Enabling the DSO transition: tools and systems

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LEO Local Energy Oxfordshire

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The need for flexibility

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The need for flexibility

- SSEN needs to ensure the physical network is capable of **safely and reliably serve customer needs at present and in the future (i.e., future network capacity constraints need to be addressed today)**
- 2 ways to make this possible:
  - Long-term network **reinforcement** (i.e., replace transformer/cable for a larger one)
  - **Flexibility** (i.e., ask customers to change their behaviour in real-time)
- Can we just **reinforce** our way out of this?
  - No, this is too costly **£££** and risky (we don't know **how much** and **where** demand might materialise in a few years)
- Can we use **flexibility** then?
  - Yes, the ultimate goal of flexibility is to resolve constraints (same as reinforcement) but cheaper, closer to real-time and by engaging local customers (i.e., shift demand/generation to a different time)
  - Can we **contract flexibility at random** without a PSA model?
  - No, the same way we cannot reinforce the network at random (long-term studies are done to assess reinforcement).
    We need to know whether there is an actual **need, how much to contract (kW and duration) and when (e.g., next week, tomorrow).**

Tools and Systems: High Level Design

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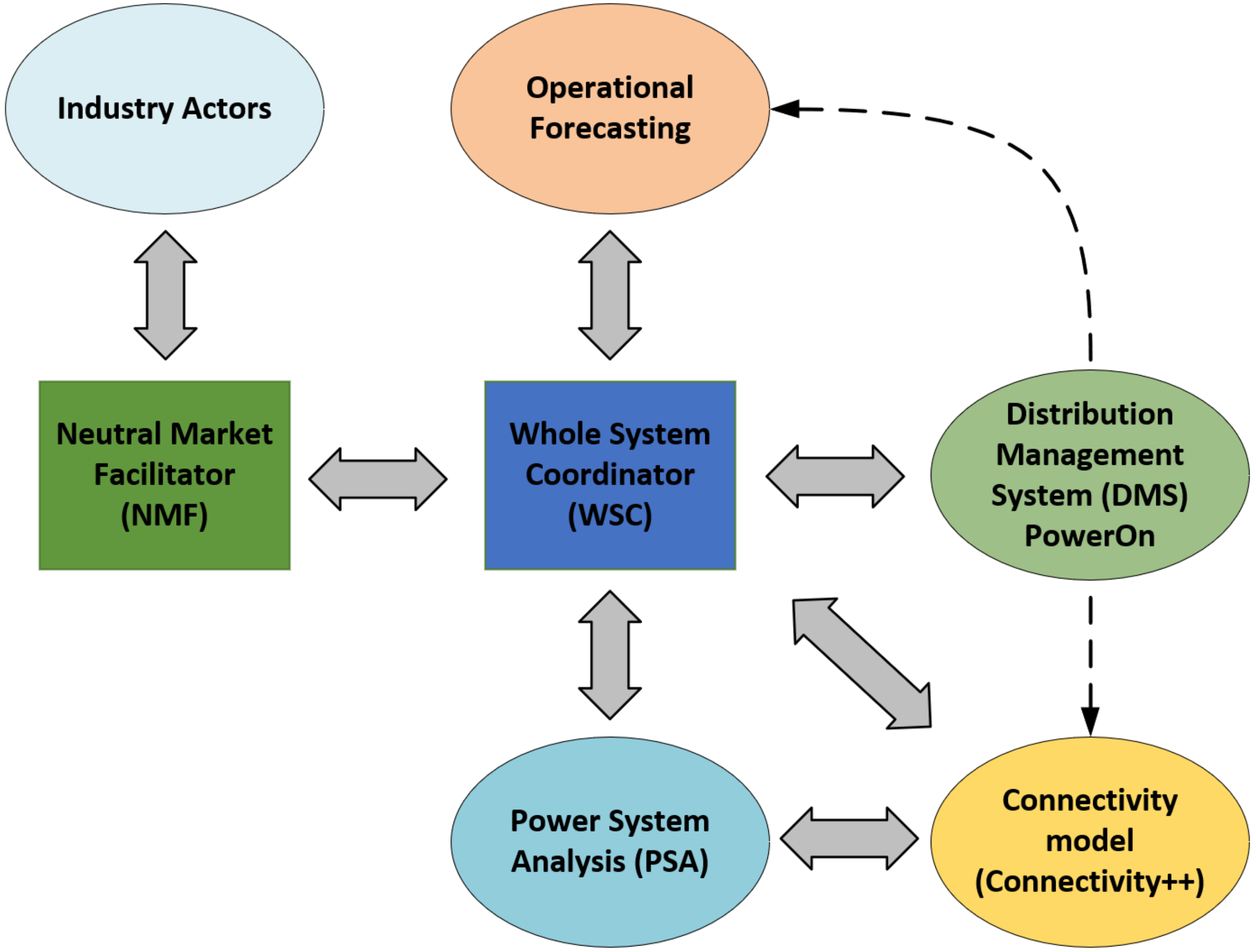
High Level Design (HLD)



