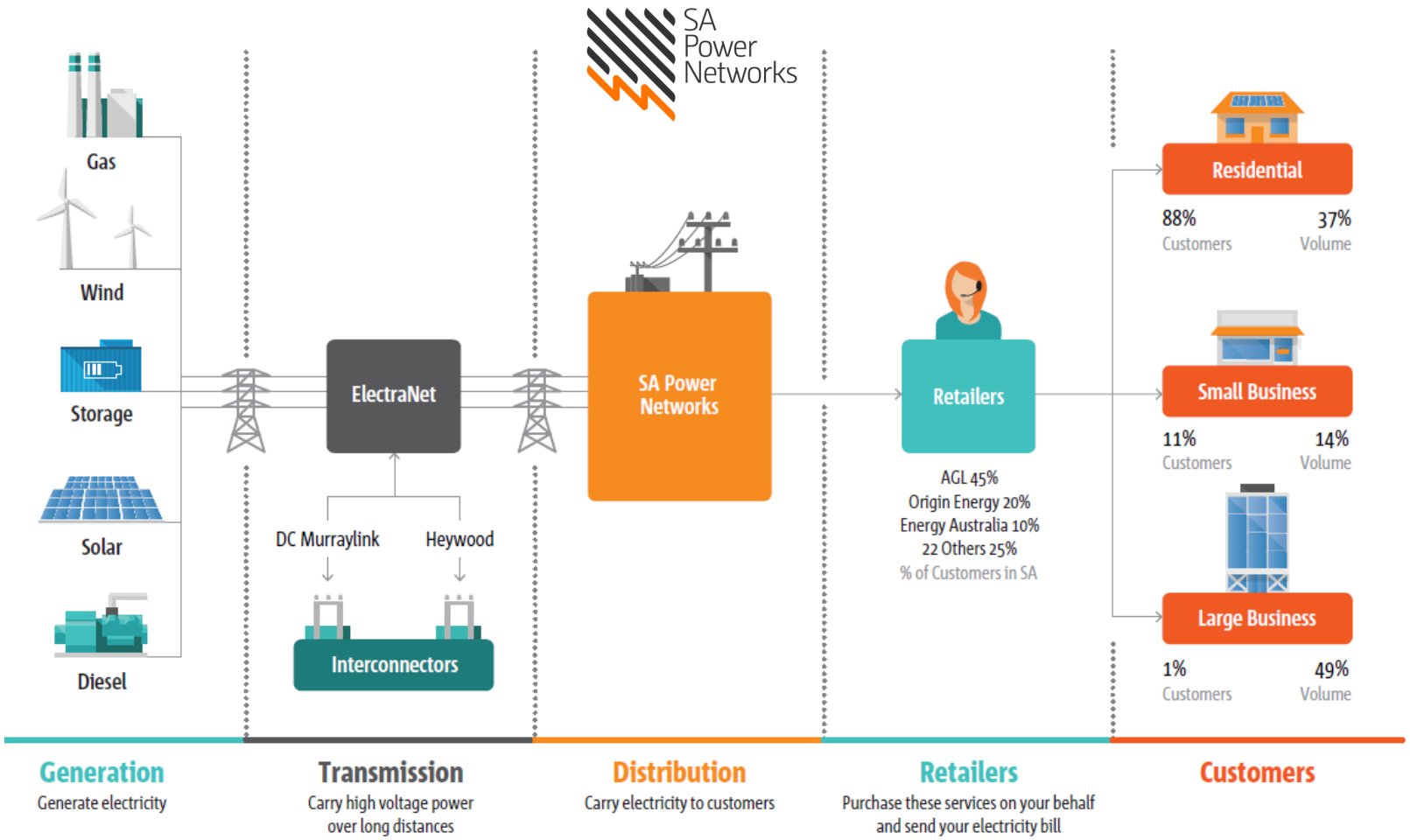
SA Power Networks

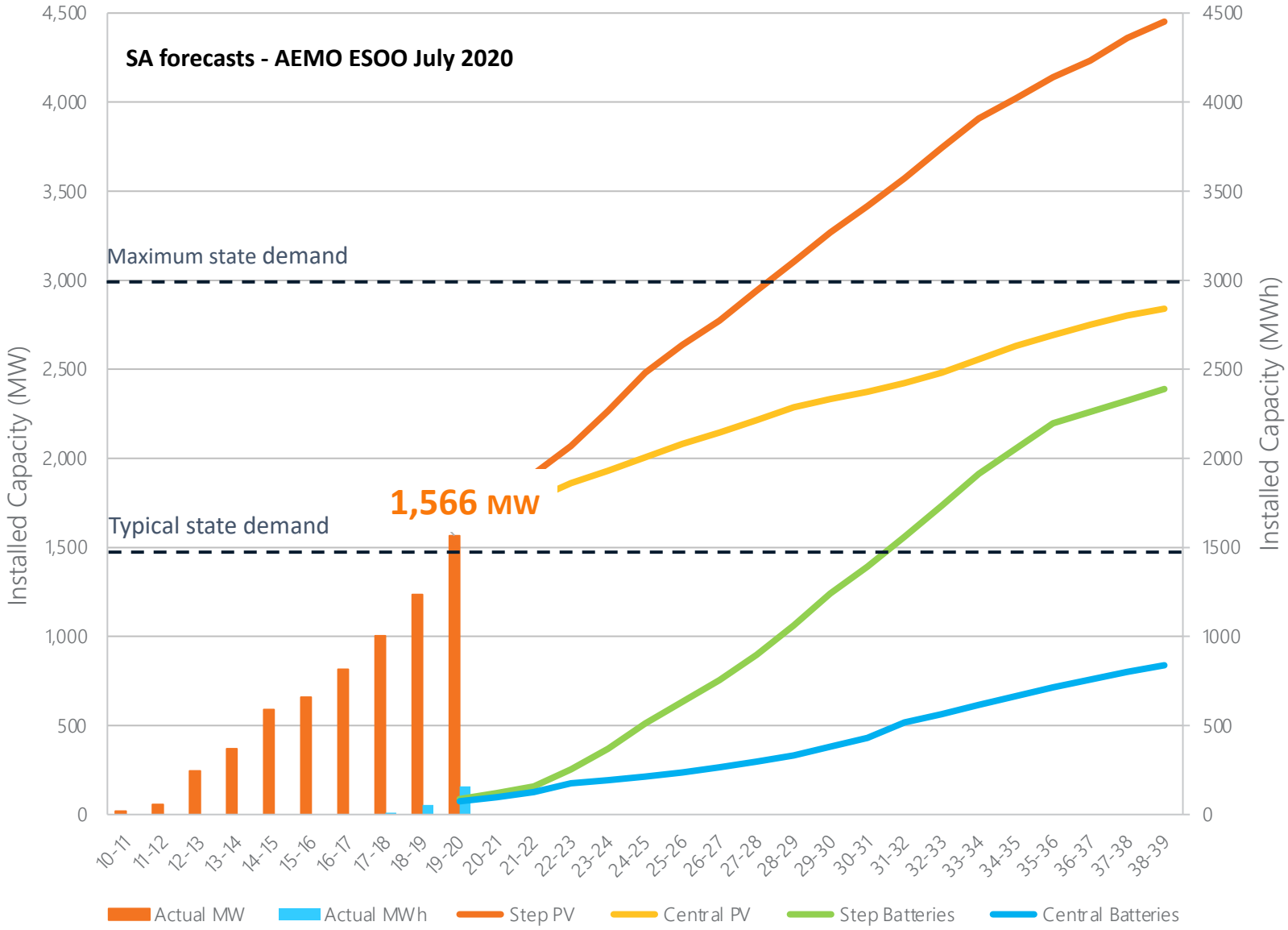
Advanced VPP Grid Integration Project

Presentation to DER Demonstrations Insights Forum, 3 August 2021

SA Power Networks



South Australia is leading the nation in the transition to distributed energy



280,000 systems
1 in 3 customers
State's largest generator
Record growth in 2020

20,000 home batteries (100MW)
6,600 enrolled in VPPs (33MW)

