



University of
Strathclyde
Engineering

Transforming Electricity Balancing: Bulk Dispatch Optimisation

From proof-of-concept to implementation

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nationalgrid**ESO**

EPSRC

Engineering and Physical Sciences
Research Council

Bulk Dispatch Optimisation

- Operate with increasing challenging system conditions
- Increasing number of balancing units
- Meeting zero carbon operation ambition by 2025 and decarbonised power system by 2035



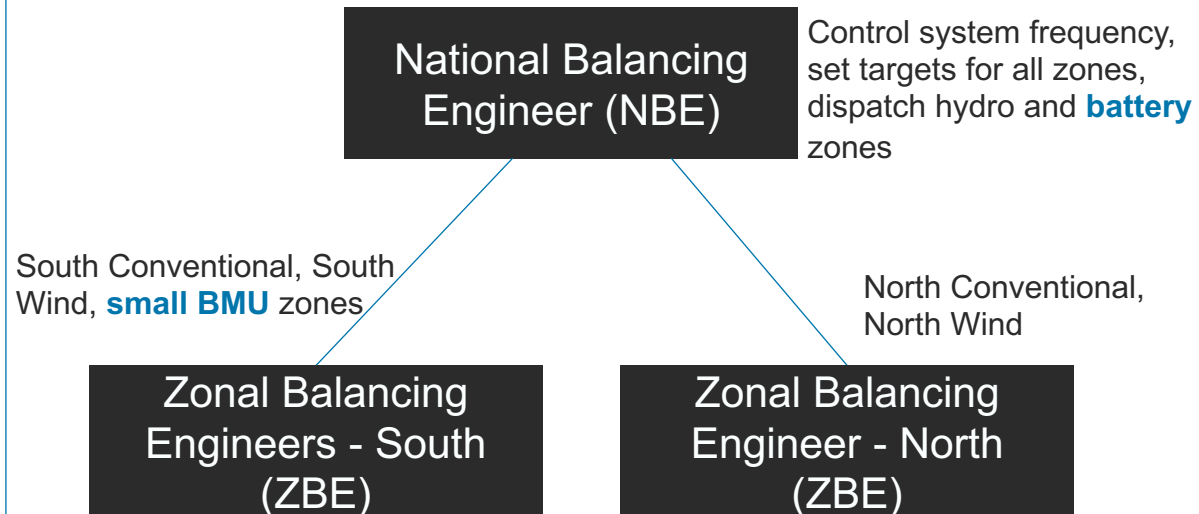
