# SEP2 Implementation & Testing for Dynamic Connections

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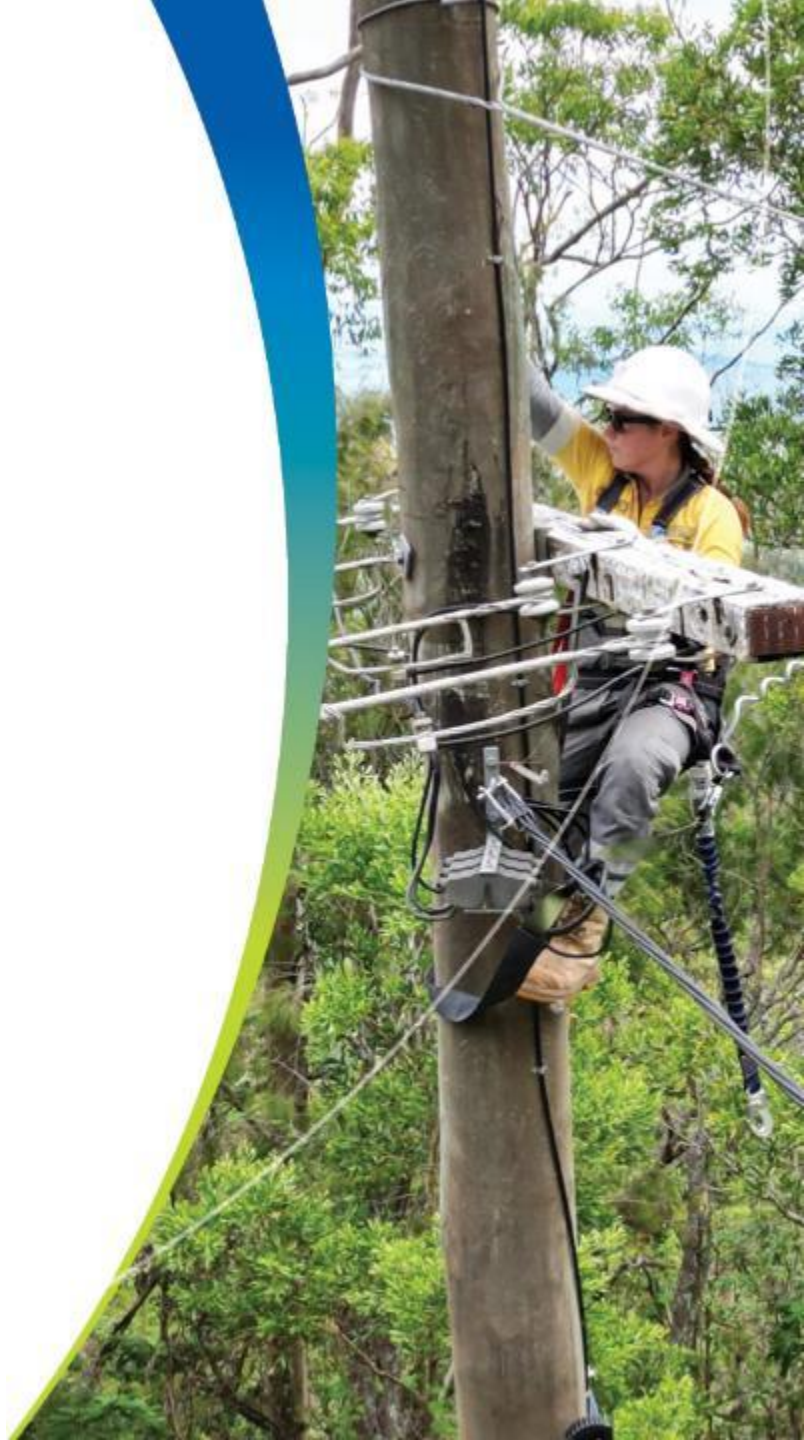


