



AVEVAWORLD
PARIS

Meeting the challenges of a shifting energy market through data analytics

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Agenda

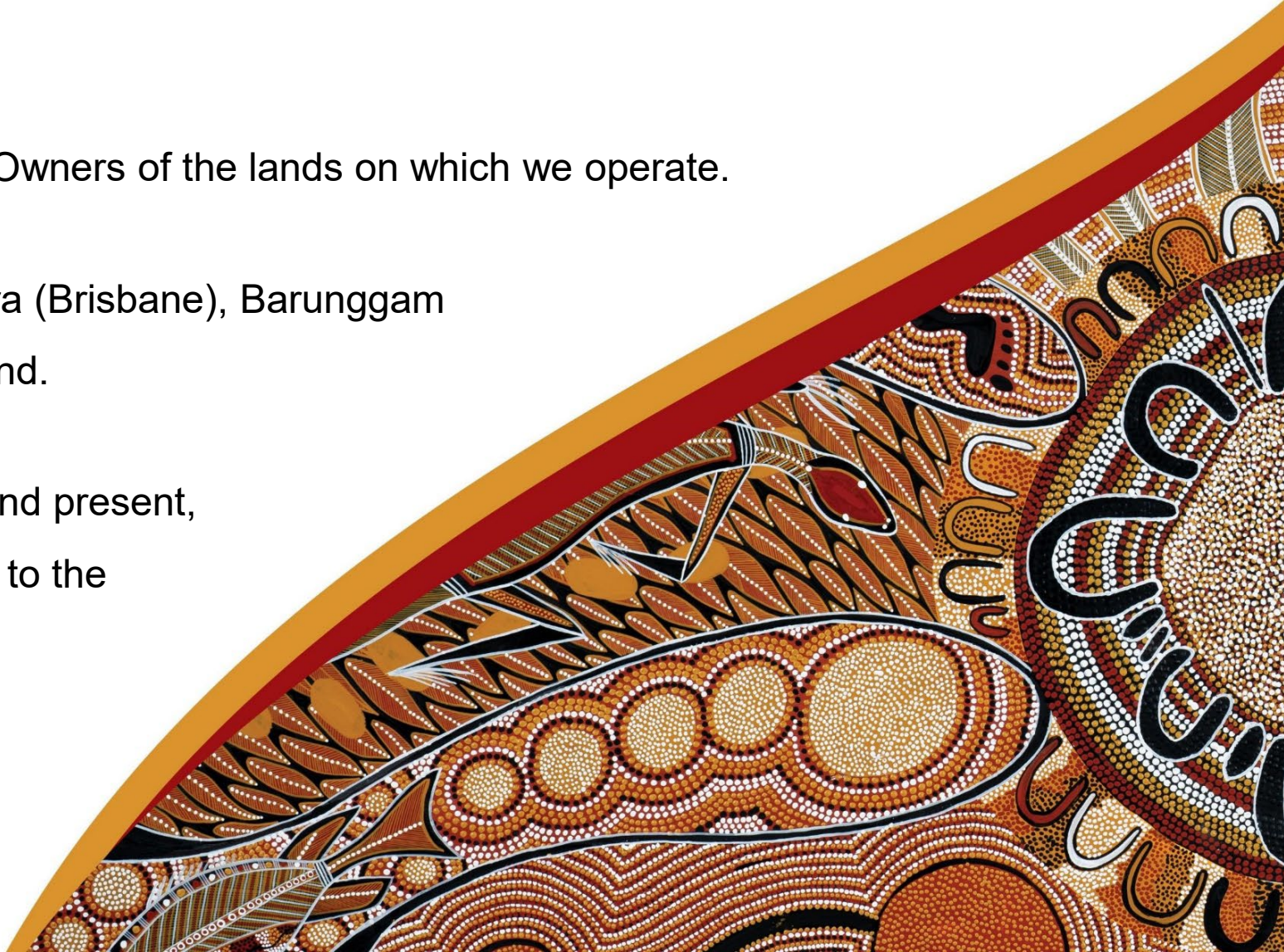
- Acknowledgement of Country
- About CS Energy
- Australia's Electricity Market
- How have operations changed? What are the challenges of transition?
- How has CS Energy responded?
- What's next?

Acknowledgement of Country

CS Energy acknowledges the Traditional Owners of the lands on which we operate.

We live, work, and learn on Turrbal, Yagera (Brisbane), Barunggam (Kogan Creek), and Gaangalu (Callide) land.

We pay our respects to their elders past and present, and recognise their continuing connection to the land, waters, and community.



CS Energy meets market demand through flexible plant operations

Challenge

- Widely varying generation profiles as increased renewables enter the market resulting in negative energy prices
- Unplanned outages resulted in offline units during peak generation demand

Solution

- Leverage AVEVA™ PI System™ to streamline the operations and flex to market and weather conditions

Results

- **Forward planning of maintenance and plant operations based on forecasted weather and market demands (Shifting Outages)**
- **Real Time Monitoring and alerts of remote greenfield sites (Increased Safety and optimised critical resource allocation)**
- **Optimised Asset strategy**



Who is CS Energy?

CS Energy is a Queensland Government-owned energy corporation that was established in 1997. We are a major provider of electricity in Australia with an energy portfolio of more than 3,500 megawatts.



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Coal-fired generation

- 1 Callide B Power Station – 700 MW
- 2 Callide C Power Station – 848 MW, 50/50 JV
- 3 Kogan Creek Power Station – 750 MW
- 4 Gladstone Power Station – 1,680 MW, trading rights

Renewables and firming

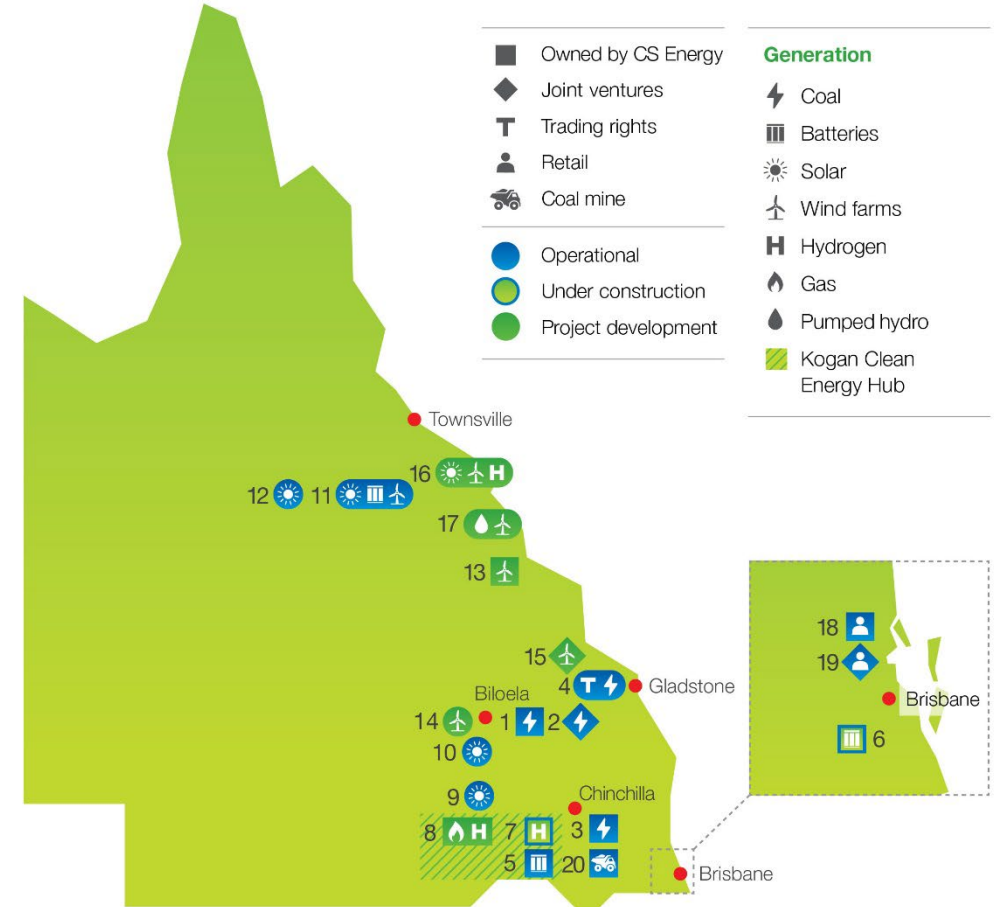
- 5 Chinchilla Battery – 100 MW/200MWh
- 6 Greenbank Battery – 200MW/400MWh
- 7 Kogan Renewable Hydrogen Demonstration Plant
- 8 Brigalow Peaking Power Plant – 400 MW
- 9 Columboola Solar Farm – 162 MW, Power Purchase Agreement
- 10 Moura Solar Farm – 56 MW, Power Purchase Agreement
- 11 Kennedy Energy Park – 60 MW, Offtake Agreement
- 12 Hughenden Solar Farm – 15 MW, Power Purchase Agreement
- 13 Lotus Creek Wind Farm – 285 MW
- 14 Banana Range Wind Farm – 230 MW, multi-party project
- 15 Boulder Creek Wind Farm – 228 MW, 50/50 JV
- 16 HyNQ – multi-party project
- 17 Capricornia Energy Hub – 1.4 GW, multi-party project

