MERLIN

Modelling the Economic Reactions Linking Individual Networks

Milestone 2

1.06 Flexible Service Valuation Mechanism

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1 Flexible Service Valuation Methodology

The existing planning methodologies practiced by DNOs in the UK predominately use worst-case-scenario interconnection studies, e.g. winter/summer max load/gen studies. These avoid the complexities of technoeconomic analyses that reflect the realities of real time operations. Furthermore, new technologies and customer expectations, such as increasing renewable energy penetration and business opportunities around aggregated loads, are changing our energy mix. This makes integrated resource planning even more mission critical and robust for utilities. DNOs are experiencing more complexity around network reinforcement and are considering flexible services as a solution to constraint management and network stability. To facilitate an effective assessment of flexible services, an economic valuation mechanism for flexible services is necessary.

DNOs traditionally value flexible service based the Net Present Value (NPV) of deferring expensive capital equipment e.g. deferring reinforcement of a £10 million subsea cable for three years provides an NPV saving of £x, which can be used for procuring flexible services. There is ongoing work within the Open Networks Project by Baringa to include additional factors when valuing flexible services including the impact of Network losses, impact of carbon and option value. This is the method outlined in Section 2 'Proposed Short Term Flexible Service Valuation' and is the first valuation methodology MERLIN will consider. This baseline valuation methodology will be augmented in the 'Possible Future Flexible Service Valuation' and 'Possible Future Plus Flexible Service Valuation' methodologies considering additional system and social factors.

The second Valuation method 'Possible Future Flexible Service Valuation' outlined in Section 3 builds on the values described in 'Proposed Short Term Flexible Service Valuation' methodology and includes new and unconventional value streams associated with asset health, CAPEX and OPEX savings, and flexible service costs. Section 4 'Possible Future Plus Flexible Service Valuation' considers further costs and savings that are not typically valued. These costs and savings are associated with social costs that influence the ratepayers, customers, and other general stakeholders. Section 5 describes an alternative value stream option, 'Operating assets beyond capacity'. This is an alternative option that we will explore in our modelling.

For each valuation methodology, there are numerous value streams that are identified as components to the total method. Not all value streams will be included in the MERLIN scenarios and simulations but are documented. Some of these are discounted due to the difficultly of utilising robust datasets or values or due to the confinements of the MERLIN project, such as 3.06 Location Multiplier, 3.13 Avoided Transmission Losses, 4.5 Net Avoided Air Pollutants. With more research, these could be explored in future work.

Each valuation mechanism will provide a total cost associated with the network reinforcement required. Section 6 outlines how the total monetary valuation will be tested in the MERLIN project through different scenarios that consider varying ratios of availability and utilisation payments. While MERLIN considers value streams available in a flexible services market, it is worth noting that there are other value streams that flexible services can earn outside of this market that will not be considered in this project.

Each valuation mechanism will identify a total monetary value that can be attributed to flexible services. The defined valuation mechanisms will be computed by Opus One's GridOS Integrated Distribution Planning (GridOS IDP) software to enable informed planning and financial simulations with flexible solutions. Later in the project, a cost benefit analysis will be performed to enable the

comparison of the benefits between different simulations and market rules and to expand the current approach on Flexible Service Valuation.

The report has been put together in collaboration with Scottish and Southern Energy Networks, The University of Cambridge Energy Policy Research Group and Opus One Solutions.

2 Proposed Short Term Flexible Service Valuation

The Proposed Short Term Flexible Service Valuation reflects how DNO's will value flexible services, which are known as Constraint Management Zones (CMZ), based on the methodology proposed by the Open Networks Project.

The value streams considered are listed below, with a summary description included. Information on how these value streams will be calculated within the Grid OS IDP modelling tool can be found in Milestone 2 report 1.07 Grid OS IDP Configuration and Development and within the accompanying 1.06 Flexible Service Valuation Formulas workbook.

2.1 Value Streams Considered in the MERLIN Project

Cost to Distribution Network Operators (DNOs)

2.1.1 Traditional Reinforcement Net Present Value (NPV)

- Current practice to manage constraints within DNOs is to engage in capital intensive "traditional" reinforcement e.g. increasing the size of transformers or cables. Typically, these traditional reinforcements are costly and take a long time to build and energize.
- There is value in deferring traditional reinforcement by utilising flexible services e.g. an energy storage unit can reduce the load on a transformer by discharging during peak times. It is likely that the transformer will still need to be reinforced if load growth continues, but this date can be deferred by x years. Current CMZ practice assumes traditional reinforcement can be deferred by 4 years.
- Deferring asset reinforcement creates monetary savings through NPV calculations. These NPV savings are used to calculate the amount of money available to invest in flexible services. SSEN uses an interest rate of 4% when calculating NPV savings based on feedback from the finance team.