National Grid ESO

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National Grid ESO



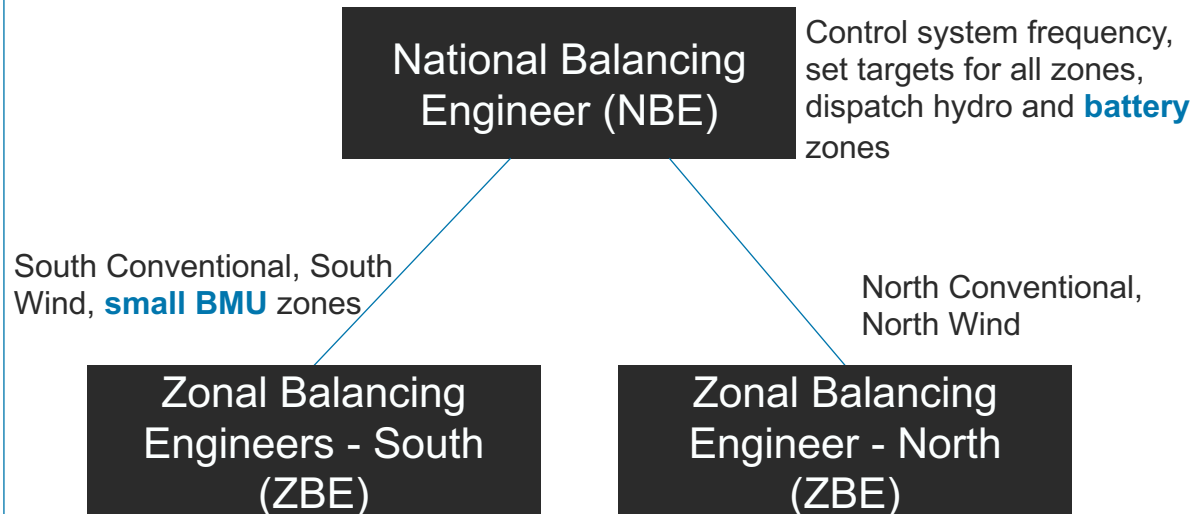
Bulk Dispatch Optimisation

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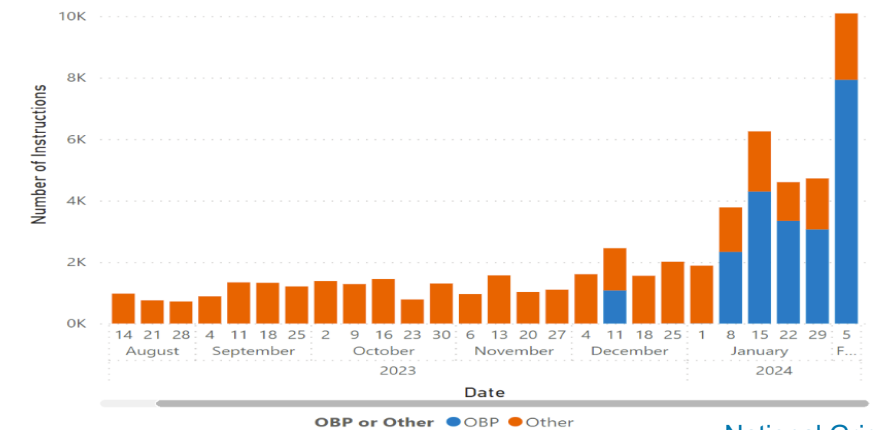


National Grid ESO

- PoC developed Apr - Sep 2021
- Go-live on the 12th Dec 2023
- Over 20k instructions to Batteries and small BMUs
- 11 cases with problems



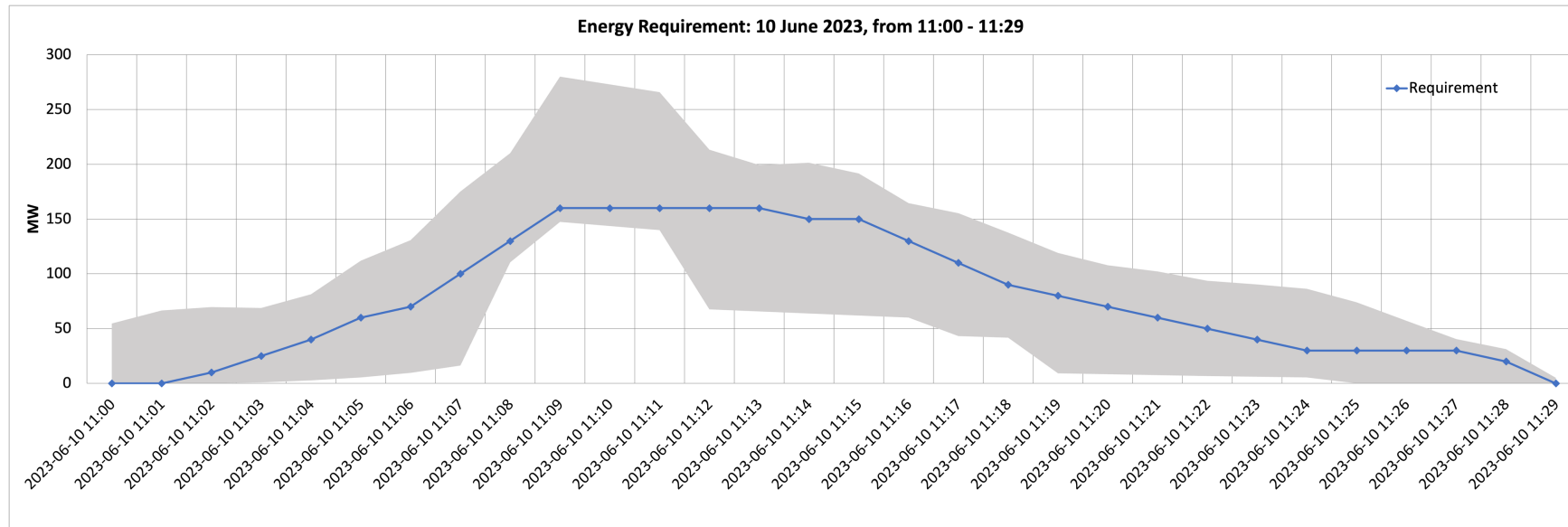
Weekly Total Number of Bid/Offer Acceptances Batteries