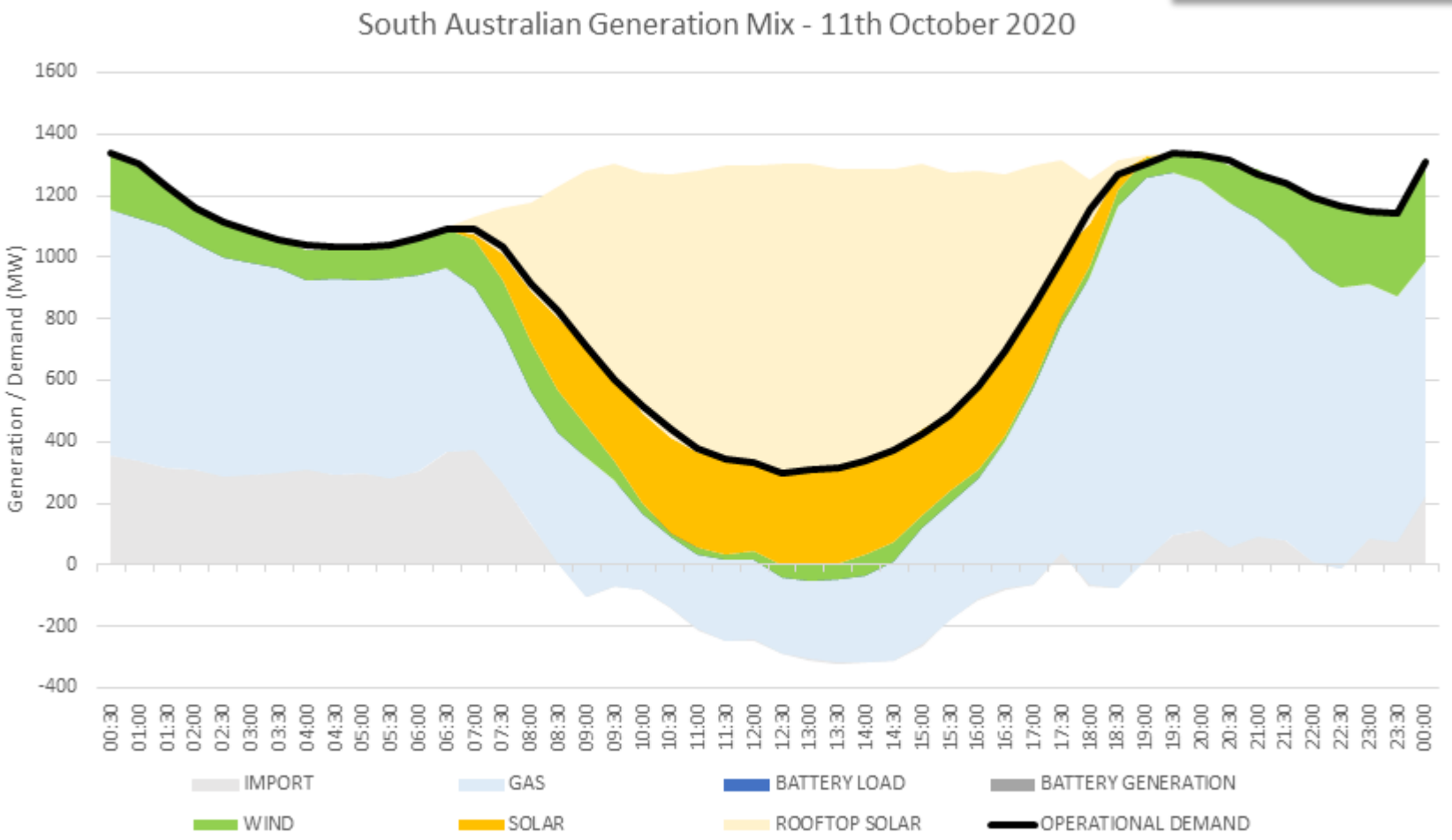
9 active VPPs

The world's first 100% solar state

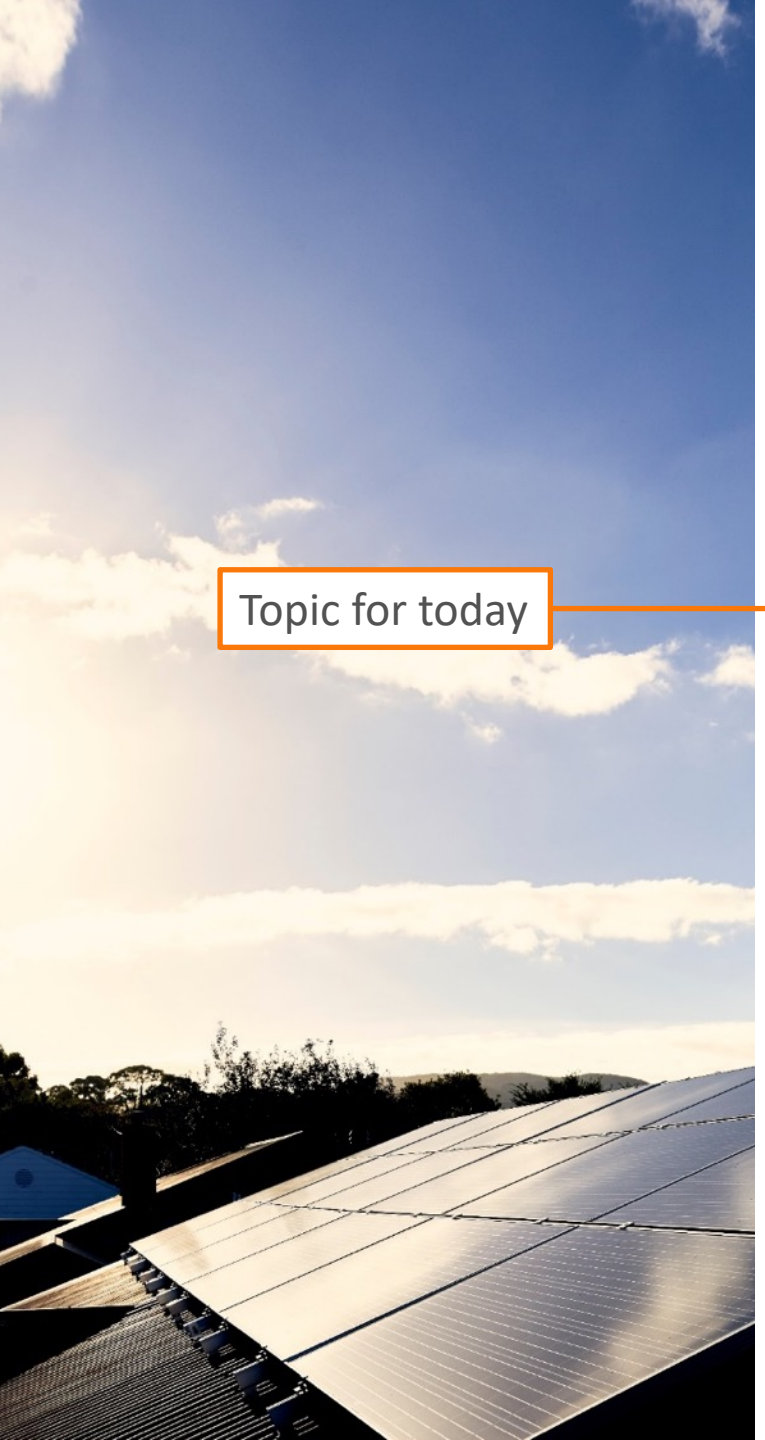
All of South Australia's power comes from solar panels in world first for major jurisdiction

By Richard Davies

Posted Sun 25 Oct 2020 at 9:05am



- Operational demand **300MW** (previous record 458MW)
- **SA 100% solar powered** for the first time
- Distribution network import reached **21MW**
- Net residential and business loads were **negative**
- **>50%** of substations in reverse flow
- **No** gigawatt scale power system in the world has been operated at this level



Our role in the energy transition

- Provide enough **network capacity** to meet customer needs
  …and do this efficiently

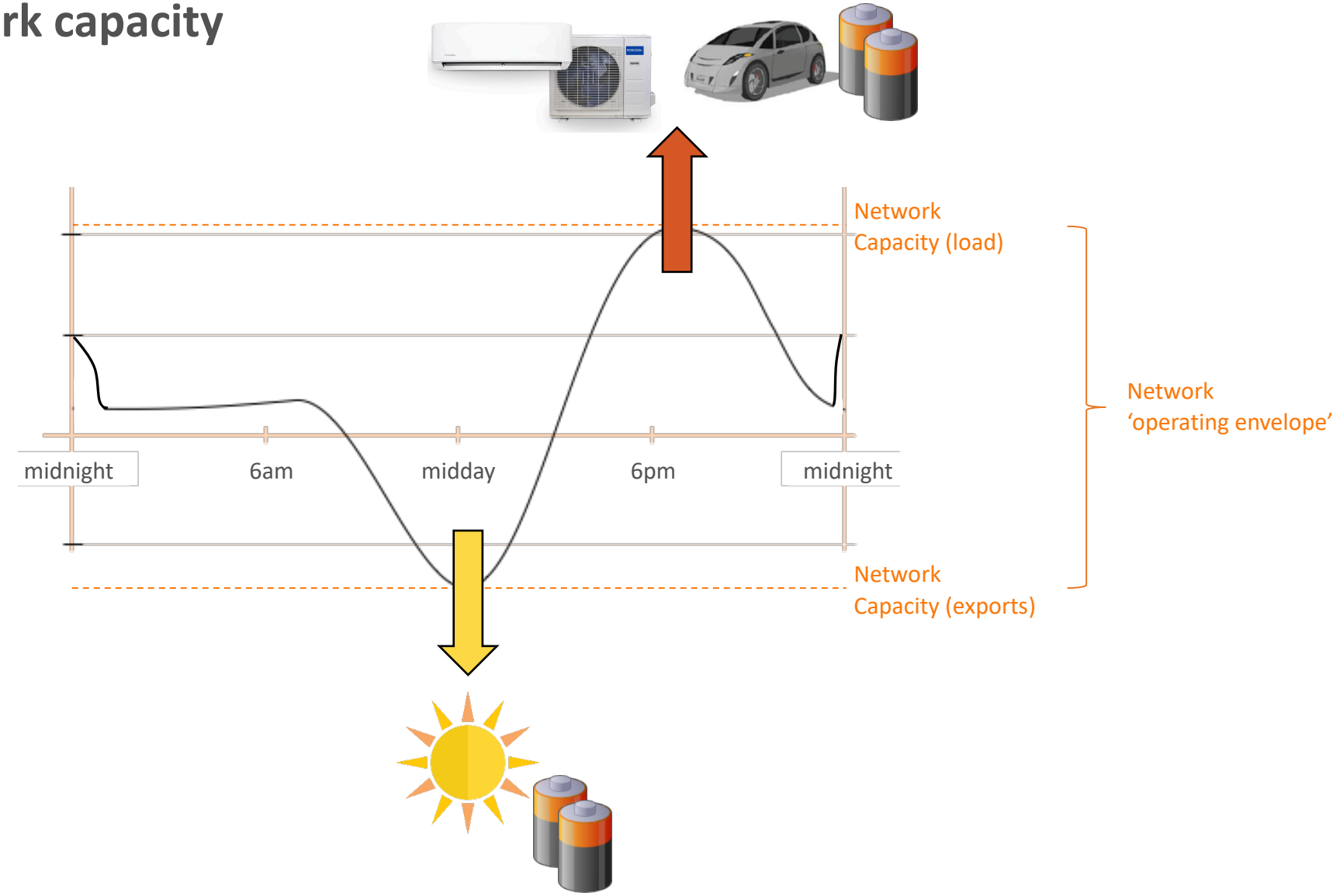
- Help customers connect, and get the most value from, their own **distributed energy resources**

- Maximise VPP's and aggregators' **access to wholesale and ancillary services markets**

- **Reward customers for efficient use of the network**
  - Give long-run signals through cost-reflective tariffs
  - Target short-run / local constraints through demand-response programs and network support contracts
  - Maximise opportunities for DER customers and aggregators to access network value streams

