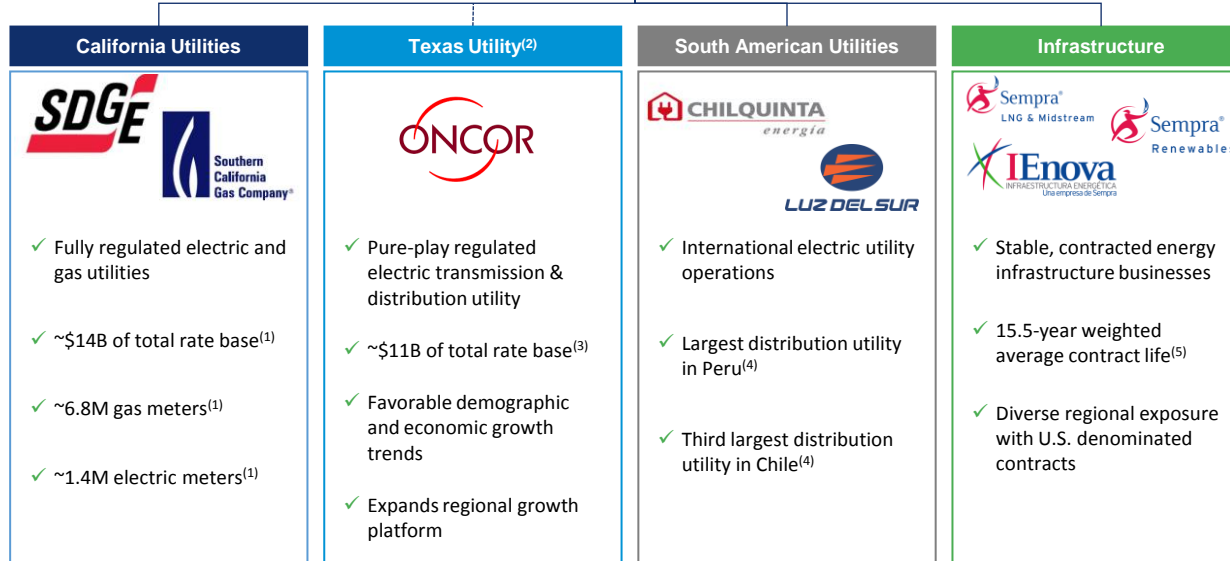


Redefining Renewables SCADA



David Jeon, Technical Services
Manager - Sempra Renewables



(1) As of September 30, 2017.

(2) Pending Merger, subject to closing conditions, including the receipt of approval of the Public Utility Commission of Texas and US Bankruptcy Court of Delaware, among others. There can be no assurance that the Merger will be completed on the terms or timetable currently contemplated, or at all.

