Energy Networks Innovation Process

Annual Project Progress Form

The voice of the networks

Notes on Completion: Please refer to the NIA Governance Document to assist in the completion of this form.
Do not use tables

Step 1 - Initial Project Details

Project Title

Headroom – Whole System Thinking

Project Reference

NGED_NIA_073

Nominated Project Contact(s)

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Project Start Date

09/23

Project End Date

05/25

Scope (15000 Characters max)

This project aims to evaluate the whole energy system to determine the benefit per unit of added headroom. This benefit will be quantified in terms of both the reduced cost of energy (£/MWh) and reduced grid carbon intensity (CO2/MWh) that can attributed to increased distribution network headroom, for each voltage level, at critical times of year, and different constraint scenarios. By understanding this, we will be able to drive timely and cost-effective innovation towards these opportunities.
The project consists of two phases with increasing detail and granularity. We begin by quantifying the magnitude of benefit available from increasing headroom, then delve deeper into how different asset classes and archetypical variances will vary the benefit, providing greater rigor to the results.

To understand the benefit per unit of headroom, we will explore the difference between two scenarios - one where networks have sufficient headroom to allow distribution-connected assets to connect and dispatch freely, and one where there is a headroom shortfall that results in curtailed dispatch and - potentially - reduced or delayed connections.

- Consideration will be made of the voltage level and different constraint scenarios, including critical times of year when constraints are likely.
- We shall look across our network to identify illustrative instances (voltages, locations, network topologies, generation mixes) that we can study to understand the impact of headroom reduction, and to provide insights about how this varies across voltage levels.
- To quantify the benefit, the impact of headroom reduction on the capacity and dispatch behaviour of distribution-connected assets (generation, storage, demand) will be reflected as an input in PLEXOS and a Balancing Mechanism model, which will be run to model the impact on system prices and system carbon emissions.
- We shall review this benefit across two different time periods to be selected between today and 2035 that have different generation mixes and demand profiles.

Objective (15000 Characters max)

- Develop a methodology to calculate the whole system value of network headroom.
- Produce representative headroom archetypes that demonstrate where headroom provides value to the energy system.
- Quantitatively understand what parts of the network added headroom has the most significant financial benefit to the whole energy system. This will be discussed in terms of voltage level, types of connected generation, and types of connected demand.
- Understand the constituent parts of customer bills which are most impacted by added headroom, i.e. wholesale price savings, balancing market savings, carbon savings.
- Collated information to give values for £/MWh and CO2/MWh headroom whole system benefit, which will vary depending on archetype grouping.

Success Criteria (15000 Characters max)

Stage 1 Success Criteria

- Hold a workshop with subject matter experts from NGED DSO, National Grid ESO (now NESO), and project partners (Baringa, EA Technology Ltd), to inform the project direction.
- Develop a comprehensive methodology to understand the value of network headroom. This should be in collaboration with National Grid Electricity Distribution, Baringa and EA Technology Ltd.
- Produce a conceptual translation of headroom on generation, storage, and demand to help understand how to model headroom availability.
- Develop an understanding of how the value network headroom availability differs according to voltage level and time-base scenarios.
- Following detailed PLEXOS energy market simulation studies, understand how headroom availability changes the carbon intensity of the grid and consequently offers carbon savings.
- Incorporate constraints based on a national view into PLEXOS to understand the proportion of available low carbon generation that is curtailed, which otherwise supports the merit order effect.
- Develop an understanding of how the proportion of renewable generation affects the wholesale price. During Stage 1, this will be at a national level with only qualitative consideration of whether demand and generation assets are connected to the distribution network or transmission network.
- Develop an understanding of the scale of benefit increased distribution headroom may have in terms of £/MWh, and CO2/MWh. At Stage 1, this will explore what times of the year the benefit is largest.
- Produce detailed summary reports that outline the methodology in detail, the sources of any data used, and present key findings in a clear and understandable way. These should incorporate the effect additional network headroom has on other aspects of the customer bill, including balancing system costs, network costs, and carbon accounting costs.

