MERLIN

Modelling the Economic Reactions Linking Individual Networks

Milestone 5

Operation Plan for Intra-Day and Day-Ahead Simulation Trials

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This report sets out the plan for running live simulation trials that will test day-ahead and intra-day markets using the Grid OS Flexibility Market Simulator (FMS). It details the trials that will be tested, how the trials will be conducted, who the participants are expected to be and how the learnings will be shared

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Introduction

Background

The MERLIN project is working towards improving our understanding on how Distribution Network Operators (DNOs) or Distribution System Operators (DSOs) can effectively manage flexible services (for their own use or as neutral facilitators) such as those provided by generators, energy storage units and demand side response, among others. The goal is to improve our understanding on the economic impact these flexible services could have in a number of possible future world scenarios. MERLIN is also exploring the impacts of managing constraints through traditional reinforcement and alternative DNO controlled methods, which can be used to evaluate the cost-effectiveness of flexible services. Modelling allows us to understand possible positive and negative financial impacts of flexible services in a safe and risk free environment, with relevant learning passed to sister innovation projects TRANSITION and Project LEO. This can help us make better and more informed decisions in order to reduce customer costs and support the drive to net zero.

1.1 Aim

The aim of this report is to set out the plan for running live simulation trials that will test day-ahead and intra-day markets using the Grid OS Flexibility Market Simulator (FMS). This is the first time SSEN has trialled such a tool and will likely be the first time that market participants will have engaged with such a tool, as well. This report details the trials that will be tested, how the trials will be conducted, who the participants are expected to be, and how the learnings will be shared.

1.2 Day Ahead and Intra-Day Trials

The trials to be tested have previously been described at high level in the **Milestone 2 Report 1.08 Defining Scenarios for Economic Modelling**. **Milestone 4 Reports 2.01 Grid OS Flexibility Market Simulation (FMS) Configuration** and **2.08 Grid OS Flexibility Market Simulator** detail how users will interact with the Grid OS FMS tool throughout the trials.

Prerequisites for Trials.

Before the trials can begin a number of deliverables must be completed:

1. Rose Hill primary in Oxfordshire and its associated 11kV and 33kV feeders must be uploaded to the Grid OS IDP tool.

2. A specific set of constraints must firstly be modelled within the Grid OS IDP tool. These constraints can be actual constraints we expect to experience on the network over the next few years or artificially created so we can test a specific service e.g. DSO Peak Management constraints. The constraints will be relevant to those required in 1.3.2. Trial use cases section.

3. The cost of these constraints using traditional reinforcements must be calculated using the various valuation mechanisms described in report **1.06 Flexible Service Valuation Mechanism Workbook**.

4. The value of long term flexibility contracts must then be calculated using the valuation mechanisms described in **report 1.06**. This will allow us to compare the value of long term contracts against intra-day and day-ahead market offers. (Note: this is a key learning outcome as it can influence when a DNO/DSO should start using a day-ahead and intra-day market mechanism).

5. The trial will require that participants are onboarded ahead of interacting with the software. Ideally these participants will include existing service providers within the LEO and TRANSITION projects. Confirmation that the participants are willing to attend will be necessary.

6. Simulating market liquidity is another requirement. It is possible that the selected location of the primary in question may have a limited number of flexible service providers or providers that are unable to meet the simulated constraint requirement. To address this problem, additional flexible service providers can have their assets imported into the simulated network or SSEN's market operator user(s) can assign flexible service positions to core project members e.g. The Project Manager can assume the role of a demand side response aggregator. These artificially created service providers must be clearly identifiable and learnings shared with the participants post model run.

7. Completion of flex service providers details e.g. Type, size, location, availability time windows, etc. for flex service participants requirement inputs. This must be done prior to commencement of the trials to ensure accurate powerflow results can be run on the Grid OS FMS tool for day-ahead and intra-day simulations trials.

Trial Use Cases

There will be six use cases based on the four services that will be trialled as part of the MERLIN project, which include:

1. DSO Peak Management (Load Related): Flexibility required in the form of reduced demand, increased generation, or dispatched storage to mitigate the impact of a network constraint e.g. constraint caused by additional electric vehicle (EV) load requiring transformers to be reinforced.

2. DSO Peak Management (Generation Related): Flexibility required in the form of increased demand, reduced generation, or dispatched storage to mitigate the impact of a network constraint e.g. constraint caused by additional photovoltaics (PV) generation requiring transformers to be reinforced.

3. DSO Constraint Management: The delivery of flexibility during a fault following an outage which involves the loss of a critical asset that puts the local network at risk and requires the immediate delivery of flexibility. E.g. a fault on the 11kV network causes 1000 customers to lose supply. A flexible service could potentially be used to bring customers back on supply, while the fault is being fixed.

