'scenarios' cover the variation in the 'volumes' of certain building blocks i.e. number of connections.
2. Differing network analysis 'sensitivities' cover the variation in the 'behaviour' of certain building blocks, e.g. their profiles and other key variables. (It is likely that these profiles will come from the networks.)
3. Differing CBA analysis sensitivities that can be applied during the investment options appraisal process e.g. discount rates, costs of carbon, inflation etc.

These variations should be developed in workshops with the local authority partners and signed off by all parties.

5.5. Define baseline network modelling scenario

Rather than four scenarios for the SPAs, a single view should be created that can be reviewed by local authority stakeholders and improved with local evidence. Ideally, the default view should reflect the forecasts currently used by networks in their investment appraisal studies.

For WPD, this represents the 'best view' and covers most of the building blocks of the study. The gas network relevant building blocks can be updated to include the projections used by the gas network in their investment appraisal studies, though logical consistency between the scenarios is important. A second scenario, or an alternative view may be included to reflect some of the sensitivities desired by local authority stakeholder(s).

5.6. Create the disaggregated baseline dataset

5.6.1. Rationale for a disaggregated dataset

Once the baseline network modelling scenario datasets are combined, the geographic / network level may need to be disaggregated to a more granular level. This creates a straw-man dataset which can then be aggregated up to higher levels (i.e. an SPA) and updated with evidence from local authority stakeholder(s), while reflecting the current forecasts or demand modelling used by the energy networks.

The method and level of disaggregation needs to be agreed in a workshop between the process analysts and the energy networks, then signed off by relevant parties for each building block. The methods of disaggregation are likely to be based on customer counts at each level, combined with network informed factors such as load data or off-gas customer counts. The output of this stage is a full building block dataset at the lowest spatial level possible for the SPAs in the study.

5.6.2. Requirements for the disaggregation process

For Project EPIC, the building blocks are disaggregated to postcode, distribution substation, HV feeder, or primary substation, depending on the technology type. This split is informed by at which level the building block may connect to the energy network, or at which level the data is needed for network analysis.

For the electricity networks, the lowest level is defined as distribution substation areas split by number of customers on each postcode. The data required for this from the electricity networks is a count of customers (by profile class) by distribution substation and postcode. (Only count of customers and LCTs by profile class by distribution substation are relevant.) Data is also needed covering the network hierarchy linking these distribution substations to HV feeders up to primary substations (the DFES level). A single distribution substation may serve multiple postcodes and though the DNO may analyse this data aggregated to distribution substation, the postcode split is retained as this is useful for GDN and local authority purposes.

Much social or energy data may not be available at postcode, the postcode level projections therefore is more a representation of customer counts at each postcode and may take proportional splits from Output Area (OA), Lower Super Output Area (LSOA) or other data sources for the purpose of being able to aggregate by postcode or distribution substation.

For building blocks relevant to the gas network, it is agreed for Project EPIC to project these as changes on a baseline at postcode level for the numbers of technologies which connect at the distribution level (< 7 bar). It should be noted that the majority of domestic and commercial heat connects to the low pressure networks, whilst large commercial, industry, green gas injection and flexible power generation are more likely to connect to the MP (<2bar), IP (<7bar) and occasionally HP (>7bar) depending on proximity. The data required for this is a list of postcodes, provided by the process analyst, and customer counts for each of these provided by the gas network.

At the end of this process, a complete "best view" draft dataset should have been created covering projections for each building block at the appropriate level of disaggregation. A second scenario representing an alternative view may also be included.

5.7. Stage II – outputs, roles and processes overview

5.7.1. Outputs for this stage

The outputs that need to be signed off at this stage are:

- The sensitivities included as part of the dataset - signed off by all parties
  - Data type: included as a column in the dataset (could be in XLSX, CSV or SQL)
- The first draft dataset of DFES / regional FES data disaggregated to the agreed voltage / pressure levels.
  - Data type: dataset in excel or other format.

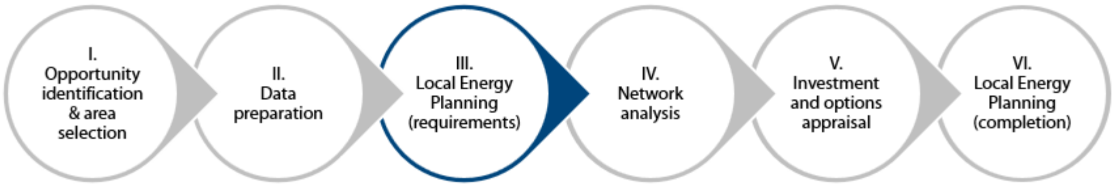
5.7.2. Stage II – roles and data flows overview

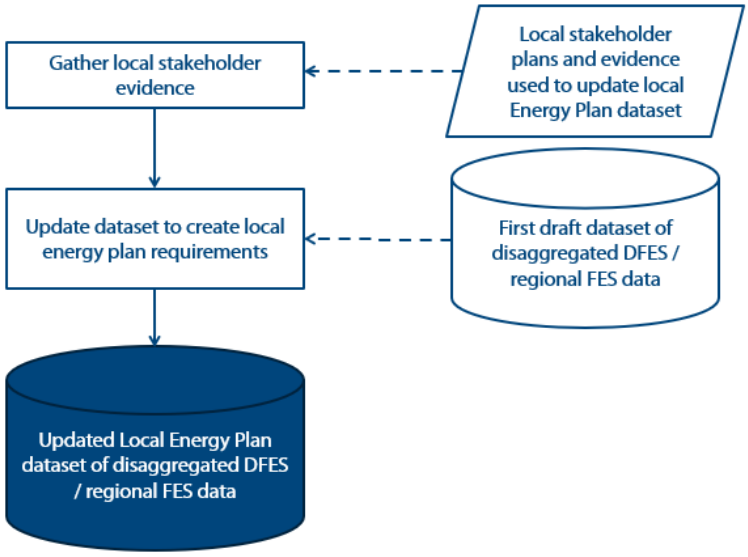
Stage II
Roles and responsibilities
Local authority stakeholder(s)
The role of the local authority stakeholder(s) at this stage is to provide or review local data relating to new housing and C&I developments.
DNO network planner
The role of the DNO network planner at this stage is to review and sign off the data scope including the technology types, timeline, baseline, sensitivities, and methods of DFES data disaggregation.
GDN network planner
The role of the GDN network planner at this stage is to review and sign off the data scope including the technology types, timeline, baseline, sensitivities, and methods of Regional gas FES data disaggregation.
Process analyst
The role of the process analyst at this stage is to create the baseline dataset at the correct level that will be reviewed and updated by the local authorities in the next stage. The baseline dataset will be structured as agreed and include the sensitivities and scenarios.
Data flows
Local authority stakeholder(s)

The local authority stakeholder(s) can share data with the project team that will inform the scenarios and sensitivities, such as whether a heat network is being planned. Data on the planned new developments of housing and C&I properties is also required by the process analyst.
DNO network planner
The DNO network planner needs to provide the most recent DFES data to the process analyst, as well as defining the default network investment scenario that relates to the local areas in study. The DNO also needs to provide network customer data to facilitate the disaggregation process, including customer counts by voltage level, profile class and postcode.
GDN network planner
The GDN network planner needs to provide up to date forecast data (could be regional FES for instance) to the process analyst, as well as network customer data at postcode level to facilitate the disaggregation process.
Process analyst
The role of a process analyst can be completed by the networks as part of this approach. The process analyst needs to combine and disaggregate recent DFES / regional gas FES data including options for scenarios and sensitivities to create a final draft dataset.

6. Trial Process Stage III: Energy Requirements Plan creation

Local energy plan network process





6.1. Gather stakeholder evidence and requirements

Local stakeholders are engaged throughout the steps to choose the SPAs and data sensitivities. This stage covers the discussions and engagement with local stakeholders specifically relating to the creation of a local energy plan.

Input from the local authority stakeholders can be categorised covering the following sections:

- Policies and plans relating to specific developments of new housing or C&I properties
- Policies and plans relating to building fabric efficiency improvements
- Plans for large energy projects such as a heat networks, wind and solar
- Plans for low-carbon transport or electric vehicle infrastructure
- Planning policies related to the use of fossil fuels including fossil generation

6.1.1. Stakeholder data gathering

In preparation for the EPIC planning workshops the process analyst will engage with local authority stakeholders to gather strategic area planning data. This data will include:

- Details of new housing and commercial and industrial developments
- Plans for EV charging and other transport energy requirements
- Energy efficiency and building retrofit plans
- Details of heat network developments
- Plans to decarbonise heat both on public and private properties
- Plans to support or deploy renewable energy generation or storage projects

6.1.2. Strategic area engagement workshops

For the EPIC trial process it is intended run two iterations of workshops for each of the strategic areas. The objective of the first workshop will be to review the baseline DFES data for the SPA and agree the quantitative updates to the data informed by local policies and local ambitions with the local and unitary authority stakeholders.

Topics to discuss at the first workshop will include:

- Confirm the new developments (domestic, commercial and industrial) that are planned for the SPA
- Discuss the energy efficiency and/or building retrofit schemes that are in place
- Talk through what large energy projects (including generation, storage and heat networks) are planned for the SPA
- Review the plans for EV infrastructure/low carbon transport plans
- Discuss the policies that are in place which might impact future generation with fossil fuels
- Talk through the plans for decarbonisation of heat (both in public and private property)

The objective of the second workshop will be for us to present the newly updated DFES data and gain stakeholder agreement that the data accurately reflects local policy as well as confirming the use-cases that will be analysed for each SPA

6.2. Update dataset to reflect local energy plan requirements

Quantitative and locational data is required to input into the local energy plan and update the initial draft building block dataset. This data is requested by the local energy plan process analyst and used to create the local energy plan. The changes and updates can be discussed and confirmed at a workshop with the local stakeholders.

The intention is to identify a single “best view” requirements plan however it is likely that a small number of alternative scenarios and sensitivities will be identified. For the EPIC Trial Plan these scenarios and sensitivities are identified in part two of this report.

By the end of this step the updates to the “best view” scenario draft dataset should be discussed and agreed by all parties. It may be appropriate to caveat that the local energy requirements plan is not a commitment from the local authority to adopting the development described but an agreement that it describes the most representative scenario for the area.

The draft dataset is focused on the energy network impacts for the SPAs, wider system-balancing needs at a national scale are assumed to be managed as the dataset is unlikely to represent a significant departure from the bounds of the ESO FES. The risk that the results fall outside of manageable system-balancing needs cannot be reduced to zero but mitigated by a review of the output datasets.