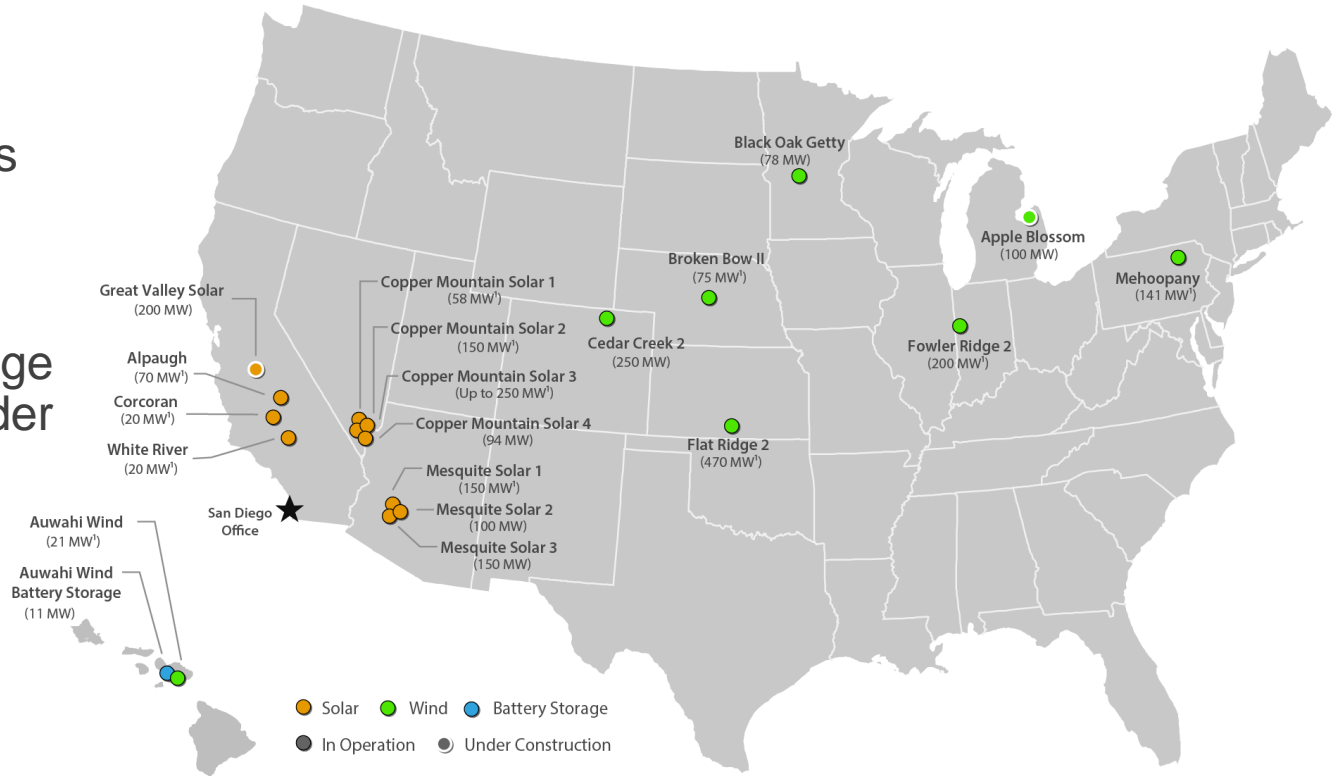
(3) As of December 31, 2016.

(4) Reflects local regulators 2016 annual statistical reports; Ministro de Energía y Minas (Peru), and Comisión Nacional De Energía (Chile).

(5) Contract life primarily relates to contracts with customers for energy transportation, delivery, storage, generation and processing and other services, and is comprised of the remaining life of current contracts after September 30, 2017 or the full life of contracts starting after that date; includes renewables assets, Cameron LNG facility and IEnova. Sempra owns 66.4% of IEnova and a 50.2% joint venture interest in the Cameron LNG facility. The ability to successfully complete major construction projects, including the Cameron LNG facility currently under construction, is subject to a number of risks and uncertainties. Please refer to the "Risk Factors" section of our most recent Annual Report on Form 10-K and the "Factors Influencing Future Performance" section of our most recent Quarterly Report on Form 10-Q for a description of the risks and other factors associated with these opportunities.

Sempra Renewables

Over 3,000 MW of solar, wind, and battery energy storage in operation and under development and construction



(1) Sempra's ownership is 50%





Case Study: Retrofitting SCADA at Great Valley Solar

- Great Valley Solar is located just outside of Fresno, CA
- It is made up of four sites:
 - Rojo – 100 MW
 - Verde – 60 MW
 - Amarillo – 20 MW
 - Azul – 20 MW
- All sites are tied together at a single Substation
- The sites were built with five separate SCADA systems, one for each site plus the Ocho Substation

What is SCADA ?

Standard vs Advanced

Standard SCADA for Solar

- Need to custom configure to all end devices and HMI Screens
- Standard PID loops to control three (3) loops, Power and combination of Var/Voltage/PF
 1. Power & Var
 2. Power & Voltage
 3. Power & Power FactorBoils down to controlling Active and Reactive Power.
- Costly to deploy, commissioning time is in months.
- Typical solutions ranging from PLCs to DCSs and other options in between.
- Need to add Data Historian, whether it's a system version or third party solution.
- Heavy engineering work required to tie in storage.

Its main duty is Data Collection, a very expensive data collector.