4. Offsetting / Peer to Peer (P2P): A service where one Market Actor in a constrained area agrees to increase/decrease its demand/generation ahead of another Market Actor in the same constrained area increasing/decreasing its demand/generation by the same amount. This service also includes the charging or discharging of electric vehicles to enable increased generation or increased demand. This service supports both constrained and unconstrained networks.

5. Marginal Import Capacity (MIC) & Marginal Export Capacity (MEC) Trading: A service where one Market Actor within a constrained area can increase the level of export or import at one of its meter point administration (MPANs) through purchasing excess Authorised Supply Capacity for a period of time from another Market Actor in the same constrained area.

Trial Use Case 1: DSO Peak Management (Load Related)

Service Type: DSO Peak Management (Load Related)
Service Description: DSO Thermal Constraint will be simulated on the Grid OS FMS e.g. Transformer over capacity. The constraint will have been pre-prepared and demonstrated to be observable via powerflow analysis prior to the simulation taking place.
Time Period
Time Period: Constraint will be simulated within the next 4 years (2020 - 2023)
Simulation Length: Simulation will be run over a one week period, using 'reference days' taken from a typical constrained year.
Players & Responsibilities
Players: DSO, Flexible Service participants within connected area. Flexible service participants outside connected area, Project MERLIN partners assuming flexible service roles where necessary. The Opus One model will be pre-populated with flexible service locations prior to the simulation beginning.
Responsibilities: DSO will advertise constraint on Grid OS FMS e.g. 1MWhr reduction required between 13:00 and 13:30. Flexible service participants will respond with service availability and cost e.g. 0.2MWhr available @ £200 per MWhr
Market Operation & Rules
Operation: Offers accepted through pay as clear auction. Participants will get a second attempt to sell services during intra-day auction. Participants must be technically able to resolve constraint as Grid OS FMS utilise powerflow. Refer to report 2.08 Grid OS Flexibility Market Simulator for detailed breakdown.
Market Rules: See the Basic Market Rules from "Market Rules Development Initial Variant", 3 February 2020, https://ssentransition.com/wp-content/uploads/2020/02/Market-Rules-Development-Phase-1-v1.0.pdf
Constraint Pricing
Constraint prices i.e. DSO WTP will be left blank. Flexible service providers will insert prices they are willing to sell their services for.
Location
Rose Hill and all 11kV downstream feeders and 33kV upstream feeders to Cowley BSP
Simulation Trials
Simulation 1: 11kV constraint pay as clear / Simulation 2: 11kV constraint pay as bid

Trial Use Case 2: DSO Peak Management (Generation Related)

Service Type: DSO Peak Management (Generation Related)
Service Description: DSO Thermal Constraint will be simulated on the Grid OS FMS e.g. Transformer over capacity. The constraint will have been pre-prepared and demonstrated to be observable via powerflow analysis prior to the simulation taking place.
Time Period
Time Period: Constraint will be simulated within the next 4 years (2020 - 2023)
Simulation Length: Simulation will be run over a one week period, using 'reference days' taken from a typical constrained year.
Players & Responsibilities
Players: DSO, Flexible Service participants within connected area. Flexible service participants outside connected area, Project MERLIN partners assuming flexible service roles where necessary. The Opus One model will be pre-populated with flexible service locations prior to the simulation beginning.
Responsibilities: DSO will advertise constraint on Grid OS FMS e.g. 1MWhr increase required between 13:00 and 13:30. Flexible service participants will respond with service availability and cost e.g. 0.2MWhr available @ £200 per MWhr

Market Operation & Rules
Operation: Offers accepted through pay as clear auction. Participants will get a second attempt to sell services during intra-day auction. Participants must be technically able to resolve constraint as Grid OS FMS utilise powerflow. Refer to report 2.08 Grid OS Flexibility Market Simulator for detailed breakdown.
Market Rules: See the Basic Market Rules from "Market Rules Development Initial Variant", 3 February 2020, https://ssentransition.com/wp-content/uploads/2020/02/Market-Rules-Development-Phase-1-v1.0.pdf
Constraint Pricing
Constraint prices i.e. DSO WTP will be left blank. Flexible service providers will insert prices they are willing to sell their services for.
Location
Rose Hill and all 11kV downstream feeders and 33kV upstream feeders to Cowley BSP
Simulation Trials
Simulation 1: 11kV constraint pay as clear / Simulation 2: 11kV constraint pay as bid