6.3. Stage III – outputs, roles and processes overview

6.3.1. Outputs for this stage

The outputs that need to be signed off at this stage are:

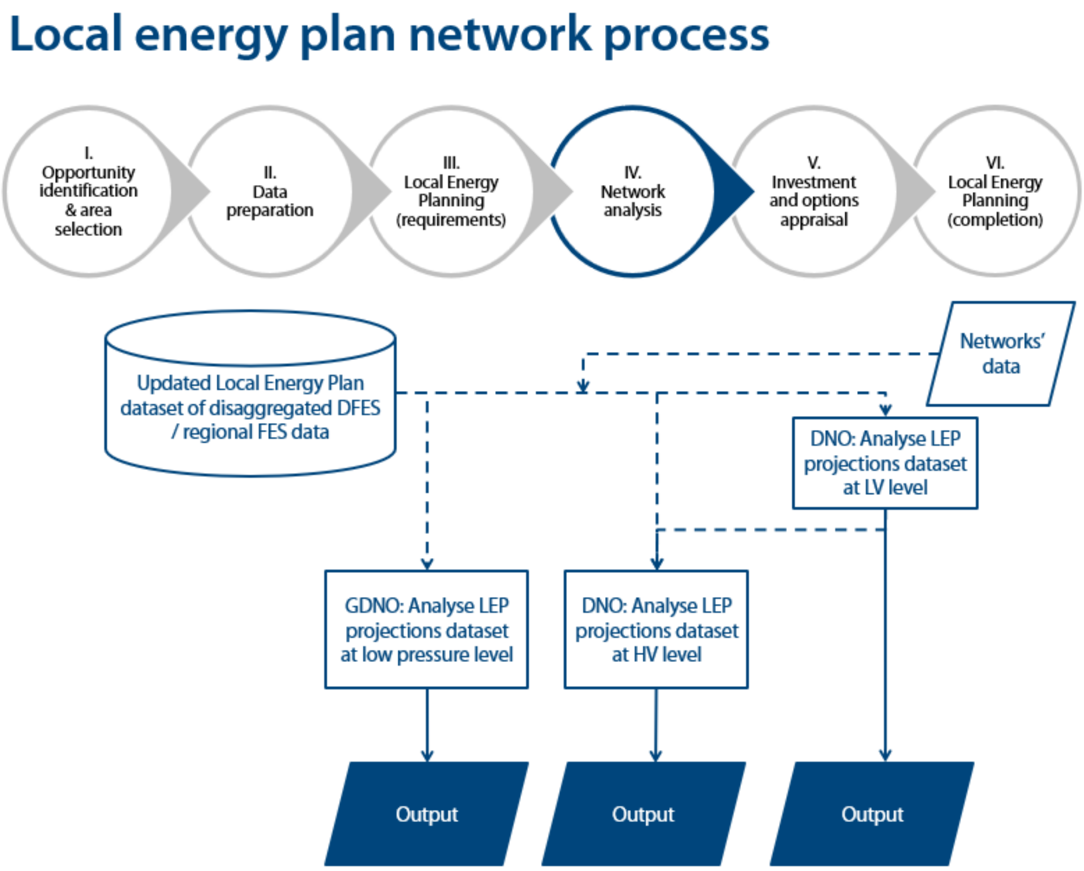
- The local energy plan dataset at the disaggregated level
    - Data type: excel dataset (or other file type) – likely to be a revised version of the DFES dataset with additional disaggregation.

6.3.2. Stage III – roles and data flows overview

Stage III
Roles and responsibilities
Local authority stakeholder(s)
The role of the local authority stakeholder(s) is to input the necessary plans and policies during the engagement and workshop processes and sign off the final local energy requirements plan which has updated the previous "best view" dataset.
DNO network planner
The role of the DNO network planner at this stage is to review the local energy plan and any assumptions which have been made in updating the previous projection data.
GDN network planner
The role of the GDN network planner at this stage is to review the local energy plan and any assumptions which have been made in updating the previous projection data.
Process analyst
The role of the process analyst at this stage is to update the "best view" building block projections dataset (including all use-case projection variations) using the data inputs from the local authority stakeholders, producing a new dataset signed off by all parties.
Data flows
Local authority stakeholder(s)
The local authority stakeholder(s) will input any plans or policies relating to the processes analysed in this stage. The local authority stakeholder(s) will also receive the existing "best view" dataset to review and provide feedback on.

DNO network planner
No input data is required from the DNO network planners at this stage, however the DNO network planner will review the updated local energy plan and sensitivities dataset from the process analyst.
GDN network planner
No input data is required from the GDN network planners at this stage, however the GDN network planner will review the updated local energy plan and sensitivities dataset from the process analyst.
Process analyst
The process analyst at this stage will share the "best view" dataset with the local authority stakeholder(s) and then receive data from the local authority stakeholders to create the local energy plan dataset. The process analyst will share the local energy plan dataset at the appropriate disaggregated level ready for the next stage of network analysis. (and for sensitivities)

7. Trial Process Stage IV: Network analysis



7.1. Run the gas network analysis

Typical gas demand modelling is run on an automated system taking Xoserve data combined with network topology data. The standardised trial process from Project EPIC will be a more manual look at the changes in technology connections at postcode level, while including the inflows from areas of the network outside the SPAs. In order to manually alter modelled demands, the GDN network planner will be required to export baseline demand from the modelling software, alter them based on the data provided, then re-import them into the model. As the nodes used to group individual meter points together do not correspond to postcodes, a lookup will need to be performed using data from the DDS system, which lists demands on a per property basis, against a node number and postcode.

The data inputs will consist of forecast data for building block technology connections, potentially including energy or volume values as well as numbers of connections. Network data and data on potential new customer connections can be provided by the GDN to the process analyst for this stage. The exact structure and scope of the data inputs is undefined at the moment and will be decided as part of the trial going forward.

A further part of the process requiring further definition is the treatment of new demands identified by the local energy plan, particularly where these are remote from the existing gas network which would make it more challenging to attribute demands to nodes. There is an expectation that a workaround can be implemented using DDS software, but spatial data may be required alongside the demand data. Network extensions are not currently expected to be modelled, as this would require design and costing input from additional teams within the GDN.

Having imported the demand data, the LP model will then be run, and results compiled to identify impacts on network pressures particularly at network extremities, to identify reinforcement requirements. This process will be repeated across all models covering demands and assets within the SPAs. Further analysis will then be done on the IP/MP model, with revised demands based on uplift from the LP model and changes to any direct connections affected by the local energy plan. This process will be repeated for the HP network – although a view may need to be taken on whether changes in demand are sufficient to warrant this. Through the course of the above process, revised flows through relevant governors and PRIs will be gathered, to be checked against capacity data to identify upgrade requirements.

7.2. Run the LV analysis

7.2.1. Brief description of methodology

The current LV analysis process is run by WPD in the LV analysis tool NIFT. Data inputs are provided from the DNO or process analyst in the form of .csv. The input data covers the building block forecasts for the distribution substations in the area.

In the current process, the forecast data is supplied at ESA level and then assigned using an apportionment algorithm, however this data may be provided already disaggregated to distribution substation level. Partner sign-off will be required on these input tables.

The WPD LV analysis tool (NIFT) already contains asset data for the WPD licence areas, supplied during the development of the Network Assessment Tool as part of Electric Nation (2016 -19). The asset data, customer numbers and demand profiles (using ACE 49 style p and q profiles) are assessed for all LV networks within the study area using a Debut assessment to assess both thermal and voltage issues in each of the study years. Additional asset data such as transformer size and cable costs are also required data inputs. The NIFT tool also carries out some high level assessment of the confidence level relating to the asset data (e.g. is the feeder abnormally long, or count of customers very high). As a result of this assessment, if the data quality/confidence in the data is low then discussions with WPD may be needed to cover any more recently available data.

7.2.2. Data inputs

For each distribution substation the DNO provides a count of customers by profile class as well as the Estimated Annual Consumptions (EAC) for each profile class are provided. The

LCT forecasts are provided by the process analyst showing numbers of connections by technology type (building block) by year at distribution substation level.

Customer data is provided by profile classes, with the following included:

- Profile One – Elexon Class 1 (Unrestricted Domestic Medium Consumption 3000- 7500 kWh per annum)
- Profile Two –Elexon Class 2 – domestic electric central heating, Economy 7 customers)
- Profile Three –Elexon 3 Non-Domestic Unrestricted customers (unrestricted commercial small estate shop, extended opening)
- Profile Four – Elexon 4 = Non-Domestic Economy 7 customers (day/night meter small estate shop extended opening with Economy 7)
- Profile Five – Elexon Profile 5 <20% Load Factor
- Profile Six - Elexon Profile 6 20% to 30% Load Factor
- Profile Seven - Elexon Profile 7 30% to 40% Load Factor
  - Profile Eight - Elexon Profile 8 >40% Load Factor

For each substation to be analysed the DNO will provide the number of customers in each profile class and an EAC for each of the profile classes. Where there are half-hourly metered customers connected to the LV network, these will be included in the analysis by determining the profile class that best reflects the shape of that customer's profile and including the customer as if they were associated with that profile class and giving their total annual consumption as an EAC.

Where the Energy Requirements Plan includes new developments, then dummy substations will be created and data representing the types of customers, expected load and associated LCT and generation will be provided. The details of this process are under development and will be confirmed in the requirements specification for the NIFT analysis. In the longer term, as customers are settled with half-hourly metering data the current profile classes will be phased out. Representative profiles will still provide a useful starting point for new customers being added to the system but the method of reflecting the assumed profiles within the network analysis tools will need to be updated as the smart meter data replaces the traditional Elexon profiles.

Included in Appendix 5: Draft specification for managing new developments for modelling is further information detailing how project EPIC intends to manage new developments for modelling (currently in draft).

The following building block values are provided in the defined units for the years to be modelled.

- Solar PV – domestic solar PV
- HPUMP – note at the moment a single heat pump profile is included in the model , rather than a split for ASHP and GSHP. Profiles are for domestic heat pumps, rather than heat pumps used for C&I buildings.
- PUREEV- load from a 7kW battery only EV for a domestic charger (off-street parking)
- HYBRIDEV – as above, but a 3.5kW plug-in hybrid

- PUREEVTOU – load from a 7kW battery only EV for a domestic charger (off-street parking) for an active responder to a Time of Use tariff where charging is delayed until the end of the evening/early hours of the morning (randomised start time between 22:00 and 02:00)
- HYBRIDEVTOU – as above but for a 3.5kW PHEV
- New build domestic customers/dwellings
- New I&C customers/floorspace

Additionally, data provision may include provision of alternate load profiles or other data to be used for sensitivity analysis, for example, variants of heating profiles reflecting the impact of time of use tariffs and/or thermal stores.

Similarly, the input data will need to be specify variables such as the investment strategy to be applied. For example, in the case of the 'just-in-time' investment strategy the NIFT would select the next incremental transformer size available whereas under the 'fit-for-the-future' investment strategy, the largest available transformer size may be selected.

The count of customers by profile class data is provided by the DNO, the LCT forecasts are provided by the process analyst.

Currently, this is the full list of technologies assessed as part of the NIFT tool – additional building blocks would need to be discussed with the process analyst. The asset data, customer numbers and demand profiles (using ACE 49 style p and q profiles)are assessed for all LV networks within the study area using a Debut assessment to assess both thermal and voltage issues in each of the study years.

7.2.3. Data outputs

Outputs from the NIFT tool are in .csv format, are configurable and can be summarised in PowerBI views. The configuration of the output will need to consider what outputs from the LV modelling is required as an input to the HV. This will include, as a minimum, the load profiles for the distribution substations in different years. The NIFT tool can also analyse potential solutions to the constraints identified. Information about transformer upgrades where the NIFT has identified the need to increase transformer capacity may need to be passed to the HV modelling tool to avoid double-counting of network upgrades. The attributes of each solution are defined including features such as headroom released, CAPEX and OPEX cost, which year a solution becomes available and its lifetime. Additional metrics may be required to support the use of other values in the ENA Whole System CBA tool, for example, to assess the benefits of changing a transformer relative to using flexibility services then the improved transformer condition should be taken into account by reflecting the improved health index and lower risk of failure and associated Customer Interruptions (CI) and Customer Minutes Lost (CML). Included in the NIFT tool is a modelling system to find the optimum solution set for the constraints identified. The means by which the data is validated for each year will be included in the HV and LV automation tool specification documents (WP2 D3 and D4).

7.3. Run the HV analysis

7.3.1. Brief description of methodology

For each year in the forecast period, the modelled system is updated with new customer network locations and forecasted connections. In some cases, this will be provided by the dummy substations created to support the analysis in the NIFT tool. New connections associated with certain building blocks will be assumed to result in the creation of a new HV connection e.g. larger scale generation, rapid EV charging stations etc. The connection location of these new connections will be determined based on geographical location data provided as part of the Energy Requirements Planning (section 6). These will either take the form of:

- New HV connections into existing HV feeders based on either closest substation or feeder depending on the HV network data available.
- Dedicated HV connections back to the closest Primary Substation where the new connection exceeds typical capacities determined by HV network planners.

Network analysis will take place with two variants;; top-down and bottom-up which allows for the impact of the different approaches to be determined.

- Top-down analysis is more consistent with the current method to model HV networks which is to take the SCADA measurements for a HV feeder and pro-rata the observed load between the HV connected customers and distribution substations to generate profiles at these nodes to be used for power flow analysis.
- Bottom-up analysis will use the load profiles generated within the NIFT and will ensure greater consistency with the LV analysis, but risks the expected profiles not summating to the observed measured loads and therefore having a reduced accuracy.