Next Generation SCADA for Solar

(PXiSE SCADA Embedded with PI System)

- Template configuration to all end devices.
 1. Leverage 400+ Interfaces available in PI to communicate to multitudes of end devices
 2. Leverage PI AF to minimize error on end device configuration
 3. Faster checkout
- Advanced PID with feed forward to control three (3) loops, Power and combination of Var/Voltage/PF
 1. Power & Var
 2. Power & Voltage
 3. Power & Power FactorCombination of active and reactive power control at 60 Hz vs 1 Hz
- Economical to deploy, commissioning time is weeks.
- Off the shelf hardware, SEL3355 industrial computer or a Server Class Computer
- Built in OSIsoft PI Historian.
- Advanced Energy Storage control ready.

Efficient Data Collection and intelligent control that leverages the strength of the OSIsoft PI System.

Solving the Complexity of Renewable SCADA



To most EPCs in the renewables sector, SCADA has always been the most complex part of the project. Without heavy oversight it is often overlooked and rushed. Most of the time they lack the expertise and have to rely on contractors.



CHALLENGE

Great Valley Solar has five (5) SCADA systems to manage 4 sites.

- The existing system was not flexible or scalable to manage the 4 sites.
- Time consuming to deploy, tedious to commission.
- Another system to manage in the Remote Operation Center (ROC)

SOLUTION

PXiSE ACT was utilized to provide for the single SCADA for the facility

- PI AF was leveraged to setup the database
- PI Vision was used for the HMI.

RESULTS

Through the PXiSE ACT solution, we have a single system that ties the 4 sites together.

- PXiSE ACT provides a single Web based control screen for the operators.
- Underlying PI structure makes it easy to maintain and use.



Standard SCADA Challenges

- Operators requires 5 separate HMI stations to operate the site.
- 5 licenses needed to be managed and maintained.
 - High O&M cost
 - Heavy reliance on contractor O&M service.
- Tied to the operating system
 - Microsoft OS's have end of life date!
 - Potential for whole system upgrade due to OS expiration.
- Database and HMI needs to be manually configured.

Advanced SCADA Solution



- Leverage the strength of PXiSE ACT and OSIsoft PI System.
 - Initially a joint venture formed between Sempra Energy and OSIsoft.
 - Underlying structure is OSIsoft PI platform integrated with high-speed advanced control and data analytics
- 1 license need to be managed and maintained.
 - Low O&M cost
- Loosely tied to the operating system
 - Because the platform is software based, just an update on software is needed.
- Database and HMI are self replicating. PI AF database and PI Vision are used.

Benefits and Implications



- Easier and faster to deploy
 - All 4 sites are treated as one under a single platform.
 - Simple configuration easily scaled and deployed in weeks
 - Unified Alarm system.
- Lower cost to implement and operate
 - Lower field installation cost
 - Lower O&M cost – software license cost decreased by a factor of 4.
- Better performance with intelligent controls
 - Energy Storage ready.
 - Unifying control for Remote Operations Center (ROC).
- Applicable in large scale wind farm or solar farm with or without Battery Energy Storage System (BESS)

Solving the Complexity of Renewable SCADA



To most EPCs in the renewables sector, SCADA has always been the most complex part of the project. Without heavy oversight it is often overlooked and rushed. Most of the time they lack the expertise and have to rely on contractors.