Stage 2 Success Criteria

- A successful expert workshop is held, with attendance from National Grid DSO, ESO, and project partners. The outcomes of the workshop have successfully directed the project towards maximum value.
- Incorporate constraints based on individual voltage levels into PLEXOS to understand the proportion of available low carbon distribution connected generation that is curtailed, which otherwise supports the merit order effect.
- Develop an understanding of how the proportion of renewable generation affects the wholesale price. During Stage 2, this will be at a national level with detailed consideration of whether demand and generation assets are connected to the distribution network or transmission network.
- Provide an understanding of the scale of benefit increased distribution headroom may have in terms of £/MWh, and CO2/MWh. At Stage 2, this will explore what times of the year the benefit is largest but also consider the relative split between GB wide free dispatch and the benefit gained from increased distribution network headroom.
- Detailed summary reports ~~are produced for Stage 2~~ that outline~~s~~ the methodology in detail, the sources of any data used, and present~~s~~ key findings in a clear and understandable way. This should incorporate the effect additional network headroom has on other aspects of the customer bill, including balancing system costs, network costs, and carbon accounting costs.

Stage 3 Success Criteria

- A successful expert workshop is held, with attendance from National Grid DSO, ESO, and project partners. The outcomes of the workshop have successfully directed the project towards maximum value.
- Incorporate constraints based on geographic zones and voltage levels into PLEXOS to understand the proportion of available distribution connected generation that is curtailed, which otherwise supports the merit order effect.
- Develop an understanding of how the proportion of renewable generation affects the wholesale price. During Stage 3, this will be at a zonal level with detailed consideration of whether demand and generation assets are connected to the distribution network or transmission network in different parts of Great Britain.
- Provide an understanding of the scale of benefit increased headroom may have in terms of £/MWh, and CO2/MWh. At Stage 3, this will explore the impact of geographic differences as explored in the PLEXOS GB zonal model.
- Detailed summary reports ~~are produced for Stage 3~~ that outline~~s~~ the methodology in detail, the sources of any data used, and present~~s~~ key findings in a clear and understandable way. This should incorporate the effect additional network headroom has on other aspects of the customer bill, including balancing system costs, network costs, and carbon accounting costs.
- Describe the potential impact of how locational marginal pricing may impact the modelling employed in this project. Identify how different wholesale market structures would vary the extent to which headroom benefits the wholesale market.
- Provide insight on how available distribution network headroom influences ESO/DSO dispatch strategies that seek to promote electricity consumption at least carbon intensive times.

(Following a stage gate review process at the end of Stage 1, it was decided to expand stage 2's scope, and de-scope several areas of Stage 3)

Step 2 - Performance Outcomes

Performance Compared to Original Project Aims, Objectives and Success Criteria

Details of how the Project is investigating/solving the issue described in the NIA Project Registration Pro-forma. Details of how the Project is performing/performed relative to its aims, objectives and success criteria. (15000 Characters max)

Stage 1 Success Criteria

A successful expert workshop is held, with attendance from National Grid DSO, ESO, and project partners. The outcomes of the workshop have successfully directed the project towards maximum value.
Completed - During Stage 1, two workshops were held with NGESO, NGED DSO, and project partners in attendance. Feedback from these sessions has shaped the project direction.

Following the October kick-off workshop, the following assumptions were made to the modelling methodology:
Demand reinforcement should be excluded from Stage 1 of the work. This was chosen as a means to calculate an upper bound for curtailment benefit.
The chosen study years should include 2023 as a baseline year, and the latest study year should be 2034 to be in line with BAU network planning horizons.

Following the end of stage 1 workshop in February, several changes were made to the original project scope, to direct the project towards maximum value. It was acknowledged in Stage 1 that the network curtailment modelling which forecasted generation curtailment volumes and profile had several assumptions which did not hold up to scrutiny. There is no known methodology to assess curtailment at a system-wide scale, as such the revised project direction for Stage 2 focuses on establishing 'cost-curves' to calculate the scale of expected benefit across a range of curtailment volumes. Further information on this change is detailed in the following section.