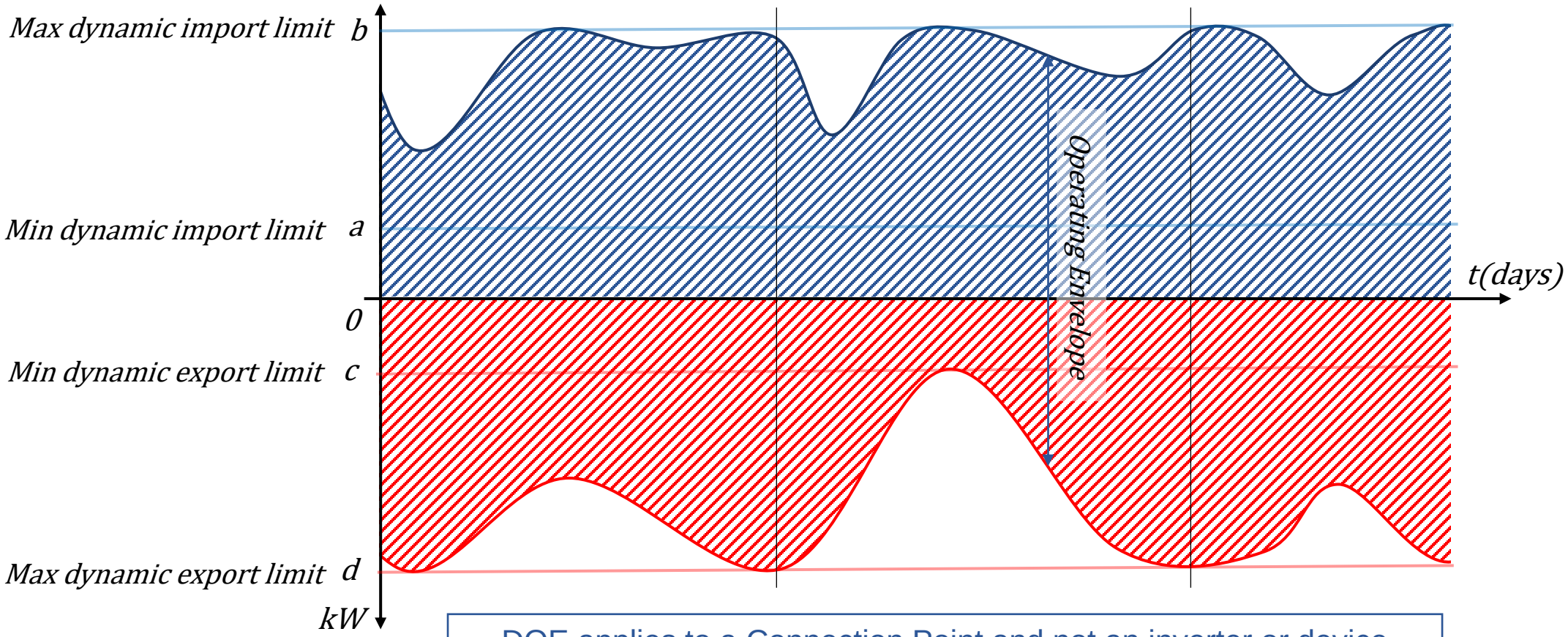
**Callide Power Station**
**1,548 MW**

~4,500 PV applications/month
**~0.5 GW a year**

**1 Callide** of capacity every **3 years**

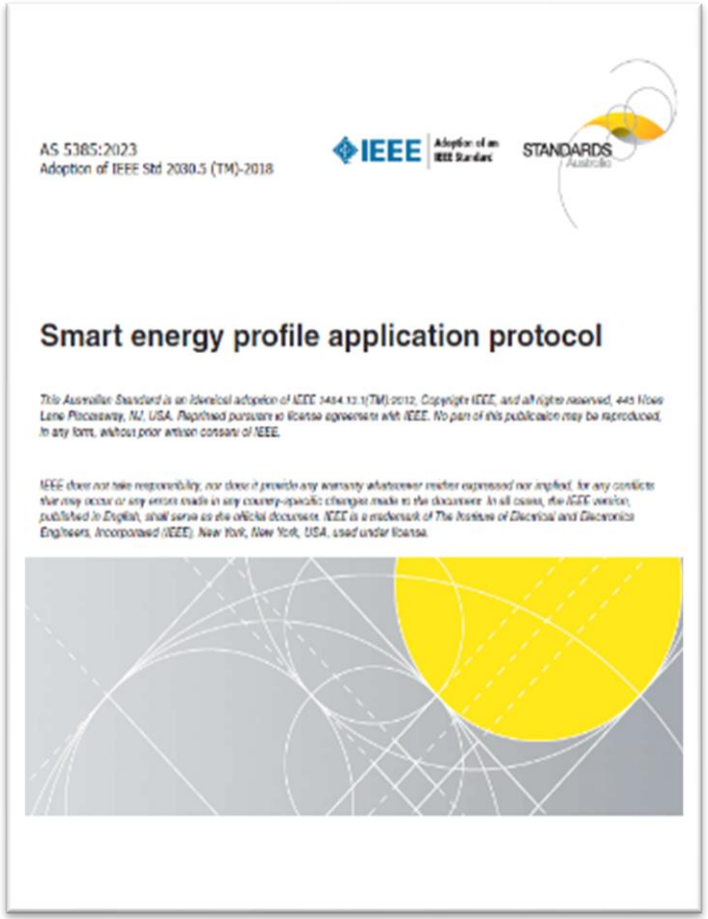
**Rooftop Solar 0.010 MW**

# Dynamic Operating Envelopes (DOE)




DOE applies to a Connection Point and not an inverter or device

# AS 5385 or IEEE 2030.5 Smart Energy Profile Application Protocol (SEP2)




# SA HB 218 (CSIP-AUS)

# Internet Outages