For the top-down analysis, the measurement data provides a base measurement which must then be updated for subsequent years to reflect the changes in the various building blocks. This can be achieved by adding scaled profiles for load, generation and storage technology in the same way that the adjustments are made to primary substation profiles for the network analysis underlying the shaping subtransmission reports. The profile changes for the various building blocks are captured in the customer behaviour profiles and assumptions report[14]. There may be a need to apply correction factors as the profiles included in this report are relevant for the level of customer diversity observed at a primary substation and the diversity for an individual HV feeder / distribution substation would be expected to be less.

[14] https://www.westernpower.co.uk/downloads-view-reciteme/303103 Accessed: May 2021

Power flow analysis is completed for the system to identify any areas with constraints and to understand the scale and duration of the constraints. These constraints will be based on thermal and voltage constraints but not take into consideration limitations from fault currents which are driven by developments across the higher voltage system.

From the constraints, configurable resolution options can be identified. For example, upgrade distribution transformer, upgrade cable/overhead line capacity, split the load of a HV feeder by extending the primary busbars to include a new circuit breaker and installing new assets to connect the overloaded feeder allowing the load to be split. As the manual assessment of investment options would be too time-consuming to be viable, the generation of these investment options will be automated and will not include detailed circuit lengths and paths that would be generated by a network planner. At this stage, inputs can be configured based on the use-cases that have been identified as inputs for the cost benefit analysis stage. For example, the assumed availability and cost of flexibility services can be varied.

The power flow analysis is then repeated with the identified resolution options to assess impact on the network. Thus, while the network analysis and investment option generation are separate stages within the overall EPIC process, where these are performed by the same analysis tool then they will be carried out together.

7.3.2. Data inputs

For the bottom-up approach, the following data inputs are required and should be specified with the project partners (this is a topic of ongoing discussion between the Project EPIC stakeholders):

- Load modifications at HV/LV substations
  - An output from the LV network analysis (NIFT)
- Existing demand increase / reduction for large customers connected to the existing 11kV feeder network
- New large customers connecting into existing or new 11kV feeders and their expected locations
  - From the updated disaggregated DFES dataset
  - Any correction factors required to adjust for the lower level of diversity observed on individual HV feeders.
- Dummy substation data reflecting new developments expected to result in additional distribution substations being created (including their expected locations).

There are also top-down data inputs at this stage:

- Primary substation demand profiles including the primary transformers and the HV feeders. Existing metrics used for load distribution on the 11kV feeder network (eg. transformer/connection capacities or maximum demand as appropriate)
- Volumes of additional load/generation and storage for different years (from the WPD DFES)

- The profiles used to translate additional DFES volumes to modified load profiles (from the customer behaviour profiles and assumptions report[15])
- Any correction factors required to adjust for the lower level of diversity observed on individual HV feeders compared to primary substations

As for the LV analysis, any variants in network profiles would need to be provided to the tool as well as the specific network investment strategy to be applied when generating the network investment options.

7.3.3. Data outputs

The HV feeder network analysis can output data in various ways, but will be configured to align with the DNO internal approach for network analysis. As for the LV analysis, the outputs will include an assessment of the network issues that are predicted, their location, duration and scale, their type (voltage or thermal). Similarly, the information for the network options generated by the tool will include the fields required for inclusion in the Cost Benefit Analysis tool, i.e. year, CAPEX cost and any network benefits in terms of health index, reduction in CML/CI. or reduction in technical losses.. The likely output data format is .csv.

7.3.4. EHV caveat

It should be noted that EHV analysis is not included at this stage and the resulting investment options appraisal therefore only covers part of the overall investment required. It may be useful to compare the resulting profile of the primary substations (having undergone the EPIC process) to the primary profiles used for the strategic sub-transmissions planning to examine the difference.

7.4. Stage IV – outputs, roles and processes overview

7.4.1. Outputs for this stage

The outputs that need to be signed off at this stage for the LV, HV and gas networks:

- A set of electricity network constraints, the location, date and duration that constraints arise, and potential solutions if that is an agreed output at this stage, including the capacity / storage / distribution additions to solve constraint.
    - Output as .csv with list of substations and constraints
- Predicted load profiles/changes in capacity to support a more granular network capacity forecast map
- Output from the gas network analysis, to include a set of potential network upgrades required.

[15] https://www.westernpower.co.uk/downloads-view-reciteme/303103 Accessed: May 2021

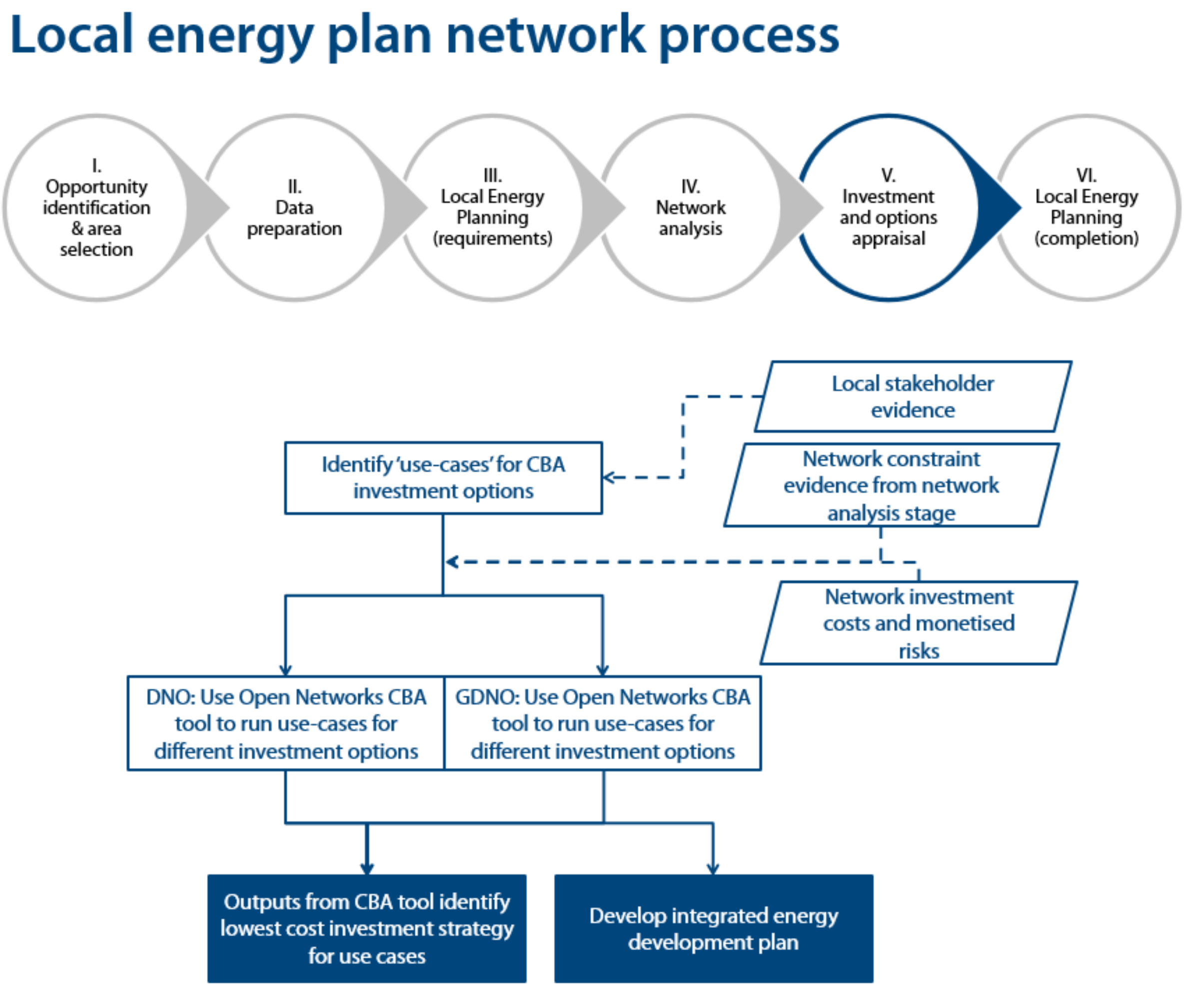
- Capacity requirements from the upstream system whether import or export which would (in a whole system model) be used to model additional green or green gas to be available for import. Could also be capacity requirements for exporting distributing generation / green gas

7.4.2. Stage IV – roles and data flows overview

Stage IV
Roles and responsibilities
Local authority stakeholder(s)
There is no requirement of local stakeholder time during this stage.
DNO network planner
The role of the DNO network planner at this stage is to review the LV and HV analysis process and ensure that the outputs are compatible within the DNO business-as-usual approach. The DNO network planner may also be required to provide network data. It is likely that different DNO network planners may need to be involved depending on the voltage levels being analysed. For example, LV planners, 11kV planners and network strategy planners.
GDN network planner
The role of the GDN network planner at this stage is to review the gas network analysis process and ensure that the outputs are compatible within the GDN business-as-usual approach. The GDN network planner may also be required to provide network data.
Process analyst
The role of the LV process analyst will be to take the disaggregated forecast data at distribution substation level and a count of customers and assess the impact on the LV network. The role of the HV process analyst will be to take the disaggregated forecast data at HV feeder level and assess the impact on the HV network. The role of the gas network process analyst will be to take the disaggregated forecast data and assess the impact on the gas network.
Data flows
Local authority stakeholder(s)
There are no data flows to or from the local authority stakeholder(s) during this stage.
DNO network planner
The DNO network planner may need to provide network asset data to the process analysts, as well as existing demand trends and other network data.
GDN network planner
The GDN network planner may need to provide network asset data to the process analysts, as well as existing demand trends and other network data.

Process analyst
The LV process analyst will receive distribution substation level forecast data, network asset data and customer profile data to use in the assessment of the impact on the LV network. The HV process analyst will receive HV-feeder level forecast data, top down primary substation demand data from WPD, and the results of the LV analysis to assess the impact on the HV network. The gas network process analyst will receive the disaggregated forecast data, use network flow data and new customer location data to assess the impact on the gas network.

8. Trial Process Stage V: Investment and options appraisal



8.1. Define the network investment options

The various network investment options under review will inform the identification of the use-cases for the cost benefit analysis stage. Three network investment option strategies are presented below, however other specific options may also be included.

8.1.1. 'Just in time' investment

The 'just in time' approach broadly aligns with the baseline approach of making individual network investments only as and when network demand becomes apparent and connections applications are made. This approach minimises risk and regret cost, but foregoes the opportunity to harness economies of scale and economies for combining investments. It may also prove to be more expensive over the longer term potentially requiring multiple network upgrades.

8.1.2. ‘One touch’ investment

Under a ‘one touch’ strategy, investment is made as demand becomes apparent and connections are triggered but network assets are then future proofed by building in additional capacity to meet the anticipated growth in demand.

8.1.3. ‘Strategic’ investment

A ‘strategic’ investment strategy entails taking a more holistic approach to look at the totality of energy requirements across multiple sites and customers and developing a proposal to make anticipatory investment to unlock net zero and regional economic growth opportunities. This implies taking more risk but also seizing the opportunity to combine investments, harness economies of scale and collaboration.

8.2. Incorporate the use-cases

The use-cases have been defined in stage II of the process, based on discussion with local authority stakeholder(s). The use-cases are designed to assist with decision making between different approaches by comparing the benefits of investment options generated for each approach. At this stage, additional data that isn’t included in the disaggregated dataset is provided by the gas and electricity network planners and incorporated by the process analyst in the individual runs of the cost benefit analysis model. This input data includes monetised risks, standardised values of flexibility, and traditional asset reinforcement. For the most part, costs for asset replacement are included in the LV and HV modelling, with the potential for scaled variations in the CBA tool.

Once the data is prepared for the use-case runs of the cost benefit analysis tool, the process analyst combines these to explore the impacts of each.