National Grid ESO

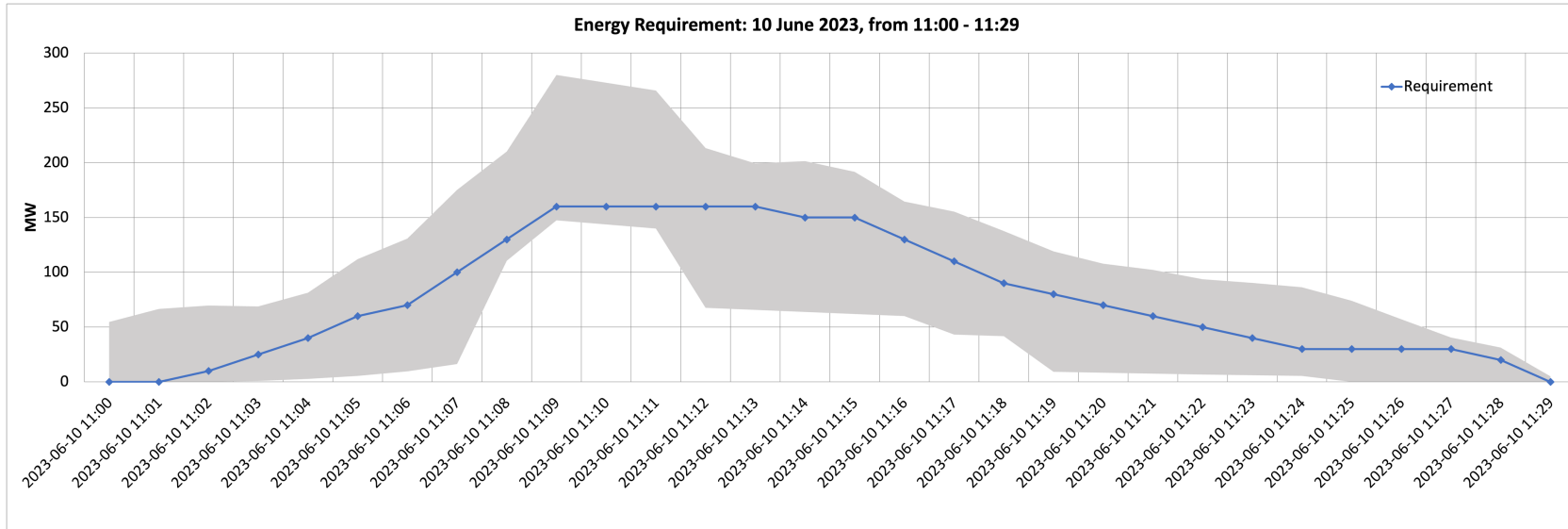
Bulk Dispatch Optimisation

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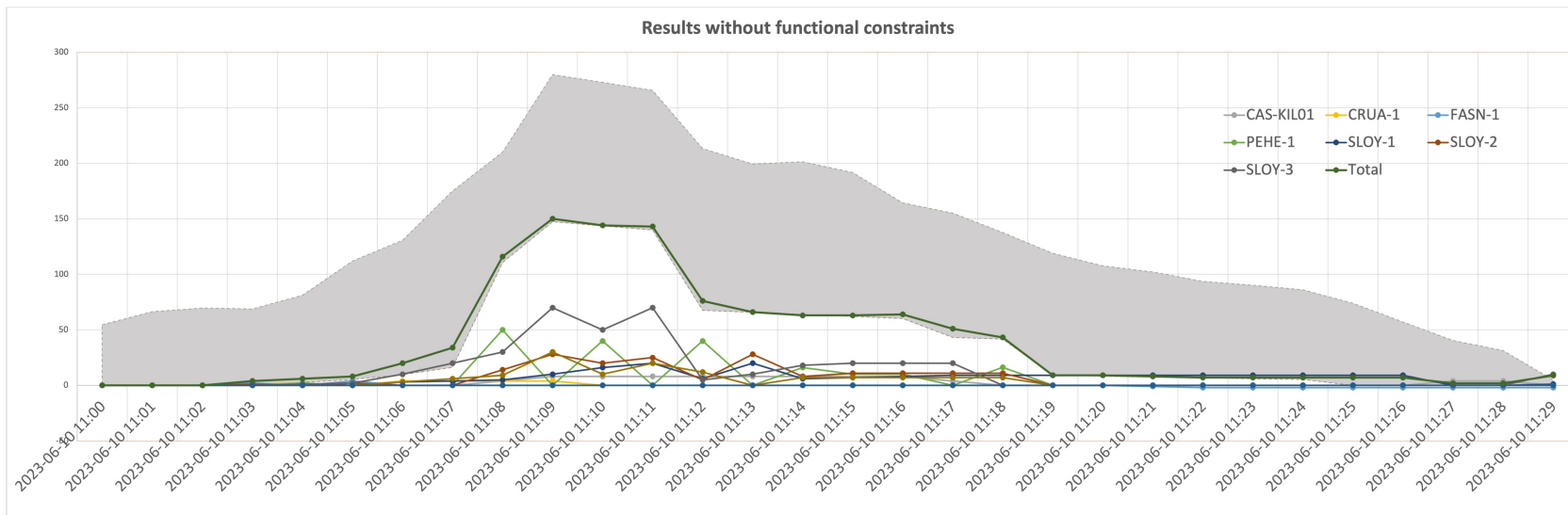
Determine economical redispatch for a *given* energy requirement