Without sensible fallback mechanisms, what might a communication outage look like once most customers are dynamic?

- Customer changes Wi-Fi password
  - 1 customer = 0.01 MW
- Local suburb telco outage
  - 10k customers = 100 MW
- Major Telco outage or DNSP Utility Server outage
  - ~10+ GW of capacity

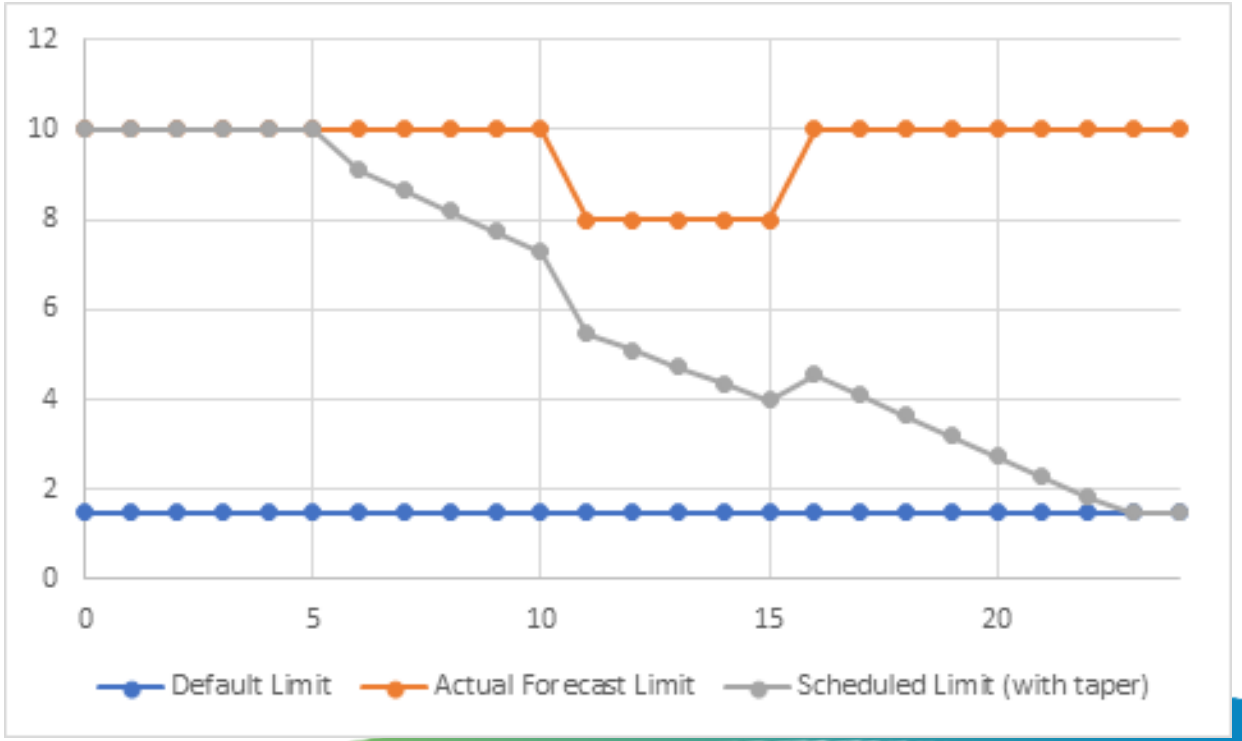
# Forecasting and Loss of Comms

Import / Export Limits can be scheduled into the future in case of loss of comms.