Initial use-cases that have been identified include:

- **Just in time’ vs. ‘fit for the future’:** a BAU network upgrade to meet immediate demand/load, or invest in upgraded assets to meet longer term future demand.
- **Network asset vs. flexibility solution**: an asset intervention/upgrade, or contract a flexibility solution to delay or avoid asset intervention.
- **On-street chargers vs. rapid charging hubs**: support local charging by deploying a number of low voltage residential on-street chargers, or a smaller number fast charging hubs connected to 11kv feeders.
- **Energy efficiency as a network benefit**: explore use of energy efficiency to reduce network (peak) demand and delay network upgrades
- **GDN input. Hybrid heat pumps as a network benefit:** using the gas network and hybrid heat pumps to reduce peak electricity demand and electricity network costs. Explore impacts on CO2 emissions and gas network costs.

Comparing the results for different areas for different approaches is not intended to provide a definitive answer that option A is always better than option B but rather show the difference for a given location, scenario and year. This knowledge will then be used to optimise the selection of investment options for the whole area which may well be a mixture of different approaches in different locations.

8.3. Run the use-cases through the CBA tool

8.3.1. Incorporate Network Analysis Cost Data

The key input required to run the CBA tool model is a set of costs data, including capital expenditure, operating expenditure and cashflow, for each of the network options and sensitivities.

8.3.2. Apply other CBA inputs and variables

The variables need defining for each use-case, and processed using a CBA tool so that the outputs can be used by the local authority and energy network stakeholders. Many of the variables are already pre-confirmed within the ENA Whole System CBA tool (and summarised in the second deliverable for work package two in project EPIC 'EPIC Investment Options Appraisal Tool Specification', these will be confirmed and sensitivities added as needed.

Table 2 Cost sensitivity analysis will include the following items

Value	**Comment**	**Default value , variants**
Assumed Weighted Average Cost of Capital	The default value will reflect the ED1 price control for electricity. Gas investment analysis will use the value from their latest price control. (Will an updated value be available in our timescales?)	
Inflation / discount rate		
Cost benefit analysis values Carbon	Value of CO2 savings	
Cost of flexibility services	Investment options for flexibility services will be based on the current value of flexibility services, this may be expected to fall as the market becomes more liquid.	

The ENA Whole System CBA tool also includes facilities for analysing the tipping point. These will be examined for each use case.

8.3.3. Run through the CBA tool for each use-case and sensitivity

The typical outputs from the CBA tool is a set of costed investment options, with economic and societal costs/benefits on an annual basis.

8.3.4. Analyse and report outputs

The Project EPIC Work Package two, deliverable two (titled EPIC Investment Options Appraisal Tool Specification) will outline the functionality of the CBA tool and further details of the process of running the ENA Whole System CBA tool will be available as that is published.

8.4. Stage V – outputs, roles and processes overview

8.4.1. Outputs for this stage

The outputs that need to be signed off at this stage are:

- The output of the ENA Whole System CBA tool for each of the use-cases that have been selected and defined in Stage II.

8.4.2. Stage V – roles and data flows overview

Stage V
Roles and responsibilities
Local authority stakeholder(s)
The role of the local authority stakeholder(s) at this stage is to inform and review the use-cases which form the inputs to the cost benefit analysis.
DNO network planner
The role of the DNO network planner at this stage is to review the various investment options that inform the use-cases, and to provide input data for the cost benefit analysis.
GDN network planner
The role of the GDN network planner at this stage is to review the various investment options that inform the use-cases, and to provide input data for the cost benefit analysis.
Process analyst
The role of the process analyst at this stage is to take the outputs of the network analysis stage to define the use-cases with stakeholder input, and use these as inputs for the cost benefit analysis process.
Data flows
Local authority stakeholder(s)
At this stage there are no datasets required by the local authority stakeholder(s).
DNO network planner

Costed data inputs for each step of the cost benefit analysis process is required from the DNO, as defined in the CBA tool.
GDN network planner
Costed data inputs for each step of the cost benefit analysis process is required from the GDN, as defined in the CBA tool.
Process analyst
The process analyst receives the outputs from the network analysis stages, plus any additional data required to define the use-cases. They will then combine these with the costed data inputs to use within the CBA tool.

9. Trial Process Stage VI: Strategic Area Energy Planning (completion)

Having run through the previous five stages of the process for the selected strategic areas, the data projections and detailed analysis should be available to develop the Local Energy Plan which can include:

- The expected selection of network investments including justification for their selection / omission of other options,
- results of sensitivity analysis,
- results of variants of the energy scenario e.g. with or without a major investment such as a heat network
- A commentary on the levels of certainty within the plan

This data and these plans can then be used by the DNOs and GDNs to assess their networks and enable investment decisions to be made that supports the ambitions of the local authorities in the selected strategic areas. It may be prudent for the Local Energy Plan to also include signposting to potential investment strategies (for example, co-investment).

10. EPIC Trial Plan

This section describes the trial plan for the EPIC project which, at a high level, consists of two key steps:

- Step 1: The first step of the trial will be to run the 'best view' scenario through the LV, HV and gas network analysis tools with the updated data from the Local Authorities for each of the SPAs. This will form the baseline for the SPA to which each of the use-case variants/scenarios will be applied. This is described in section 13.1 Trial Plan Run 1: Baseline Scenario.
- Step 2: The second step will be to vary this baseline data according to each the relevant use-cases for each SPA to examine the resulting network impact on the LV, HV and gas network analysis tools. This may also include appropriate sensitivity analysis runs too, if required. Therefore, the second stage will have multiple network analysis runs; one run for each use-case for each SPA to examine the network impact. This is described in sections 13.2, 13.3, 13.4, 13.5 and 13.6.

Top down vs Bottom up : The HV analysis will be carried out in two different ways; top down and bottom up.. Top down analysis will use the measured HV load on a feeder and allocate this to distribution substations based on capacity. This will provide a degree of consistency with the current methods of planning on the HV network. However as we are analysing the LV network for EPIC, we can also compare the results if we carry out the analysis "bottom up" and use the outputs of the NIFT to model the load at distribution substations. This is likely to give better consistency with the LV analysis. These two different approaches are likely to result in differences to the constraints that are identified and the investment options that are suggested. Therefore each of the Runs described below will have a Top down and Bottom up version.

For both the baseline and each relevant use-case, full network analysis will be undertaken for a selected primary substation within each SPA to identify the network requirements, constraints etc. The output from each step will then be taken forward to examine the appropriate network investment options.

11. Description of draft CBA trial use-cases in Project EPIC

The project EPIC stakeholders have developed five draft use-cases which represent the current options for sensitivity testing and investment options appraisal in the Project EPIC trial. It should be noted however that these use cases are still to be tested and reviewed with local authority stakeholders and informed by specific local plans and projects. Therefore, these use-cases may be modified after discussions with the local authorities at the workshops scheduled for late May. An overview of these use cases is shown in Figure 5.

Two of the CBA uses cases are intended to focus on investment options that could be made by the networks, including an option to invest in a "fit for the future" network asset and the option to use flexibility as an alternative to network investment. The remaining three draft use cases are focused around decisions that may be taken by local authorities on their planning for modes of EV charging, energy effeciency and choice of low carbon heating solutions.

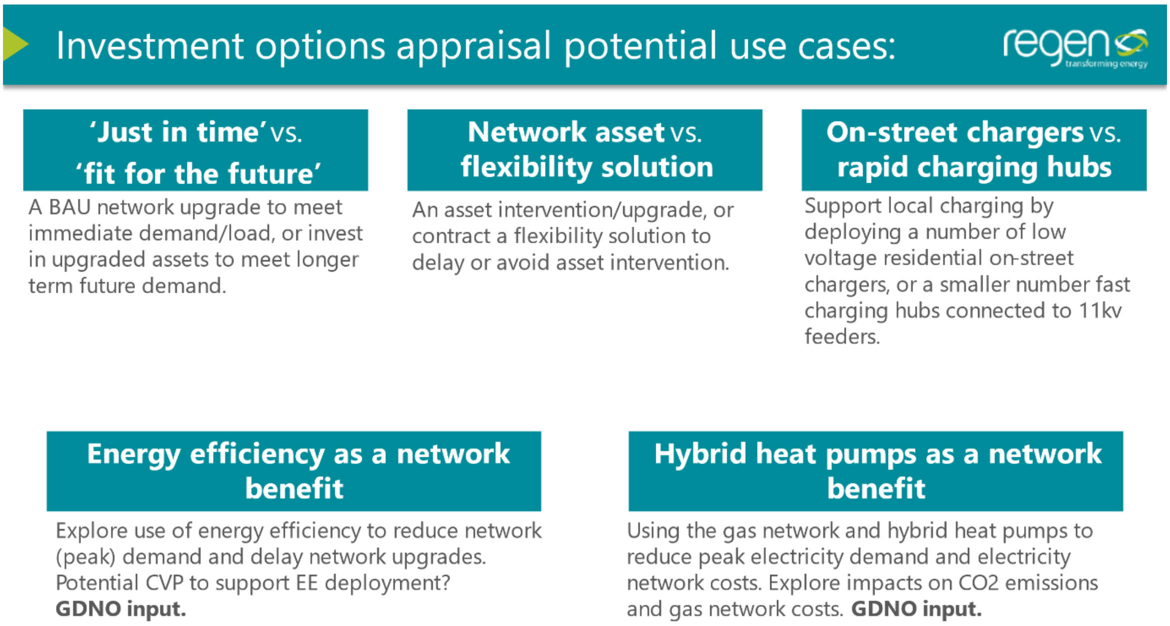


Figure 5 Overview of potential use-cases in Project EPIC

The CBA use cases will be trialled using the ENA Whole System Cost Benefit Analysis Tool. The design specification for the use of the CBA tool will be documented in EPIC project deliverable Work Package 2 Deliverable 2,, Investment option appraisal tool specification

A final decision will be taken as to which use cases to trial in each SPA. This will depend on the results of energy requirements planning as well as the network analysis. The intention however is that each use case will be trialled in at least one SPA.

11.1. Definition of each use-case

11.1.1. Use-case 1: On-street EV chargers vs. rapid charging EV hubs

This use-case tests the network impacts of different electric vehicle charging strategies by varying the location, number and power rating of public chargers to deliver the same amount of energy to electric vehicles in the SPA. By varying the connection voltage and also power capacity of the charger connections, different impacts on the network can be assessed. There are two main scenarios within this use-case:

- A higher number of low-voltage on-street chargers connected to LV distribution sub-stations.
- Relatively fewer 'fast' chargers connected to an 11kV feeder

To compare the expected impact of managing peak loading, we will model each of these scenarios under a constrained (or Time of Use) loading and an unconstrained loading.

This use-case will be presented within the input distribution substation / HV feeder projections dataset as two distinct scenarios varying the number of chargers. Each charger archetype has a set assumed average connection capacity and the profiles of each of the two charger types, though distinct, are not varied themselves as part of the trial runs.

The cost benefit analysis is expected to focus on the difference in EV charger capital and operating costs, as well as the difference in network investment that would be required.

Previous engagement with local authority stakeholders suggests that hydrogen and CNG vehicles are not a major part of their low-carbon transport plans. Those that do include this technology tend to do so for commercial vehicles only and therefore, are likely to have a smaller impact on the networks when compared to EV rollout projections. However, this will be confirmed with the local authorities for project EPIC in the upcoming workshops.

11.1.2. Use-case 2: Energy efficiency as a network benefit

This use-case tests the network impacts of different proliferation levels of energy efficiency improvements in the built environment driven by local plans and policies in each of the SPAs. This use case is aligned with Ofgem' guidelines that networks should consider measures to manage demand and reduce peak demand, as well as flexibility, as a means to reduce network costs.

"We anticipate that DNOs will work with suppliers, aggregators, local authorities, and other third parties to develop mutually beneficial proposals. These might include working with local councils to identify priority areas to upgrade the energy efficiency of buildings to proactively help to curb demand growth." Ofgem RIIO-ED2 Business Plan Guidance

At the moment, energy efficiency reduction of the baseload demand is not a specific building block within the DFES or the ESO FES. However, the ESO FES does contain a number of energy efficiency demand reduction benchmarks, and some analysis of the historic relationship between demand reduction and peak demand at the system level.