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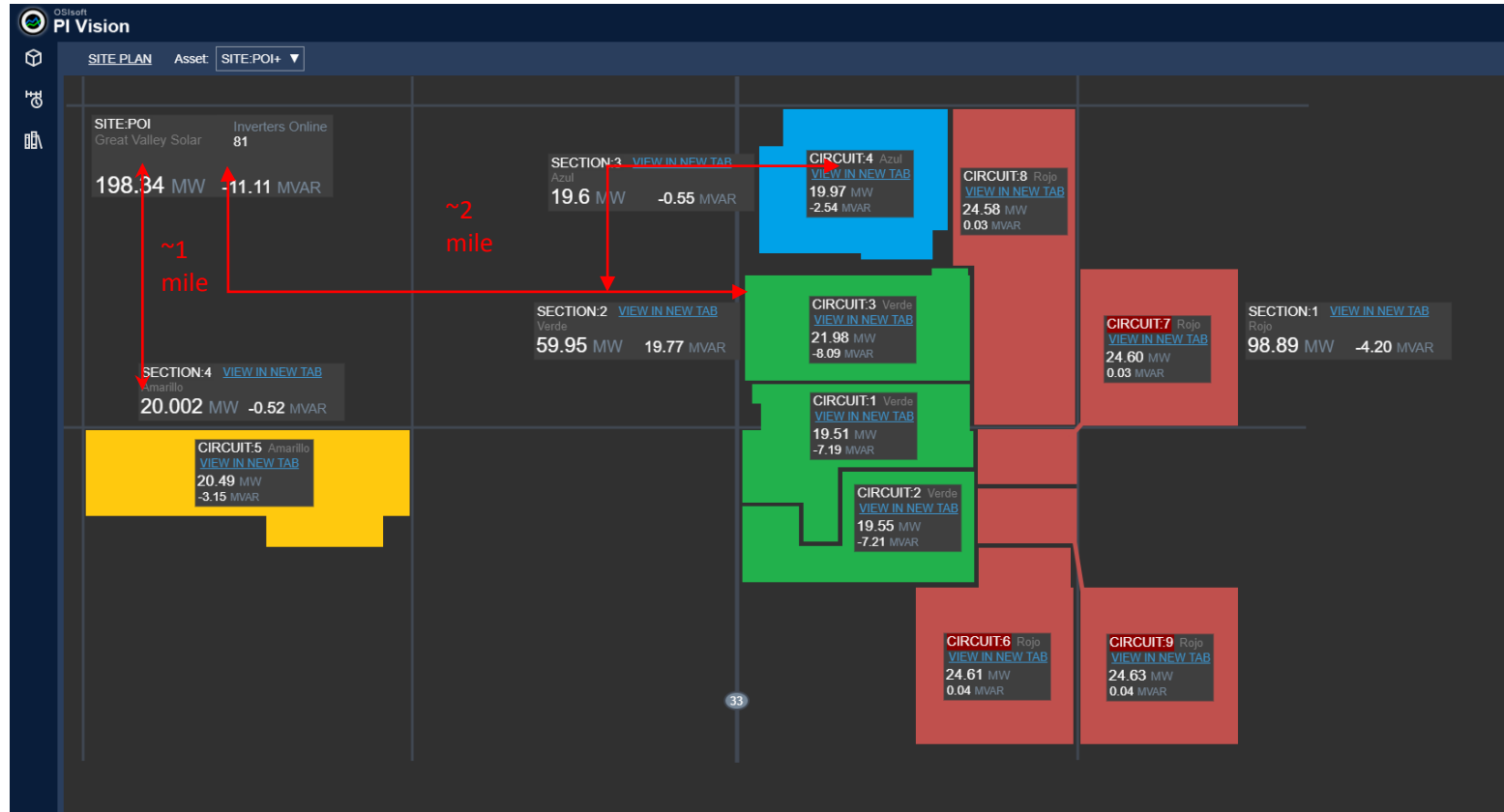
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