Bulk Dispatch Optimisation



Determine economical dispatch for a given energy requirement

Are existing decision support tools fit for purpose?



Current models lack actionable decision support due to limitations in modelling of ramps, price-curves, and temporal constraints

Bulk Dispatch Optimisation

A PoC built on the University of Strathclyde's power system analysis tool OATS

Functional Requirements	Status
1 Headroom/Footoom	Done
2 Ramp rates (single elbow)	Not started
3 MW Requirement	In progress
4 Min cost optimisation	Done
5 PWL price curves	Not started
6 Notice to offer (NTO)	Not started
7 Notice to bid (NTB)	Not started
8 Min zero time (MZT)	Not started
9 Ramp rate with elbows	Not started

Functional Requirements	Status
1 HeadRoom/FootRoom	Done
2 Ramp rates (single elbow)	Done
3 Lower/Upper bounds on Requirement	Done
4 Min cost optimisation	Done
5 PWL price curves	Done
6 Notice to offer (NTO)	Done
7 Notice to bid (NTB)	Done
8 Min zero time (MZT)	Done
9 Min non-zero time (MNZT)	In progress
10 Response Time	In progress
11 Notice to deviate from zero (NDZ)	In progress
12 Flat top time	Done
13 Max delivery period	Not started
14 Max delivery volume-offer	Not started
15 Max delivery volume-bids	Not started
16 Time-varying prices	Done

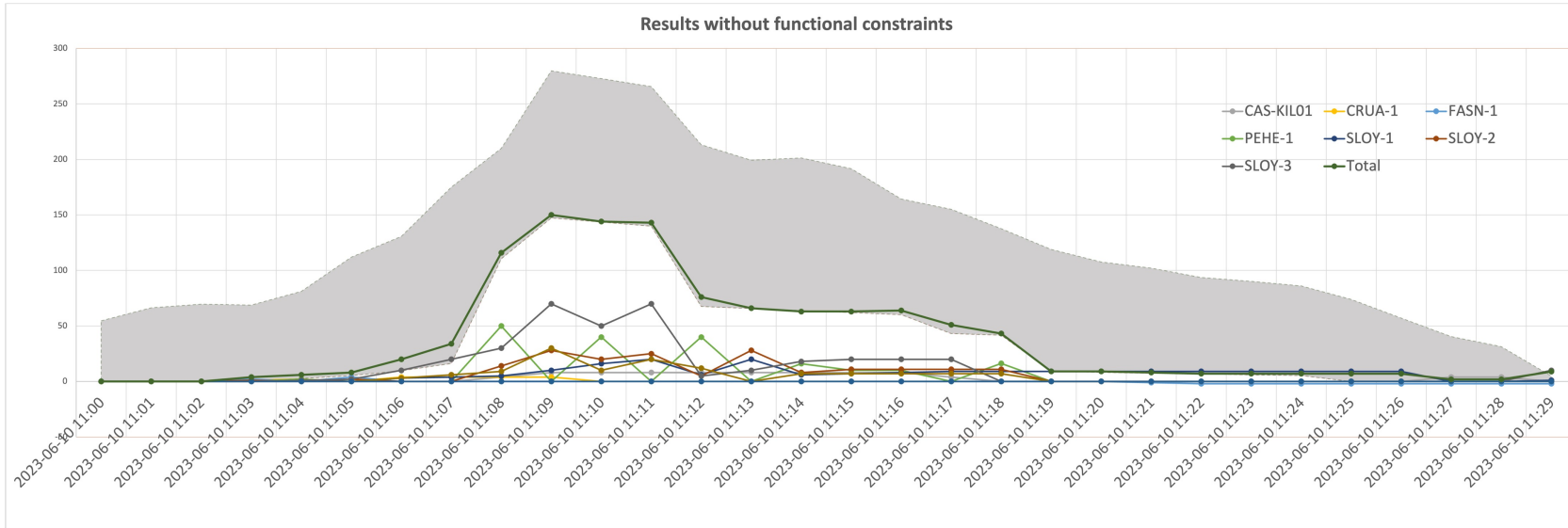
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10 Response Time	Done
11 Notice to deviate from zero (NDZ)	Done
12 Flat top time	Done
13 Max delivery period	Done
14 Max delivery volume-offer	Done
15 Max delivery volume-bids	Done
16 All or nothing	Done
17 Close Instructions	Done
18 Time-varying prices	Done
19 Ramp rate with elbows	Done
20 Max contracted hrs	Done
21 Max utilisation time	Done
22 Max occurrences	Done