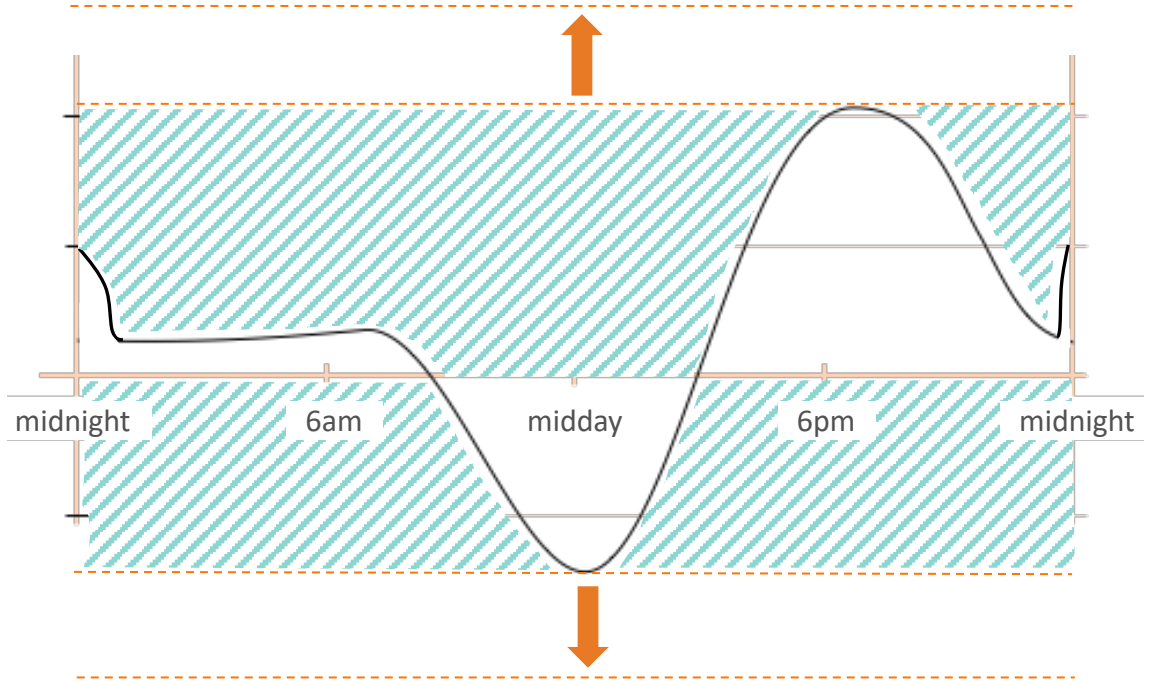
- Manage the impacts of DER to:
  - Maintain **safety, security and quality of supply** at the distribution network
  - Help AEMO manage **system security** issues

Distribution network capacity



Strategies for network capacity

Fill the spare capacity with flexible DER and loads

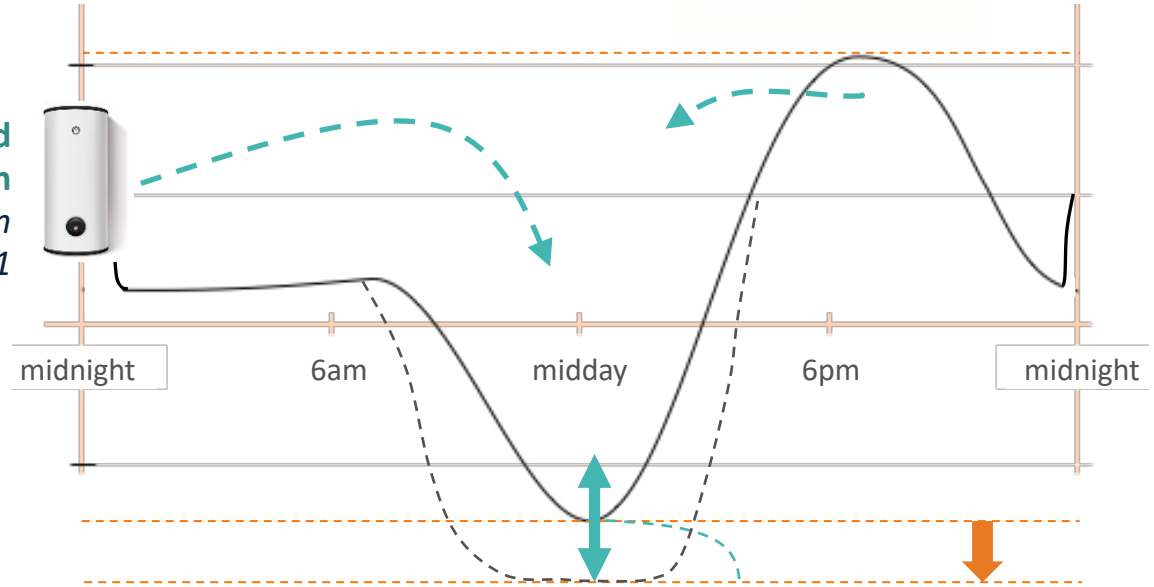


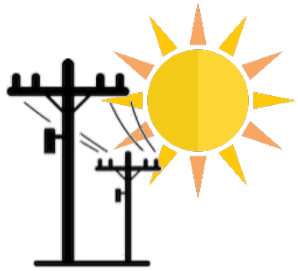
Stretch the network capacity through smarter network management

Our active initiatives

New tariffs and price signals
'Solar sponge' ToU tariff launched in 2020

Shifting controlled load into the solar trough
Smart hot water trial in SA in 2021





Network access & pricing reform
Remove regulatory barriers to network investment in solar enablement

Flexible export limits
$30 million program 2020-25 to activate smart inverters to operate dynamically within available capacity

Improving network voltage
$10 million program upgrading 140 zone substations in 2020-21

Stretch **Fill**

Advanced VPP Grid Integration Trial

Flagship $2 million trial with $1 million of ARENA funding

- Co-design with Tesla and industry an API and business rules for VPP/grid integration and ‘dynamic operating envelopes’
- Develop new hosting capacity estimation engine and web API
- Demonstrate capability to raise per-site export limit to 10kW at unconstrained times
- Test at scale in the real word & explore value created

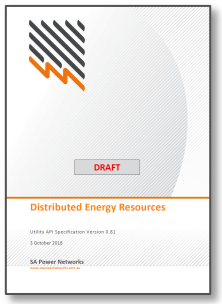
ARENA
Australian Government
Australian Renewable Energy Agency

