



XCEL ENERGY PROJECT UPDATES

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PEÑA STATION/PANASONIC PILOT



- 1MW/2MWh Yunicos Lithium-Ion Battery
 - 4 x Y-cubes at 250 kW
- 1.3MW Carport PV @ 13.2 kV
- 200kW Panasonic rooftop PV
- Microgrid Switchgear and Relays
 - SEL-751 Relay
 - S&C 13.8 kV Islanding Switch



USE CASES

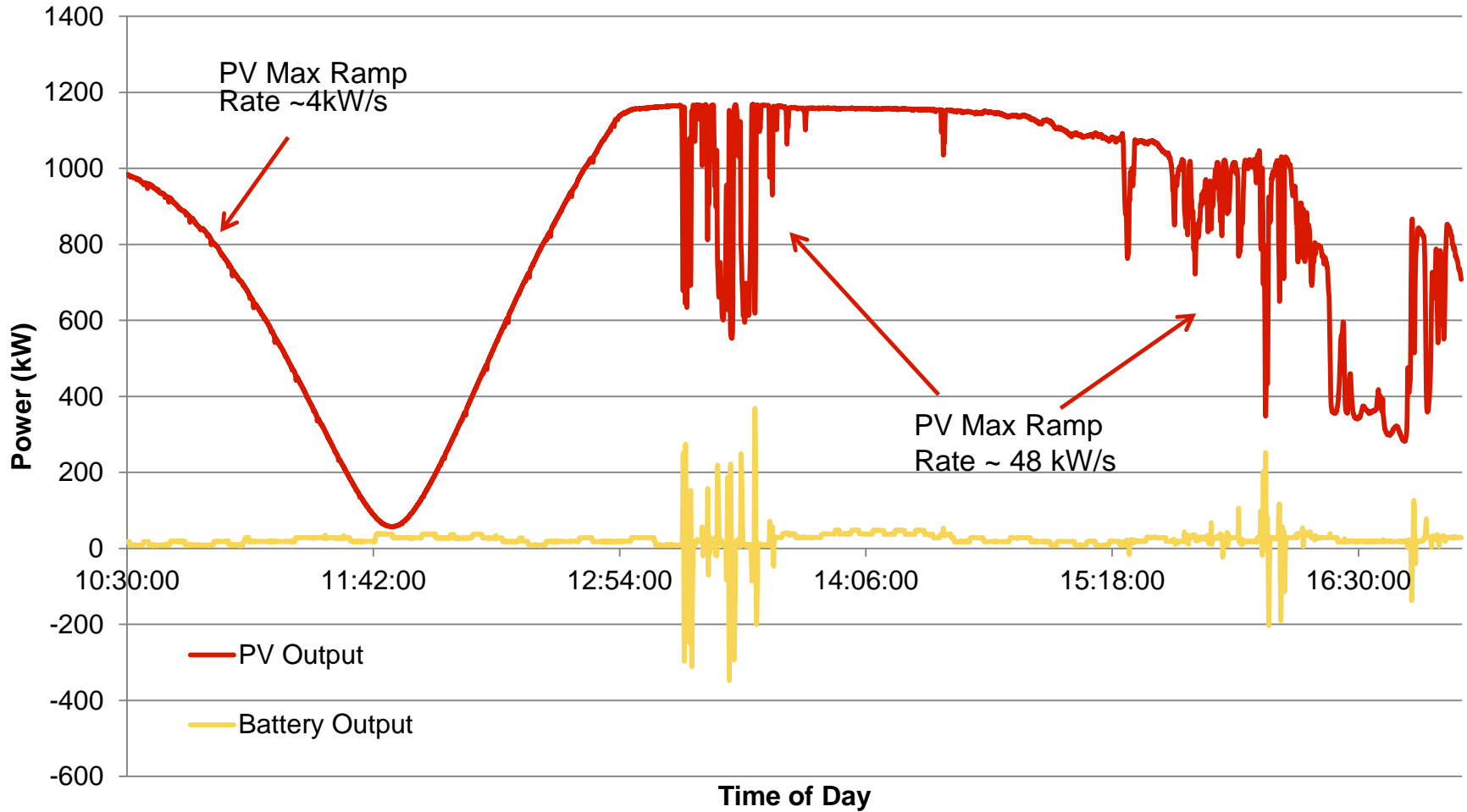


- Microgrid/Islanding of Panasonic building
- Peak Demand Reduction
 - System Peak Demand Reduction (AutoGrid)
 - Feeder Peak Demand Reduction
- Voltage Regulation
- PV smoothing/Ramp Rate Limiting
- Energy Arbitrage
- Frequency Response