It is a CSIP requirement that clients store at least 24 scheduled events for each DER that can be actioned in response to a loss of communications.

We aim to send forecasts at:

- 5 min intervals for first hour (12 events)
- 30 min intervals for next 23 hours (46 events)



# Ramping and Randomization

SEP2 provides ability to specify ramp rates per event and for fallback state.

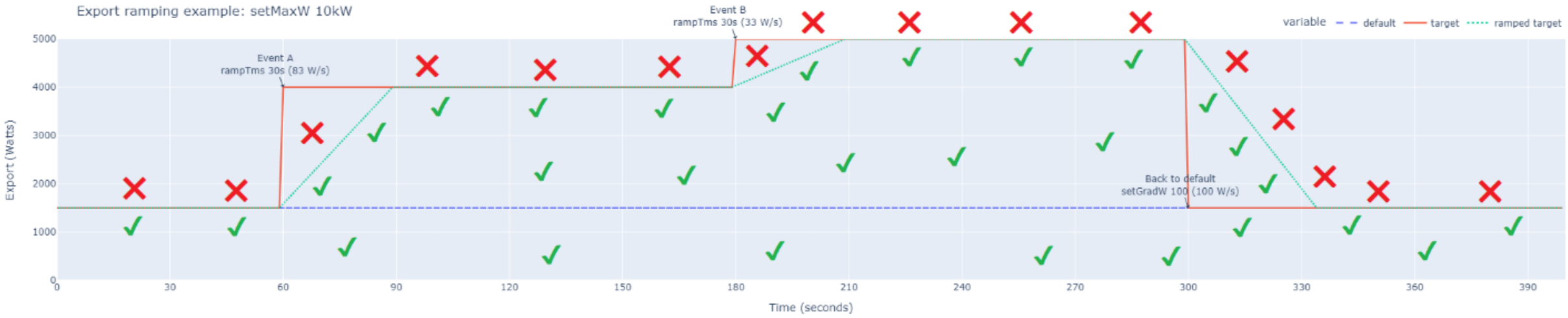
It also allows for setting a random delay at the start and end of events.

# Ramping

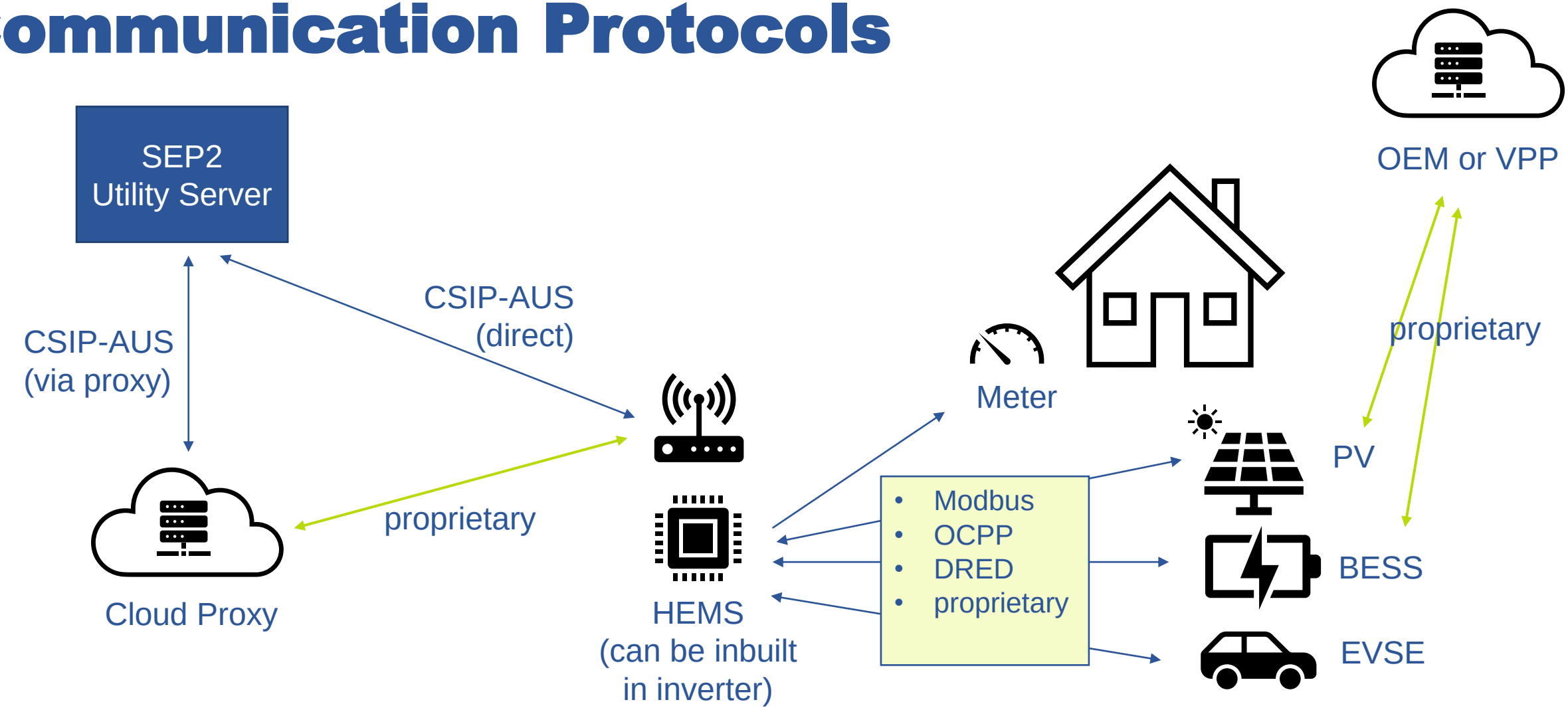
But beware … we are talking about limits and not controls.