TESLA

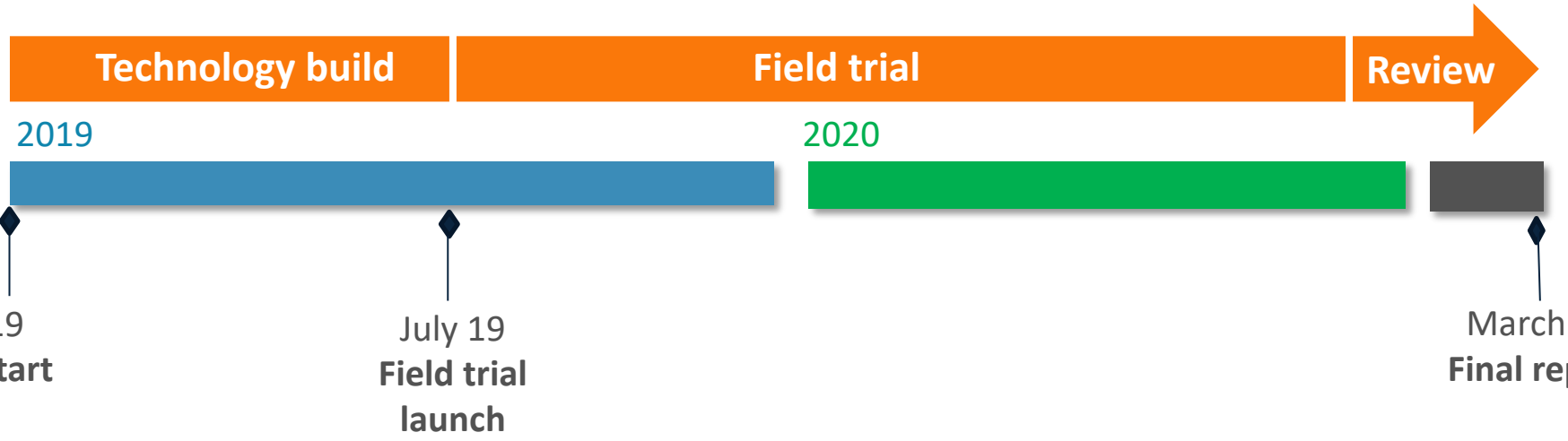
CSIRO

Advanced VPP Grid Integration Trial

2018 industry consultation on API standards



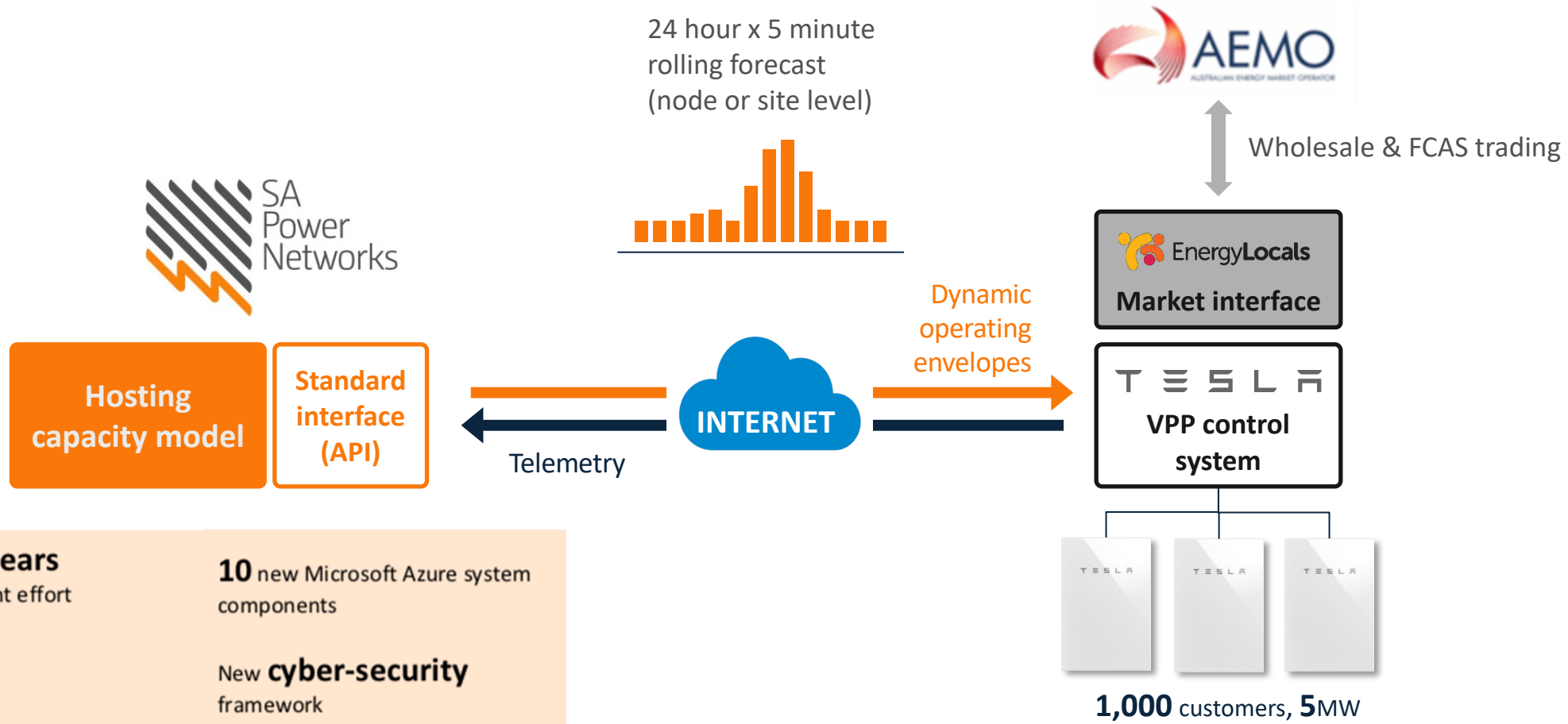
Draft API spec modelled on IEEE 2030.5



Founder members* of DER API Working Group – towards Australian 'CSIP' for IEEE2030.5

* With the ZepBen/ANU *evolve* project

Advanced VPP Grid Integration Trial



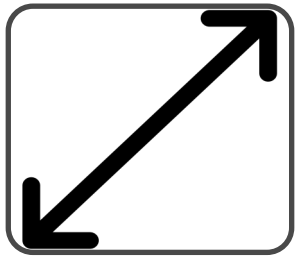
3.2 staff years
of development effort

11,000
lines of code

10 new Microsoft Azure system components

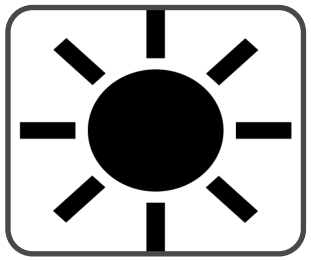
New **cyber-security** framework

Calculating dynamic operating envelopes



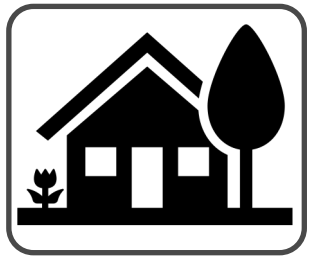
Network model

- 17 low voltage areas modelled in detail
- Every LV feeder is mapped to one of the 17 prototypes, parameterised by its specific configuration
- Thermal limits set according to transformer rating
- Template-based voltage limits – based on customer & conductor type and geographical location



Solar PV model

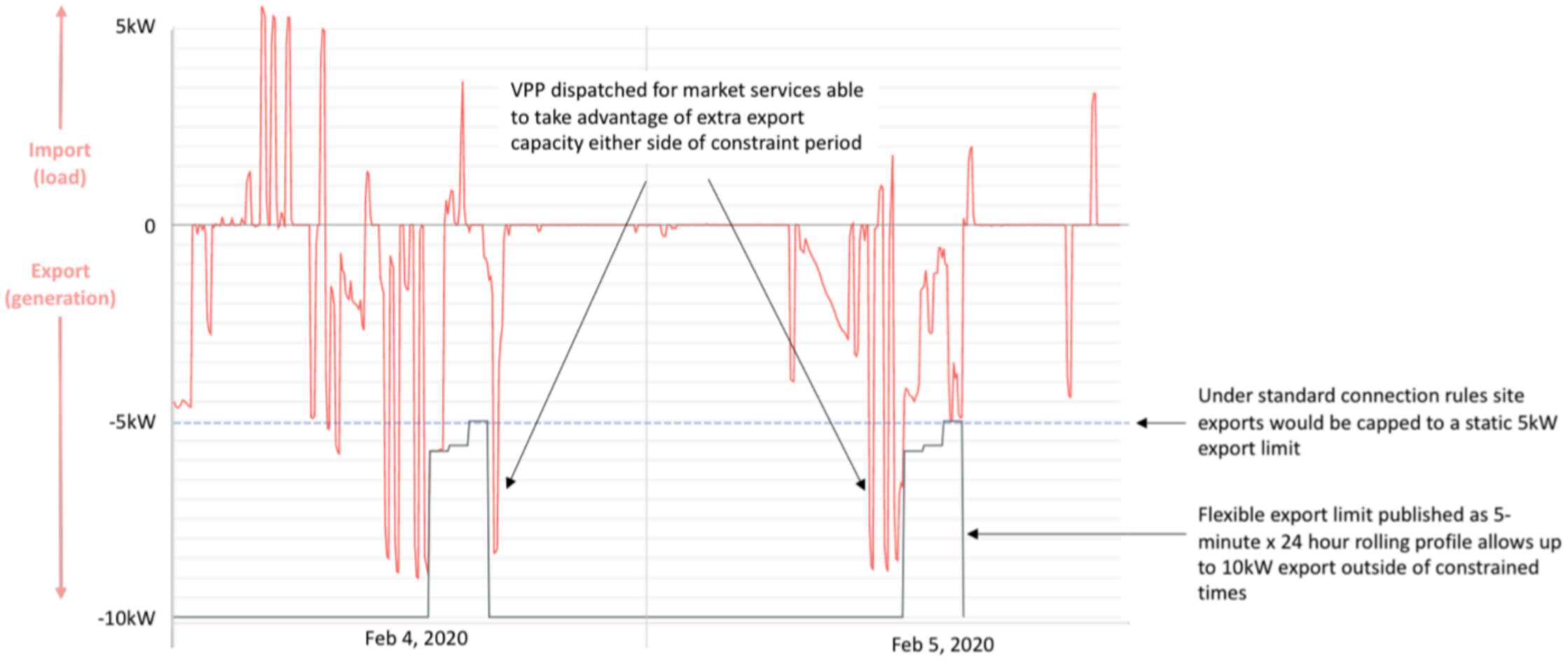
- Location-based solar model using historical “estimated actuals” from ANU Solcast project
- Enhanced with solar insolation data from Weatherzone (forecasts, updated every 15 min)
- Scaled by installed PV capacity and conversion factor from W/m2



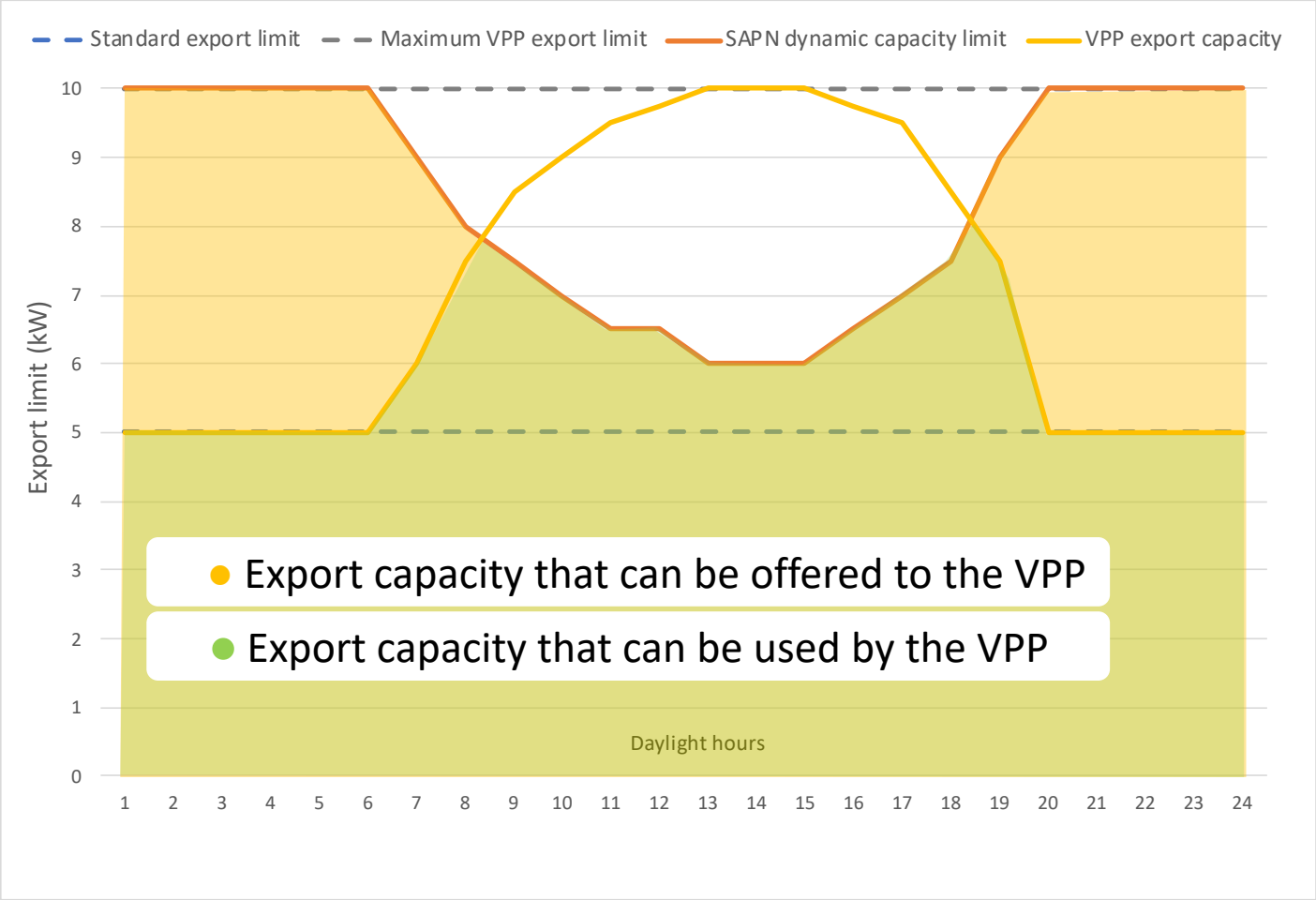
Load model

- Based on analysis of sample set of historical smart meter data by the University of Adelaide – developed load profiles for Commercial, Residential, Residential Hot Water
- Profiles selected and scaled based on temperatures from Weatherzone (forecasts, updated every 15 minutes)
- Scaled by average demand for each load category