A comprehensive methodology to understand the value of network headroom is produced. This should be completed in collaboration with National Grid Electricity Distribution, Baringa and EA Technology Ltd.
Completed - Stage 1 established a methodology to forecast the value of network headroom across UK DNOs. Collaboration between NGED, ESO and the project partners within Stage 1's workshop allowed for feedback on assumptions and the employed methodology. Specific detail on the methods used is captured in the Stage 1 reports accessible on the NGED website. National Grid - Headroom - Whole System Thinking

A conceptual translation of headroom on generation, storage, and demand is produced in Stage 1, which helps understand exactly how to model headroom availability.
Completed – Specific details can be found in the End of Stage 1 report. https://www.nationalgrid.co.uk/downloads-view-reciteme/660492

An understanding of how the value network headroom availability differs according to voltage level, and according to time-base scenarios.
Completed – EA Technology performed a sensitivity study using Transform™ and NGED's Simple Curtailment Tool. Further details can be found in the Stage 1 Network Modelling Report.
https://www.nationalgrid.co.uk/downloads-view-reciteme/660491

Following detailed PLEXOS studies, understand how headroom availability changes the carbon intensity of the grid and consequently offers carbon savings.
Completed – The CO2 emission which could be avoided through headroom relief is forecast to range between 0.7 Mt ('Network Curtailment' scenario) and nearly 5 Mt ('Maximum Constrained Generation' scenario) accumulatively from 2023 to 2034. This is broadly equivalent to the total life-cycle CO2 emissions savings of 20 to 170 thousand electric vehicles compared to petrol or diesel internal combustion engine vehicles. Further details can be found in the End of Stage 1 report. https://www.nationalgrid.co.uk/downloads-view-reciteme/660492

Incorporate constraints based on a national view into PLEXOS to understand the proportion of available low carbon generation that is curtailed, which otherwise supports the merit order effect.
Completed – Curtailment profiles for distribution connected generation assets were incorporated into PLEXOS within Stage 1. https://www.nationalgrid.co.uk/downloads-view-reciteme/660492

Develop an understanding of how the proportion of renewable generation affects the wholesale price. During Stage 1, this will be at a national level with only qualitative consideration of whether demand and generation assets are connected to the distribution network or transmission network.
Completed – A sensitivity study was performed in Stage 1. A more granular assessment producing cost curves illustrating the scale of impact at different volumes of renewable curtailment will be produced in Stage 2.
https://www.nationalgrid.co.uk/downloads-view-reciteme/660492

Provide an understanding of the scale of benefit increased distribution headroom may have in terms of £/MWh, and CO2/MWh. At Stage 1, this will explore what times of the year the benefit is largest.
Completed - The accumulated system cost saving could range from ~£330m to ~£17bn between 2023 and 2034 (£27.5m to £1.4bn annually); this represents a saving of 0.2% to 7.0% of the total system cost by 2034. The carbon cost saving that could be achieved in each year is between £5m and £125m, making an impact on annual carbon cost at 0.2% (2023) to 40% (2034). This is equivalent to reducing the emission from 17,000 (2023) to 120,000 (2034) Internal Combustion Engine vehicles over their lifetime. The impact on wholesale price is between £0.70/MWh and £6.00/MWh of which a material proportion could be used to reduce customer bills. The stage 1 forecast for the cost of carbon ranges from £8.1m to £125m in the 2034 study year. https://www.nationalgrid.co.uk/downloads-view-reciteme/660492

Detailed summary reports are produced for Stage 1 that outlines the methodology in detail, the sources of any data used, and presents key findings in a clear and understandable way. This should incorporate the effect additional network headroom has on other aspects of the customer bill, including balancing system costs, network costs, and carbon accounting costs.
Completed – Details of the methodology, data sources, and findings can be found in the two Stage 1 projects available on the 'Headroom – Whole System Thinking' project page, accessible on the NGED website. National Grid - Headroom - Whole System Thinking