2.1.2 Network Losses

- Flexible services can potentially increase/decrease the overall network losses e.g. utilising demand side response (DSR) instead of building a new overhead line may reduce the overall network losses.
- The RIIO-ED1 Ofgem CBA assigns a price for losses reduced on the network, which can be added to the network model.
- The total losses of a network with traditional reinforcement can be compared against the losses of a flexible service within the Grid OS IDP tool.

2.1.3 Flexible Service Administration and Management Costs

- Managing flexible services will incur costs to the DNO as man hours will be needed to manage financial transactions and monitor the efficacy of the services. These costs are estimated based on current CMZ management cost estimates. It is important to capture these costs when comparing flexible services to traditional reinforcement.

2.2 Value Streams Excluded from the MERLIN Project

The only value stream not considered in MERLIN that is considered within Proposed Short Term Flexible Service is Optionality, described below.

2.2.1 Optionality

- This involves accounting for some flexibility/optionality when providing services e.g. assigning additional value to flexible services where the future is uncertain. Option value is problematic, because it requires probabilistic view of the future. It is quite difficult to include all available futures which might be helped by a flexible service and so it has been excluded from this value stream. The Open Networks Project has included optionality as a sandbox feature to be included at a later date. For further details about the use of option value see the Cambridge M2 Report (Section 6).

3 Possible Future Flexible Service Valuation

The Possible Future Flexible Service Valuation includes the costs calculated in the Proposed Short Term Flexible Service Valuation and considers several new costs or savings currently not valued. This includes costs and savings associated with asset health, CAPEX and OPEX savings, and flexible service costs. These additional values allow DNOs to expand their approach on flexible service valuation.

The value streams considered are listed below, with a summary description included. Information on how these value streams will be calculated within the Grid OS IDP modelling tool can be found in Milestone 2 report 1.07 Grid OS IDP Configuration and Development and within the accompanying 1.06 Flexible Service Valuation Formulas workbook.

3.1 Value Streams Considered in the MERLIN Project

Cost to Distribution Network Operators (DNOs)

3.1.1 Remaining Asset Life Value

- Assets that have not reached the end of their useful life have remaining value. They can be sold or re-used e.g. an asset with 10 years remaining life has a higher resale value than an asset of the same type that has 1 year of remaining life. We will use the deprecation factor within the RIIO-ED1 CBA when calculating remaining asset life value.

3.1.2 Asset Life Costs

- Total asset life costs for traditional reinforcement should be considered when calculating NPV deferral savings. These details include upfront OPEX, CAPEX and planned outage costs required to install assets. It also includes ongoing OPEX such as maintenance and associated planned outages, which incur diesel generation and customer interruption (CI) and customer minutes lost (CML) costs.

3.1.3 Net Avoided Outage Costs (Asset Health)

- Given the health of an asset, an associated failure rate can be assigned. The failure rate of an asset can predict the likelihood of an outage, resulting in subsequent costs e.g. assets in poorer health conditions are more likely to experience faults and cause Customer Interruptions (CIs) and Customer Minutes Lost (CMLs). The formula and assumptions to calculate this will be available in the accompanying 1.06 spreadsheet.

3.2 Value Streams Excluded from the MERLIN Project

These remaining elements were considered and discussed, but ultimately will not be quantified in the MERLIN project for reasons such as the exclusion of the Transmission network and the variation of locations being limited in MERLIN or due to general availability of robust datasets. With more research, these could be explored in future work.

3.2.1 Location Multiplier

- It is understood that some geographic areas present higher costs due to increased complexity or regulation.
- The cost of a more expensive project location can be factored into the general project costs in the NPV component.

3.2.2 Ancillary Service Cost

- Services such as black start capability, voltage regulation, and peak reactive support can require additional costs for procurement.
- Voltage regulation and peak reactive services are considered as services in MERLIN and will use the same value streams as real power services. Black start capabilities are not considered as a service in MERLIN.

3.2.3 Lost Utility Revenue

- Consideration of flexible services results in lower regulatory asset value, which is primarily captured in capital infrastructure.
- Utilities may also experience additional costs due to interconnection or capital costs incurred by the utility.