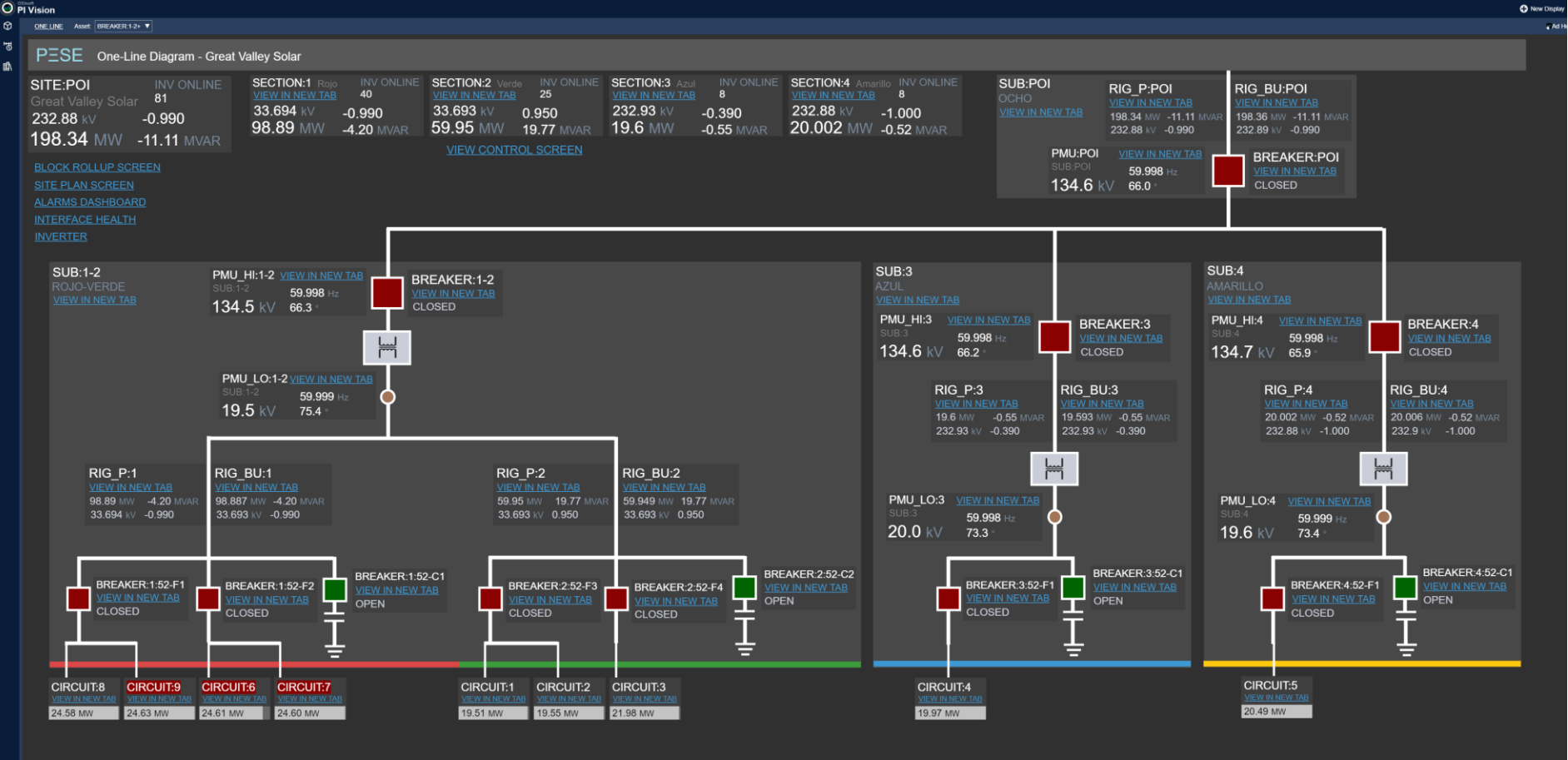
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Great Valley Solar