Stage 2 Success Criteria

A successful expert workshop is held, with attendance from National Grid DSO, NESO, and project partners. The outcomes of the workshop have successfully directed the project towards maximum value.
Completed – Engagement throughout the project was held at pivotal decision points. NGED DSO staff provided resource to complete curtailment analysis using NGED's Simple Curtailment Tool in Stage 2. Furthermore, outputs from Baringa's power market modelling analysis were verified by National Grid's Market Analytics team.

Incorporate constraints based on individual voltage levels into PLEXOS to understand the proportion of available low carbon distribution connected generation that is curtailed, which otherwise supports the merit order effect.
Complete – Curtailment profiles were established on a voltage level, technology type level, and half hourly basis, before being aggregated into an hourly model suitable for PLEXOS. Considering voltage levels in the 2034 study year:

- LV experienced 11% of DG curtailed in 2034, mostly solar assets
- HV experienced very little curtailment due to demand reinforcement assumptions, which increased capacity ahead of demand constraints as per the business plan.
- EHV experienced ~1.5% of available export curtailed,
- 132kV experienced 4% of available export curtailed.

Further details are available in the End of Stage 2 market modelling report: https://www.nationalgrid.co.uk/downloads-view-reciteme/693214

Develop an understanding of how the proportion of renewable generation affects the wholesale price. During Stage 2, this will be at a national level with detailed consideration of whether demand and generation assets are connected to the distribution network or transmission network.
Complete –

Merit-order price suppression
As you bring more zero-marginal-cost renewables into the dispatch stack, they displace gas-fired plant at the margin, shaving a few pounds per megawatt-hour off the average market price.
In the Best-View case (with "released headroom" curtailment profiles), the modelling finds an average wholesale price saving of £1.9 bn over 2023–34, equivalent to roughly £2–3 /MWh of suppression at peak renewables penetration .
Price-duration curves in the report show the biggest downward price shifts occurring in high-renewables hours (mid-day summers), but a persistent few-pound effect right through the year.

Grid carbon-intensity reductions
By running more low-carbon generation instead of fossil-fired units, the system avoids 1.95 $MtCO_2$ of emissions in the 2023–34 period under Best-View .
Translating that into an average intensity, the report estimates a drop of ≈5–10 gCO_2/kWh across the decade when comparing the released-headroom case to a constrained-network baseline.
This "dual benefit" of lower prices and lower intensity is presented as a strong no-regrets lever for DSO investment: every MWh of curtailed renewables you unlock not only earns back £2–3 but also cuts 0.2–0.3 kg CO_2.
Further details are available in the End of Stage 2 market modelling report: https://www.nationalgrid.co.uk/downloads-view-reciteme/693214

Provide an understanding of the scale of benefit increased distribution headroom may have in terms of £/MWh, and CO2/MWh. At Stage 2, this will explore what times of the year the benefit is largest but also consider the relative split between GB wide free dispatch and the benefit gained from increased distribution network headroom.
Complete –The scale of benefit increased headroom may have on the distribution network was assessed for 2023, 2028, and 2034. An hourly model was established, which determined the benefit throughout the year. Stage 2 forecast greatest benefit during the summer months, which coincides with the increased volume of Solar PV export as well as the outage window where our network has lowest capacity. Each study year featured sensitivity of the volume of curtailment experienced, and the scale of benefit per unit of curtailment was calculated as around £100/MWh for each study year. Carbon emissions fell over the study year, with a difference between curtailed and uncurtailed scenarios falling from 0.24 Mt to 0.08 Mt in 2034. The accumulated carbon cost was £213m, significantly less than wholesale market costs and ancillary market costs.