3.2.4 Net Avoided Restoration Costs

- Flexible services may help or hinder restoration, but additional research is required to determine a valuation mechanism.

3.2.5 Avoided Distribution Capacity Infrastructure

- Flexible services may save distribution infrastructure costs, but additional research is required to determine a valuation mechanism.

3.2.6 Wholesale Market Price Impacts

- There may be impacts of flexible services on wholesale market prices, but additional research is required to determine a valuation mechanism.

3.2.7 Avoided Ancillary Services

- MERLIN is not considering costs to the transmission system.

3.2.8 Avoided Transmission Losses

- MERLIN is not considering costs to the transmission system.

3.2.9 Avoided Transmission Capacity Infrastructure and O&M

- MERLIN is not considering costs to the transmission system.

3.2.10 Participant Flexible Service Cost

- New flexible service providers may require additional hardware or infrastructure costs to enrol the flexible service. These should be added to the cost of flexible services.
- Examples include connection or monitoring costs.
- These costs have been excluded as we are primarily interested in DNO costs in this project and the costs to flexible services are unknown and highly variable.

3.2.11 Flexible Service Administration and Management Costs

- The cost of administering and managing flexible services by the service provider should be included when comparing the cost of flexible services vs the cost of traditional reinforcement.
- These costs have been excluded as we are primarily interested in DNO costs in this project and the costs to flexible services are unknown and highly variable.

4 Possible Future Plus Flexible Service Valuation

The Possible Future Plus Flexible Service Valuation includes the values calculated in the Proposed Short Term Flexible Service Valuation and Possible Future Flexible Service Valuation and considers several new costs or savings that SSEN does not currently value. This includes costs/savings associated with social costs that influence the ratepayers, customers, and other general stakeholders.

The value streams considered are listed below, with a summary description included. Information on how these value streams will be calculated within the Grid OS IDP modelling tool can be found in Milestone 2 report 1.07 Grid OS IDP Configuration and Development and within the accompanying 1.06 Flexible Service Valuation Formulas workbook.

4.1 Value Streams Considered in the MERLIN Project

4.1.1 Loss of Export Capacity

- Due to constraints on the network, there are energy exports from assets that are lost, such as PV energy. These costs should be considered to understand the cost to SSEN of running the system with constraints on the network.

4.1.2 Avoided Energy

- Energy generation and costs that were saved because of acquired flexible services can be considered (locational bulk marginal price).
- These savings may be experienced by the ESO rather than the DSO.

4.1.3 Community Generation Credit

- Flexible services can be assigned additional value in order to stimulate new markets by the regulator. This is done in New York under the Community Generation Credit. This will be explored within MERLIN. Details on how this is calculated and assumptions can be found within the accompanying 1.06 Excel workbook.

4.1.4 Net Avoided Greenhouse Gasses (GHG)

- Flexible services can increase/decrease GHG emissions associated with a network e.g. energy storage may be less carbon intensive than building a new overhead line.
- GHG emissions can be estimated for both flexible and traditional reinforcement options using UK government guidelines. The social cost of emissions can then be calculated using the Ofgem RIIO-ED1 CBA to understand what the monetary cost involved is.

4.2 Value Streams Excluded from the MERLIN Project

The following social value streams will not be considered during MERLIN. Some of these require more research for a robust valuation mechanism and prove difficult for determining metrics for measurement. However, they can be aggregated into the annual social cost described above.

4.2.1 Net Avoided Air Pollutants

- Further research needs to be done to evaluate the impact of air pollutants and value outcomes.
- The cost of net avoided air pollutants can be factored into the annual social cost.

4.2.2 Avoided Water Impacts

- Further research needs to be done to evaluate the impact to water and value outcomes.
- The cost of avoided water impacts can be factored into the annual social cost.

4.2.3 Avoided Land Impacts

- Further research needs to be done to evaluate the impact to land and value outcomes.
- The cost of avoided land impacts can be factored into the annual social cost.

4.2.4 Net Non-Energy Benefits

- Further research needs to be done to evaluate non-energy benefits such as avoided service terminations, avoided uncollectible bills, health impacts, employee productivity, and property values.
- The value of non-energy benefits can be factored into the annual social cost.

4.2.5 Net Non-Energy Costs

- Further research needs to be done to evaluate non-energy costs such as indoor emissions and noise disturbance.
- The value of non-energy benefits can be factored into the annual social cost.