Enabling greater market access – raising export limits



Research results: DER export capacity



Key results

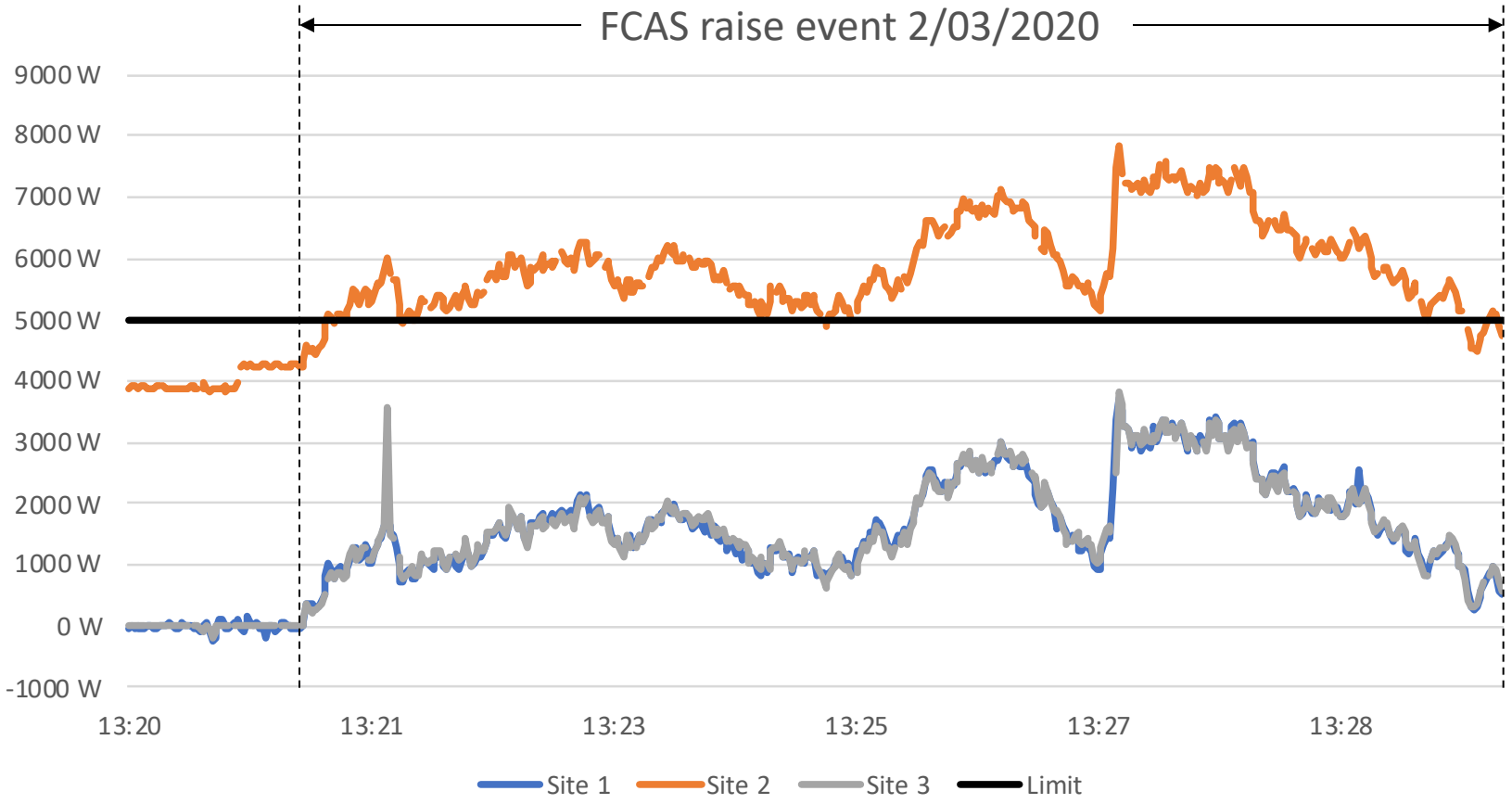
- **Whole-day average export capacity** can be increased **from 5 kW to 8 kW across the year** – up to 10 kW in winter
- **Daylight-hours average export capacity** can be increased **from 5 kW to 6 kW across the year** – to no less than 8kW in winter

Caveat

Notice the difference between **what can be offered to the VPP** and **what the VPP can effectively use:**

- Max 5 kW Battery export capacity
- + Max 5 kW PV export capacity **(only during daylight hours)**

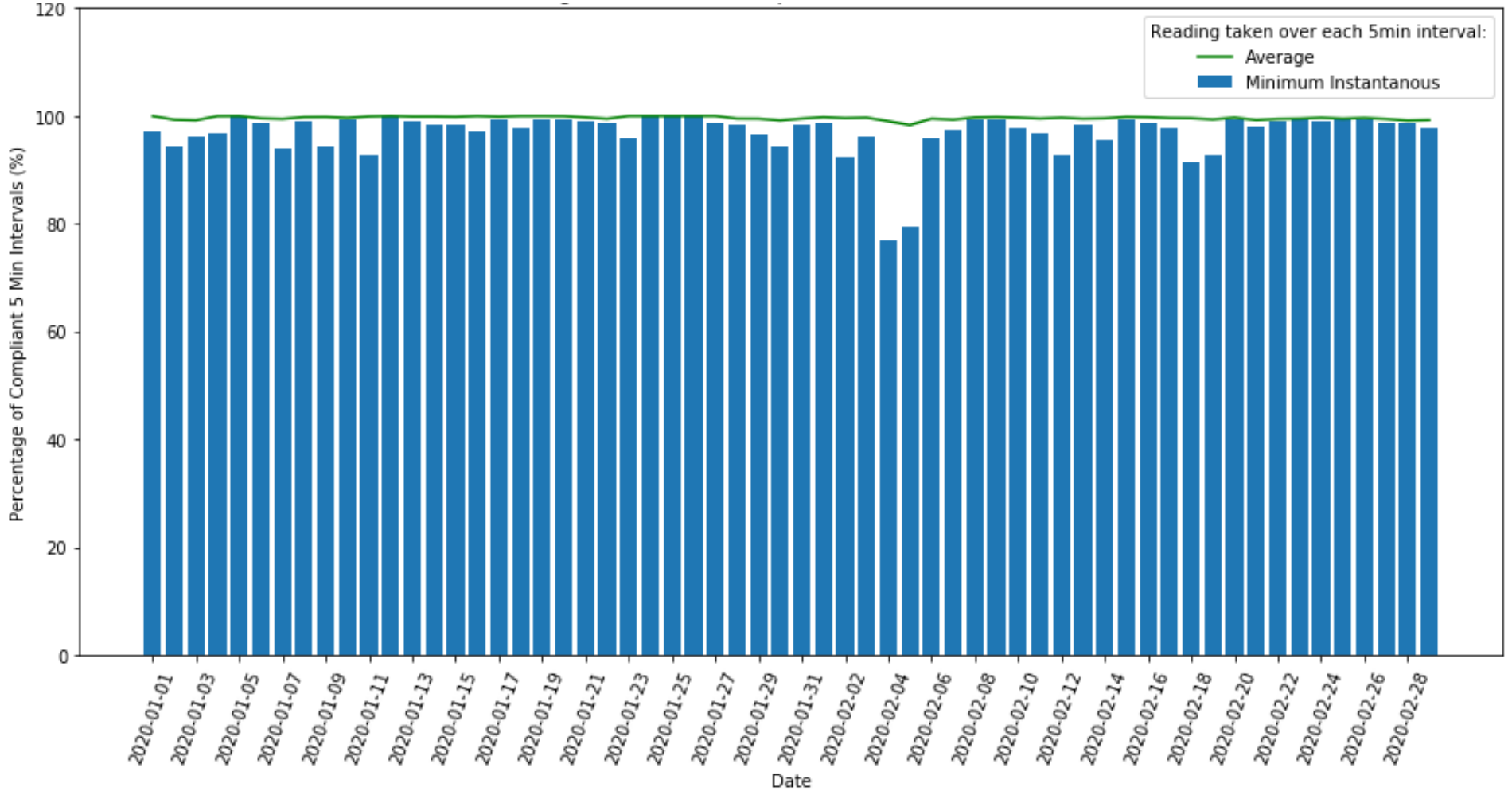
Enabling greater market access – FCAS



- **Site 2** was already exporting and could not have participated in the FCAS response under a static 5kW limit
- With a static 1.5kW export limit, all sites would be severely constrained in their ability to respond