Further details are available in the End of Stage 2 market modelling report: https://www.nationalgrid.co.uk/downloads-view-reciteme/693214

Detailed summary reports are produced for Stage 2 that outlines the methodology in detail, the sources of any data used, and presents key findings in a clear and understandable way. This should incorporate the effect additional network headroom has on other aspects of the customer bill, including balancing system costs, network costs, and carbon accounting costs.
Complete – Two reports were authored in Stage 2, the first authored by EA Technology covers the curtailment analysis, the second authored by Baringa describes the market modelling and ancillary service modelling. Both are available on the 'Headroom – Whole System Thinking' project page, accessible on the NGED website. https://www.nationalgrid.co.uk/innovation/projects/headroom-whole-system-thinking

Required Modifications to the Planned Project Approach During the Course of the Project

The Network Licensee should state any changes to its planned methodology and describe why the planned approach proved to be inappropriate. Please confirm if no changes are required. (15000 Characters max)

During the course of the project, two change requests were issued and approved following National Grid's project management governance. Both were required to update the scope of the project towards outcomes deemed most valuable by our DSO project sponsor.

Change request 1: June 2024

Following the Stage Gate Review between Stages 1 and 2, the scope of Stage 2 and 3 was refined based on the feedback given in the End-of-Stage 1 workshop. Stage 2 was modified, and Stage 3 was cancelled. This required the following modifications:

Additional Stage 2 Network Modelling:

- Refinement to EATL's Transform™ modelling to increase the number of representative days used in generating a forecasted annual curtailment profile driven by network constraints, inclusion of abnormal running arrangements within Transform™ development of more realistic battery storage profiles, and benchmarking against historic and forecasted curtailment volumes. This was made to improve the accuracy of the annual profile, required to perform a full year's curtailment modelling, but not possible with the existing four representative days scoped at the beginning of the project.
- As Transform™ was not able to study 132kV networks or GSP constraints, NGED's Simple Curtailment Tool was used to forecast curtailment across 17 Grid Supply Points within NGED's licence areas.

Additional Stage 2 Power Market Modelling:

- In addition to the work agreed previously for Stage 2, Baringa would conduct more thorough PLEXOS analysis in order to create representative cost curves detailing the magnitude of system wide benefit when considering the spectrum of curtailment, which may be incurred.
- Provision for 22 additional PLEXOS runs to determine Headroom cost curves using multiple sensitivities.
- Increased Subject Matter Expert (SME) involvement within the Ancillary Services modelling team to establish cost curves.
- Provision for increased costs incurred in Stage 1 of the project.

National Grid Project & Programme Management:

- Due to the increased stage duration required to undertake the additional modelling (23 weeks compared to the original 10), additional project and programme management time was required.

De-scoping of Stage 3:

- Based on feedback from the NGED Project Sponsor, the overall objectives of the project was met within the revised Stage 2 plan.
- Stage 3 originally involved moving towards a Zonal Market model within PLEXOS, to understand the relative benefit of headroom on a geographic basis, along with an understanding of how the value Headroom can bring will be affected by a move to locational marginal pricing.
- Following feedback, and changes in National Policy regarding Locational Marginal Pricing (LMP) the priority of these features was reduced.
- Considering the increased workload of Stage 2, it was proposed to de-scope several aspects of Stage 3 and re-utilise the budget for the additional work proposed in Stage 2.

Change Request 2: April 2025

During Stage 2 of the project, an additional change request was issued to account for additional National Grid time spent on the project:

- This change was largely due to increased internal resource spent on the project during Stage 2 delivery, delivering aspects of the 132kV network curtailment modelling in conjunction with EA technology, and reviewing technical outputs. Whilst within scope of the previous change request, this activity took more time than forecast and utilised a larger proportion of the project budget than previously allocated. This change facilitated more detailed network analysis, stronger review of outputs, and further dissemination of the project's key findings to internal and external stakeholders.