Trial Use Case 3: DSO Constraint Management

Service Type: DSO Constraint Management
Service Description: An unplanned outage constraint will be simulated on the Grid OS FMS e.g. Transformer outage. The constraint will have been pre-prepared and demonstrated to be observable via powerflow analysis prior to the simulation taking place.
Time Period
Time Period: Constraint will be simulated within the next 4 years (2020 - 2023)
Simulation Length: Simulation will be run over a one week period, using 'reference days' taken from a typical constrained year.
Players & Responsibilities
Players: DSO, Flexible Service participants within connected area. Flexible service participants outside connected area, Project MERLIN partners assuming flexible service roles where necessary. The Opus One model will be pre-populated with flexible service locations prior to the simulation beginning.
Responsibilities: DSO will advertise constraint on Grid OS FMS e.g. 1MWhr reduction required between 13:00 and 13:30. Flexible service participants will respond with service availability and cost e.g. 0.2MWhr available @ £200 per MWhr
Market Operation & Rules
Operation: Offers accepted through pay as clear auction. Participants will get a second attempt to sell services during intra-day auction. Participants must be technically able to resolve constraint as Grid OS FMS utilise powerflow. Refer to report 2.08 Grid OS Flexibility Market Simulator for detailed breakdown.
Market Rules: See the Basic Market Rules from "Market Rules Development Initial Variant", 3 February 2020, https://ssentransition.com/wp-content/uploads/2020/02/Market-Rules-Development-Phase-1-v1.0.pdf
Constraint Pricing
Constraint prices i.e. DSO WTP will be left blank. Flexible service providers will insert prices they are willing to sell their services for.
Location
Rose Hill and all 11kV downstream feeders and 33kV upstream feeders to Cowley BSP
Simulation Trials
Simulation 1: 11kV constraint pay as clear / Simulation 2: 11kV constraint pay as bid

Trial Use Case 4: Offsetting / Peer to Peer (P2P)

Service Type: Offsetting / Peer to Peer (P2P)
Service Description: A service where one Market Actor in a constrained area agrees to increase/decrease its generation/demand ahead of another Market Actor in the same constrained area increasing/decreasing its generation/demand by the same amount e.g. Tesco agrees to increase load while energy storage units discharge load by the same amount
Time Period
Time Period: P2P will be simulated within the next 4 years (2020 - 2023)
Simulation Length: Simulation will be run over a one week period, using 'reference days' taken from a typical constrained year.
Players & Responsibilities
Players: DSO, Flexible Service participants within connected area. Flexible service participants outside connected area, Project MERLIN partners assuming flexible service roles where necessary. The Opus One model will be pre-populated with flexible service locations prior to the simulation beginning.
Responsibilities: FSP will request P2P service using Grid OS FMS e.g. FSP A requests 1MWh increase in load required between 13:00 and 13:30. FSP B will respond with 1MWh increase in generation between 13:00 and 13:30
Market Operation & Rules
Operation: FSPs can input costs into the FMS. Visibility of load/generation requests and flows will be visible on the FMS tool. Participants must be technically able to resolve constraint as Grid OS FMS utilises powerflow. Refer to report 2.08 Grid OS Flexibility Market Simulator for detailed breakdown.
Market Rules: See the Basic Market Rules from "Market Rules Development Initial Variant", 3 February 2020, https://ssentransition.com/wp-content/uploads/2020/02/Market-Rules-Development-Phase-1-v1.0.pdf
Constraint Pricing
N/A for Offsetting / P2P
Location
Rose Hill and all 11kV downstream feeders and 33kV upstream feeders to Cowley BSP
Simulation Trials
N/A

Trial Use Case 5: Marginal Import Capacity (MIC) & Marginal Export Capacity (MEC) Trading

Service Type: MIC & MEC Trading
Service Description: A service where one Market Actor within a constrained area can increase the level of export or import at one of its meter point administration (MPANs) through purchasing excess Authorised Supply Capacity for a period of time from another Market Actor in the same constrained area
Time Period
Time Period: Simulated within the next 4 years (2020 - 2023)
Simulation Length: Simulation will be run over a one week period, using 'reference days' taken from a typical constrained year.
Players & Responsibilities
Players: DSO, flexible service participants within connected area, flexible service participants outside connected area, Project MERLIN partners assuming flexible service roles where necessary. The Opus One model will be pre-populated with flexible service locations prior to the simulation beginning.
FSP A will request a connected capacity change, FSP B will request a connected capacity change that balances FSP B's request. The FMS operator will update the network model for the locations the changes apply to.
Market Operation & Rules
Operation: FSPs can input costs into the FMS. Visibility of load/generation requests and flows will be visible on the FMS tool. Participants must be technically able to resolve constraint as Grid OS FMS utilises powerflow. Refer to report 2.08 Grid OS Flexibility Market Simulator for detailed breakdown.
Market Rules: See the Basic Market Rules from "Market Rules Development Initial Variant", 3 February 2020, https://ssentransition.com/wp-content/uploads/2020/02/Market-Rules-Development-Phase-1-v1.0.pdf
Constraint Pricing
Dependent on the FSP
Location
Rose Hill and all 11kV downstream feeders and 33kV upstream feeders to Cowley BSP
Simulation Trials
N/A

Day ahead and intra-day simulation trials

The MERLIN project will hold trials for day ahead and intra-day markets. The purpose of these trials is to understand how market participants will interact with the Opus One tool, which can be used to further develop it to UK customer needs. We also will be looking to understand when it will be most applicable to use such a tool i.e. when will the use of a tool lead to cost savings?