Enhancements
Production
QAE
Go-live on 12 Dec 2023

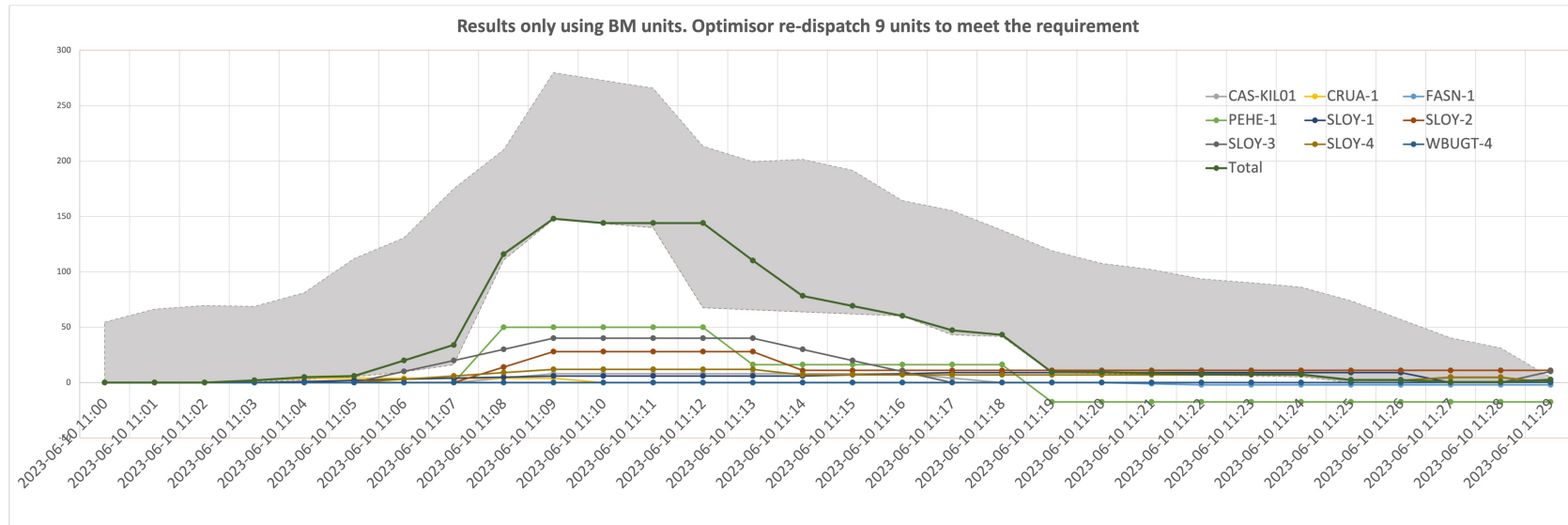


- Several *world's first* functional constraints within an optimisation model
- The resulting problem is a large-scale MILP
- The PoC was further developed within NGESO's balancing programme