Retail

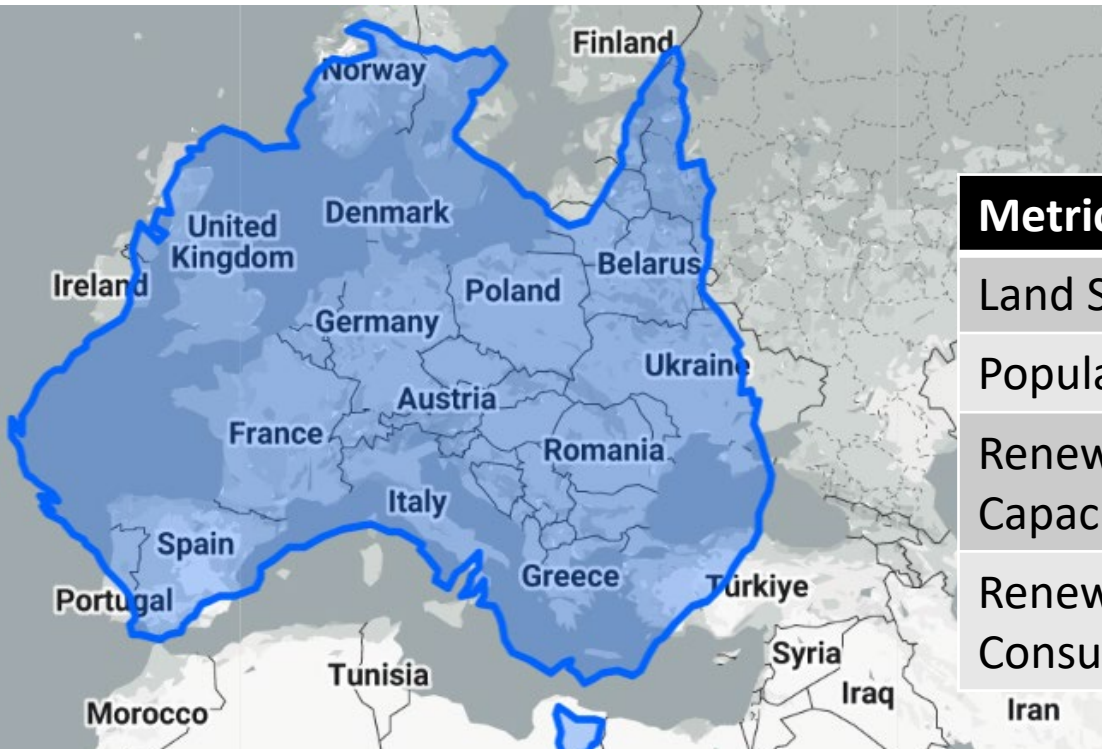
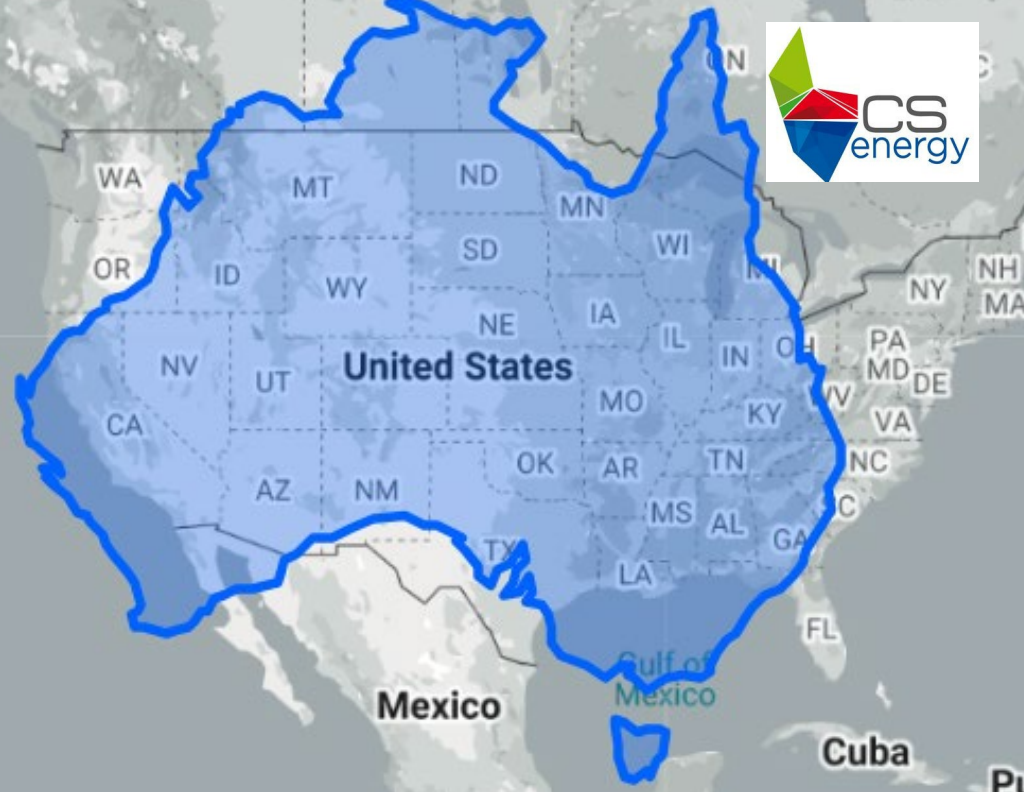
- 18 Large commercial and industrial – Queensland
- 19 Alinta Energy 50/50 joint venture – South East Queensland

Coal assets

- 20 Kogan Mine ML 50074 – 130 Mt, MDL 335 – 400 Mt

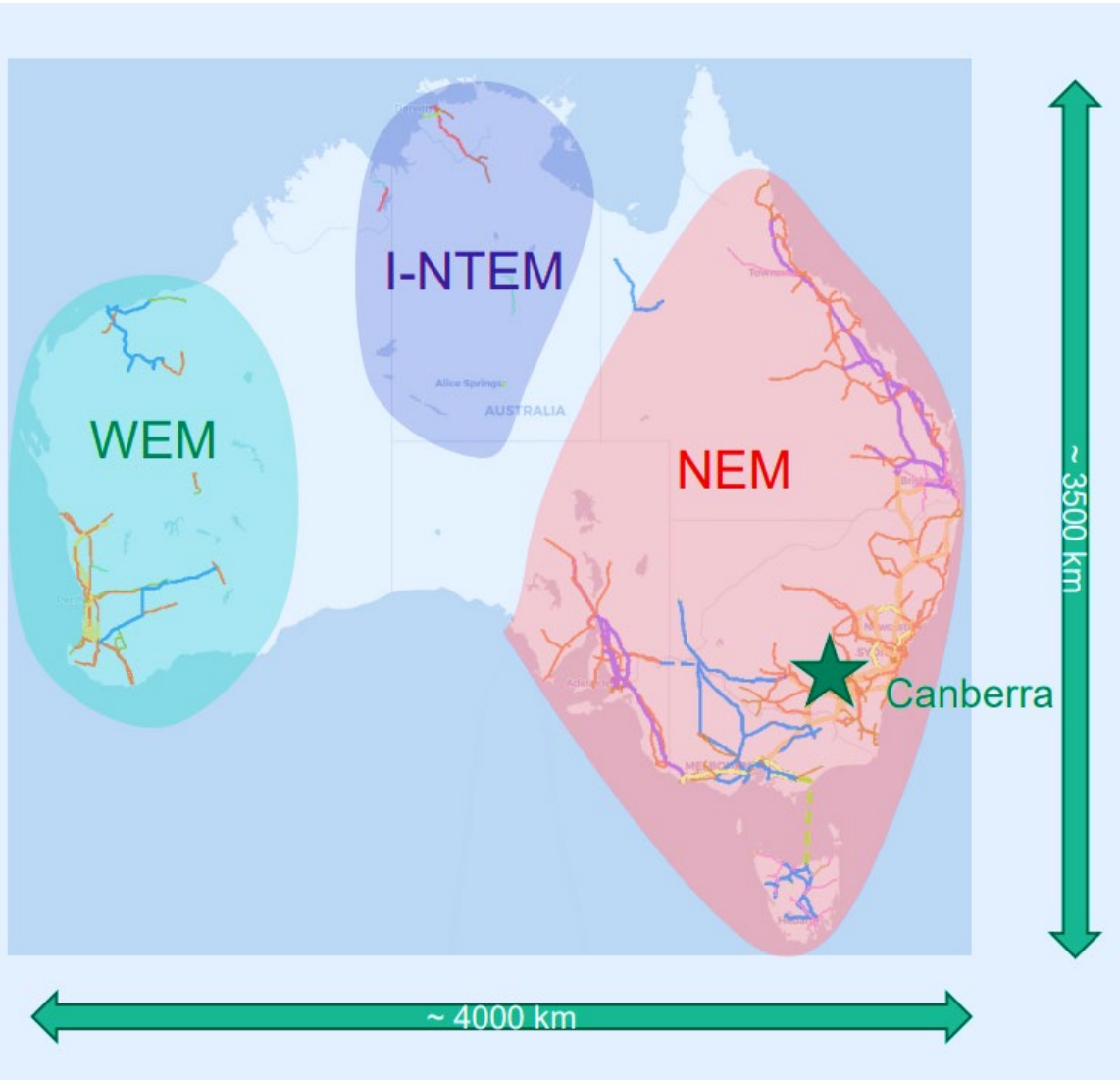


How is Australia different from other countries?