Lessons Learnt For Future Projects

1) Stage 1 Learnings

a) Curtailment modelling

- **Summer-only view hides risk.** The Transform™ model used just four DFES representative days; only the "summer-peak-generation" profile contained export, so all forecast curtailment fell in June-Aug and around midday – essentially a PV-only problem. *Lesson:* other DNOs using similar snapshots will underestimate winter wind or shoulder-season constraints and may time-lag reinforcement.
- **Solar PV is the dominant LV–EHV driver.** Even within that limited window, PV curtailment set the pattern for all technologies, peaking at 12-15 h.
  Lesson: voltage-rise limits, not thermal headroom, are likely to bite first in high-PV regions.
- **Behavioural assumptions on BESS swing results.** Static "charge-at-night / discharge-at-midday" profiles overstated curtailment; the report recommended revisiting battery profiles and even regulatory reform to give operators confidence in BESS benefits.
  Lesson: network studies should iterate battery operating envelopes with developers to avoid pessimistic blocking of storage connections.
- **Parametric averaging masks local hotspots.** The coarse archetype approach may under-report HV constraints where real feeders have far less voltage headroom.
  Lesson: supplement top-down tools with connectivity-based, feeder-level analysis before refusing or heavily constraining schemes.
- **No demand-driven reinforcement.** Stage 1 froze asset ratings, so curtailment simply grew with distributed generation; this overstates risk where demand growth will trigger uprating anyway.
  Lesson: align curtailment forecasts with your investment planning rules for a fairer picture of "natural" headroom release.

b) Power-market modelling

- **Range-finding benefit test.** Two cases – *Network Curtailment* (low) vs *Maximum Constrained Generation* (high) – produced a 2023-34 wholesale system-cost saving between **£0.33 bn and £17 bn**.
  Lesson: even crude curtailment data showed headroom is potentially worth multiples of typical DNO reinforcement budgets.
- **Price and carbon impacts concentrate in tight margins.** Winter evenings saw the sharpest price uplift (up to £10/MWh) and carbon penalty when headroom was absent. *Lesson:* releasing distribution constraints is system-critical precisely when consumers and ESO need it most.
- **Grid carbon intensity.** The carbon emission which could be avoided through headroom relief will range between 0.7 Mt and nearly 5 Mt, which is equivalent to nearly 200 thousand electric vehicles' carbon saving over their lifetime
- **Early signal for DER services.** Value of lost Balancing-Mechanism and ancillary-service opportunities was highlighted but not quantified, hinting at extra upside as ESO widens <1 MW access.

2) Stage 2 Learnings

a) Curtailment modelling

- **Methodology upgrades deliver year-round realism.** Twelve seasonal representative days, demand-driven reinforcement, realistic grid-scale & domestic BESS cycling, V2G uptake, and planned-outage deratings replaced the Stage 1 simplifications.
  Lesson: other DNOs can borrow this modular improvement list to tighten their own headroom studies.
- **Curtailment triples and migrates downstream.** Annual curtailed energy rises to **8.5 TWh by 2034**, enough to power 3.2 M homes; after 2030 the LV network overtakes 132 kV as the largest source, driven by domestic PV voltage rise.
  Lesson: investment priority shifts from early 132 kV bulk schemes to mass-LV voltage solutions later in the decade.
- **Solar still king, but wind & BESS matter upstream.** Solar accounts for **4.8 TWh** curtailed in 2034, yet decision-tree analysis shows BESS exports are now the single biggest predictor of 132 kV curtailment.
  Lesson: operators must model storage dispatch flexibly and examine whether ANM set-points are inadvertently blocking batteries.
- **Seasonal diversity emerges.** EHV/132 kV curtailment in winter and shoulder months grows because of wind and gas generation.
  Lesson: winter constraints are coming – don't rely solely on summertime voltage solutions.
- **Model limitations acknowledged.** EA Technology notes that parametric averaging still smooths out feeder extremes and advocates a follow-on connectivity-based tool.
  Lesson: granular digital-twin style tools are the next step to target reinforcement precisely.