BLOCK ROLLUP

Asset: RIG_P:POH+ ▼



198.34 MW



232.88 kV



1 | Rojo

98.887 MW

CIRCUIT:9

[VIEW IN NEW TAB](#)

24.63 MW

BLOCK:55

[VIEW IN NEW TAB](#)

2.467 MW

BLOCK:56

[VIEW IN NEW TAB](#)

2.465 MW

BLOCK:75

[VIEW IN NEW TAB](#)

2.469 MW

BLOCK:76

[VIEW IN NEW TAB](#)

2.464 MW

BLOCK:77

[VIEW IN NEW TAB](#)

2.458 MW

BLOCK:78

[VIEW IN NEW TAB](#)

2.463 MW

BLOCK:79

[VIEW IN NEW TAB](#)

2.458 MW

BLOCK:80

[VIEW IN NEW TAB](#)

2.472 MW

BLOCK:81

[VIEW IN NEW TAB](#)

2.453 MW

BLOCK:82

[VIEW IN NEW TAB](#)

2.456 MW

CIRCUIT:8

[VIEW IN NEW TAB](#)

24.58 MW

BLOCK:57

[VIEW IN NEW TAB](#)

2.456 MW

BLOCK:58

[VIEW IN NEW TAB](#)

2.454 MW

BLOCK:59

[VIEW IN NEW TAB](#)

2.460 MW

BLOCK:60

[VIEW IN NEW TAB](#)

2.455 MW

BLOCK:61

[VIEW IN NEW TAB](#)

2.448 MW

BLOCK:62

[VIEW IN NEW TAB](#)

2.461 MW

BLOCK:63

[VIEW IN NEW TAB](#)

2.456 MW

BLOCK:64

[VIEW IN NEW TAB](#)

2.461 MW

BLOCK:65

[VIEW IN NEW TAB](#)

2.465 MW

BLOCK:66

[VIEW IN NEW TAB](#)

2.460 MW

CIRCUIT:7

[VIEW IN NEW TAB](#)

24.60 MW

BLOCK:53

[VIEW IN NEW TAB](#)

2.456 MW

BLOCK:54

[VIEW IN NEW TAB](#)

2.464 MW

BLOCK:67

[VIEW IN NEW TAB](#)

2.454 MW

BLOCK:68

[VIEW IN NEW TAB](#)

2.454 MW

BLOCK:69

[VIEW IN NEW TAB](#)

2.458 MW

BLOCK:70

[VIEW IN NEW TAB](#)

2.463 MW

BLOCK:71

[VIEW IN NEW TAB](#)

2.457 MW

BLOCK:72

[VIEW IN NEW TAB](#)

2.460 MW

BLOCK:73

[VIEW IN NEW TAB](#)

2.467 MW

BLOCK:74

[VIEW IN NEW TAB](#)

2.468 MW

CIRCUIT:6

[VIEW IN NEW TAB](#)

24.61 MW

BLOCK:42

[VIEW IN NEW TAB](#)

2.465 MW

BLOCK:43

[VIEW IN NEW TAB](#)

2.465 MW

BLOCK:44

[VIEW IN NEW TAB](#)

Calc Failed

BLOCK:45

[VIEW IN NEW TAB](#)

2.468 MW

BLOCK:46

[VIEW IN NEW TAB](#)

2.457 MW

BLOCK:47

[VIEW IN NEW TAB](#)

2.462 MW

BLOCK:48

[VIEW IN NEW TAB](#)

2.453 MW

BLOCK:49

[VIEW IN NEW TAB](#)

2.465 MW

BLOCK:50

[VIEW IN NEW TAB](#)

2.456 MW

BLOCK:51

[VIEW IN NEW TAB](#)

2.461 MW

BLOCK:52

[VIEW IN NEW TAB](#)

2.459 MW

2 | Verde

59.95 MW

CIRCUIT:1

[VIEW IN NEW TAB](#)

19.51 MW

BLOCK:26

[VIEW IN NEW TAB](#)

2.440 MW

BLOCK:27

[VIEW IN NEW TAB](#)

2.443 MW

BLOCK:28

[VIEW IN NEW TAB](#)

2.449 MW

BLOCK:29

[VIEW IN NEW TAB](#)

2.430 MW

BLOCK:30

[VIEW IN NEW TAB](#)

2.436 MW

BLOCK:31

[VIEW IN NEW TAB](#)

2.438 MW

BLOCK:32

[VIEW IN NEW TAB](#)

2.446 MW

BLOCK:33

[VIEW IN NEW TAB](#)

2.428 MW

CIRCUIT:2

[VIEW IN NEW TAB](#)

19.55 MW

BLOCK:34

[VIEW IN NEW TAB](#)

2.455 MW

BLOCK:35

[VIEW IN NEW TAB](#)

2.445 MW

BLOCK:36

[VIEW IN NEW TAB](#)

2.450 MW

BLOCK:37

[VIEW IN NEW TAB](#)

2.439 MW

BLOCK:38

[VIEW IN NEW TAB](#)

2.441 MW

BLOCK:39

[VIEW IN NEW TAB](#)