Metric	Australia	Europe	United States
Land Size	7.7 M km ²	10.2 M km ²	9.8 M km ²
Population	~27.1 M	~745.1M	~345.4 M
Renewables - Capacity	38%	23%	22%
Renewables - Consumption	9%	12.4%	9%

Australia's electricity market



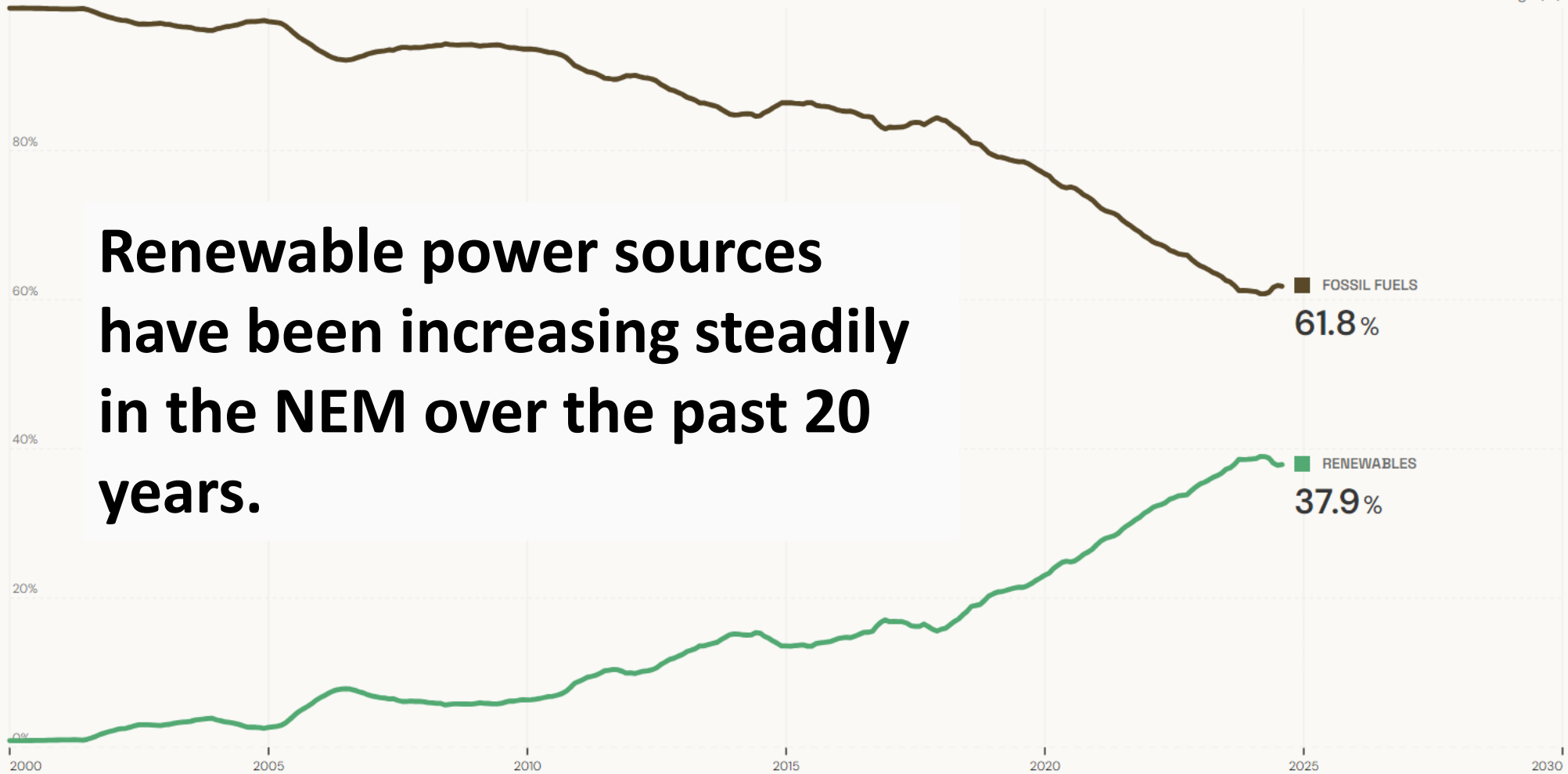
- 3 separate grid networks.
- NEM connects 5 states and 1 Territory
- I-NTEM connects 1 Territory
- WEM connects 1 State
- 5 time zones across the country (4000km, 2 hour difference between East and West Coast)

Australia's electricity transition

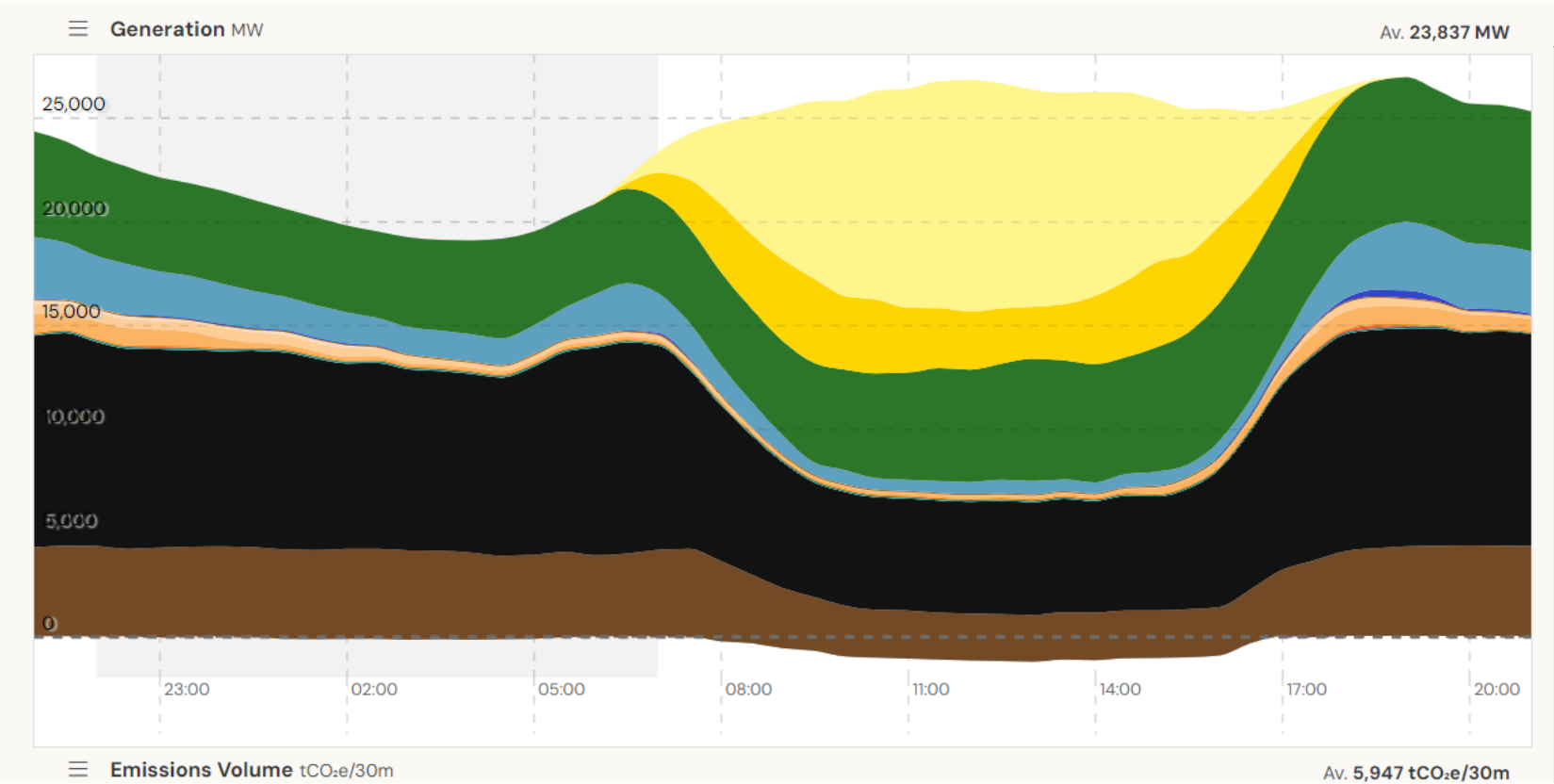


NEM 12 Month Average (%)