Functions/Platforms Summary:

- **Operational Forecasting:** provides a view of **demand/generation** profiles at granular nodal level for 0-10 days ahead of real-time
- **Distribution Management System (PowerOn):** Provides control room view of **live/real-time network connectivity** and power flows
- **Power System Analysis (PSA):** Computes anticipated **power flows** under different near-term topology change and forecast scenarios
- **Whole System Coordinator (WSC):** Provides the core intelligence for **flex market decision making**, allows an input interface for control room, and manages automated data flows between sub-component DSO systems
- **Neutral Market Facilitator (NMF):** Provides a user interface **portal for DSO interaction with the Industry Actors** to enter/accept their available flex service volumes/costs, and for them to request approval for peer-to-peer (P2P) capacity trades
- **Connectivity model (Connectivity++):** The **master model that holds the network** and how customers relate to it and master repository for key **network parameters** (e.g., impedance, ratings and normal running arrangement).

PSA use cases in TRANSITION

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PSA network model use case in TRANSITION/LEO

- The Flexibility Markets and Services that we are trialling in project LEO/TRANSITION are all related to the underlying electricity network, and our DNO requirements to **serve customer present and future needs**

- This requires the **development of accurate network models** and tools to support **decision making**
  - Based on our model of the network: **Do we have constraints?** If so, **do we need flexibility?**
    - If so, **where** is it needed in the network (BSP/Primary), **how much** and **for what time period?**
    - Where are the **flexibility assets** connected in the network (HV/LV)?

- The network model and PSA tool are used at several stages during the flexibility trials, **with different functionalities required from the PSA tool depending on the timeframe and output required:**
  - Peer-to-Peer (P2P) MEC capacity trade approval
  - DSO flexibility requirements (needs analysis) and contracting
  - DSO flexibility dispatch

PSA Network Model Development

Key Attributes:

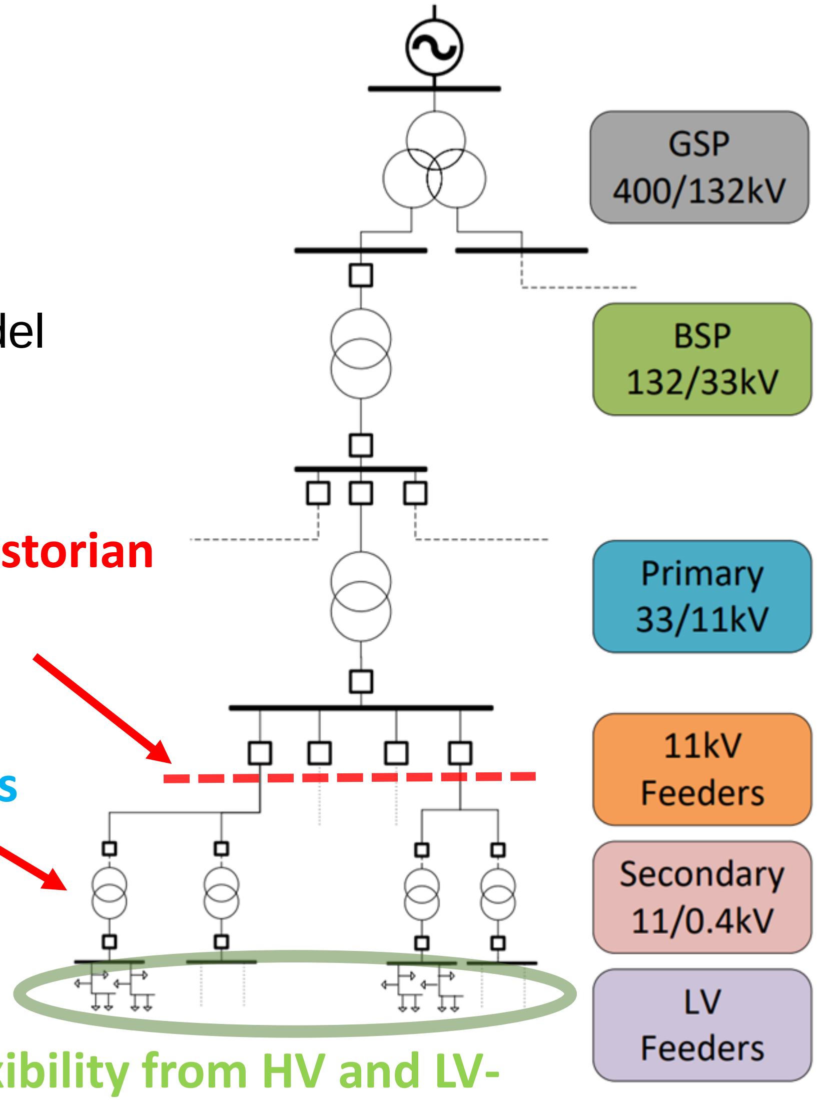
- Developing combined **EHV / HV / LV Models**
- Using DIgSILENT PowerFactory
- Using **Common Information Model (CIM) interoperability** for model transfer between platforms and PSA software

TRANSITION area of interest

- **2** GSPs
  ⇩
- **6** BSPs
  ⇩
- **13** Primaries
  ⇩
- **125** HV Feeders
  ⇩
- ~**1,700** Secondary substations

SCADA/PI historian stops here

~ 100 LV substations have LV monitors



Procuring flexibility from HV and LV-connected customers

PSA workflow in TRANSITION/LEO

The **PSA is within the WSC** and it performs **power flow** and **optimal power flow (OPF)** calculations based on a set of **inputs**. After the calculations it then provides a set of **outputs** and a **flag (converged)**.

- ❑ **Inputs:**
  - ❑ Network model (lines/cables, transformers, customers, generators, **flex assets**)
  - ❑ Forecasts of demand and generation at each point (**downscaled** where not available e.g. LV network)
  - ❑ Ratings for cables/lines and transformers (to judge whether a component is **overloaded or not**)
- ❑ **Flag:**
  - ❑ Converged? (true/false)
- ❑ **Outputs:**
  - ❑ Iterations needed to converge (XX iterations)
  - ❑ What is the **power flowing** in each of the components (e.g., 100kW flowing through transformer XX)?
  - ❑ Does this result in **overloading** of components? (e.g., transformer XX is rated at 90kVA, so 111%)
  - ❑ Does this result in **voltage issues**? (e.g., overload results in voltage drop at transformer terminal)
  - ❑ Where do we need to **dispatch flexibility assets** to resolve overloading or voltage issues?