b) Power-market modelling

- **Best-view whole-system benefit ~£2.5 bn (2023-34).** £1.93 bn wholesale, £0.21 bn carbon and £0.35 bn balancing-service savings when Stage 2 curtailment is removed .
  Lesson: that is equivalent to ~£200 m / year – a material addition to business-case appraisals for LV voltage upgrades.
- **Voltage segmentation sharpens targeting.** LV delivers **37 %** of cumulative benefit by 2034 (£796 m) while 132 kV provides **53 %** early on but falls thereafter.
  Lesson: regulators and investors can tie funding to time-phased, voltage-specific benefit streams.
- **Benefit elasticity highlights policy risk.** Varying curtailment ±80 % swings benefit between **£0.49 bn and £3.9 bn**.
  Lesson: headroom value balloons if renewables race ahead faster than grid build – a realistic outcome under Clean-Power 2030 ambitions.
- **Data science confirms cascading effects.** Models show LV PV curtailment explains most HV/EHV constraints, and 132 kV is increasingly storage-driven.
  Lesson: releasing LV headroom can relieve upstream networks, reinforcing the case for coordinated planning across voltages.
- **NESO-DSO coordination is non-negotiable.** Curtailment that blocks DER participation pushes up balancing costs; primacy rules, real-time data exchange and ANM upgrades are flagged as prerequisites.
  Lesson: treat curtailment as a priced action in both ANM and ESO markets to avoid counter-productive dispatch.
- **Curtailment treated as fixed load in PLEXOS.** This transparent approach captures wholesale, carbon and service impacts in one metric, making it easy for other TSOs/DSOs to replicate.

Outcomes of the Project

When available, comprehensive details of the Project's outcomes are to be reported. Where quantitative data is available to describe these outcomes it should be included in the report. Wherever possible, the performance improvement attributable to the Project should be described. If the TRL of the Method has changed as a result of the Project this should be reported. The Network Licensee should highlight any opportunities for future Projects to develop learning further. (15000 Characters max)

The project was aimed to provide network operators such as National Grid Electricity Distribution an improved understanding of where additional network headroom can provide the greatest benefit to consumers, via a reduction in their energy bills. Whilst a direct saving did not occur during the project, the most significant outcome of the project is the ability for network operators to quantify the benefit of additional headroom as ~£100/MWh.

This figure has now be carried forwards into National Grid's DSO benefit report, submitted to Ofgem. Looking forwards, further applications of this benefit will be explored, including ceiling prices for flexibility procurement.

The sensitivity study which suggested which voltage levels would have the greatest impact on wholesale markets has highlighted areas in which NGED are looking to develop capabilities further. Greater voltage control on the LV networks is a key step to better allow more renewables such as Solar PV to export freely. These are capabilities being explored in projects such as LV ACT and Phase Switch System.

Step 3 - Outputs And Implementation

Data Access Level & Quality Details

A description of how any network or consumption data (anonymised where necessary) gathered in the course of the Project can be requested by interested parties. This requirement may be met by including a link to the publicly available data sharing policy. (15000 Characters max)

All reports and supporting work are published on the 'Headroom - Whole System Thinking' project page accessible on the NGED website. https://www.nationalgrid.co.uk/innovation/projects/headroom-whole-system-thinking

Additional data can be requested by contacting NGED directly by emailing nged.innovation@nationalgrid.co.uk
NGED data can be requested via the National Grid Connected Data Portal (https://connecteddata.nationalgrid.co.uk).
(www.nationalgrid.co.uk/innovation/contact-us-and-more)

Foreground IPR

A description of any foreground IPR that have been developed by the project and how this will be owned. (15000 Characters max)

The Relevant Foreground IPR is:

- All deliverable reports and documents produced during the project delivery.

The Relevant Background IPR required to produce this is:

- National Grid's network modelling data including the Simple Curtailment Tool
- The PLEXOS model used by Baringa
- The Transform™ tool used by EA Technology Ltd.