There is uncertainty over the level of network demand reduction that can be achieved through energy efficiency, which is reflected in the range of scenario outcomes in the ESO FES. As part of the EPIC project, the network impacts of energy efficiency will be modelled as part of this use-case, applied for LV and HV connected customers, as well as for gas network analysis.

Through the use of national benchmarks, (such as those in the ESO FES) augmented with local plans and evidence, a local reduced peak energy demand will be tested in Project EPIC. The sources of the reduction in the peak electricity demand (from domestic and C&I properties) due to energy efficiency improvements are proposed to be broken down into five categories within Project EPIC:

- Improvements to the energy efficiency of domestic electrical appliances
- Reductions in the heating requirement of domestic properties due to improved thermal efficiency
- Improvements to the energy efficiency of C&I electrical appliances
- Reductions in the heating requirement of C&I properties due to improved thermal efficiency
- Improvements to the energy efficiency of electrical industrial processes

Changes to the peak energy demand from these five sources are then assigned to Elexon profile classes so that they can be included in the profile analysis work at LV and HV level. These are shown in Table 3.

The baseline scenario here is likely to be a low proliferation of energy efficiency across the SPA and the variation will be a higher percentage of energy efficiency measures.

Peak electricity reduction factor	Factor detail
A	Domestic heat
B	Domestic appliances & lighting
C	Commercial heat
D	Commercial appliances & lighting
E	Industrial

Table 3 Peak electricity reduction factors

11.1.3. Use-case 3: Hybrid heat pumps as a network benefit

This use-case tests the variety of network impacts of heat pumps versus hybrid heat pumps for domestic and C&I low-carbon heating. The variation in this use-case is in the number of connected heat pumps or hybrid heat pumps, by setting. The hybrid heat pumps in this use-case are gas network connected and therefore this use-case spans both electricity and gas network investment planning.

To compare the expected impact of managing peak loading, we will model each of these scenarios under a constrained (or Time of Use) loading and an unconstrained loading.

We will not include a sensitivity run comparing air source and ground source heat pumps as this data required is not yet available. This may, however, be something to consider in the future.

11.1.4. Use-case 4: 'Just in time' vs. 'Fit for the future' investment

Use Case 4 is intended to explore the options available to networks to make low risk short term network upgrades to support the current and near term demand, versus options to invest upgraded assets to meet future and anticipated demand in the longer term.

These options are defined as two network investment strategies:

- A "just in time" strategy which is able to meet the near term requirements of new connection customers and short term demand
- A "fit for the future" strategy which considers network upgrades to meet future demand growth

The investment strategies will be run for each of the SPA scenario plan strategies.

The CBA is expected to focus on the analysis of the comparative costs and benefits of the two strategies including:

- Capital costs
- Operating costs
- Potential flexibility requirements
- Risk of regret expenditure
- Risk of loss of customer service
- Carbon savings and benefits.

11.1.5. Use-case 5: Network asset versus flexibility solution

Use Case 5 is intended to explore the options available to networks to use flexibility services as an alternative to a network asset or to use flexibility to delay network investment.

It is likely that the use case will compare three potential strategies

- A straight asset investment option
- A flexibility option
- A flexibility option for a time period and a later asset investment

The investment strategies will be run for each of the SPA scenario plan strategies.

The CBA is expected to focus on the analysis of the comparative costs and benefits of the three strategies including:

- Capital costs
- Operating costs
- The value of flexibility optionality

- Risk of regret expenditure
- Risk of loss of customer service
- Carbon savings and benefits.

Recognising that WPD is already appraising flexibility options using a different Common Evaluation Methodology (CEM) CBA tool, the proposed modelling approach for flexibility within the EPIC project will be necessarily straightforward. For the identified network issues, we will calculate the exceedance for each half hour and total up the MWh (or more likely KWh) of service requirement which is then costed at a flat rate e.g. £300/MWh. This approach should generate useful learning of the potential value of flexibility on the HV network which is not currently modelled with the CEM tool (which is restricted to 33kV and above).

11.2. Use-case data structure and data sharing

The use-cases in Project EPIC are to be included in the database structure in one of three places.

- **Scenario variations**: used to represent a variation in the technology type or total number (or capacity) of connections to the energy networks. For example, this includes a variation between hybrid heat pumps and heat pumps.
- **Profile variations:** used to represent a variation in the demand profile of a building block technology type. The specific way this is realised is dependent on the network analysis tool, however this includes representing variations in underlying electricity demand due to improvements in energy efficiency.
- **Network Investment 'strategies'**: used to represent the variation in costs from either different investment options, or, from the scenario or profile variations. This is included as different input costs in the CBA tool.

12. Data inputs and exchanges that are common across all use-cases

For the LV, HV and gas network analysis, a single projection dataset will be produced at the relevant geographic scale. This is the base scenario which will be varied according to the use-cases in which, aside from the specific case being tested, all of the input data remains the same.

Each run of the network analysis may include up to five use-cases. In some cases this will mean multiple runs with different input data. However, in other cases it may involve a single run.

Timeframe

Across all use-cases the timeframe is from the baseline year (2021) yearly out to 2035, with the option to include 5-year steps from 2035 to 2050.

Base scenarios

The default scenarios are based on the WPD best view, taken from one of the four WPD DFES WPD 2021 scenarios. These will be updated with local evidence from the local authority stakeholders but, outside of the use-case variations, follow a single projection by building block, relevant geography, and by year.

Building blocks

The technology categories to be used in Project EPIC are as defined in the building blocks summarised in Appendix 2: Building blocks summary.

Geographic areas

The three SPAs used in Project EPIC are as defined in WP1 D1: the Area Selection Document. The network analysis run at LV and HV will be run for a single Primary substation area for each of the SPAs.

New homes and C&I properties

The build rate for identified new homes and C&I properties (as previously assessed in the WPD DFES 2020) is the same across the use-cases and is benchmarked to balance between the average historic build rates in the local area and the planned build rates going forward.

13. EPIC Trial Plan Details

The trial plan described here provides details of the 'trial runs' for each use-case and the data variations required. It should be noted that this is provisional as the use-cases still need to be discussed and agreed with the local authorities at the workshops that are scheduled for late May.

13.1. Trial Plan Run 1: Baseline Scenario

<table>
<tr><th colspan="2" rowspan="3"></th><th>Run 1</th></tr>
<tr><th>Baseline scenario</th></tr>
<tr><th>Scenario variation</th></tr>
<tr><td rowspan="3">Project EPIC SPA</td><td>SW Bristol</td><td>Y or N. Primary substation TBC</td></tr>
<tr><td>N Bristol</td><td>Y or N. Primary substation TBC</td></tr>
<tr><td>Bath Enterprise Zone</td><td>Y or N. Primary substation TBC</td></tr>
<tr><td colspan="2">Description</td><td>DFES data disaggregated down to LV, HV and gas network level updated with local plans and policies.

This is a single scenario and will be the scenario against which all other use-cases are compared.</td></tr>
<tr><td colspan="2">Outputs</td><td>The outputs from this run are the network impacts of the baseline scenario and will be used as the baseline comparator for each of the subsequent use-cases.

For a full list of outputs, please see WP2, D2 investment option appraisal tool specification (first circulated 21/05/21).</td></tr>
<tr><td rowspan="3">Additional detail</td><td>LV</td><td>NA</td></tr>
<tr><td>HV</td><td>NA</td></tr>
<tr><td>Gas</td><td>NA</td></tr>
</table>

13.2. Trial Plan Run 2: Use-case 1

<table>
<tr><th colspan="2" rowspan="3"></th><th>Run 2</th></tr>
<tr><th>On-street EV chargers vs rapid charging EV hubs</th></tr>
<tr><th>Scenario variation</th></tr>
<tr><td rowspan="3">Project EPIC SPA</td><td>SW Bristol</td><td>Y or N. Primary substation TBC</td></tr>
<tr><td>N Bristol</td><td>Y or N. Primary substation TBC</td></tr>
<tr><td>Bath Enterprise Zone</td><td>Y or N. Primary substation TBC</td></tr>
<tr><td colspan="2">Description</td><td>The input variations to the baseline data will be number of chargers, the power rating of chargers (inherent in the type of charger itself) and network location of chargers. There are two scenarios to be tested:

• Scenario 1 is a high number of on-street chargers connected to the LV network, and a low number of rapid charging hubs connected to the HV network. (This may align to the baseline scenario.)
• Scenario 2 is a low number of on-street chargers connected to the LV network, and a higher number of rapid charging hubs connected to the HV network, relative to scenario 1.
• We will then include a sensitivity value to account for managed (or constrained) charge profiles for each scenario. For example, using the assumption that Time-Of-Use tariffs or charging control systems will manage peak loads to an extent, reducing the impact on the network</td></tr>
<tr><td colspan="2">Outputs</td><td>The outputs of the network analysis at this stage need to be input to the CBA tool as network asset intervention costs (CAPEX, OPEX etc). Other CBA tool costs such as the cost of the charger are also inputs but don't come from the network analysis stage.

For a full list of outputs, please see WP2, D2 investment option appraisal tool specification (first circulated 21/05/21).</td></tr>
<tr><td>Additional detail</td><td>LV</td><td>This dataset is provided by Regen to EA Technology as a .csv of projected connections by distribution substation by year, with two scenarios to be run in their network analysis tool.</td></tr>
</table>

	HV	The HV analysis will also take LV network analysis outputs as an input. This dataset is provided by Regen to PSC as a .csv of projected connections by HV feeder by year, with two scenarios to be run in their network analysis tool.
	Gas	

13.3. Trial Plan Run 3: Use-case 2

		Run 3
		Energy efficiency as a network benefit
		Profile variation
Project EPIC SPA	**SW Bristol**	Y or N. Primary substation TBC
	N Bristol	Y or N. Primary substation TBC
	Bath Enterprise Zone	Y or N. Primary substation TBC
Description		The input variation to the baseline data will be a reduction in the peak electricity demand, varying the categories laid out in section 11.1.2 and assigned to relevant Elexon profile classes. Two scenarios will be tested: • Scenario 1: A revised peak electricity profile on the LV, HV and gas networks, taking into account typical energy efficiency improvements. (*This may align to the baseline scenario*.) • Scenario 2: A revised peak electricity profile on the LV, HV and gas networks, networks taking into account higher than average energy efficiency improvements in each of the categories laid out in section 11.1.2
Outputs		The outputs of the network analysis at this stage need to be input to the CBA tool as network asset intervention costs (CAPEX, OPEX etc). This trial run will account for both gas and electricity network asset intervention costs. For a full list of outputs, please see WP2, D2 investment option appraisal tool specification (first circulated 21/05/21).

Additional detail	**LV**	In the NIFT, the changes to peak demand are varied through changing the annual demand and choosing the level to which this will impact the peak demand. This dataset is provided by Regen to EA Technology as a .csv of projected connections by distribution substation by year, with two scenarios to be run in their network analysis tool.
	HV	The HV analysis will also take LV network analysis outputs as an input. This dataset is provided by Regen to PSC as a .csv of projected connections by HV feeder by year, with two scenarios to be run in their network analysis tool.
	Gas	The input variations for the gas network analysis for this run are profile based and won't be included in the postcode level dataset.

13.4. Trial Plan Run 4: Use-case 3

		Run 4
		Hybrid heat pumps as a network benefit
		Scenario variation
Project EPIC SPA	**SW Bristol**	Y or N. Primary substation TBC
	N Bristol	Y or N. Primary substation TBC
	Bath Enterprise Zone	Y or N. Primary substation TBC
Description		The input variations to the baseline data will be heat pump and hybrid heat pump deployment projections. Two scenarios will be tested: • Scenario 1 will have high heat pump deployment, and low hybrid heat pump deployment. (*This may align to the baseline scenario*.) • Scenario 2 will have relatively lower heat pump deployment, and higher hybrid heat pump deployment. The variation between building blocks does not vary where on the electricity network these heat pumps will connect.