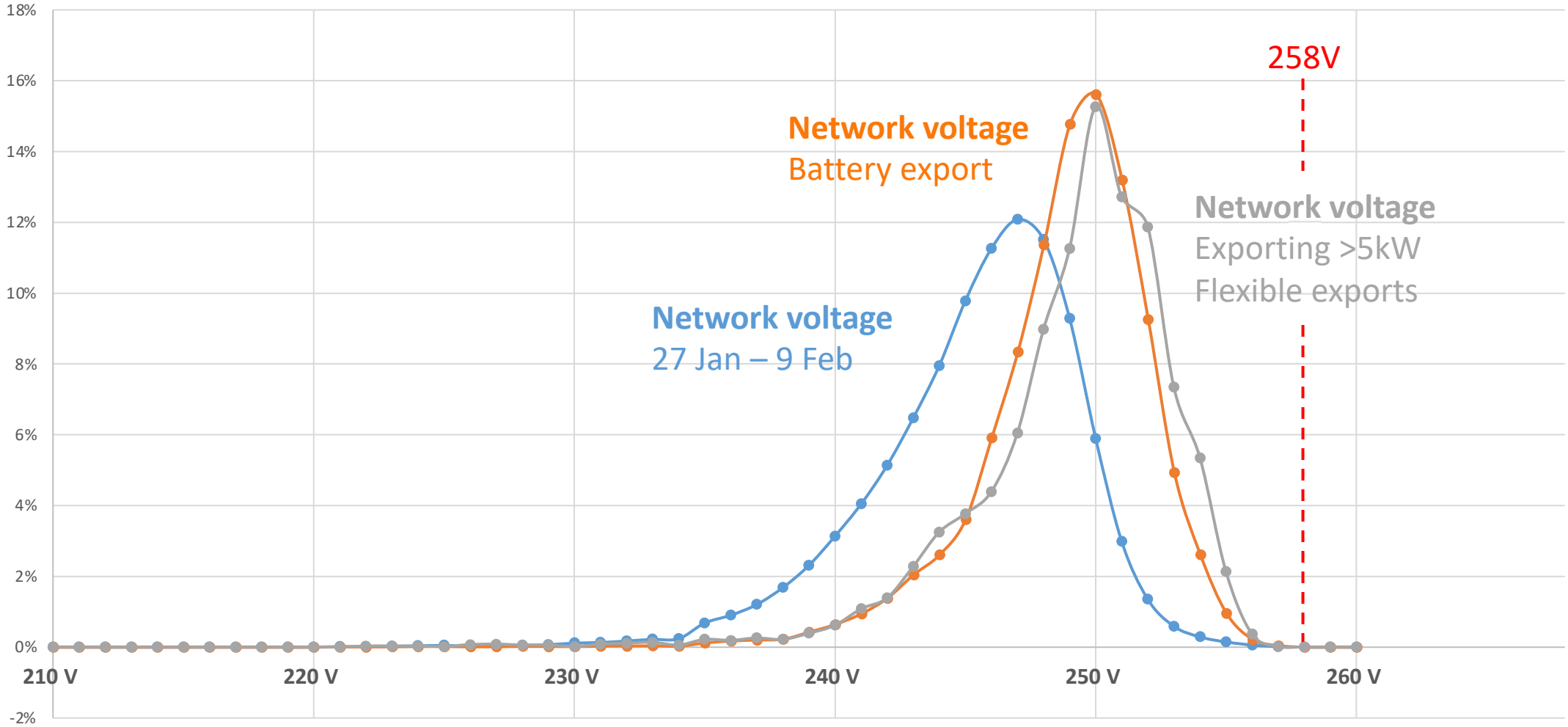
Compliance to published operating envelopes

- Operating protocol based on 5-minute average
- Allows for transient excursions for contingency FCAS response

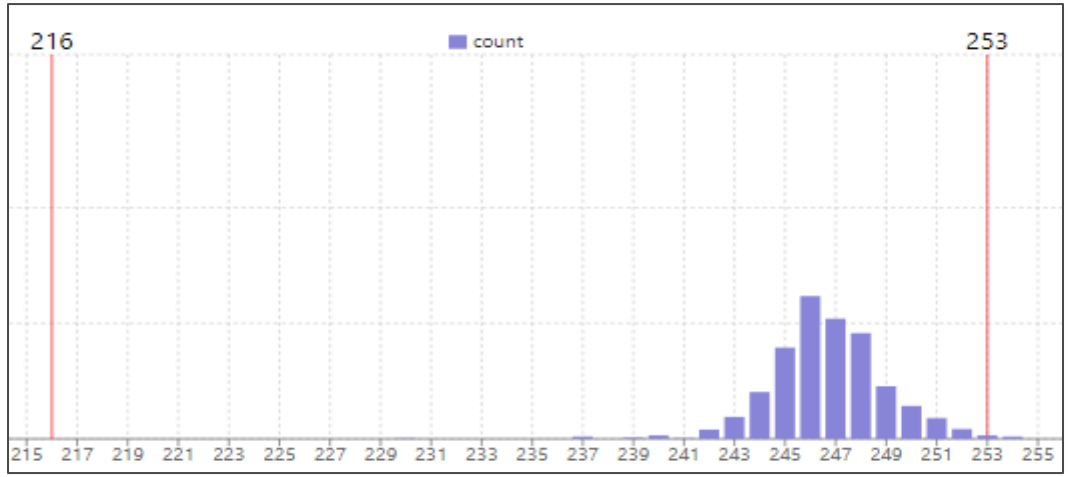


Voltage Performance under flexible exports

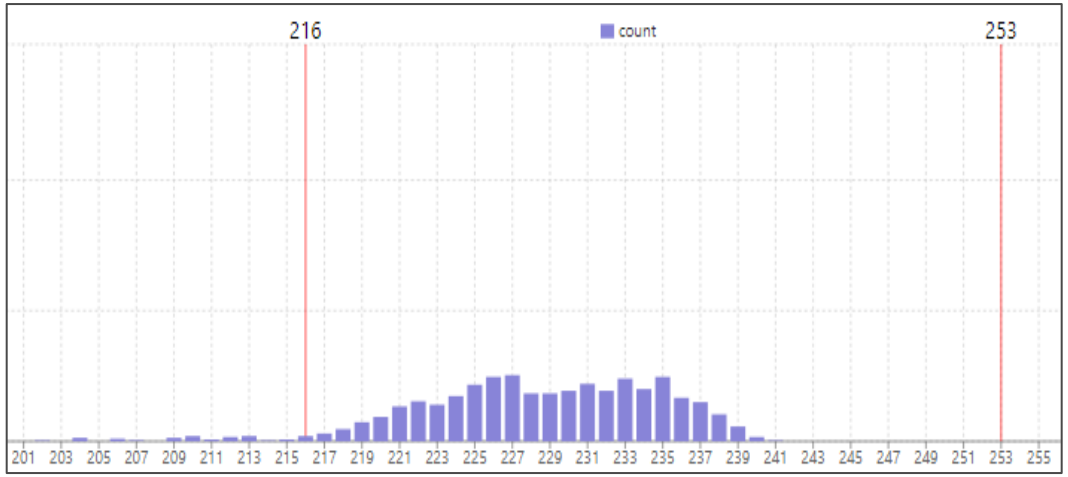
Goal – do not degrade network voltage by enabling exports > 5kW



Research question: can data from VPP sites inform network visibility?



Voltage distribution – minimum demand 10/11/2019



Voltage distribution – peak demand 30/01/2020

Research question: can data from VPP sites inform network visibility?

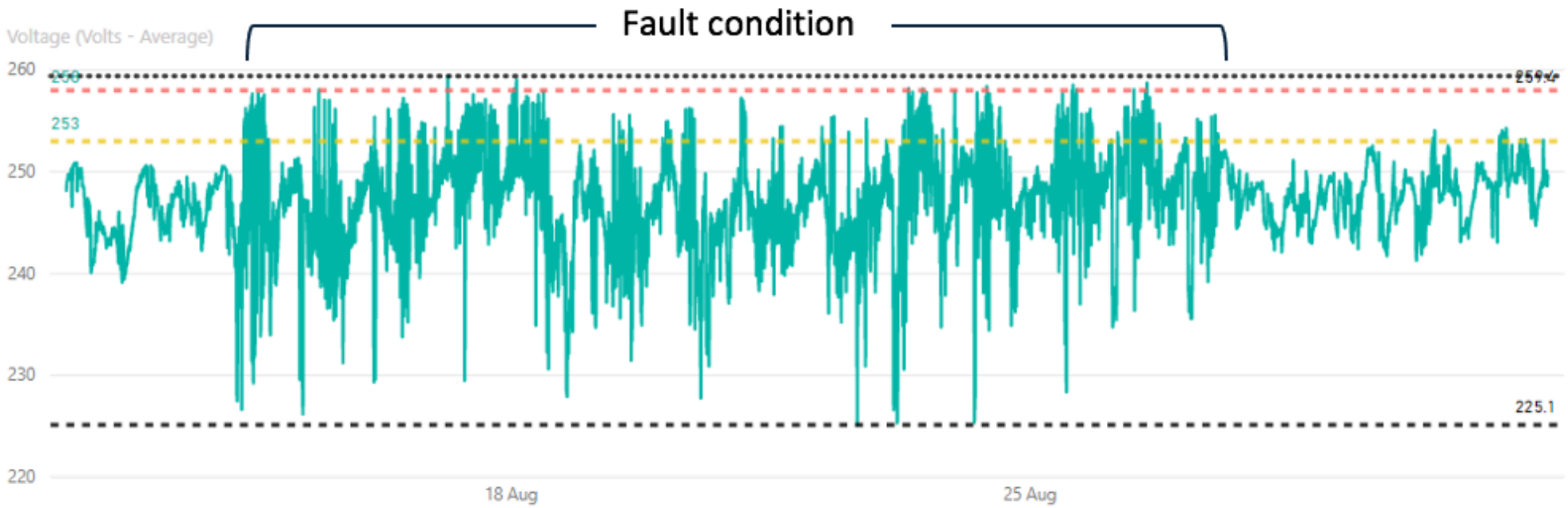
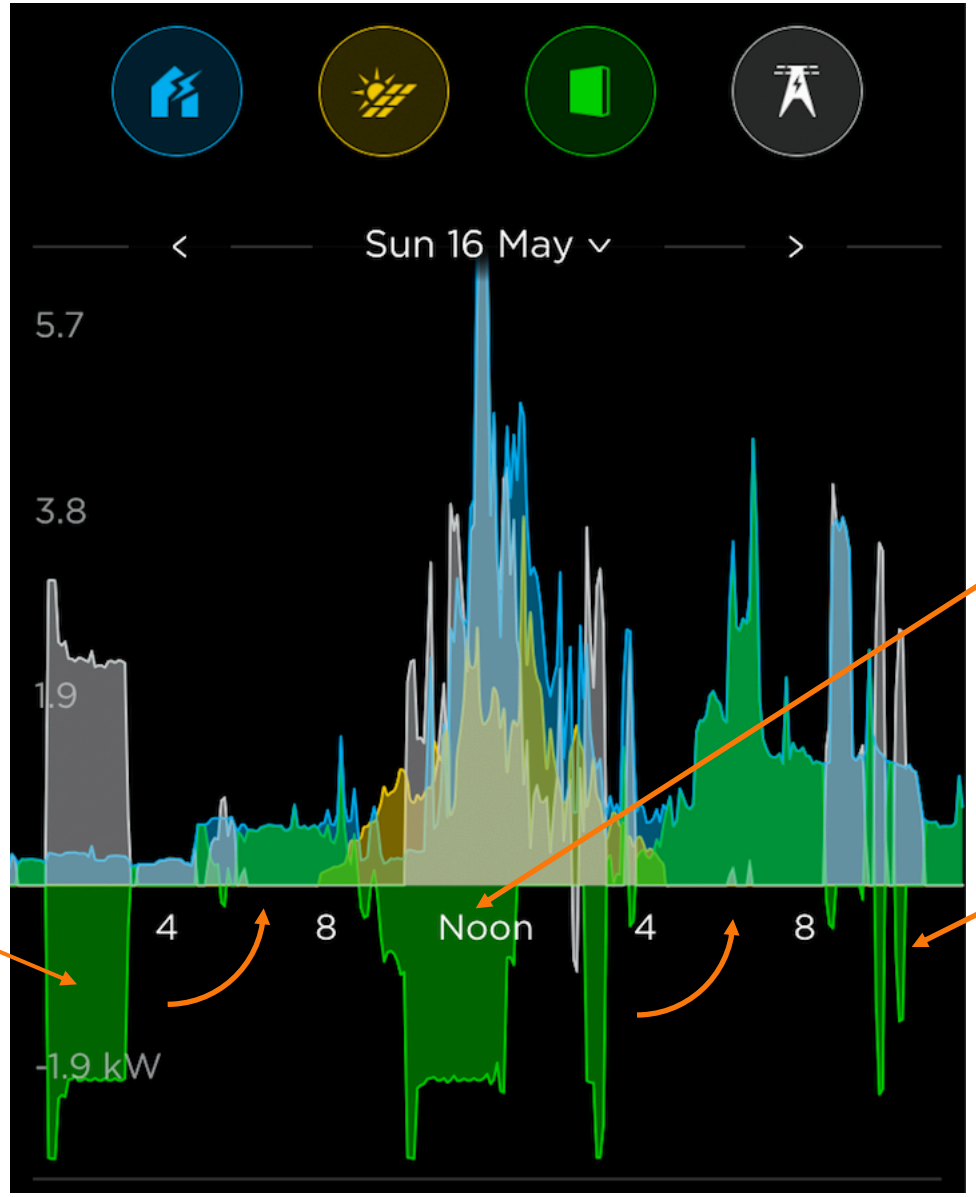