Bulk Dispatch Optimisation

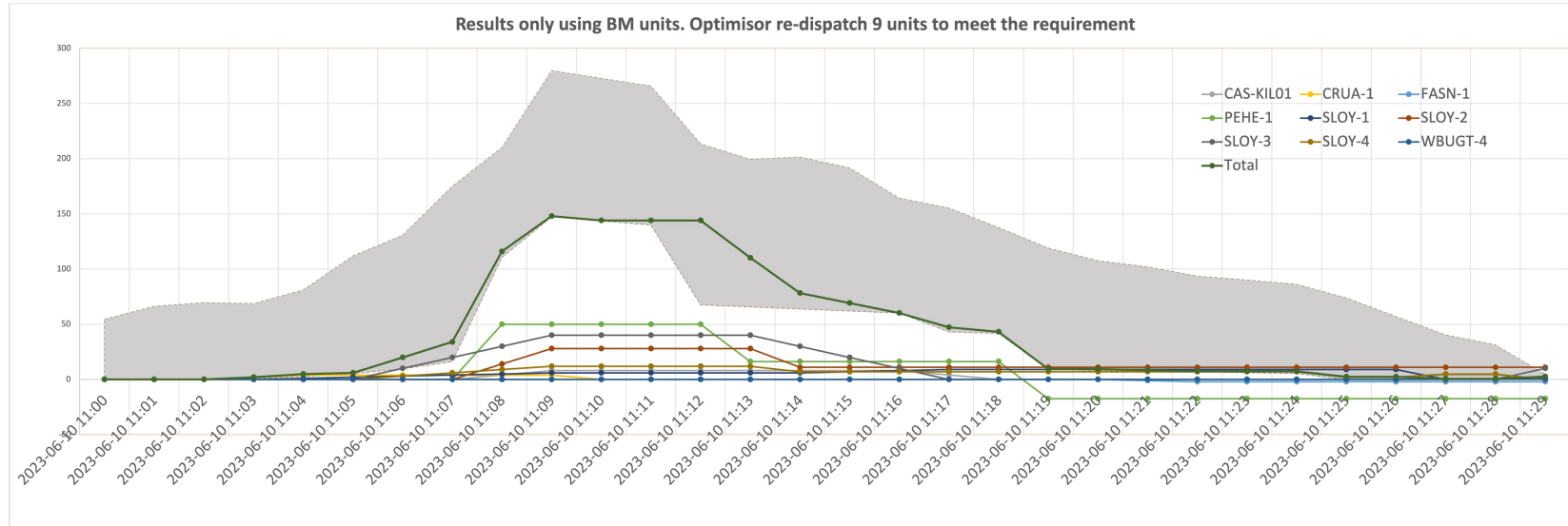


Modelling of functional constraints provides actionable decision support

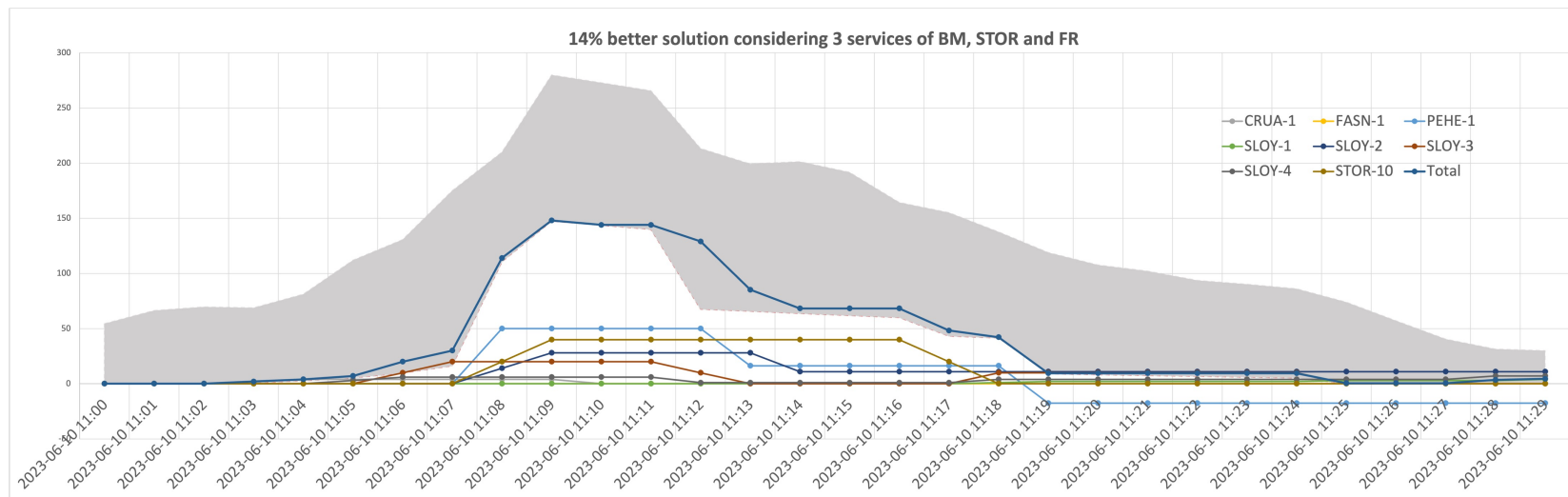


Bulk Dispatch Optimisation

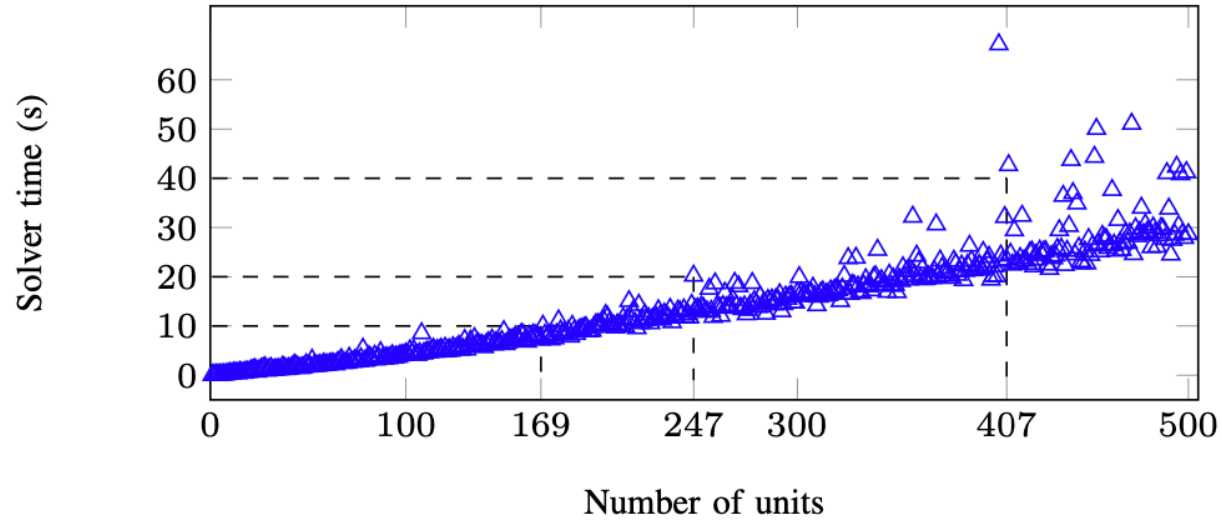
Ability to handle multiple services



The optimisation by design is agnostic to service type



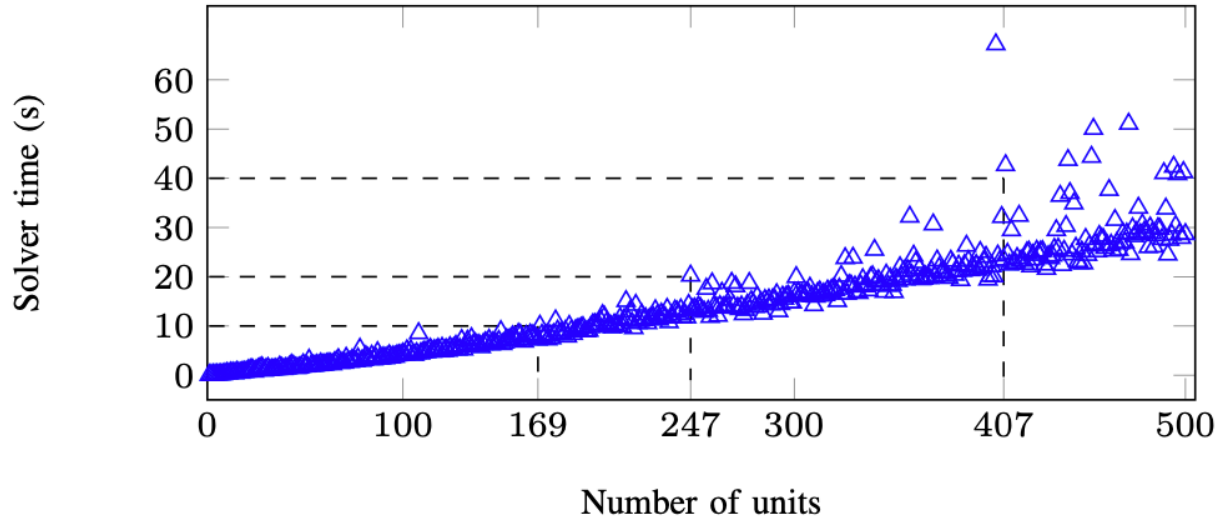
Computational performance



PoC model written in Pyomo solved with Gurobi

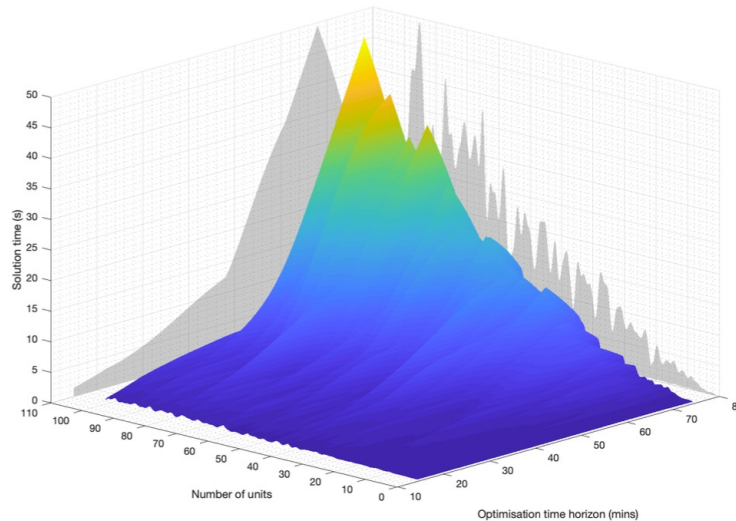