		Heat pumps are reported in the WPD DFES and ESO FES as Building block: Lct_BB005. Hybrid heat pumps are reported as Building block: Lct_BB006.
Outputs		The outputs of the network analysis at this stage need to be input to the CBA tool as network asset intervention costs (CAPEX, OPEX etc). This trial run will account for both gas and electricity network asset intervention costs. For a full list of outputs, please see WP2, D2 investment option appraisal tool specification (first circulated 21/05/21).
Additional detail	**LV**	
	HV	The input for the HV analysis for both scenarios is the output from the LV network analysis.
	Gas	The data will be shared in a postcode level database with changes on the baseline year.

13.5. Trial Plan Run 5: Use-case 4

		Run 5
		'Just-in-time' vs 'Fit for the future' investment
		Network investment strategy
Project EPIC SPA	**SW Bristol**	Y or N. Primary substation TBC
	N Bristol	Y or N. Primary substation TBC
	Bath Enterprise Zone	Y or N. Primary substation TBC
Description		The two network investment strategies that will be modelled on the baseline scenario: • Strategy 1: A "just in time" strategy which is able to meet the near term requirements of new connection customers and short term demand. (*This may align to the baseline scenario*.) • Strategy 2: A "fit for the future" strategy which considers network upgrades to meet future demand growth.

Outputs		The CBA tool inputs for this are the outputs from the network analysis in run 1 (the baseline scenario), for the gas and electricity network asset interventions. CAPEX and OPEX costs for both "just in time" and "fit for the future" are required. For a full list of outputs, please see WP2, D2 investment option appraisal tool specification (first circulated 21/05/21).
Additional detail	**LV**	
	HV	
	Gas	

13.6. Trial Plan Run 6: Use-case 5

		Run 6
		Network asset vs Flexibility solution
		Network investment strategy
Project EPIC SPA	**SW Bristol**	Y or N. Primary substation TBC
	N Bristol	Y or N. Primary substation TBC
	Bath Enterprise Zone	Y or N. Primary substation TBC
Description		This use case will compare two potential strategies will be modelled on the baseline scenario: • Strategy 1: A straight asset investment option. (*This may align to the baseline scenario*.) • Strategy 2: A flexibility option. The flexibility option will be threshold based and assigned a financial threshold value. If this value is exceeded a reinforcement will then be triggered. •
Outputs		The CBA tool inputs for this are the outputs from the network analysis in run 1, for the gas and electricity network asset interventions. CAPEX, OPEX, and the value of flexibility optionality are all required as inputs to the CBA tool.
	LV	

Additional detail	**HV**	
	Gas	

13.7. Potential Additional Trial Plan Runs

Having taken into account feedback from the first set of workshops with the local authorities, some additional sensitivities may be included (and will be confirmed at the second set of workshops held shortly):

- SW Bristol SPA: A higher-than-average deployment of ground mounted solar PV.
- BEZ SPA: Network investment brought forward to 2030 (rather than the 2050 default in the baseline scenario). If modelled, this will not be a sensitivity within the DFES data but will use the ENA Whole System CBA tool to determine the impact of bringing forward the CAPEX investment prior to 2030.

13.8. Trial Plan Expected Runs within Network Analysis Tools

For every Primary substation the following runs will be carried out in the PSC HV network analysis tool. For every run both reinforcement and flexibility options will be calculated and the comparisons will take place in the CBA tool by comparing the reinforcement and flexibility options for a subset of results.

The analysis runs for the NIFT are given by the rows requiring bottom up analysis.

Run number	Baseline / use case	Use case scenario	Sensitivity variant	top down/ bottom up
1	Baseline	n/a	Default balance of managed and unmanaged charging	TD
2	Baseline	n/a	Default balance of managed and unmanaged charging	BU
3	Use Case 1 - EV	High on street charging	Default balance of managed and unmanaged charging	TD
4	Use Case 1 - EV	High on street charging	Default balance of managed and unmanaged charging	BU
5	Use Case 1 - EV	Low on street charging	Default balance of managed and unmanaged charging	TD
6	Use Case 1 - EV	Low on street charging	Default balance of managed and unmanaged charging	BU
7	Use Case 1 - EV	High on street charging	Sensitivity value of managed charging	BU
8	Use Case 1 - EV	Low on street charging	Sensitivity value of managed charging	BU
9	Use case 2 - Energy Efficiency	Baseline energy efficiency	N/A	TD
10	Use case 2 - Energy Efficiency	Baseline energy efficiency	N/A	BU
11	Use case 2 - Energy Efficiency	High energy efficiency	N/A	TD
12	Use case 2 - Energy Efficiency	High energy efficiency	N/A	BU
13	Use Case 3 - Heat Pumps	Baseline HP allocation	N/A	TD

14	Use Case 3 - Heat Pumps	Baseline HP allocation	N/A	BU
15	Use Case 3 - Heat Pumps	Baseline HP allocation	Sensitivity value of AS vs GS	BU
16	Use Case 3 - Heat Pumps	Baseline HP allocation	Sensitivity value of managed charging	BU
17	Use Case 3 - Heat Pumps	Hybrid Heat Pumps	N/A	TD
18	Use Case 3 - Heat Pumps	Hybrid Heat Pumps	N/A	BU
19	Use Case 4 - Investment Strategy	Baseline Just In Time	N/A	TD
20	Use Case 4 - Investment Strategy	Baseline Just In Time	N/A	BU
21	Use Case 4 - Investment Strategy	Fit for the Future	N/A	TD
22	Use Case 4 - Investment Strategy	Fit for the Future	N/A	BU
23	Use Case 5 – Flexibility Solution	High flexibility threshold	N/A	TD
24	Use Case 5 – Flexibility Solution	High flexibility threshold	N/A	BU
25	Potential additional use case for SW Bristol SPA	High ground-mounted solar deployment	N/A	TD
26	Potential additional use case for SW Bristol SPA	High ground-mounted solar deployment	N/A	BU

14. Appendix 1: WECA policies summary

The information in this table summarises some of the wider WECA policies that are likely to have an impact on the energy network and was correct at the time of writing (April, 2021). It is included here as an example to illustrate the variety of local authority policies that are likely to feed in to the EPIC process.

Relevant policy	Status	Relevant outputs	Policy update next due	Frequency of updates	Any engagement with WPD
Local Industrial Strategy	Published	WoE Local Industrial Strategy	Summer 2021?	Unknown	Unknown
WECA EV Charging Strategy	In development	Strategic plan for EV charging infrastructure	Summer 2021	Unknown	None yet
WECA Decarbonisation of Transport Strategy	In development	Approach to decarbonisation of transport as transport authority	Autumn 2021	Quarterly via Transport Board	None yet
Joint local Transport Plan	Published	https://travelwest.info/projects/joint-local-transport-plan	Report to Transport Board June 2021	As required via Transport Board	None yet
Spatial Development Strategy	In development	Once adopted will set the strategic planning policy framework and key diagram for future housing, employment and infrastructure provision in the WECA area. https://www.westofengland-ca.gov.uk/west-of-england-strategic-planning/	Spatial Development Strategy	In development	Once adopted will set the strategic planning policy framework and key diagram for future housing, employment and infrastructure provision in the WECA area.

					https://www.westofengland-ca.gov.uk/west-of-england-strategic-planning/
Climate Emergency Action Plan	Published	https://westofengland-ca.moderngov.co.uk/documents/s2200/CE%20Action%20Plan.pdf	June 2021	Progress updated every 6 months	none
Mass Transit SOBC			Summer 2021		
MetroWest and 10 Year Rail Delivery Plan	Metro West in development. 10 Year Rail Delivery Plan published.	https://travelwest.info/projects/metrowest Improved rail connections across region Station enhancements and step free access Freight study into new intermodal terminals and express hubs	Spring 2022	Bi-monthly to Strategic Rail Steering Group	None yet
Renewable Energy Resource Assessment	In draft	Identify renewable generation opportunity across area as well as identify ambition	Spring 2021	Likely updated as part of Local Plan evidence reviews	None yet
Infrastructure and Investment Delivery Plan	In development	Will provide the evidence baseline for the SDS by assessing the sufficiency of the current and planning infrastructure projects to support existing and planned growth.		Likely to be updated annually	Initial engagement on known existing capacity constraints and sharable mapping (and other) data.

Low Carbon Challenge Fund	Grant Scheme	Local Energy Scheme – approx. 6 MW of renewable energy in 5-6 projects. 4 MW project in Avonmouth in development. Green Business Grants – likely 1 MW of renewable energy in scattered rooftop solar PV sites across the region.	LCCF will run from July 2019 - March 2023		Individual project applicants to contact WPD where DNO approval needed.

15. Appendix 2: Building blocks summary

Category	Vector	Units	Technology or demand source	Sub-technology	Building block ref
Generation	Electricity Generation	MW	Biomass & Energy Crops (including CHP)	-	Gen_BB010
Generation	Electricity Generation	MW	CCGTs (non CHP)	-	Gen_BB009
Generation	Electricity Generation	MW	Geothermal	-	Gen_BB019
Generation	Electricity Generation	MW	Hydro	-	Gen_BB018
Generation	Electricity Generation	MW	Marine	Tidal stream	Gen_BB017
Generation	Electricity Generation	MW	Marine	Wave energy	Gen_BB017
Generation	Electricity Generation	MW	Micro CHP	Domestic (G98/G83)	Gen_BB003
Generation	Electricity Generation	MW	Non-renewable CHP	<1MW	Gen_BB002
Generation	Electricity Generation	MW	Non-renewable CHP	>=1MW	Gen_BB001
Generation	Electricity Generation	MW	Non-renewable Engines (non CHP)	Diesel	Gen_BB005
Generation	Electricity Generation	MW	Non-renewable Engines (non CHP)	Gas	Gen_BB006
Generation	Electricity Generation	MW	OCGTs (non CHP)	-	Gen_BB008
Generation	Electricity Generation	MW	Renewable Engines (Landfill Gas, Sewage Gas, Biogas)	-	Gen_BB004
Generation	Electricity Generation	MW	Solar Generation	Commercial rooftop (10kW - 1MW)	Gen_BB013
Generation	Electricity Generation	MW	Solar Generation	Domestic rooftop (<10kW)	Gen_BB013
Generation	Electricity Generation	MW	Solar Generation	Ground mounted (>1MW)	Gen_BB012
Generation	Electricity Generation	MW	Waste Incineration (including CHP)	-	Gen_BB011
Generation	Electricity Generation	MW	Wind	Onshore Wind <1MW	Gen_BB016
Generation	Electricity Generation	MW	Wind	Onshore Wind >=1MW	Gen_BB015
Storage	Electricity storage	MW	Energy storage	Co-location	Srg_BB001

Storage	Electricity storage	MW	Energy storage	Domestic Batteries (G98)	Srg_BB001
Storage	Electricity storage	MW	Energy storage	Grid services	Srg_BB002
Storage	Electricity storage	MW	Energy storage	High Energy User	Srg_BB001
Injection	Fuel injection	MWh	Biomethane/bioSNG injection	Gas network injection	-
Injection	Fuel injection	MWh	Hydrogen injection	Gas network injection	-
Demand	Fuel manufacture	MW	Hydrogen electrolysis	-	-
Demand	Fuel manufacture	MW	Hydrogen SMR/ATR	-	-
Demand	Heat	Number of	Air conditioning	-	Lct_BB014
Demand	Heat	Number of	Direct electric heating	-	-
Demand	Heat	Number of	Gas boiler	Non-domestic	-
Demand	Heat	Number of properties	Heat network - gas boiler	Domestic	Lct_BB009
Demand	Heat	Number of properties	Heat network - gas boiler	Non-domestic	Lct_BB009
Demand	Heat	Number of properties	Heat network - gas CHP	Domestic	Lct_BB009
Demand	Heat	Number of properties	Heat network - gas CHP	Non-domestic	Lct_BB009
Demand	Heat	Number of properties	Heat network - Ground Source Heat Pump	Domestic	Lct_BB009
Demand	Heat	Number of properties	Heat network - Ground Source Heat Pump	Non-domestic	Lct_BB009
Demand	Heat	Number of	Heat pumps	C&I - Hydrogen hybrid	-
Demand	Heat	Number of	Heat pumps	Domestic - Gas hybrid	Lct_BB006
Demand	Heat	Number of	Heat pumps	Domestic - Hydrogen hybrid	-