**Renewable power sources
have been increasing steadily
in the NEM over the past 20
years.**



NEM daily energy mix



18 Sep 2024, 9:00 PM – 19 Sep 2024, 9:00 PM AEST

Detailed v

Energy **Contribution** **Av.Value**
GWh to demand \$/MWh

Sources

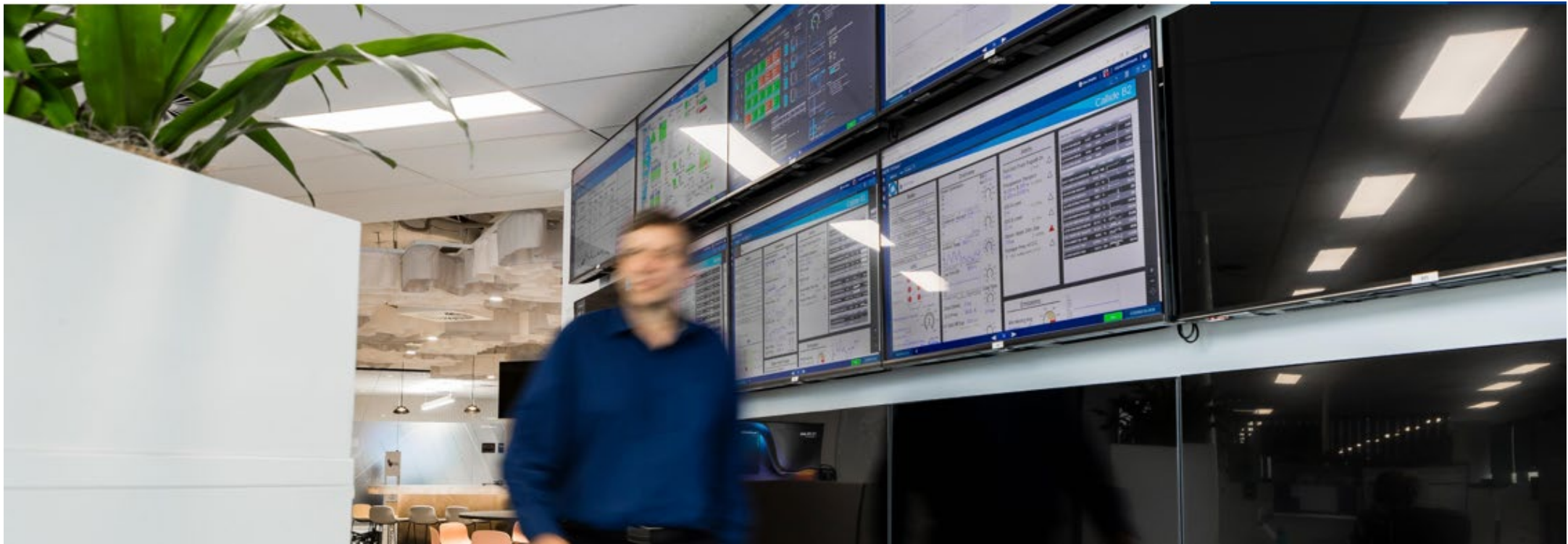
Solar (Rooftop)	81	14.0%	-\$23.04
Solar (Utility)	34	5.8%	-\$15.31
Wind	126	21.8%	\$31.01
Hydro	37	6.3%	\$54.52
Battery (Discharging)	1.0	0.2%	\$53.63
Gas (Waste Coal Mine)	1.2	0.2%	\$34.26
Gas (Reciprocating)	0.8	0.1%	\$94.32
Gas (OCGT)	5.3	0.9%	\$65.05
Gas (CCGT)	8.2	1.4%	\$54.58
Gas (Steam)	2.0	0.3%	\$33.60
Distillate	0.2	0.03%	\$54.99

What does this mean for CS Energy?



- Increased solar take up results in widely varying demand for electricity during the day
- Baseload power provision is disincentivised to maintain constant supply at times of negative prices
- Generation profiles are highly dependent on the weather
- **How do we make our plants more flexible to support the take up of renewable power opportunities?**
- **How to utilise battery storage to manage peak periods?**

How has CS Energy responded?



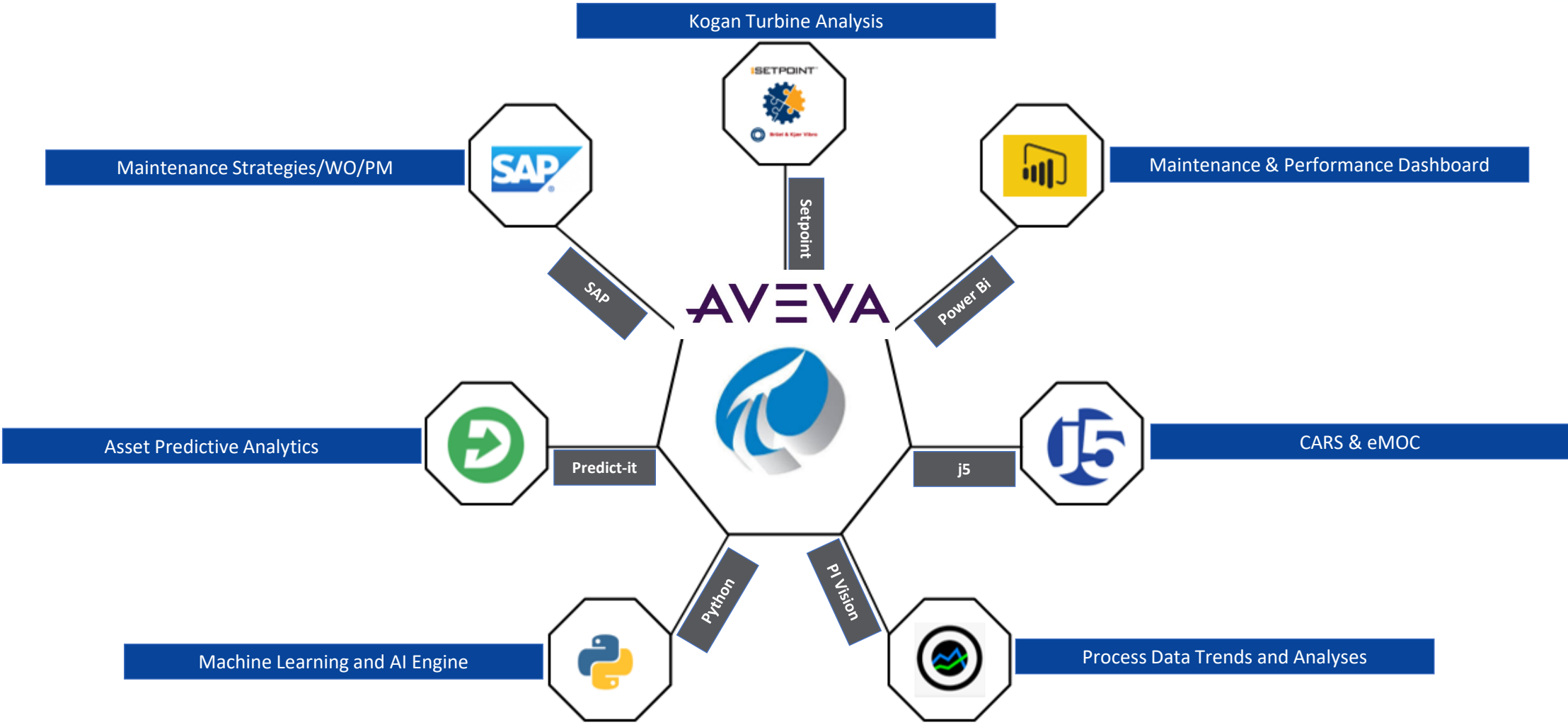
Data analytics



- > Flexible Plant Operations – adjusting plant output
- > Managing maintenance / outages to meet demand profile, Seasonal preparedness
- > Battery deployment

AVEVA PI System

Operational strength through interconnected data and functionality



Flex plant operations using PI



Real Time Monitoring

Real time operating summary of the entire power generation portfolio in PI Vision



Plant flexibility

Ramp up and ramp down based on pool price and plant conditions



Forward planning

Forecasted weather and future data tags – Forward planning and risk mitigation



Run hours

Execute maintenance strategies based on equipment run hours rather than calendar based



Planned outage

Planned outages based on real time asset conditions/historical and forecasted conditions

Flex plant operations using PI



Real time monitoring

Real time operating summary of the entire power generation portfolio in PI Vision