2.444 MW

BLOCK:40

[VIEW IN NEW TAB](#)

2.438 MW

BLOCK:41

[VIEW IN NEW TAB](#)

2.439 MW

CIRCUIT:3

[VIEW IN NEW TAB](#)

21.98 MW

BLOCK:17

[VIEW IN NEW TAB](#)

2.443 MW

BLOCK:18

[VIEW IN NEW TAB](#)

2.434 MW

BLOCK:19

[VIEW IN NEW TAB](#)

2.444 MW

BLOCK:20

[VIEW IN NEW TAB](#)

2.448 MW

BLOCK:21

[VIEW IN NEW TAB](#)

2.438 MW

BLOCK:22

[VIEW IN NEW TAB](#)

2.448 MW

BLOCK:23

[VIEW IN NEW TAB](#)

2.446 MW

BLOCK:24

[VIEW IN NEW TAB](#)

2.438 MW

BLOCK:25

[VIEW IN NEW TAB](#)

2.443 MW

3 | Azul

19.6 MW

CIRCUIT:4

[VIEW IN NEW TAB](#)

19.97 MW

BLOCK:09

[VIEW IN NEW TAB](#)

2.494 MW

BLOCK:10

[VIEW IN NEW TAB](#)

2.496 MW

BLOCK:11

[VIEW IN NEW TAB](#)

2.498 MW

BLOCK:12

[VIEW IN NEW TAB](#)

2.494 MW

BLOCK:13

[VIEW IN NEW TAB](#)

2.496 MW

BLOCK:14

[VIEW IN NEW TAB](#)

2.497 MW

BLOCK:15

[VIEW IN NEW TAB](#)

2.494 MW

BLOCK:16

[VIEW IN NEW TAB](#)

2.494 MW

4 | Amarillo

20.002 MW

CIRCUIT:5

[VIEW IN NEW TAB](#)

20.49 MW

BLOCK:01

[VIEW IN NEW TAB](#)

2.560 MW

BLOCK:02

[VIEW IN NEW TAB](#)

2.561 MW

BLOCK:03

[VIEW IN NEW TAB](#)

2.565 MW

BLOCK:04

[VIEW IN NEW TAB](#)

2.555 MW

BLOCK:05

[VIEW IN NEW TAB](#)

2.563 MW

BLOCK:06

[VIEW IN](#)

ONE-LINE DIAGRAM

INVERTER-01	INVERTER-22	INVERTER-43	INVERTER-64
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-02	INVERTER-23	INVERTER-44	INVERTER-65
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-03	INVERTER-24	INVERTER-45	INVERTER-66
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-04	INVERTER-25	INVERTER-46	INVERTER-67
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-05	INVERTER-26	INVERTER-47	INVERTER-68
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-06	INVERTER-27	INVERTER-48	INVERTER-69
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-07	INVERTER-28	INVERTER-49	INVERTER-70
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-08	INVERTER-29	INVERTER-50	INVERTER-71
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-09	INVERTER-30	INVERTER-51	INVERTER-72
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-10	INVERTER-31	INVERTER-52	INVERTER-73
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-11	INVERTER-32	INVERTER-53	INVERTER-74
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-12	INVERTER-33	INVERTER-54	INVERTER-75
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-13	INVERTER-34	INVERTER-55	INVERTER-76
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-14	INVERTER-35	INVERTER-56	INVERTER-77
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-15	INVERTER-36	INVERTER-57	INVERTER-78
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-16	INVERTER-37	INVERTER-58	INVERTER-79
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-17	INVERTER-38	INVERTER-59	INVERTER-80
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-18	INVERTER-39	INVERTER-60	INVERTER-81
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-19	INVERTER-40	INVERTER-61	INVERTER-82
VIEW >>>	VIEW >>>	VIEW >>>	VIEW >>>
INVERTER-20	INVERTER-41	INVERTER-62	
VIEW >>>	VIEW >>>	VIEW >>>	
INVERTER-21	INVERTER-42	INVERTER-63	
VIEW >>>	VIEW >>>	VIEW >>>	