Demand	Heat	Number of	Heat pumps	Domestic ASHP	Lct_BB005
Demand	Heat	Number of	Heat pumps	Domestic GSHP	Lct_BB005
Demand	Heat	Number of	Hydrogen boiler	Domestic	-
Demand	Heat	Number of	Hydrogen boiler	Non-domestic	-
Demand	Heat	Number of	Night storage heating	-	-
Demand	Heat	Number of	Primary gas boiler	Domestic	-
Demand	New Developments	m2	New C&I development	A1/A2	Dem_BB002 b
Demand	New Developments	m2	New C&I development	A3/A4/A5	Dem_BB002 b
Demand	New Developments	m2	New C&I development	B1	Dem_BB002 b
Demand	New Developments	m2	New C&I development	B2	Dem_BB002 b
Demand	New Developments	m2	New C&I development	B8	Dem_BB002 b
Demand	New Developments	m2	New C&I development	C1	Dem_BB002 b
Demand	New Developments	m2	New C&I development	C2	Dem_BB002 b
Demand	New Developments	m2	New C&I development	D1	Dem_BB002 b
Demand	New Developments	m2	New C&I development	D2	Dem_BB002 b
Demand	New Developments	m2	New C&I development	Sui Generis	Dem_BB002 b
Demand	New Developments	Number of	New Domestic housing development	-	Dem_BB001 a
Demand	Transport	Number of	CNG vehicles	Buses and coaches	-
Demand	Transport	Number of	CNG vehicles	HGV	-
Demand	Transport	Number of	Electric vehicles	Hybrid bus and coach	Lct_BB004
Demand	Transport	Number of	Electric vehicles	Hybrid car (autonomous)	-
Demand	Transport	Number of	Electric vehicles	Hybrid car (non autonomous)	Lct_BB002
Demand	Transport	Number of	Electric vehicles	Hybrid HGV	Lct_BB004
Demand	Transport	Number of	Electric vehicles	Hybrid LGV	Lct_BB004

Demand	Transport	Number of	Electric vehicles	Hybrid motorcycle	Lct_BB002
Demand	Transport	Number of	Electric vehicles	Pure electric bus and coach	Lct_BB003
Demand	Transport	Number of	Electric vehicles	Pure electric car (autonomous)	-
Demand	Transport	Number of	Electric vehicles	Pure electric car (non autonomous)	Lct_BB001
Demand	Transport	Number of	Electric vehicles	Pure electric HGV	Lct_BB003
Demand	Transport	Number of	Electric vehicles	Pure electric LGV	Lct_BB003
Demand	Transport	Number of	Electric vehicles	Pure electric motorcycle	Lct_BB001
Demand	Transport	Number of	EV Charge Point	Car parks	Lct_BB012a
Demand	Transport	Number of	EV Charge Point	Destination	Lct_BB012a
Demand	Transport	Number of	EV Charge Point	Domestic off-street	Lct_BB010a
Demand	Transport	Number of	EV Charge Point	Domestic on-street	Lct_BB010a
Demand	Transport	Number of	EV Charge Point	En-route / local charging stations	Lct_BB013a
Demand	Transport	Number of	EV Charge Point	En-route national network	Lct_BB013a
Demand	Transport	Number of	EV Charge Point	Fleet/Depot	Lct_BB011a
Demand	Transport	Number of	EV Charge Point	Workplace	Lct_BB011a
Demand	Transport	Number of	Hydrogen vehicles	Buses and coaches	-
Demand	Transport	Number of	Hydrogen vehicles	HGV	-

16. Appendix 3: Glossary

BSP	Bulk Supply Point
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CEM	Common Evaluation Methodology
CI	Customer Interruptions
CML	Customer Minutes Lost
CNG	Compressed Natural Gas
DFES	Distribution Future Energy Scenarios
DNO	Distribution Network Operator
DG	Distributed Generation
EAC	Estimated Annual Consumption
EPIC	Energy Planning Integrated with Councils
ESA	Electricity Supply Area
ESO	Electricity System Operator
EV	Electric Vehicle
FES	Future Energy Scenarios
GDN	Gas Distribution Network
GDPR	General Data Protection Regulation
GIS	Geographical Information System
GSA	Gas Supply Area
HV	High Voltage
LCT	Geographic Information System
LDZ	Local Distribution Zone
LSOA	Lower Super Output Area
LTS	Local Transmission System
LV	Low Voltage
mcm/d	millions of standard cubic metres per day
NDN	Non-Daily Metered
NIFT	Network Investment Forecasting Tool

OA	Output Area
OPEX	Operational Expenditure
PRI	Pressure Reduction Installations
SCADA	Supervisory Control And Data Acquisition
SPA	Strategic Planning Area
WECA	West of England Combined Authority
WLC	Whole Life Cost
WPD	Western Power Distribution
WWU	Wales and West Utilities

17. Appendix 4: Options for applying energy efficiency

17.1. Energy efficiency in national scenarios ESO FES 2021 and CCC

At the moment, energy efficiency reduction of the baseload demand is not a specific building block within the DFES or the ESO FES.

The ESO FES does contain a number of energy efficiency demand reduction benchmarks, and some analysis of the historic relationship between demand reduction and peak demand at the system level. A summary of the ESO energy efficiency demand reduction estimates/assumptions are shown in Table 4

The FES demand reduction assumptions, in the net zero scenarios, are broadly consistent with the Committee on Climate Changes projections for the 4th and 5th Carbon Budgets and show the majority of energy efficiency improvements were projected to occur by the early 2030s, particularly within the non-domestic sector, facilitating low carbon fuel switching and smart, flexible electricity consumption in the later 2030s and 2040s. The concentration of energy efficiency gains within a relatively short timeframe reflects the current slow uptake (also the focus on fuel poverty which tends enable latent demand), followed by a rapid sprint from 2025 to 2035 in order to meet the governments targets, and the 5th and 6th carbon budgets.

There is uncertainty over the level of demand reduction that can be achieved through energy efficiency, which is reflected in the range of scenario outcomes. Early demand reduction in the scenarios is driven by the non-domestic sector, with the expectation that private and public sector energy efficiency measures will be complete by the early 2030s in the net zero scenarios, as per the CCC's Sixth Carbon Budget. Domestic heat demand, in contrast, has historically proved more difficult to reduce through energy efficiency measures, and rollout occurs mainly in the later 2020s and 2030s. Across the scenarios, the impact of energy efficiency on non-domestic energy demand by 2030 was projected to be on average 50% higher than the impact on domestic heat demand.

17.2. Current DFES/Shaping sub-transmission process

Within the current DFES and Shaping Sub-transmission process network planners do not apply an energy efficiency improvement per se, but they do apply an assumption regarding a reduction in baseload peak demand, which is based on an extrapolation of the historic reduction in peak demand, as measured at licence area level.

This high level assumption applies a degree of overall demand reduction but is not specific to an individual geography, and therefore does not represent the targets or ambition of individual local authorities.

WPD is aware of this limitation and is planning to do more work in the area of energy efficiency; this may become a separate internal project in 2021. Other DNO's have also started work to better forecast both the annual and peak demand impacts of energy efficiency but this is fairly new and emerging. See for example Regen's work with SSEN to produce a sub-regional analysis of energy efficiency potential.

Within Wales and West's planning process future energy efficiency is similarly applied at a high level without a specific geographic or sectorial breakdown.

Part of the challenge for both networks is to get an accurate estimate of actual demand at the low voltage network, or Non-daily metered for gas, level. It is especially difficult to separate out the different classes of commercial and industrial demand sources, and to isolate efficiency impacts.

Some "living lab" type studies are being undertaken estimate the potential efficiency changes from specific measures.

Scenario	Scenario energy efficiency description
Steady Progression	Energy efficiency improves incrementally at business-as-usual rates, resulting in a very low level of energy efficiency uptake throughout the scenario timeframe. Building fabric and behavioural change reduce heat demand per household by around 10% by 2050. Domestic appliance and lighting efficiency sees a similar level of improvement. Scotland does not meet its 2045 net zero target in this scenario.
System Transformation	Low levels of societal change results in fairly low energy efficiency uptake, especially in terms of more intrusive retrofit measures and behaviour change. Building fabric and behavioural change reduce heat demand per household by around 15-20% by 2050. Domestic appliance and lighting efficiency sees a similar level of improvement. In this scenario, energy efficiency targets such as those set in the UK Clean Growth Strategy are not met, with around 10% energy efficiency improvement in the non-domestic sector by 2030, but Scotland and the UK meet their net zero targets through more centralised, government-driven technological solutions such as hydrogen heating.
Consumer Transformation	Consumer transformation features high levels of societal change and consumer engagement, resulting in high levels of energy efficiency across domestic, commercial and industrials sectors. This includes the rollout of more intrusive retrofit solutions in existing buildings, supporting the widescale electrification of heat, and high levels of behaviour change as people look to reduce their energy consumption. Building fabric and behavioural change reduce heat demand per household by around 25-30% by 2050. Domestic appliance and lighting efficiency sees a similar level of improvement. In this scenario, energy efficiency targets such as those set in the UK Clean Growth Strategy are met, with over 20% energy efficiency improvement in the non-domestic sector by 2030, and Scotland and the UK meet their net zero targets through high levels of electrified heat and transport combined with renewable energy generation.
Leading the Way	The Leading the Way scenario see's extremely high levels of consumer ambition, societal change and technological development, resulting in very high levels of energy efficiency. Building fabric and behavioural change reduce heat demand per household by around 36% by 2050. Domestic appliance and lighting efficiency sees a

	slightly higher level of improvement, driven by very ambitious changes to consumer behaviour and engagement in this scenario. In this scenario, energy efficiency targets such as those set in the UK Clean Growth Strategy and carbon budgets are exceeded, with well over 20% energy efficiency improvement in the non-domestic sector by 2030, and the Scotland and the UK meet their net zero target marginally ahead of schedule.

Table 4 Energy efficiency demand reduction assumptions FES 2021

17.3. EPIC Energy Efficiency Process Options

The EPIC project would like to scenario plan energy efficiency at a more granular level. Possibly at the level of each strategic planning area, or at the level of primary sub-station (Electricity supply area, ESA).

The options for the EPIC project are summarised below.

- Option 1 would be easiest, but may not be in the spirit of local planning and would be of limited interest to WECA And the Local Authorities.
- Option 2 or 3 would provide a greater degree of local input and would be forward looking albeit still based on high level assumptions and benchmarks
- Option 4 would require additional analysis of EPC data but could be included**, if** that analysis was then reflected in the network modelling
- Option 5, is not in scope but has been recorded as it may be applicable for future studies in cases where comprehensive building stock analysis has already been undertaken.

A key question however is how any projection of future (annual) energy efficiency would be converted into a projection of peak energy demand at ESA level. Regen has undertaken some high level benchmark analysis of the relationship between demand reduction and peak demand.

This is however a complex area and the relationship between efficiency and peak demand can be impacted by: changes in energy usage, changes in the types of demand user, behavioural changes, latent demand factors (e.g. for those in fuel poverty) and flexibility factors, in addition to energy efficiency. There are however some rules of thumb that could be applied and which would be sufficient to **prove the concept** for the purposes of the EPIC trial see Table 5. These could then be improved upon through further studies.

It would also be possible to take a conservative benchmark as an interim approach for EPIC pending the new work that WPD is undertaking. So, for example, looking at the ESO FES data a 10% EE reduction by 2030 in annual domestic demand may lead to a 4% reduction in peak load. But do we think that's correct, or would it be OK for a trial project like EPIC?

Key Questions

1) **For WECA and LA's** – what energy efficiency targets or projections have been made for the strategic areas? Do these warrant individual analysis?
2) **For PSC and EAT** – how would energy efficiency demand reduction projections be network modelled? Do you have a better methodology convert annual efficiency into a peak demand reduction?
3) **For WPD and WWU** – what level of historic demand data can be provided?