6 Assets

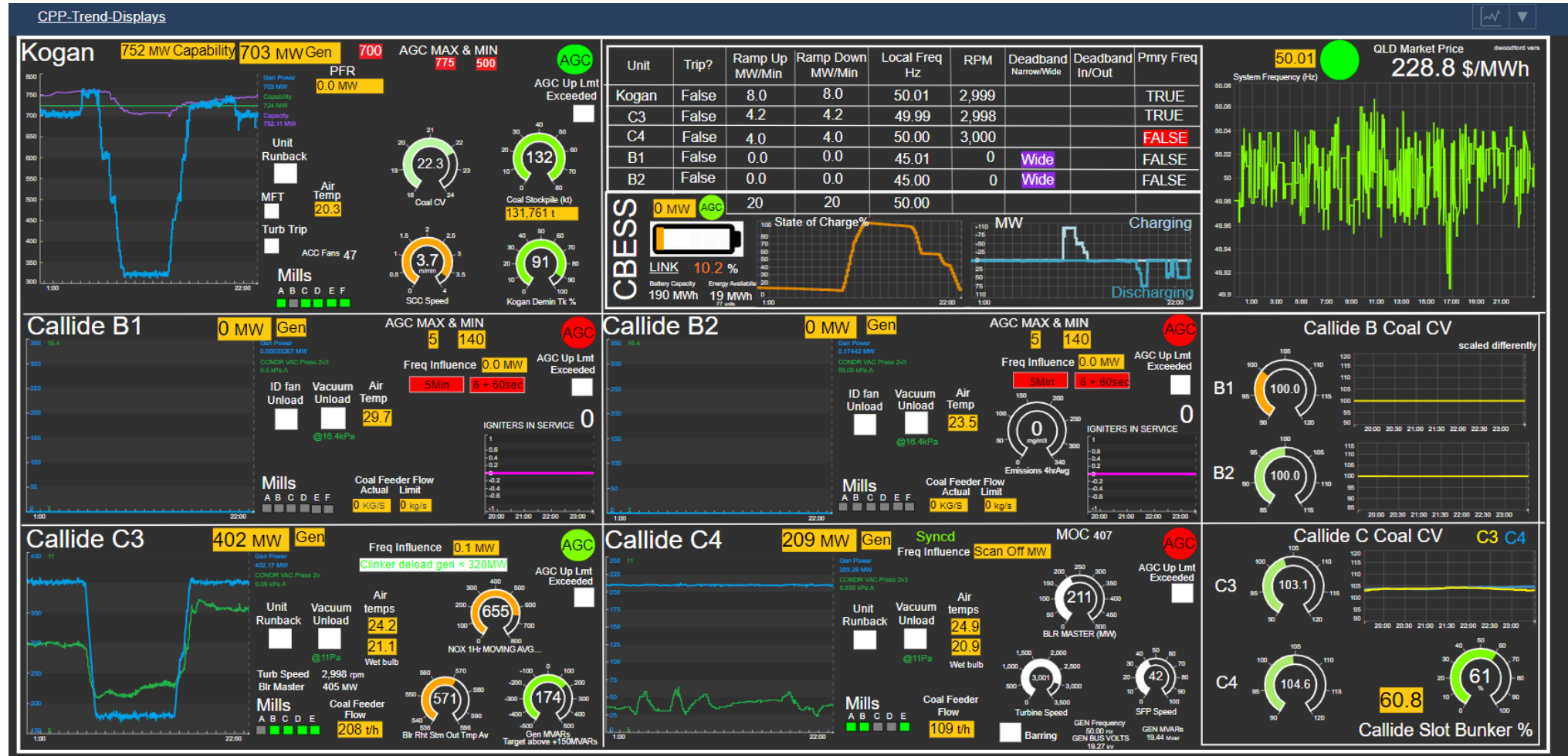
2 PI Corp Servers

100+ Interfaces

2000 + Displays

50+ Data Sources

5k + Analysis



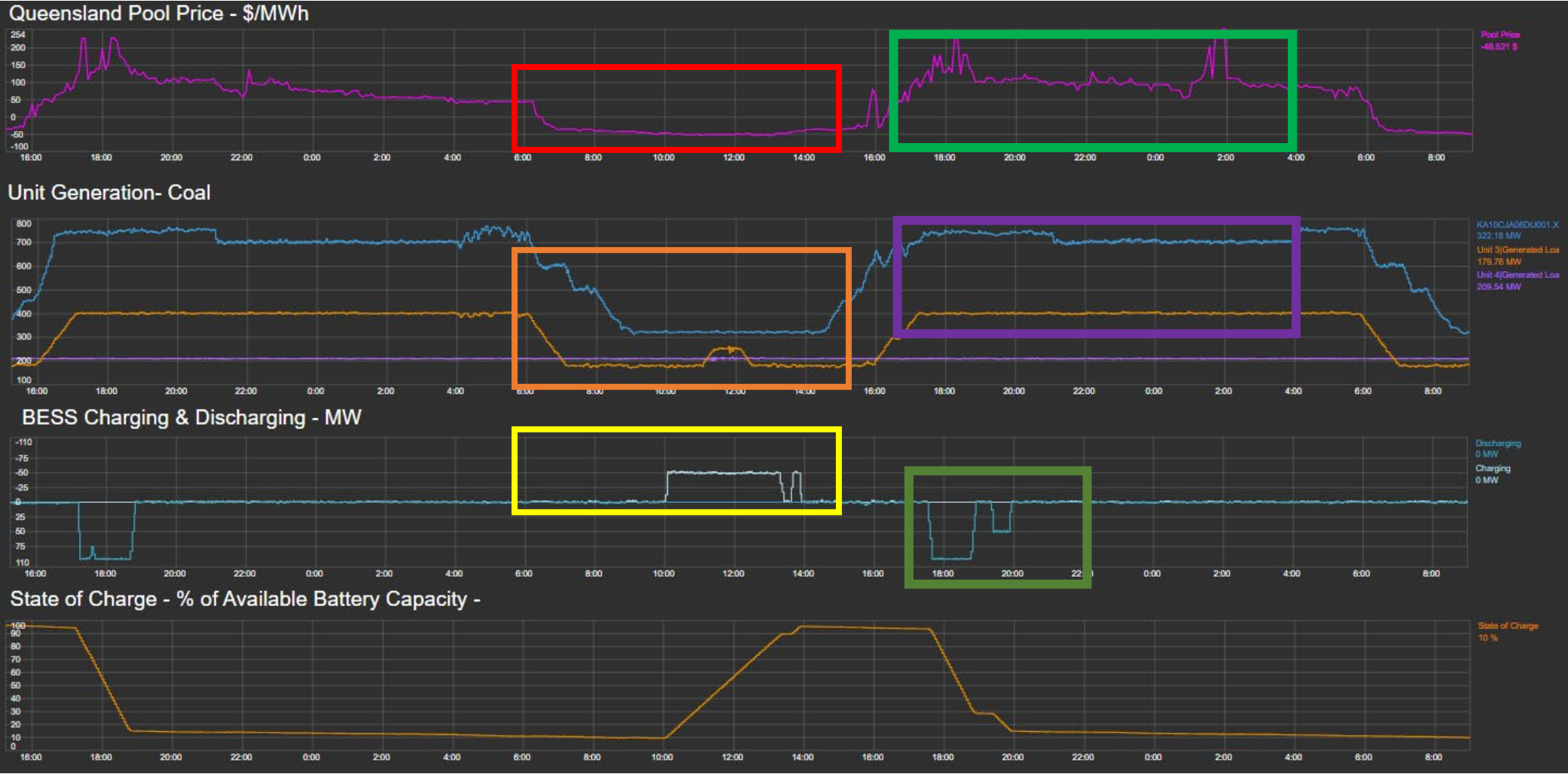
Flex plant operations using PI



Plant flexibility

Ramp up and ramp down based on pool price and plant conditions

Operating Summary of all assets based on Pool Price in the market



Flex operations- forecasting



Forward planning

Forecasted weather and future data tags – Forward planning and risk mitigation

- Kogan
 - In Pit Ash Cell (IPAC)
 - Initial Ash Disposal Area (I...)
 - Out of Pit Ash Cell (OPAC)
 - Weather
 - T+01d
 - T+02d
 - T+03d
 - T+04d
 - T+05d
 - T+06d
 - T+07d
 - T+08d
 - T+09d
 - T+10d
 - T+11d
 - T+12d
 - T+13d
 - T+14d
 - Leakage Monitoring

Name	Expression
st	ParseTime('Starttime')
et	ParseTime(Concat('Starttime', "+1d"))
RainTotalizer	TagTot('Rain Forecast',st, et,"mm", 80, "EventWeighted")
EvaporationTotalizer	-1*TagTot('Evaporation Forecast',st, et,"mm", 80, "EventWeighted")/12