Ramping does not apply to the actual power output, but the allowed limit.

Anything less than the limit is compliant.

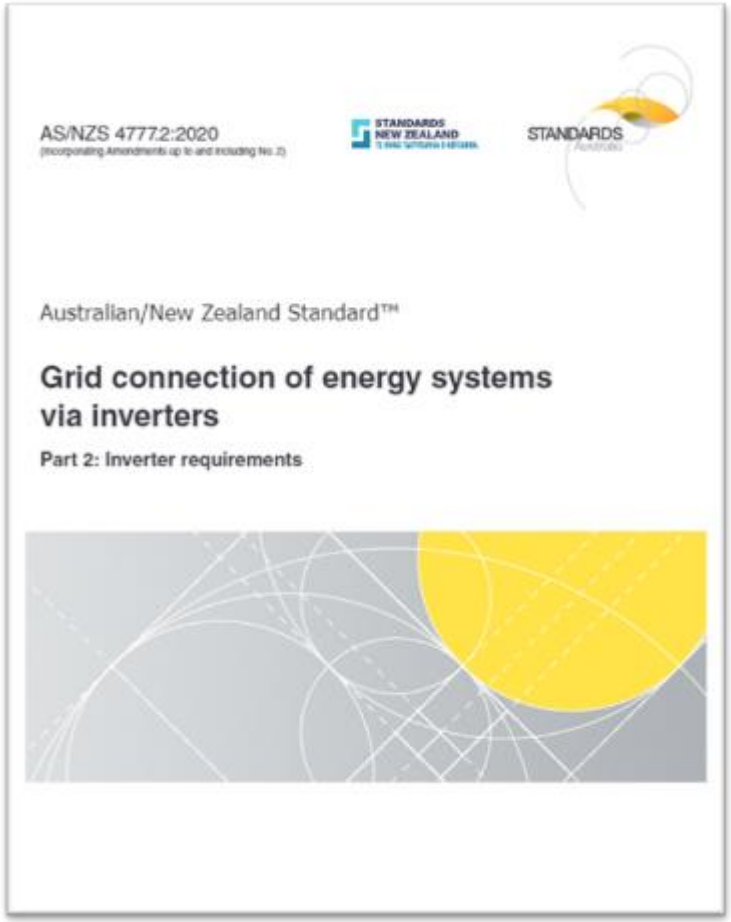


# Communication Protocols

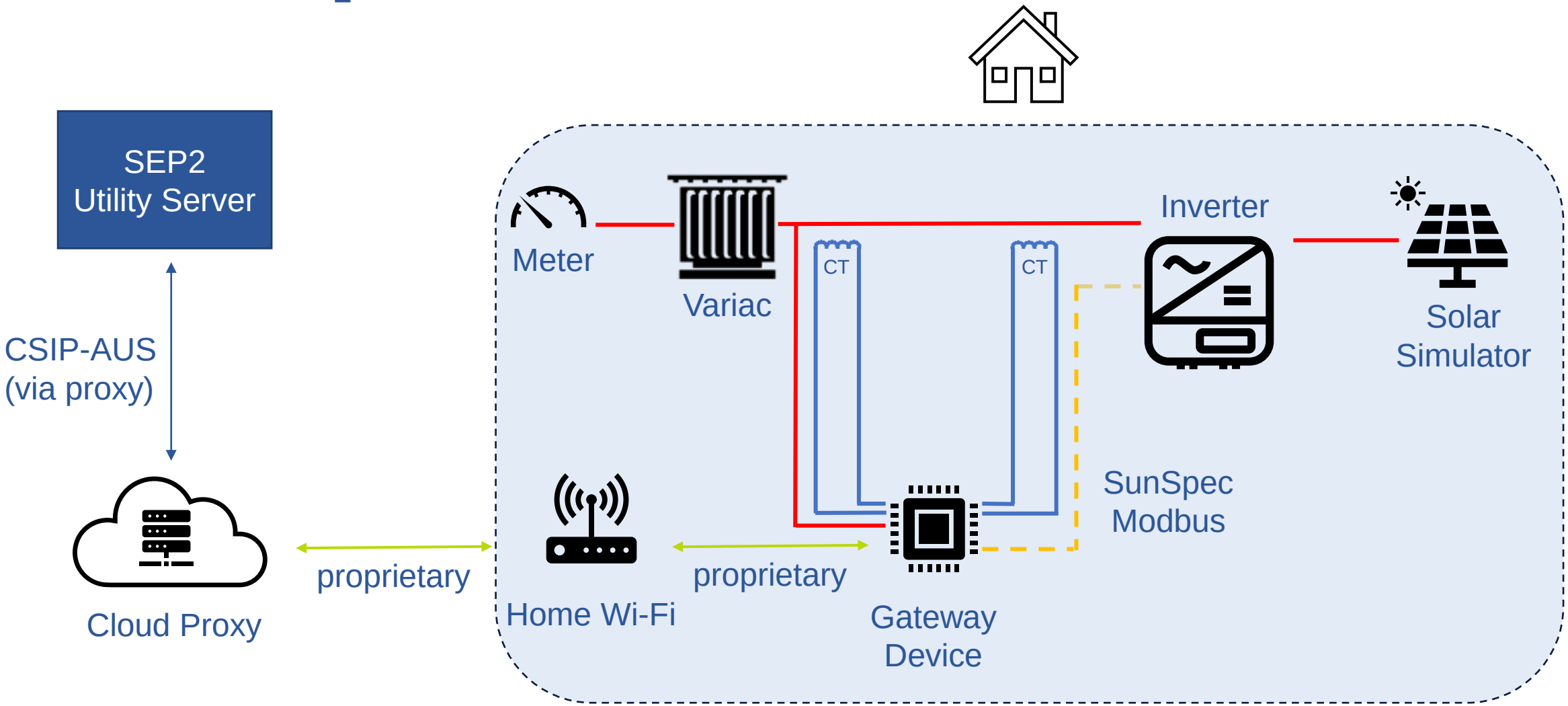


# Laboratory Testing

- AS4777.2:2020 compliance - interoperability of export control & volt-var/volt-watt response
- End-to-end connection of SEP2 Utility Server
- Review of customer & installer experience
- System operation & failure modes