TRANSITION workflow

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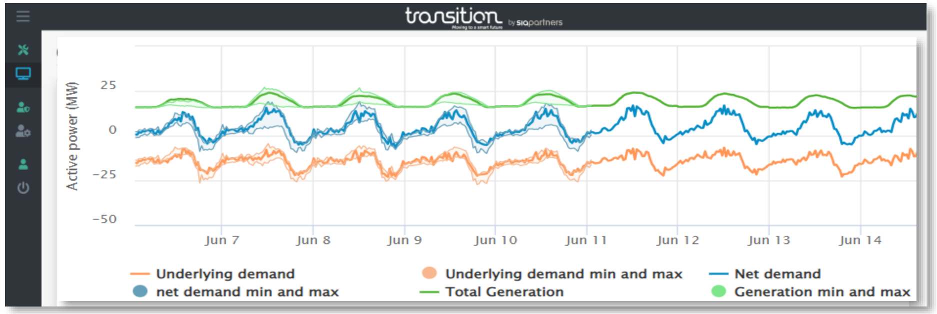
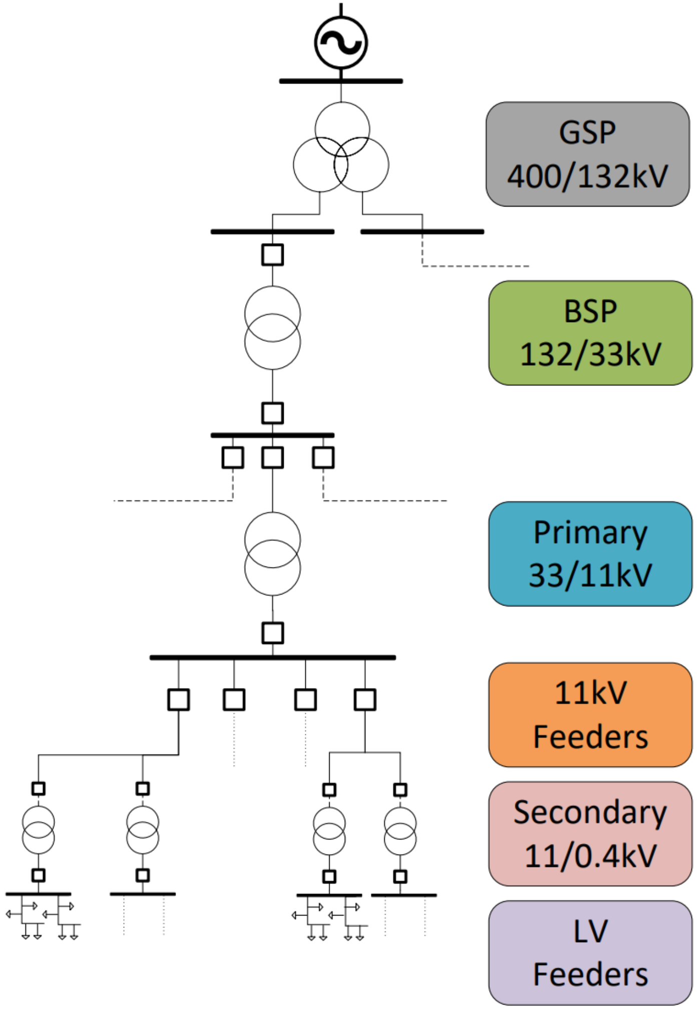
Operational Forecast