Figure 4-10: Neutral fault detection using voltage telemetry data

Customer experience and value stacking

Network tariff optimisation
battery pre-charging overnight to supply house loads during the 6am-10am peak period



Solar shifting and tariff optimisation
battery charged during ‘solar sponge’ period to supply house loads during the afternoon peak period

Market activity
Battery responding to market price signals

Next steps: multiple VPPs and new services

Tesla

- Tesla Energy Plan Customers
    - Similar size to government housing project
    - Non-uniform site characteristics
- Explore new services

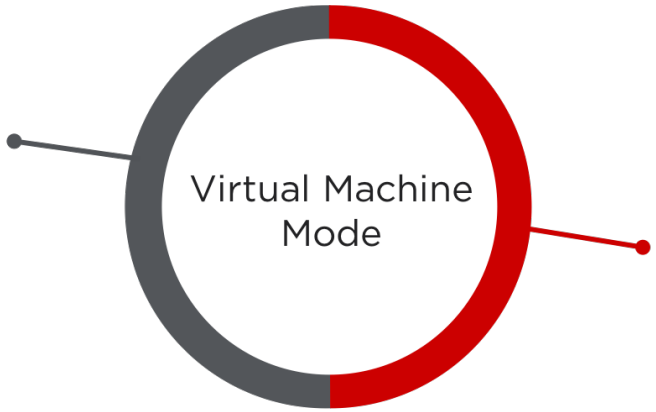
Rheem Demand Management Trial

- Initial API integration with Combined Energy in 2020
- Establish emergency “load on” mechanism

Other SA VPPs

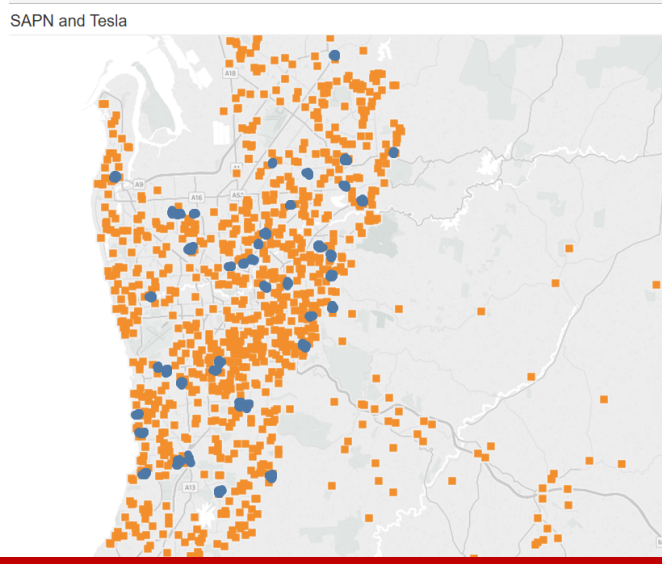
- Currently working to integrate another SA VPP

Next steps: new services trials (source: Tesla)



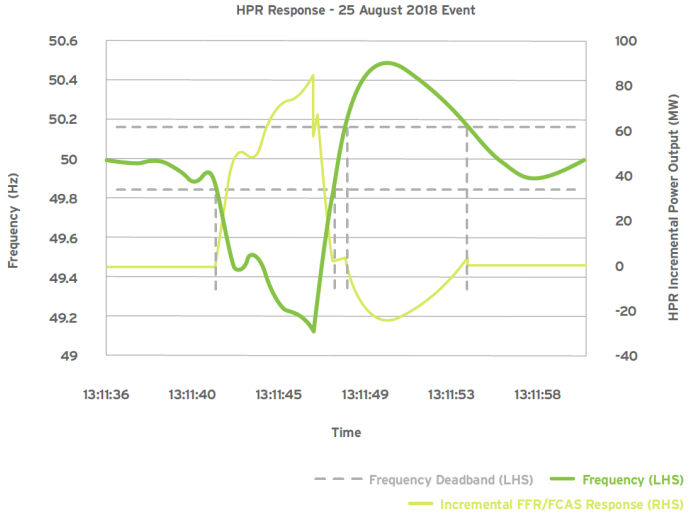
INERTIA

- Alternative to syncons for MW.s/MVA
- Configurable ‘virtual’ inertia in response to rate of change of frequency
- Super-synchronous response (faster than grid frequency)



VOLTAGE SUPPORT

- Alternative to STATCOMs for volt-var
- Provides network with visibility
- Trial underway with SAPN using behind the meter Powerwall assets set-up with prototypical volt-var curves based on network topography



FAST FREQUENCY RESPONSE

- Primary frequency control service based on frequency/watt droop curve with response time of 200ms
- Autonomous response to excursions - customisable based on dead-band
- Benefits already well demonstrated

Next steps: progression to flexible export limits for passive solar PV

Sept 2020
Agent Nominations

Jan 2020
Remote disconnect / reconnect live

July 2021
Smarter Homes
Dynamic Export limits API

SMARTER HOMES

Advanced VPP Grid Integration Trial

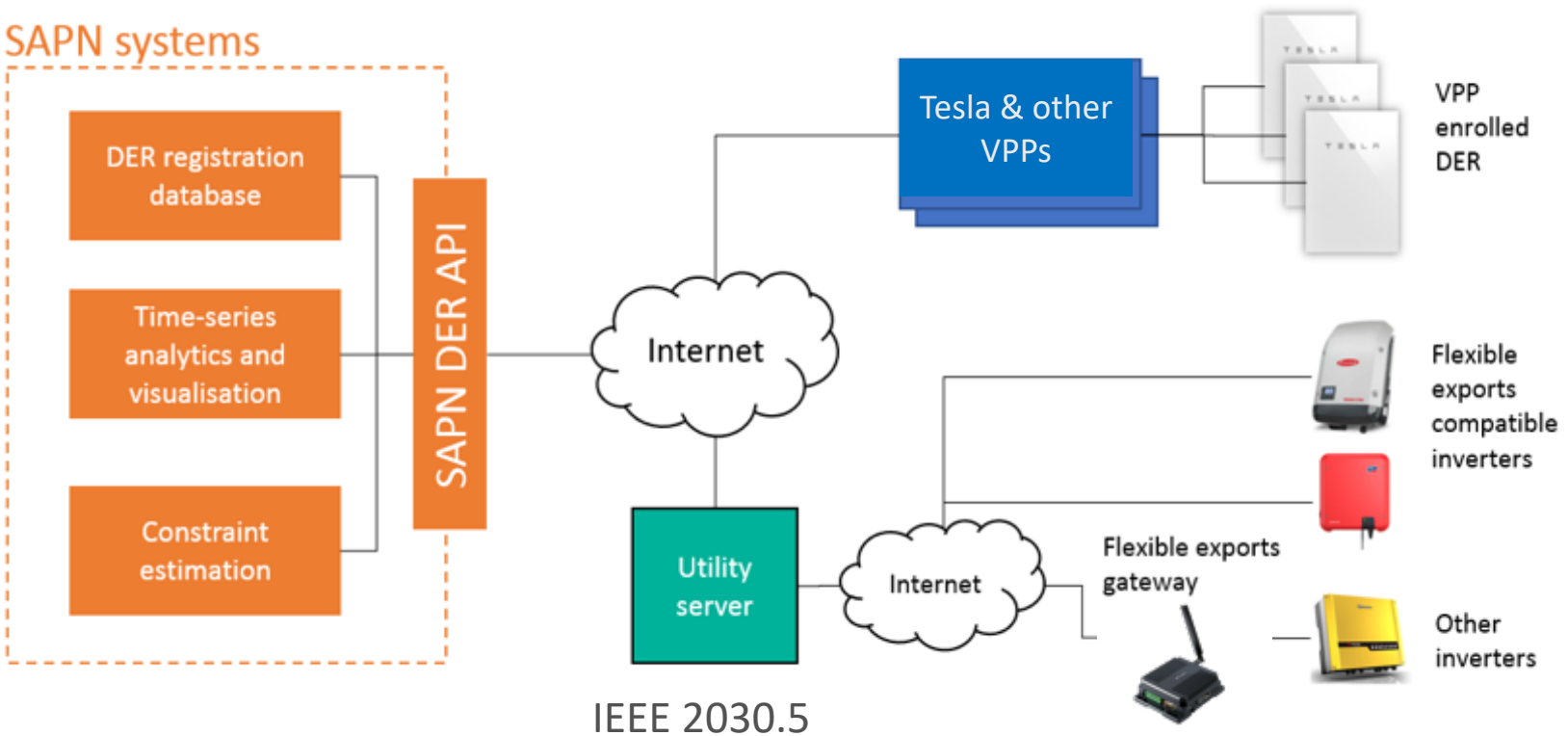
SAPN Flexible Exports for solar PV Trial