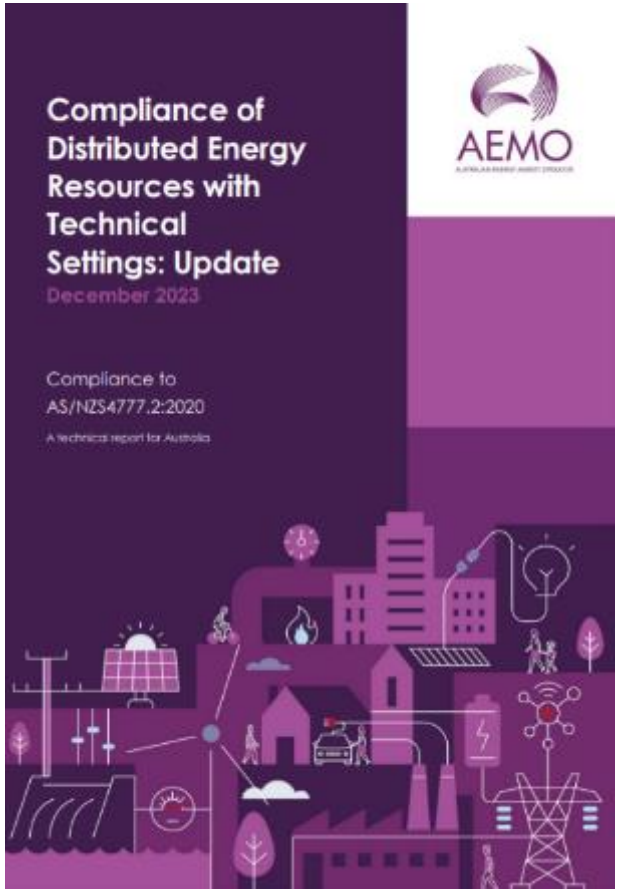


# Test Setup


SEP2
Utility Server
CSIP-AUS
(via proxy)
Cloud Proxy
proprietary
Meter
Variac
CT
CT
Inverter
Solar
Simulator
SunSpec
Modbus
Home Wi-Fi
proprietary
Gateway
Device

# Results – Operation

| | |
|---|---|
| ✓ | Interoperability of volt-var, volt-watt & export control. |
| ✗ | Reactive Power non-compliance identified, in line with AEMO's DER compliance findings. |
| ✓ | Export control effective while supplying customer's local load requirements. |
| ✓ | System can correctly adhere to a base 1.5kW export limit. |
| ✓ | System can be monitored by customer via the dedicated mobile application. |



# Results – Communication Outages

- System dropped to a minimum export limit during internet outages.
  - No locally stored forecasts - export limited when connection to the Cloud Proxy is lost.

Interestingly we found…

- 0 kW export limit implemented at inverter, if gateway device is unreachable.
  - May not meet customers' expectations of a 1.5kW min. as per network agreement.
- System drops instantly to the minimum export limit, rather than ramping down.

# Compliance Test

An export limit compliance test was carried out on Wed 21 August 2024 (14:35 to 14:50). Three individual 5-minute tests were carried out, to understand compliance of different functionality.

A. **Reduced export limit** – The export limit of the DOE Program associated with each NMI was reduced to the fixed export limit of the customer contract.
B. **System-wide program** – All NMIs were enrolled a global system program with higher priority (lower primacy) that was issued with a 1.5 kW export limit.
C. **Fallback limits** – The standard DOE program was cancelled, requiring sites to revert to their fixed export limit.

| 2024-08-21 | 14:30 - 14:35 | 14:35 - 14:40 | 14:40 - 14:45 | 14:45 - 14:50 | 14:50 - 14:55 |
|---|---|---|---|---|---|
| DOE Program (Primacy #2) | ExpLimW = 10.0 kW<br>ImpLimW = 15.0 kW | **ExpLimW** = **1.5 kW**<br>ImpLimW = 15.0 kW | ExpLimW = 10.0 kW<br>ImpLimW = 15.0 kW | No dispatch | ExpLimW = 10.0 kW<br>ImpLimW = 15.0 kW |
| System Program (Primacy #1) | | | **ExpLimW** = **1.5 kW** | | |
| DefaultControl | ExpLimW = 1.5 kW<br>ImpLimW = 1.5 kW | | | | |
| Fixed Limits | ExpLimW = 1.5 kW ImpLimW = 1.5 kW | | | | |
| Implied Mode Defaults | GenLimW = ∞ kW LoadLimW = ∞ kW<br>Connect = True Energize = True | | | | |
| Site Behaviour | ExpLimW = 10.0 kW<br>ImpLimW = 15.0 kW | ExpLimW = 1.5 kW<br>ImpLimW = 15.0 kW | ExpLimW = 1.5 kW<br>ImpLimW = 4.0 kW | ExpLimW = 1.5 kW<br>ImpLimW = 4.0 kW | ExpLimW = 10.0 kW<br>ImpLimW = 15.0 kW |
| Notes | Normal | Exp 1.5 kW<br>A - Reduced DOE | Exp 1.5 kW<br>B - System Program | Exp 1.5 kW<br>C - Default Control | Normal |