Trial 1 – Understanding long term contract costs

Trial participants e.g. Energy storage units, demand side response aggregators, will be requested to provide costs for providing a service related to the use case being trialled (section 1.3.2).

e.g. Increase in electric vehicle (EV) uptake has caused a constraint, which triggers the DSO to request a flexible service for peak management (load related) over a 4 year time horizon. A reduction in load of 1MWh is requested by the DSO to occur on 10 separate occasions over the 4 year period to help manage this constraint. A demand side response aggregator participating in the trial is willing to accept this service and bids £500 per MWh. The total cost of this long term contract is 10 x £500 = £5,000.

Understanding what flexible service participants are willing to accept for long term contracts can then be compared against what the DSO is willing to pay (see section 1.3.1, bullet point 4) and also against how the participant would bid on a day ahead and intra day market (see simulation trial 2 below).

Trial 2 – Simulating day ahead and intra-day markets

Trial participants will participate in day ahead and intra day markets using the Opus One Grid OS TE tool. The purpose of this trial is to understand how introducing competition into the market influences the bidding prices of flexible services. These prices can the be compared to the DNO's willingness to pay price (WTP) for long term contracts and the flexible services willingness to accept (WTA) prices for long term contracts.

Report 2.08 Flexibility Market Simulator details how the simulations will run on the Grid OS TE tool in detail.

Day 1	Day 2	Day 3	Day 4	Day 5
Introduction on how to use the Grid OS intra-day and day-ahead tool. Practice run on how to use the tool. Real simulation bidding begins. Two hour workshop required.	Bids and offers continue by participants. Email or phone support assistance provided if required. Bid winners announced at the end of each day. No meetings required.	Bids and offers continue by participants. Email or phone support assistance provided if required. Bid winners announced at the end of each day. No meetings required.	Bids and offers continue by participants. Email or phone support assistance provided if required. Bid winners announced at the end of each day. No meetings required.	Closedown session to provide and obtain participants feedback on simulation. One hour workshop required.

The day-ahead and intra-day market simulation event will occur over a 5 day period as detailed in the table below.

Key Assumptions:

- Representative days will be used to simulate the various use cases as offers made by the DSO e.g. on Day 1 there will be DSO offers for all peak management use cases (Generation, load, voltage). These offers will be representative of constraints that have been simulated previously as per 1.3.1 pre-requisites of trial (point 2).
- For the DSO constraint management use case, which involves simulating an unplanned fault, we will simulate the fault at a random time through use of a load forecast that would cause a fault. Participants must either have a standing offer to bid for this fault i.e. be available at multiple times during the day or must be paying close attention to updates as to when this offer becomes available.
- Offsetting/P2P and authorised supply capacity services can occur at any time. These services occur between participants. The DSO will not be involved, it will only facilitate through the use of the TE tool.

Step 1 – Market setup: The DSO will advertise service requests for all constraints based on the use cases being trialled e.g. DSO will request a demand reduction of 1MW between 17:00 and 18:00. The Grid OS TE tool will be updated so the service requests become visible and biddable to trial participants.

Step 2 – Flexibility resource bid and submission: Flexible service participants will be able to input bids for constraint services being advertised on the Grid OS TE tool. Alternatively, they can make themselves available during certain times of day they know they can supply their service for e.g. an energy storage provider can either choose to provide 1MW of generation when the DSO advertises a need for this service or they can populate the Grid OS TE tool with their known availability, such as 1MW of generation between 17:00 and 18:00 every day at a price of £100 MWhr. Authorised capacity trading and P2P can take place at any time. It is up to the participants to agree on timing and use the Grid OS TE tool to facilitate the transaction.

Step 3 – Initiate simulation: Once the bidding window has ended i.e. All bids and offers submitted within the allocated time window, the Grid OS TE tool will determine which bids have been successful against the advertised offers.

Step 4 – View simulation results: Visibility of the successful bids will be made visible to the DSO. This allows the DSO to see what prices have been submitted for the various use case services.

Step 5 – Review simulation results: Results can be displayed in a variety of formats e.g. tables, graphs, etc. and can be shared with participants. This step can be used to de-brief participants, share learnings of the trial outcomes and take suggestions on how to improve the tool / process.

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