Demand and generation forecasts



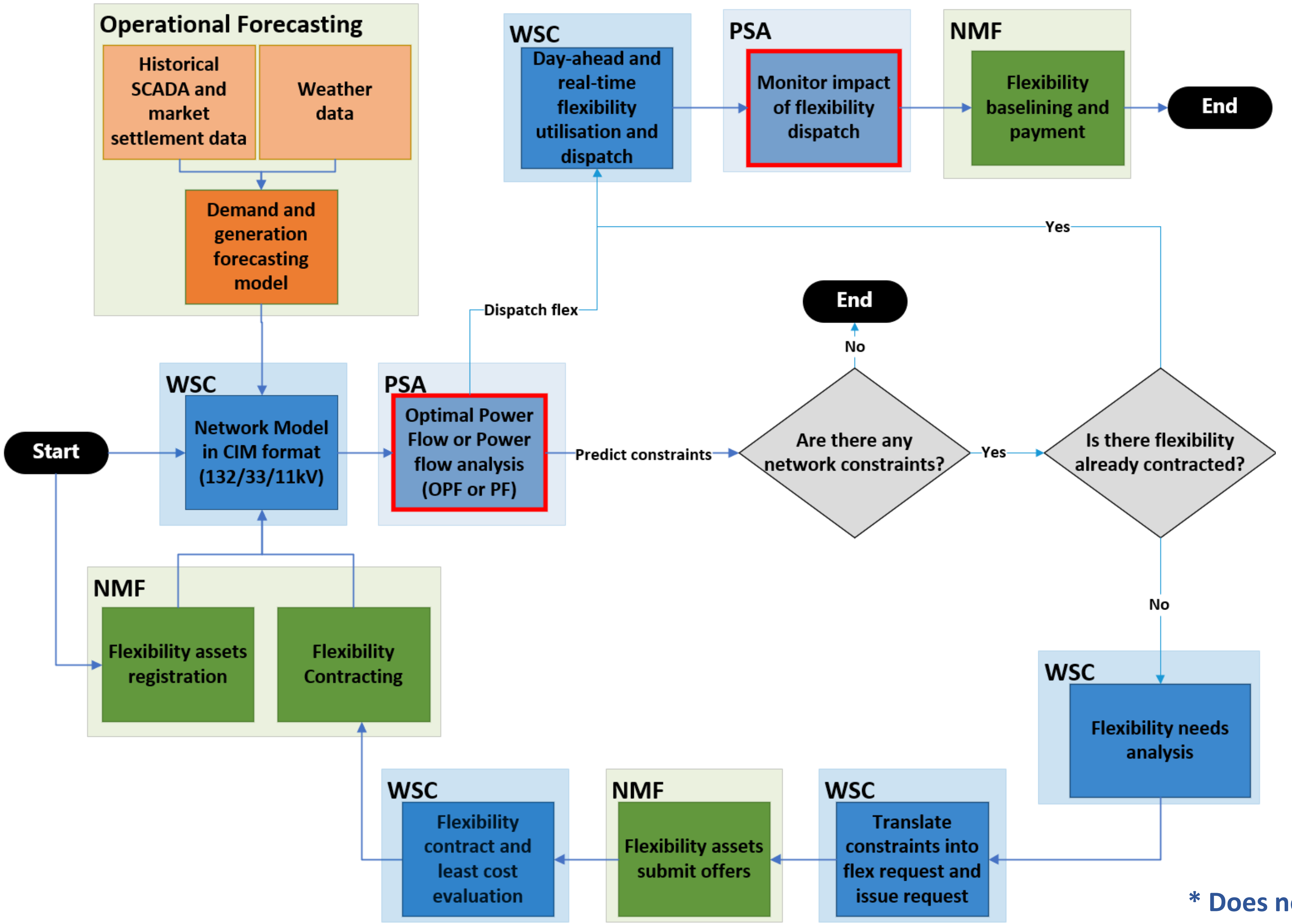
PSA network model



Flexibility market WSC/NMF

Network capacity and constraints:

- ***P2P capacity trade approval***
- ***DSO flexibility requirements and contracting***
- ***DSO flexibility dispatch***



* Does not include P2P processes

How to make research have industrial impact?

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How to make research have industrial impact?

- Look at the **practical challenges** faced by industry before proposing a solution, for example:
  - Number of nodes grows quite rapidly as we move from EHV to LV
  - LV monitoring is **not widely available** at the moment,
  - Network connectivity for LV is **not always available**,
  - **Network is changing constantly** and assets are connected/disconnected/upgraded
  - Normal running arrangement might change due to **maintenance/outages**
  - **GDPR** and data sensitivity (e.g. smart meter data needs to be aggregated or anonymised)
- Whilst developing a solution **get constant feedback from the end users**
- Review existing academic literature as well as "commercial/industry" literature (i.e., project reports, technical documents and standards e.g. EREC/EREP)
- Engage with industry via projects, most of the time projects can benefit from having extra support and partners are keen to collaborate (see Energy Networks Innovation Strategy 2022)

Thank you for your attention

For more information on TRANSITION & LEO:

https://ssen-transition.com/

https://project-leo.co.uk/

https://www.poweringnetzero.co.uk/

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Appendix

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TRANSITION workflow illustrative example