Full flexible exports service

Apr 2021
SAPN field trial commencement

April 2022
Service launch

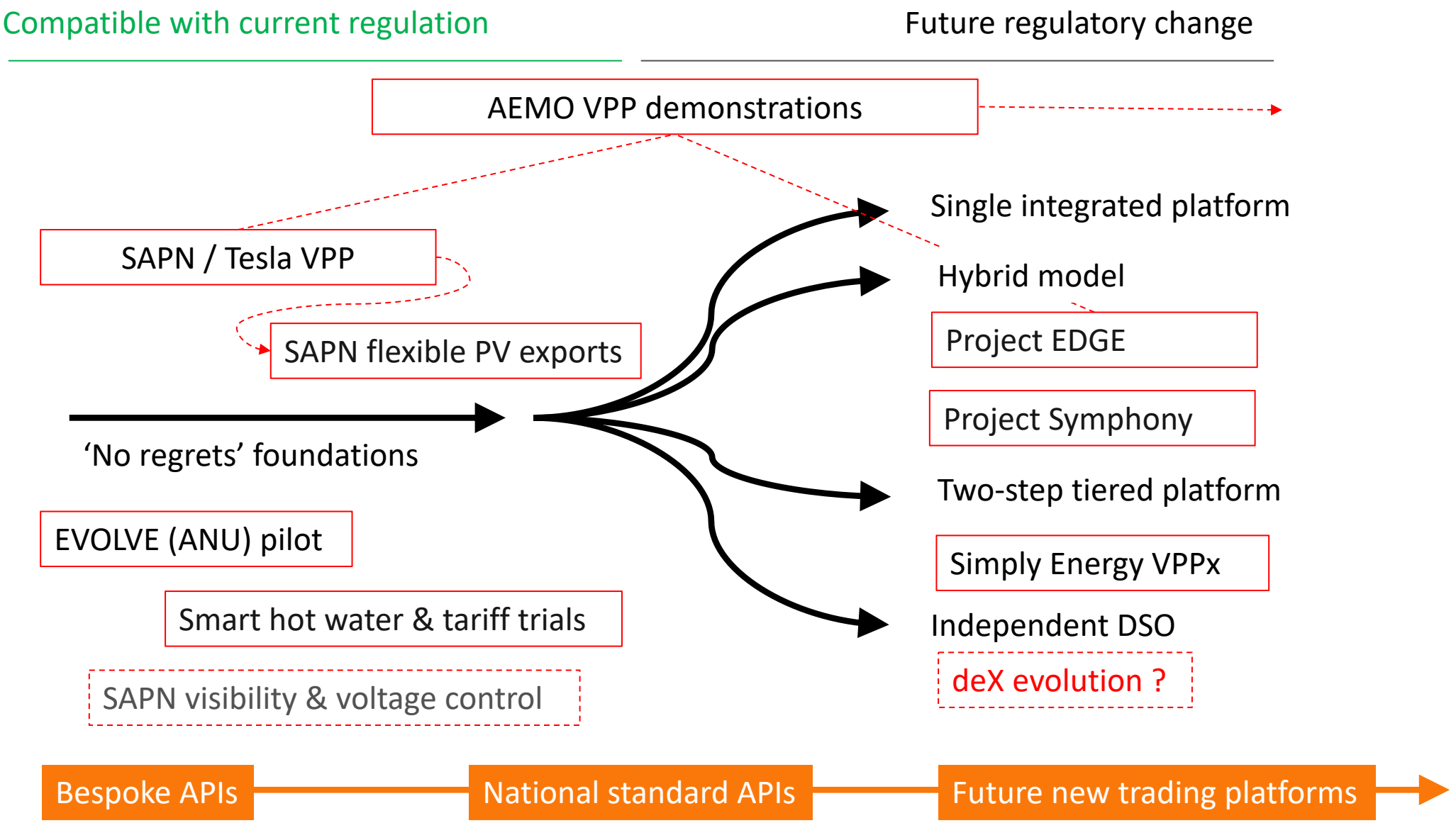
October 2022
Full network availability

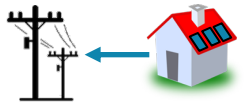
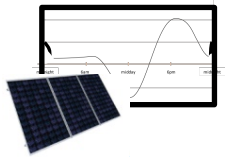


Phase 1 trials: Advanced VPP grid integration trial

Phase 2 trials: Flexible exports for solar PV trial

Open Energy Networks future market models & ARENA trial evolution



	2015	2020	2025+
 DER connections	**Fixed export limits**	**Introduce flexible export limits** ‘dynamic operating envelopes’	**Choice of flexible connection and tariff options** Tailored to customer preference
 Tariffs	**Flat tariffs**	**Cost reflective consumption tariffs** ‘Solar sponge’ ToU	**Cost-reflective two-way tariffs** Import/export tariffs
 Hosting capacity	**Static management** Use of intrinsic capacity ‘First in, best dressed’	**Dynamic management** Increase utilisation of intrinsic capacity Dynamic voltage management	**Expand and optimise** Efficiently invest in increasing hosting capacity in line with customer demand
 Market participation	**Passive DER** Self-consumption Feed-in tariffs	**Active DER** Batteries and VPPs Smart solar Managing DER for system security	**Market-integrated DER** Full value stack Market, system and network services

Access & pricing reforms

Post-2025 Market Review

A flexible future

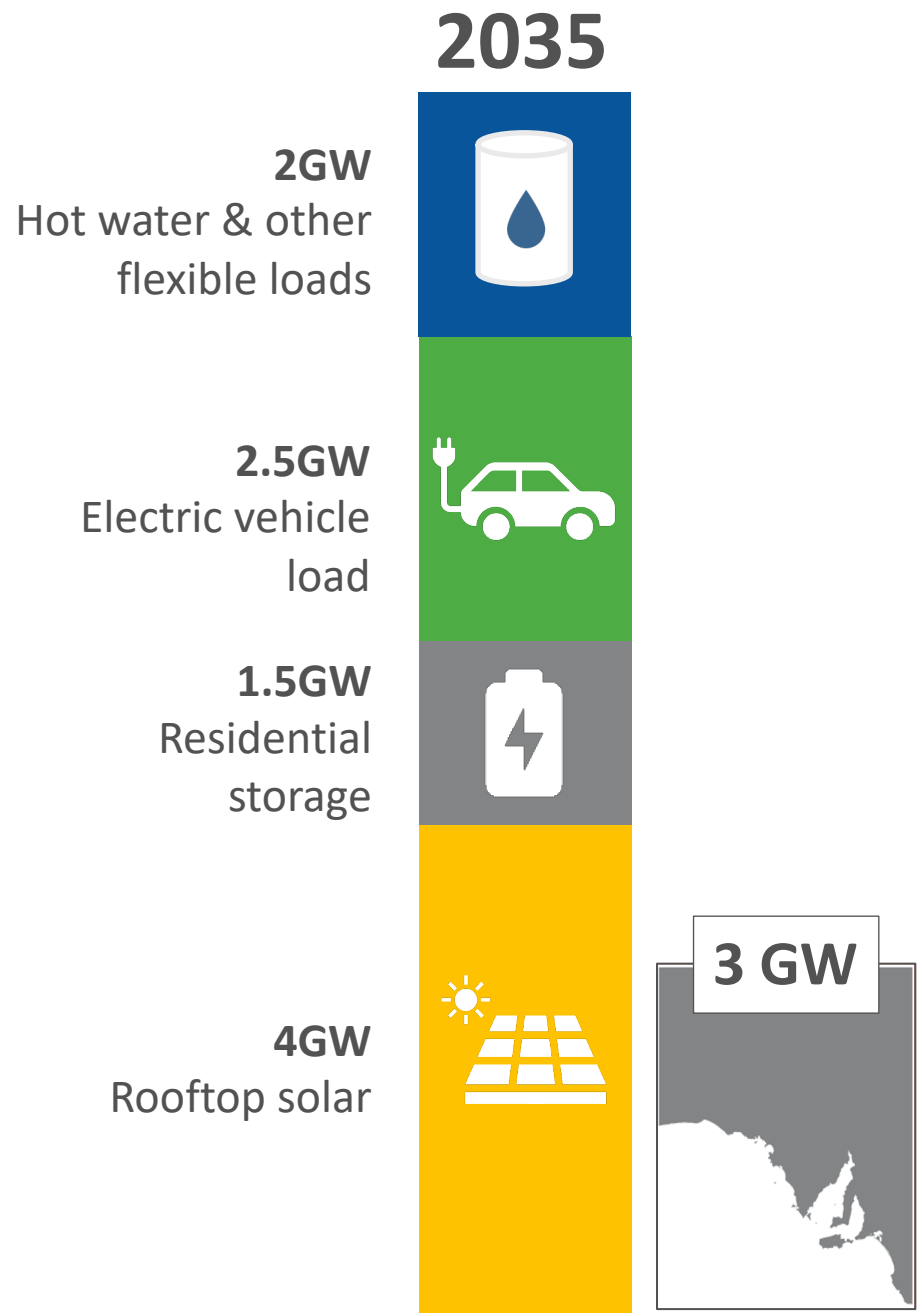
In SA today we have **<100MW flexible solar**

By **2035**, we could have **more than 10 GW of flexible resource**

Our challenge is to integrate these resources with a power system **designed for 3GW** peak demand

If we do this well, we can

- help **maximise customer and community value** from these resources and from the shared network assets
- significantly **increase network energy throughput** and asset utilisation
- help accelerate the transition to a **low-cost, low-carbon energy future for all**

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Empowering South Australia