- Significant improvement between gurobi v9.1.2 vs v9.5.0
- 15% better run times on NGESO compute server
- The production version is written in Native Gurobi AML

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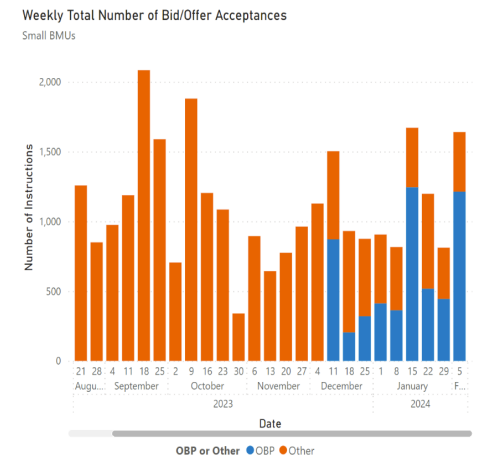
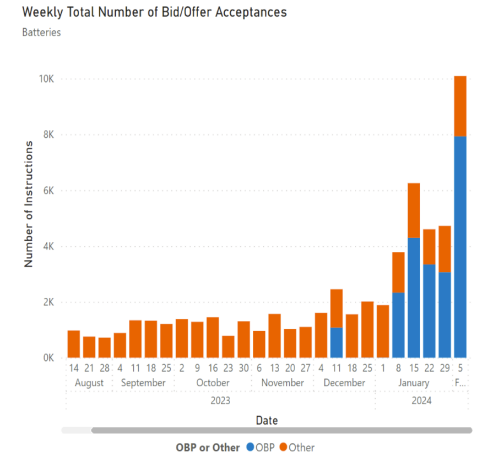


Average rate of change

- Number of units: 0.21 seconds/unit
- Time horizon: 0.47 seconds/minute

Enhanced Dispatch Efficiency

- ‘Bulk dispatch’ capability brings a functionality to the control room to dispatch balancing units economically, reducing *skip rates*
- The capability means the control room engineers spend much less time in creating instructions, and instead focus on monitoring
- The use of bulk dispatch capability is expected to increase as the confidence of ENCC grows
- Removal to the 15-minute rule and the Grid Code modification to include SoC expected to have a significant impact on BESS utilization





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