Example of flexibility requirement and workflow

Sum of all feeders for Rose Hill Primary

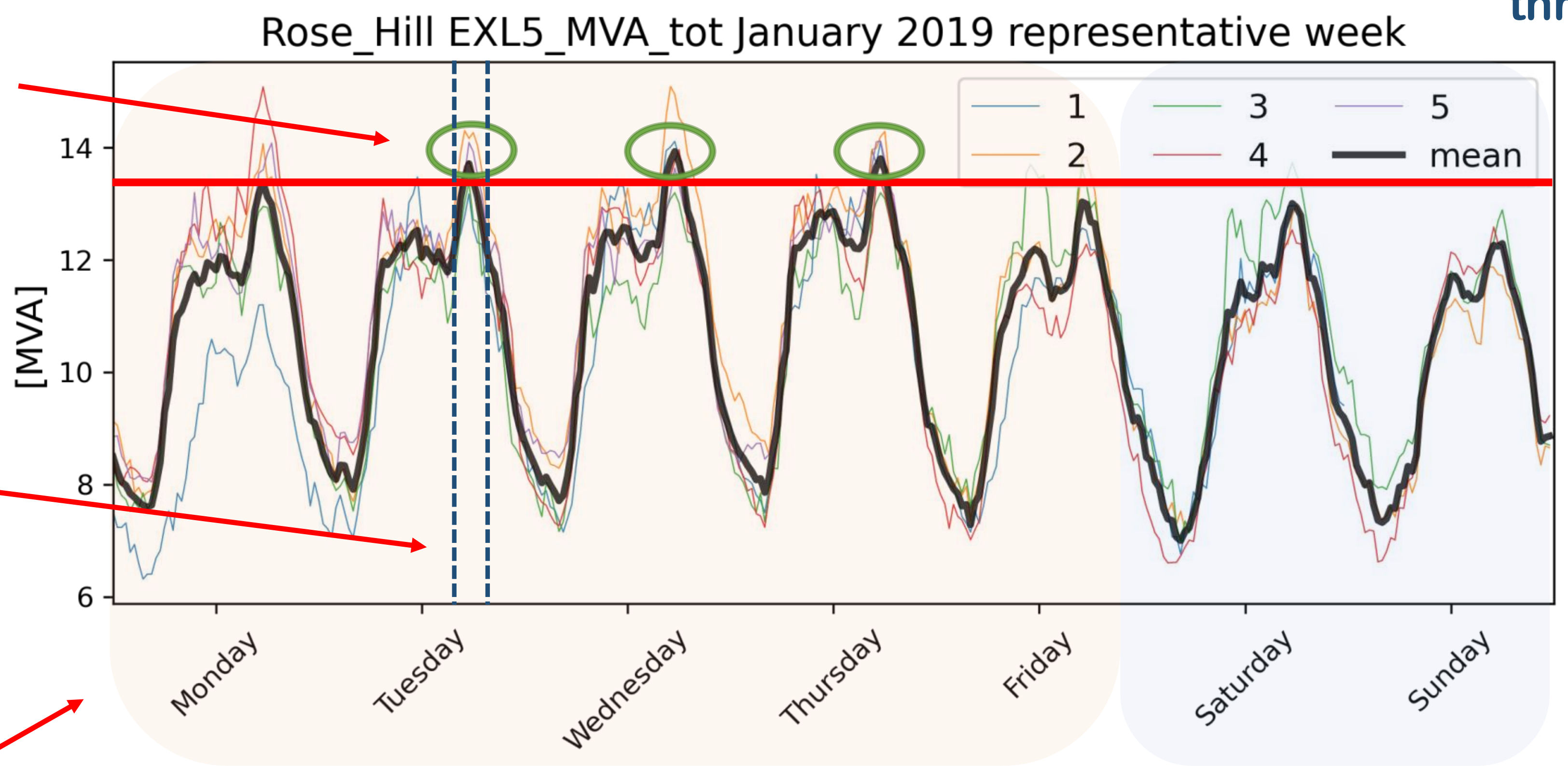
Flexibility requirement

Service window

Weekdays

Example of loading threshold for Rose Hill

Weekends



Example of flexibility requirement and workflow

- ❑ We forecast a need for 500kW of flexibility (500kW demand turn down or generation turn up) downstream of Rose Hill Primary for the week ahead
- ❑ The flexibility response is needed on Tuesday, Wednesday and Thursday and it needs to last for 2 hours (time window: 17-19hrs)
- ❑ We publish this requirement in the commercial front end (NMF)
- ❑ We receive offers from several participants (each of them have an availability and utilisation price
- ❑ We select those with the least cost (i.e., availability + utilisation) through an OPF (WSC) or manual calculation of Total Contract Value
    - ❑ The OPF uses the network model to validate the offers resolve the constraints
- ❑ We assess state of the network closer to the time of the forecasted constraint
- ❑ Flex assets with contracts are dispatched closer to real-time