Option	Basis of energy efficacy projection	How would this be calculated and applied?	Advantages / Disadvantages	How would peak demand be calculated
1	EPIC could do something similar to the current process and **extrapolate the historic peak demand reduction at either: 1a - licence area, 1b - Local Authority 1c - ESA**.	Calculation would be based on historic peak demand trendline. This would be input as a variable within the HV and LV network planning tools. A high and low sensitivity could be applied	**An advantage** here, apart from being easiest would be to not overlap or pre-empt the work that WPD is doing. **A disadvantage** is that we would not then be reflecting the EE plans, targets and ambition of the LA's (assuming they have these). Also historic demand reduction factors for electricity (mainly appliances and lighting) may not apply when we think about the electrification of heat Trends are affected by other factors such as changing customer numbers in an area. Additionally measured peak demand at primary substation (ESA) would need disaggregation and manipulation to create values for Local Authorities due to boundary differences.	This method gives a forward projection of peak demand reduction based on historic trend
2	Create a new high level annual **Local Energy Efficiency reduction factor for each EPIC**	This could be based on	This would allow a greater degree of local input and a forward looking EE reduction factor	Peak demand reduction could be based on high level benchmark analysis of the relationship

	strategic area (or Local Authority) 3 sets of high level; variables, for each strategic area. Potentially broken down by New and existing buildings	a) national benchmarks and then flexed to LA areas depending on the level of ambition b) based on workshop input from Local Authorities EE demand reduction could be entered as a network modelling variable with a high and low sensitivity. Network planners, EAT and PSC would then have to consider how to reflect that annual factor in the network models as it impacts peak demand.	This would still be quite high level and based on **benchmarks and workshop input** rather than by bottom-up analysis. Some cross checking against national and other regional projections would be used to provide evidence and justification.	between annual energy efficiency and peak demand based on the ESO FES and other national estimates But they are very high level benchmarks and are contentious.
3	Create **a Local EE factor for each strategic area broken down be the key demand sources** a) Domestic heat, b) Domestic appliances & lighting, c) Commercial heat, d) commercial appliances & lighting e) Industrial.	Same top-down approach as option 2 but the demand reduction projections would be broken down by the main demand sources. It is likely that benchmarks would have to be applied.	This would give a better breakdown by demand source and could aid a more accurate projection of peak demand shift.	Peak demand impact would have to be estimated and this is not straight forward. Breakdown by demand source would require additional analysis of the baseload demand by MPAN (electricity) and by daily metered demand. See below

4	Create a more local EE demand reduction factor for **each ESA(Primary) separately based** on an analysis of EPC data. Broken down by main demand sources: a) Domestic heat, b) Domestic appliances & lighting, c) Commercial heat, d) commercial appliances & lighting e) Industrial.	EPC analysis combined with a set of scenario assumptions about EPC performance improvement can be used to produce a more evidenced set of energy efficacy demand reduction projections by demand source. .	Would provide a more evidenced set of EE reduction factors at a lower level of granularity for each primary/ ESA Would allow a better analysis of scenario outcomes and an analysis of the potential demand reduction for each ESA	Peak demand impact would have to be estimated and this is not straight forward. Breakdown by demand source would require additional analysis of the baseload demand by MPAN (electricity) and by daily metered demand. See below
5 **Not in Scope**	Another approach, which is outside the current scope, would be to do a full building stock analysis using street level data of the sort produced by EST and CSE.	This is not in the scope of EPIC but, for replication, it could be a data source in some areas if this has already been done.	Only applicable if this analysis has already been done.	Peak demand impact would have to be estimated and this is not straight forward. See below

17.4. High level – GB electricity system peaks and annual demand

At the highest level, historic data from the GB electricity system as a whole can indicate a relationship between peak demand and annual consumption:

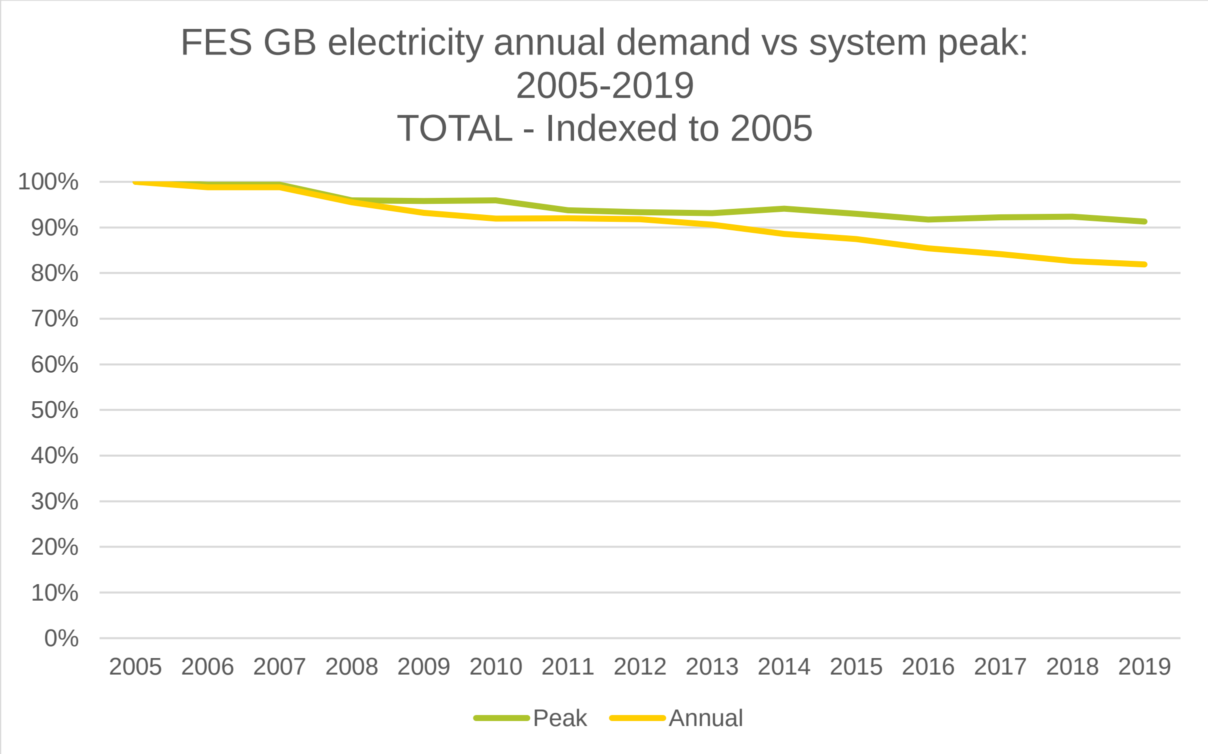


Figure 6 National Grid ESO FES historic system peak and annual demand, 2005-2019

This shows a fairly consistent 1:2 ratio (**a factor of 0.5**) between peak electricity demand reduction and annual demand reduction for nationwide electricity consumption over the last 15 years. Annual demand has dropped by 18% over this timeframe, while peak demand has dropped by 9%.

However, this wholesale view includes aspects not related to energy efficiency; for example, the increased level and sophistication of industrial Triad (TNuoS peak charge) avoidance has sought to reduce demand at peak half-hourly periods without reducing annual consumption. Similarly, the continuing shift towards a service-based economy will have resulted in changes to non-domestic electricity demand profiles.

The NGESO FES data does provide this historic data broken down by residential, commercial and industrial sector (it is not clear how this breakdown is modelled):

Table 5 - High Level Energy Efficiency to Peak Electricity Demand Reduction Factors

High Level Energy Efficiency to Peak Electricity Demand Reduction Factors		
	Suggested peak electricity reduction factor benchmarks	**Based on**
Overall Baseload electricity demand across all demand sources	0.5 (i.e. 10% energy efficiency leads to a 5% peak demand reduction)	Overall FES numbers Literature review
Domestic appliances and lighting	0.8 to 1.0	ESO FES analysis
Domestic heat (only energy efficiency)	0.3 to 0.4	ESO FES and Literature review
Domestic heat including smarter appliances, TOUT DSR, Thermal storage	0.5 to 0.9	ESO FES and Literature review
Commercial domestic and appliances	Unclear from the FES evidence likely to be in the range 0.5 to 0.7	Best guess based on historic FES data and domestic analysis
Commercial Heat	0.4 to 0.7	Best guess based on historic FES data and domestic heat analysis. Generally, commercial buildings have greater potential and incentive than domestic buildings to avoid peak demand.
Industrial Demand	Varies greatly by Range 0.2 to 0.7 Suggested mid point is 0.45	ESO FES analysis

Peak electricity reduction factor	Factor detail
A	Domestic heat
B	Domestic appliances & lighting
C	Commercial heat
D	Commercial appliances & lighting
E	Industrial

Profile class	Overall baseload electricity demand across all demand sources	Suggested peak electricity reduction factor benchmarks	
Profile One – Elexon Class 1 (Unrestricted Domestic Medium Consumption 3000- 7500 kWh per annum)	0.5	B	
Profile Two –Elexon Class 2 – domestic electric central heating, Economy 7 customers)	0.5	A	58% weighting[16]
		B	42% weighting
Profile Three –Elexon 3 Non-Domestic Unrestricted customers (unrestricted commercial small estate shop, extended opening)	0.5	D	
Profile Four – Elexon 4 = Non-Domestic Economy 7 customers (day/night meter small estate shop extended opening with Economy 7)	0.5	C	58% weighting
		D	42% weighting
Profile Five – Elexon Profile 5 <20% Load Factor	0.5	C, D, E?	

16 https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values Accessed April 2021

Profile Six - Elexon Profile 6 20% to 30% Load Factor	0.5	C, D, E?	
Profile Seven - Elexon Profile 7 30% to 40% Load Factor	0.5	C, D, E?	
Profile Eight - Elexon Profile 8 >40% Load Factor	0.5	C, D, E?	

18. Appendix 5: Draft specification for managing new developments for modelling

Where the local plan includes new developments, a simplifying assumption will be made that the new premises will be supplied by new distribution substations, rather than by connecting additional premises to existing distribution substations.

The DFES data gives new development information as number of domestic properties or square footage of the categories of non-domestic building. These building blocks are associated with a new development via a unique new development name. For each new development the expected maximum load associated with the new premises will be calculated and the number of distribution substations will be calculated based on an assumed maximum load per distribution substation e.g.750 kVA (to be confirmed with WPD planners)

Once the number of new distribution substations for the development is confirmed these will be distributed as evenly as possible geographically across the area of the development.

Dummy data for each dummy substation will need to include

1) The number of customers in each Elexon profile class
2) The average EAC per PC
3) The number of heat pumps
4) The average consumption for the heat pumps
5) The number of EV chargers
6) The average consumption for the EV chargers

Where new customers would normally be half-hourly metered, e.g. hospital, larger shops, larger schools then these will be modelled using the closest non-domestic Elexon Profile (3-8) based on the categorisation of the non-domestic property type e.g. A1, A2 and the profiles for these customers as given in the customer behaviour document. In these cases as well as the closest profile an estimate of the EAC value would also need to be provided. This can be obtained by estimating the maximum demand using the square footage and load/square footage value from the customer behaviour document and then converting from maximum demand to annual consumption based on the ratio for that profile class.

New developments will be assumed to be to a high standard and therefore may have lower estimated annual consumptions reflecting higher building efficiency, the use of energy efficient lighting and a higher likelihood of energy efficient appliances. Similarly the average heat pump consumption may be lower due to higher building standards and modern control systems.

As new developments will be assumed to include LCTs such as heat pumps and EVs then they will not be allocated additional units in subsequent years. This is a useful simplification as there would be insufficient data for the dummy substations to drive the allocation of LCTs in the same way as existing substations.

These new developments can be used to show the different impact between applying efficiency improvements to properties that are already high efficiency compared to average buildings.

Profiles for dummy subs will be passed to the HV modelling tool as will the expected substation location. The PSC tool will associate each dummy sub with the nearest HV feeder and depending on the data available in the WPD SINCAL model this will either be based on:

- Physically nearest existing 11kV feeder
- Shortest route along an existing road network (Dijkstra's algorithm)

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