4.2.6 Societal Disruption Costs

- A cost can be assigned to avoiding construction and road work, but further research may need to be done to compute this value.
- An annual social cost can be added to supplement the traditional reinforcement cost.

5 Alternative Value Stream Options

The above value streams are specifically related to valuing flexible services. However, as part of the MERLIN project we are able to extend the economic modelling to include alternative options to flexible services as described below.

5.1.1 Operating Assets Beyond Capacity

- Given the current state of an asset's life, this value stream investigates the costs incurred due to asset degradation and operating assets beyond their typical capacity by assigning a cost of operating assets beyond capacity.
- This is an alternative option to traditional reinforcement or flexible services and typically at the discretion of the DNO and their asset strategy.
- Operating an asset beyond its capacity is the acceptance of a violation. Violations can include sections of the network experiencing overvoltage, overcurrent (thermal), or overrating of equipment. Understanding if there is value in operating assets beyond capacity for periods of time to prevent reinforcement may be a useful alternative to DNOs. However, the adverse affects must also be costed e.g. reduction in asset life.

6 Distributing Value to Flexible Services

Sections 2, 3 and 4 detail valuation mechanisms a DSO can consider to understand future cost for planning scenarios. The total value which can be distributed to flexible service providers is derived from the total costs found from the chosen valuation mechanism.

Flexible service providers can be contracted through mechanisms such as long-term contracts or through an auction market-based approach. An availability payment ensures that SSEN will be able to call upon that flexible service for the contract duration and addresses the flexible service provider's long-term capital costs. A utilisation payment is the compensation for actual flexible that has been delivered and must meet the flexible service provider's operational costs.

A key consideration is the ratio of availability to utilisation payments for a flexible service. Different flexible service providers may have varying optimal ratios. In the MERLIN project, a variety of these payment ratios will be simulated in scenarios. More detail on conditions and parameters of the project scenarios can be found in the 1.08 Defining Scenarios for Economic Modelling report.

From these simulations, project MERLIN will evaluate the cost effectiveness of different payment ratios by performing cost benefit analyses on each scenario. This will address one of the key objectives of the project: determining the optimal availability and utilisation payment structure for flexible service procurement.

Appendix A - CMZ Processes

The following are the different payments by SSEN to compensate CMZ Sustain, Secure, Dynamic, and Restore procurement[1].

Procurement Method	Description	Payment Ratio
CMZ Sustain	The traditional CMZ product that supports the management of peak demand.	A=95% U=5%
CMZ Secure	Support the network during planned maintenance work.	A=90% U=10%
CMZ Dynamic	Support the network during fault conditions as a result of maintenance work.	U = 100%
CMZ Restore	Support the network during faults that occur as a result of equipment failure.	U = 100%

[1] More information can be found at https://www.energynetworks.org/assets/files/ON-WS1A-Product%20Definitions%20Updated-PUBLISHED.pdf

Utilisation Payment

$$UF_m = \sum_{j \in \mathrm{Pp}} (UP \times E_j)$$

where:

UP is the Utilisation Price, in £/MWh.

E_j is the Energy Delivered, estimated in accordance with sections generation and energy storage and Demand Side Response, as applicable, in MWh. This MWh is capped at a value no greater than the total contracted CMZ Capacity multiplied by the duration of the CMZ Event.

Availability Payment

$$AP_P = \left(\sum_{j \in Pp} A \times CM \times FO_j \times FU_j \right)$$

where:

∑_(j ∈Pp) is the summation over all Settlement Periods j, in the set Period (P) of Settlement Periods (days) in the Availability Period "p";

APp Availability Payment during period (p)

j settlement period j in the set Period

A availability price in £/MW/d

CM CMZ Capacity contracted OR requested service capacity, in MW

FOj Binary factor, equal to zero if a declaration of unavailability.

FUj Binary factor related to the delivery of contracted capacity during a CMZ Event and to the provision of complete data. If MW < 90% contracted capacity or Requested Capacity, FUj = 0, otherwise 1. Also, if less than 90% of the data is reported FUj = 0.

Storage Payment

$$SP_m = \sum_{j \in \mathrm{Pp}} (UP \times E)$$

where:

UP is the Storage Price, in £/MWh.

Ej is the Energy Requested As per the service notification instruction. It is assumed the energy delivered will equate to the energy stored/requested.

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