INVERTER:15 3 | Azul

Work State **ONLINE** AUTO Remote Emergency Stop Alarm State Global Fault State Global Fault Manual Restart Overall MPPT Scan Enabled
RUN **START** **ENABLED START** **OK** **OK** **DISABLED** **DISABLED**

Circuit Breaker On-Off Control Active Islanding Enabled Transformer High Oil Temperature Alarm Transformer Low Ion Level Alarm Transformer Low Vacuum Alarm Transformer High Pressure Alarm
ENABLED **DISABLED** **Normal** **Normal** **Normal** **Normal**

DC Input
Total DC Power
2,554.6 kW

01 136 A
02 156 A
03 158 A
04 117 A
05 138 A
06 158 A
07 159 A
08 161 A
09 137 A
10 -162 A
11 138 A
12 -2 A
13 147 A
14 147 A
15 158 A
16 137 A
17 0 A
18 0 A
19 0 A
20 0 A
21 0 A
22 0 A
23 0 A
24 0 A
25 0 A
26 0 A
27 0 A
28 0 A
29 0 A
30 0 A
31 0 A
32 0 A

Temperature
49.1 °C
Humidity
8 %

Active Power Controls

Active Power Setpoint
2,500 kW 100 %
Active Power Nominal
2,500 kW

Ramp Rate Settings

↑ 1 pct/s ↓ 1 pct/s

Reactive Power Controls

Reactive Power Control Mode

OFF VAR **PCT** PF

Reactive Power Setpoint

-426 kVAR -25.8 %

Reactive Power Nominal

1,650 kVAR

Power Factor Setpoint

1.000

Ramp Rate Settings

↑ 10 pct/s ↓ 10 pct/s

Unit 1 Running **RUNNING** AC Real Power
1252 kW
Unit 2 Running **RUNNING** AC Real Power
1245 kW

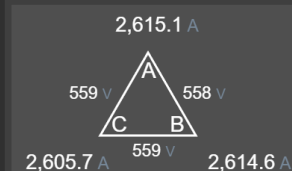
AC Active Power
2.497 MW

AC Reactive Power
-0.426 MVAR

AC Apparent Power
2.533 MVA

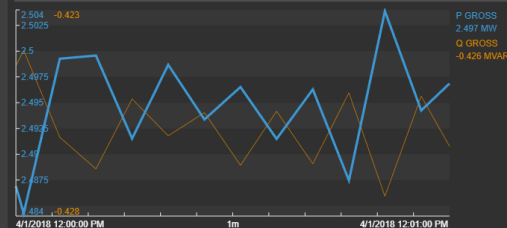
Power Factor
-0.986

Frequency
60.0 Hz



Name	Value	
INVERTER:15Alarm Code 01 Text		Normal
INVERTER:15Alarm Code 02 Text		Normal
INVERTER:15Alarm Code 03 Text		Normal
INVERTER:15Alarm Code 04 Text		Normal
INVERTER:15Alarm Code 05 Text		Normal
INVERTER:15Alarm Code 06 Text		Normal
INVERTER:15Alarm Code 07 Text		Normal
INVERTER:15Alarm Code 08 Text		Normal
INVERTER:15Alarm Code 09 Text		Normal
INVERTER:15Alarm Code 10 Text		Normal

Name	Value	
INVERTER:15Fault Code 01 Text		Normal
INVERTER:15Fault Code 02 Text		Normal
INVERTER:15Fault Code 03 Text		Normal
INVERTER:15Fault Code 04 Text		Normal
INVERTER:15Fault Code 05 Text		Normal
INVERTER:15Fault Code 06 Text		Normal
INVERTER:15Fault Code 07 Text		Normal
INVERTER:15Fault Code 08 Text		Normal
INVERTER:15Fault Code 09 Text		Normal
INVERTER:15Fault Code 10 Text		Normal



David Jeon



- djeon@sempraglobal.com
- Technical Services Manager
- Sempra Renewables

Questions

Please wait for the **microphone** before asking your questions

State your **name & company**



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Merci

谢谢

Спасибо

Danke

Gracias

Thank You

감사합니다

ありがとう

Grazie

Obrigado