# Customer Examples

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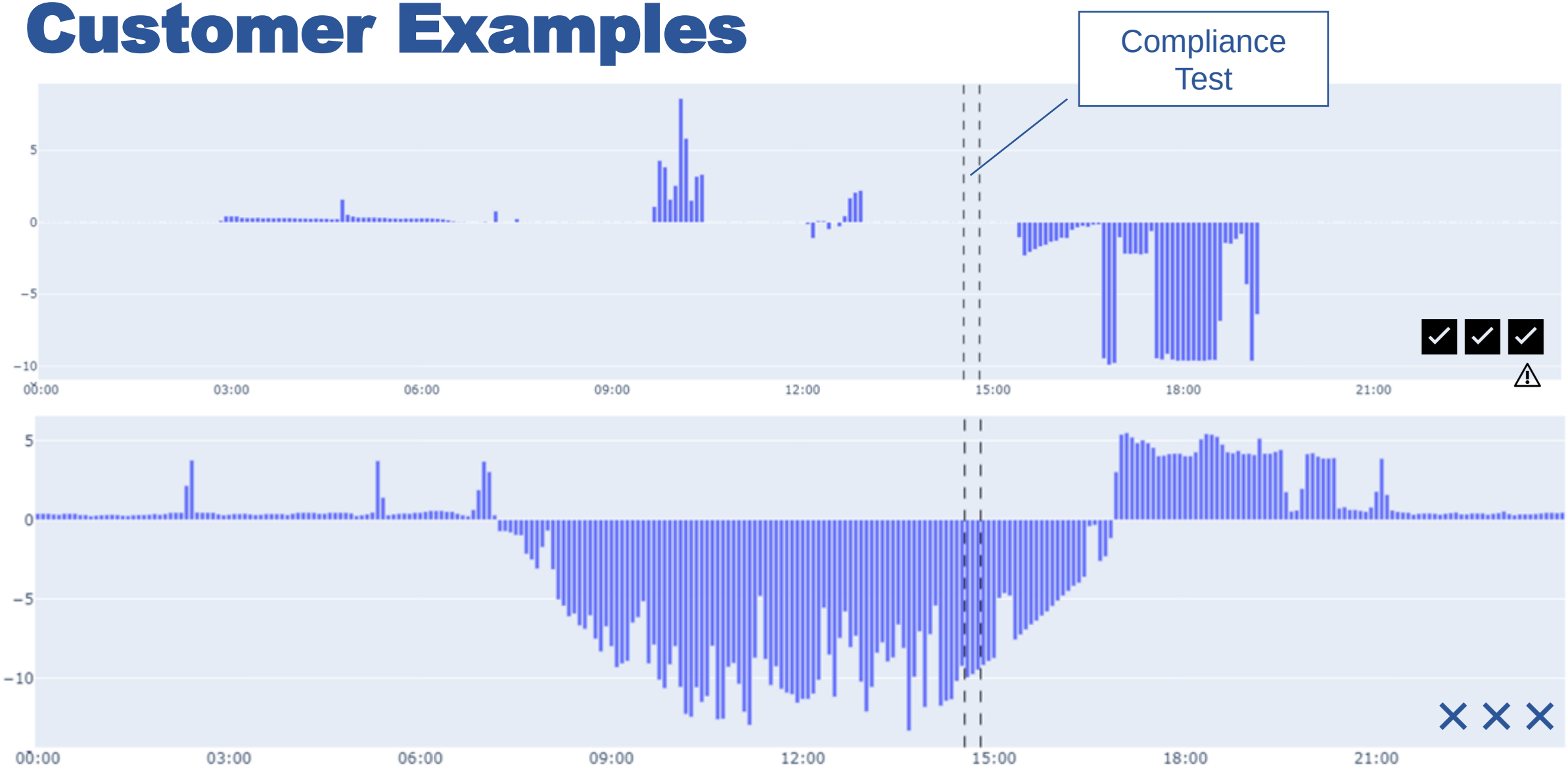


Sites not communicating with server
… so should have been max 1.5 kW Export

# Compliance Rates with Export Limit

What percentage of sampled customers exceeded the expected export limit at the time of the test?

| | ✓ Exporting at or below limit | ✗ Exporting above limit |
|---|---|---|
| Fixed – Full Export | 98% | **2%** |
| Fixed – Partial Export | 55% | **45%** |
| Fixed – Non-Export | 19% | **81%** |
| Dynamic – Unregistered | 24% | **76%** |
| Dynamic – Communicating | 57% | **43%** |

Note: for fixed connections, the max 5 min export for the whole day was used to determine compliance.

# Next Steps

- CSIP-AUS Test Procedures updated with additional tests
- Standards Australia “Behind-the-Meter Interoperability for Inverter Energy Systems” proposal
- Requirement for local storage of forecasts in future CSIP-AUS revision?
- Future mechanism for customers to better diagnose problems
- New Connection Process and Compliance team at Energy Queensland