Name	Descriptor	Stored Values	Point Source	Point Type	Digital Set
KA.Rain.Forecast.Daily.Total		Future data	L	Float32	

Kogan Forecast Temperature Data (to extract data to .csv file) (for use in bidding tool)

Next 14 days (Forecast)

Forecast Kogan Generator Output (MW) based on forecast ambient temp above

ROUNDED TO INCREMENTS/STEPS OF 1 MW

LHS Time - MUST BE *

RHS Time - MUST BE *+14d

INSTRUCTIONS

- Ensure RHS & LHS Time periods as per below
- Do NOT click Now button
- Go to Top Right Corner of screen
- Hit save disk button down arrow
- Select option "Export As .csv"
- Open file (bottom left pop up)

Assumptions ACC Fans in Service: **46/48**

- Assumes 48 ACC Fans available
- Does not assume ACC Prohumidification sprays usage
- Curve and dataset used - see image
- Curves to be developed for 47-48 Fans etc in 2023
- Switched Link to ACC Fans Data
- Shows status of all fans

Notes

- Forecast updated daily at ~11:15am ONLY
- Script that picks up data from Source and writes it to PI only starts at 11am daily (takes about ~15mins to run)
- GWCA Data available 0745, 1045, 1645, 2245 weekdays only
- GWCA Data not available/updated Saturdays and Sundays
- Source GWCA data - \\csenergypublic3\Drive\Brisbane\Share\Analytics\YYYYMMDD\forecasts\30mins

ISSUES

- Weather forecast data at night time is typically too low (i.e. actual temps are hotter than predicted at night time)
- hence forecast MW at night time is too high

Next is to build an ACC Prohumidification PI Vision Page

For assumed Damin flow rate, provides MW gain based on Temperature and solen for hours available (try looking at volume of damin water available/remaining in damin tanks for use)

e.g. testing Nov2019 - 2024 (at provided 10MW gain (3.3C day) breakdown was \$1250K)

e.g. usage days - 11-13 Jan 2023, 3 Feb 2023, 28 Mar 2023, 6&6 Feb 2024 (~15MW gain at 250M3/hr)

Driving value-Maintenance strategy



Run hours

Execute maintenance strategies based on equipment run hours rather than calendar based

Asset management strategy



- Calendar Time based strategy

Asset management strategy



- Flexible condition-based maintenance
- Use real time data
- Equipment performance.

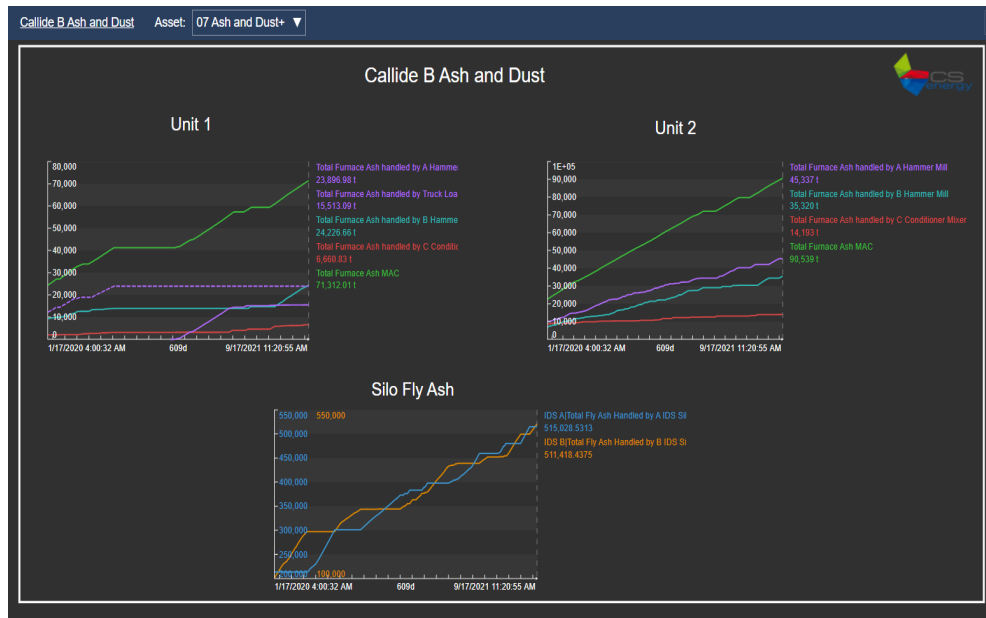
Benefits



Material Cost

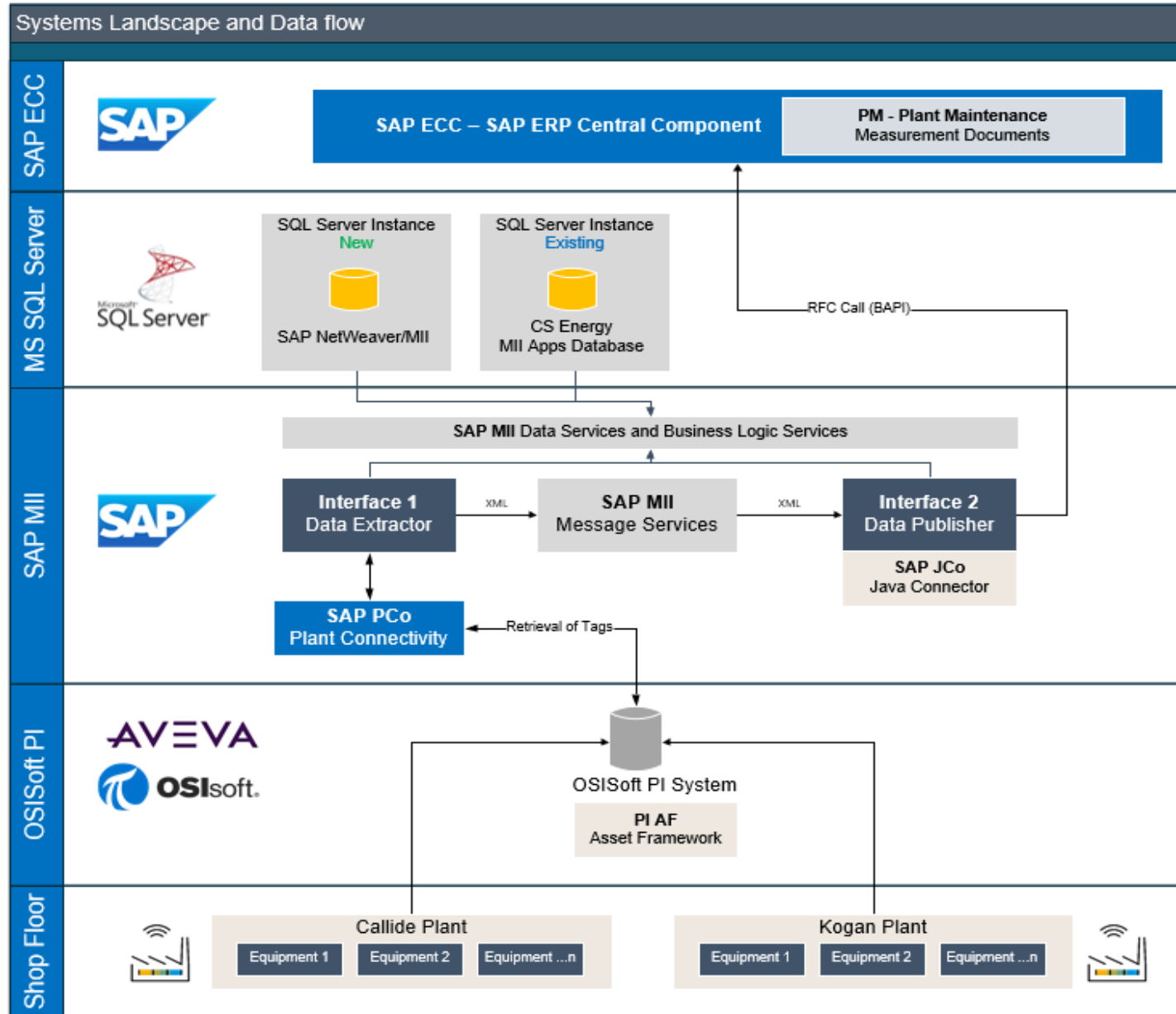


Labour optimised

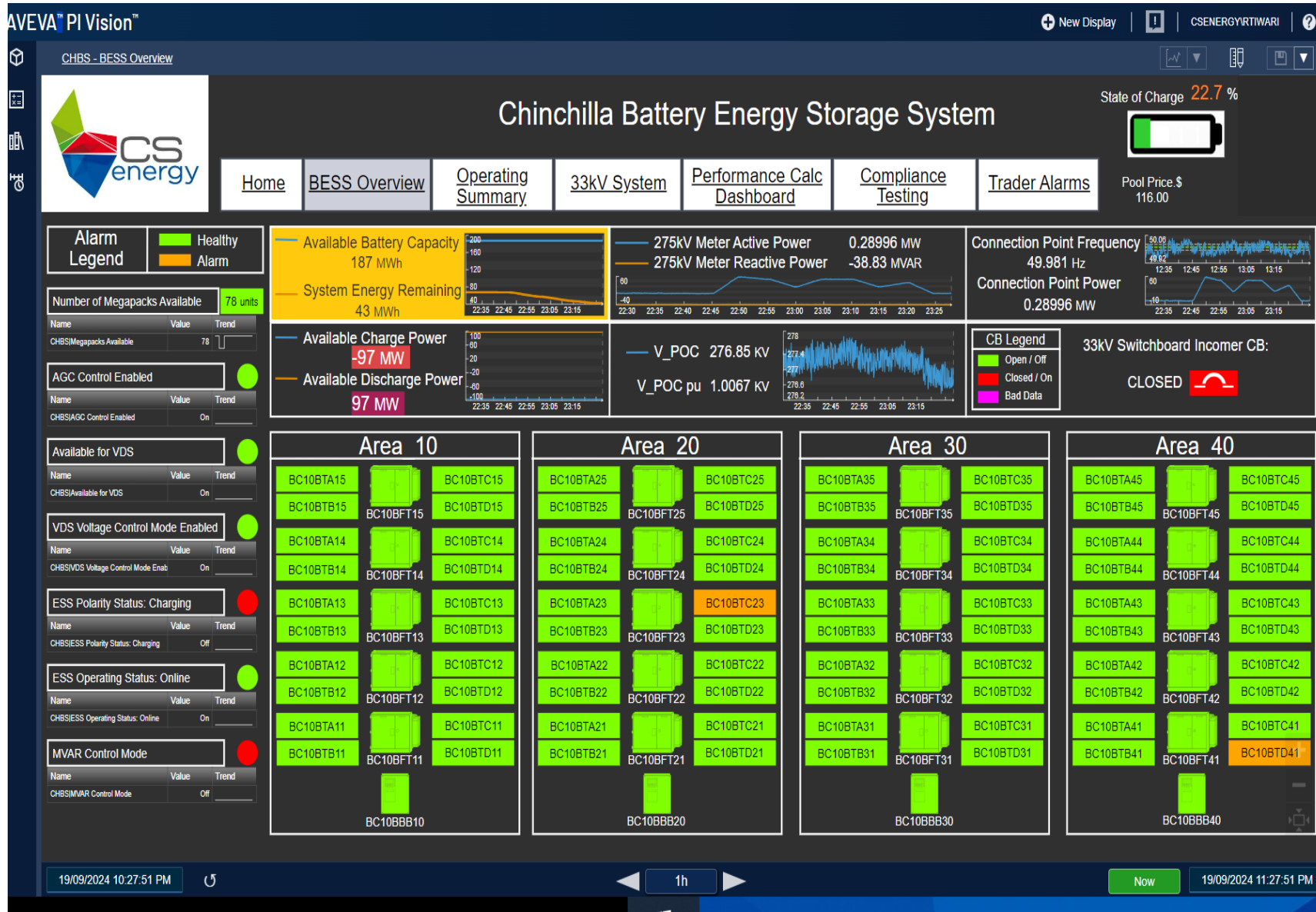


01 Fuel Supply Systems	
General Child Elements Attributes Ports Analyses Notification Rules Version	
Filter	
Name	Value
W0 Tonnes Per Shift CV Adjusted	0 t
W1	3.1975E+05 t
W2	9191790 t
W3	9193843 t
Category: Weigher	
Conveyors C2 Tonnes Weigher Daily Totaliser	135006 t
Conveyors C1-1 WEIGHER Daily Totaliser	22879901 t
Conveyors C1-2 WEIGHER Daily Totaliser	23072704 t
Conveyors S1 and S2 Totalisers	6699779 t
R4 Conveyor Coal Totaliser	63127 t
W2 R2 Weigher	980 t/h
W2 R2 Weigher Totaliser	47415152 t
W3 R3 Weigher	938 t/h
W3 R3 Weigher Totaliser	43961009 t
W4 C3-1 WEIGHER	-0.36 t/hr
W4 C3-1 WEIGHER Totaliser	12735124 t
W5 C3-2 WEIGHER	717.96 t/hr
W5 C3-2 WEIGHER Totaliser	8650340 t
W6 + W7 Weigher Totaliser	25326524 t
W6 B3-1 Weigher	0.54
W6 B3-1 Weigher Totaliser	10915951 t
W7 B3-2 Weigher	-1.44 t/h
W7 B3-2 Weigher Totaliser	14750096 t
W8 B2-1 WEIGHER	0.18 t/hr
W8 B2-1 WEIGHER Totaliser	9960714 t
W9 B2-2 WEIGHER	Scan Off
W9 B2-2 WEIGHER Totaliser	10537431 t
W10 S3 Weigher	0.375 t/h
W10 S3 Weigher Totaliser	7692454 t

Architecture - Maintenance Strategy



CHBS Dashboard- Battery



CHBS Dashboard shows:

- Total Battery Output
 - Available Battery Capacity
 - System Energy Remaining
 - Active and Reactive Power
 - Connection Point Frequency
- Number of Megapacks available (CHBS is made of 80 megapacks each delivering 1.25 MW)
- Lower half of the dashboard has overview of the process alarms
- Operating Summary Tab provides the performance in Real Time

CHBS Megapack Level Dashboard

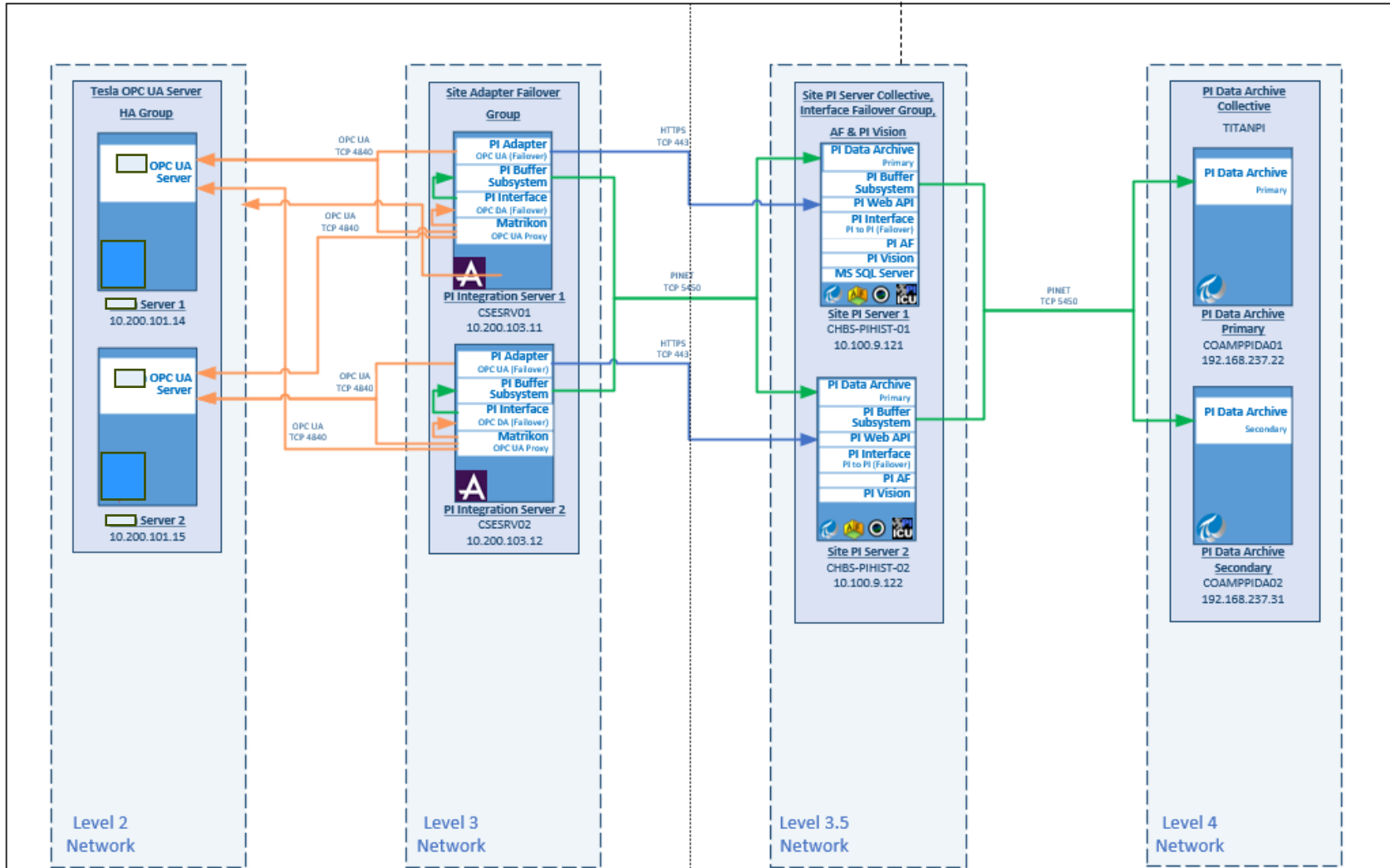


CHBS Megapack level dashboard shows:

- Trending Analog data
 - Available Charge Power
 - Available Discharge Power
 - Active Power Output
 - Maximum Battery Temperature
 - SOC (State of Charge)
- AC breaker Digital Status
- All the Process megapack alarms with the process data



CHBS PI Architecture- Battery

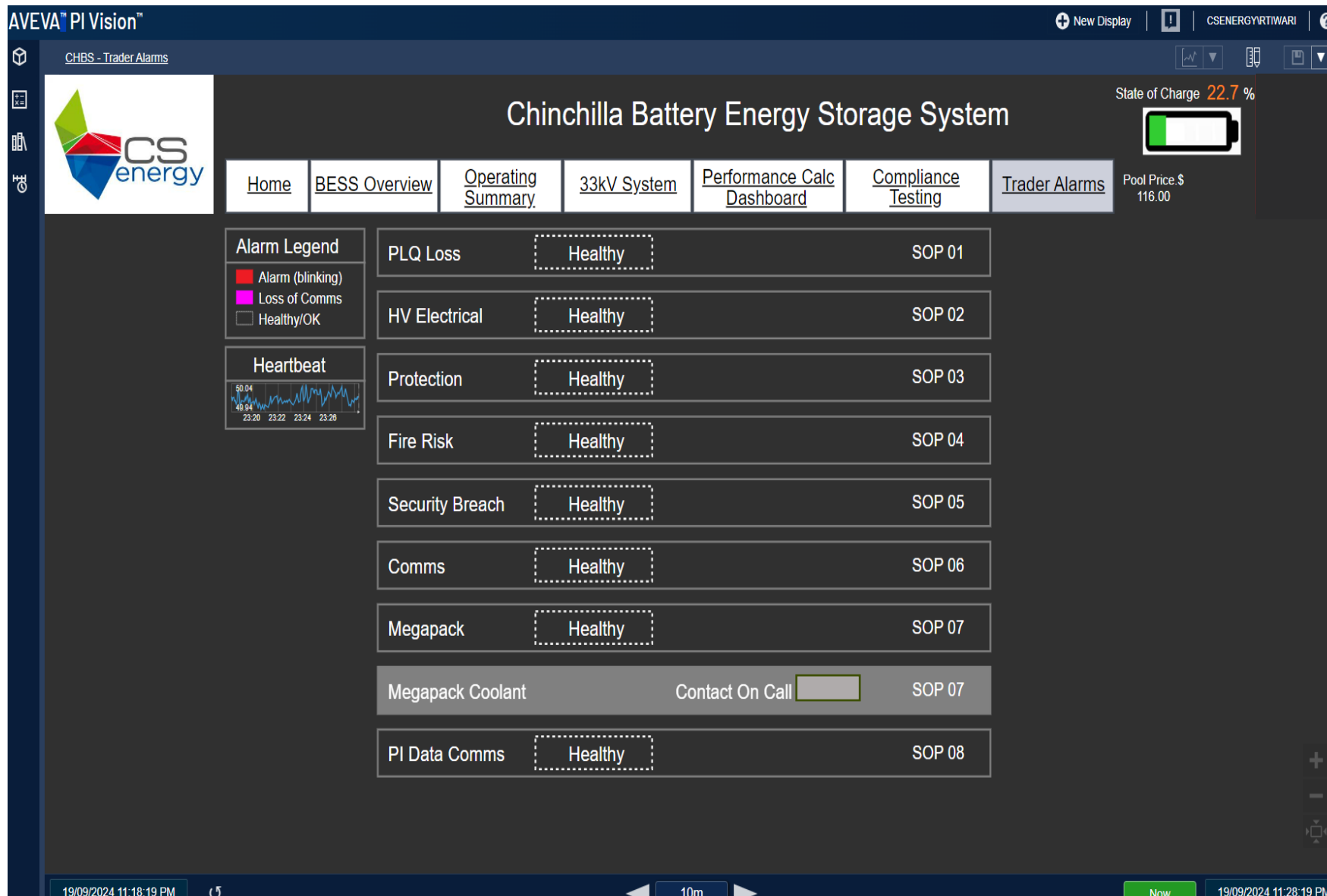


- PI UA Adapter as the OPC UA interface
- PI Adapter on the OT side rather than the DMZ side
- Server maintenance outage is always dependent on the vendor outage schedule
- Data loss will not occur for outages on DMZ or IT
- New Polling feature of PI OPC UA adapter updates the digital tag status with timestamp details

Prepared for	Revision No	Description	Date
CS Energy	1.0	CHBS PI System Architecture	2023-11-15
Project #	Title		
4384	CHBS PI System Architecture		



Critical alarms- BESS



- Critical Alarms have been categorised as per system criticality
- Pi Alarm Dashboard for assists with market regulation compliance
- Physical Traders can run the Battery Operations from Corporate office
- PI notifications are enabled for any critical alarms
- Historical data is used to compare RTU/Scada with PI alarms and fault finding

AF hierarchy and Rollup



Elements

- Elements
 - Trader Alarms
 - Comms
 - Area_10
 - Area 10 Megapacks
 - Area_20
 - Area 20 Megapacks
 - Area_30
 - Area 30 Megapacks
 - Area_40
 - Area 40 Megapacks
 - General
 - Fire Risk
 - Fire Panel
 - HV Electrical
 - 33kV Circuit Breakers
 - Aux Transformer
 - Busbar & Incomer
 - RMU
 - Transformers
 - Megapack
 - Area_10
 - Area_20
 - Area_30
 - Area_40
 - PI Data Comms
 - PLQ Loss
 - Protection
 - Security Breach
 - zz...GlobalConfiguration

Elements

- Elements
 - Trader Alarms
 - Area_10
 - Area 10 Megapacks
 - Area_20
 - Area 20 Megapacks
 - Area_30
 - Area 30 Megapacks
 - Area_40
 - Area 40 Megapacks
 - General
 - Fire Risk
 - Fire Panel
 - HV Electrical
 - 33kV Circuit Breakers
 - Aux Transformer
 - Busbar & Incomer
 - RMU
 - Transformers
 - Megapack
 - Area_10
 - BC10BTA11
 - BC10BTA12
 - BC10BTA13
 - BC10BTA14
 - BC10BTA15
 - BC10BTB11
 - BC10BTB12
 - BC10BTB13
 - BC10BTB14
 - BC10BTB15
 - BC10BTC11
 - BC10BTC12
 - BC10BTC13
 - BC10BTC14
 - BC10BTC15
 - BC10BTD11
 - BC10BTD12
 - BC10BTD13
 - BC10BTD14
 - BC10BTD15
 - Area_20

Area_10

General Child Elements Attributes Ports Analyses Notification Rules Version

Name	Backfilling
Alarm State	✓
Coolant Alarm State	✓

Name: Alarm State
 Description:
 Categories:
 Analysis Type: Expression Rollup Event Frame Generation SQC

Rollup attributes from
 Child elements of Area_10 This element - Area_10

To select attributes set criteria below

Attribute Name: Alarm State
 Attribute Level: Root Level
 Attribute Category: Trader Alarm
 Element Category:
 Element Template:

Select the function(s) to write to an attribute Evaluate

Function	Output(s)	Value At Eval	Value At Last
<input type="checkbox"/> Sum			
<input type="checkbox"/> Average			
<input type="checkbox"/> Minimum			
<input checked="" type="checkbox"/> Maximum	Alarm State		
<input type="checkbox"/> Count			
<input type="checkbox"/> Median			
<input type="checkbox"/> Population standard deviation			
<input type="checkbox"/> Sample standard deviation			

Name	Parent Element	Ca
Alarm State	BC10BTA11	Trader Alarm
Area Name	BC10BTA11	Metadata
Area Number	BC10BTA11	Metadata
Coolant Low	BC10BTA11	Real-Time Status
Coolant Low Alarm	BC10BTA11	Child Alarm;Trader Alarm
Extreme Temperature Fault	BC10BTA11	Real-Time Status
Extreme Temperature Warning	BC10BTA11	Real-Time Status
Inverter Over Temp	BC10BTA11	Real-Time Status
Iso Failure	BC10BTA11	Real-Time Status
Maximum Battery Temperature	BC10BTA11	Real-Time Analog
Megapack KKS	BC10BTA11	Metadata
Megapack Number	BC10BTA11	Metadata

What's next?



- Implementing Predictive Analytics across thermal and renewable assets
- Intensive monitoring of plant condition under flexible operations
- Regulatory Compliance Reporting (Availability, Environmental and Reliability)
- Improve Commercial Availability
- Analyse battery performance over the medium term