RAMP RATE ON 8/21/17 ECLIPSE



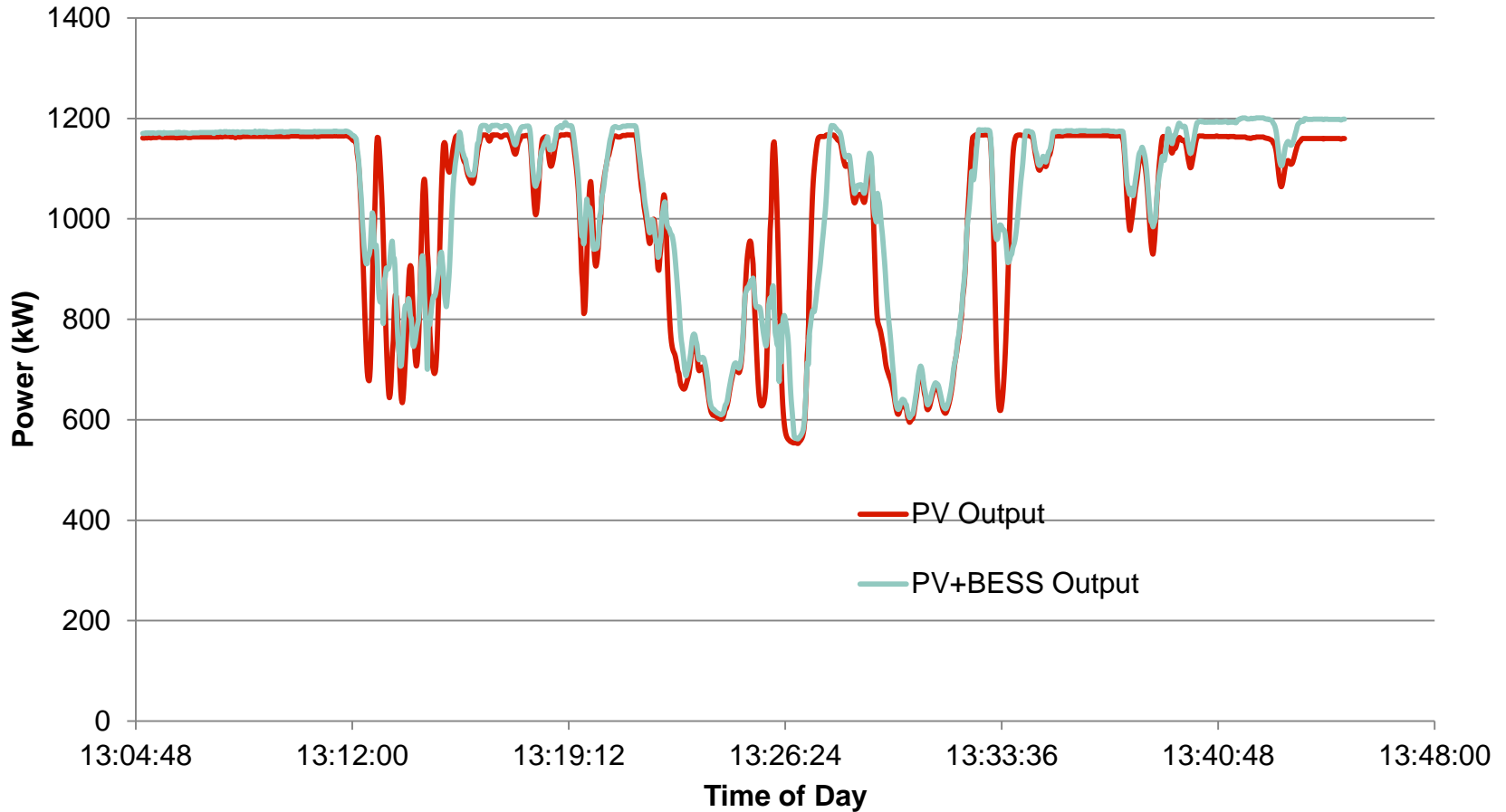
Eclipse 08/21/2017 Panasonic Project



PV "SMOOTHED" OUTPUT 8/21/17



08/21/2017 "Smoothed" Ramp Rate



STAPLETON NEIGHBOURHOOD



- Stapleton feeder has ~18.5% PV penetration
- Utility-Sited Systems:
 - System Provider: Northern Reliability
 - Six Li-Ion battery energy storage systems
 - Sited along the feeder at two different phases
- Behind-the-Meter Systems:
 - System Provider: Sunverge
 - Six Li-Ion battery energy storage systems
 - Sited in a customer's home

STAPLETON UTILITY SITED OVERVIEW



- Northern Reliability Modular Units:
 - 2 x 18 kW/69 kWh
 - 2 x 36 kW/138 kWh
 - 2 x 54 kW/207 kWh
- Use Cases:
 - Peak Demand Reduction
 - Voltage Regulation
 - Solar Time Shifting
 - Energy Arbitrage



STAPLETON BEHIND-THE-METER OVERVIEW



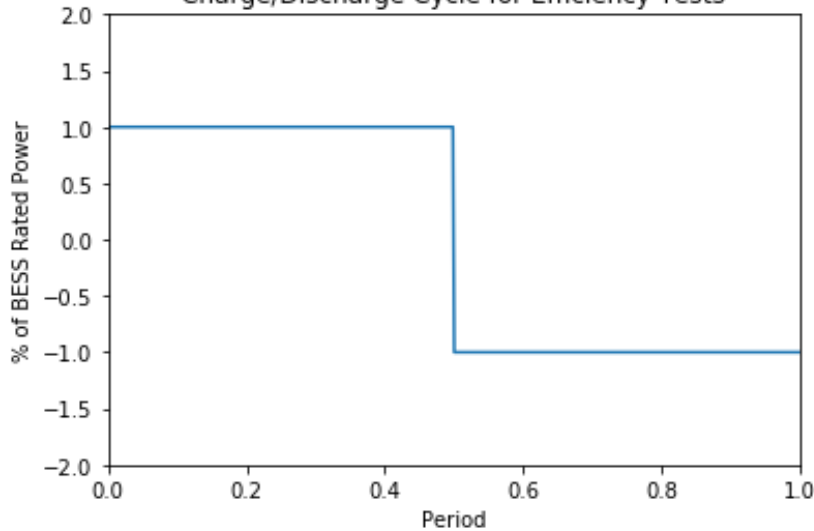
- **Sunverge SIS units**
 - 6 x 6 kW/15.5 kWh
- **Use Cases:**
 - Providing Residential Backup Power
 - Peak Demand Reduction
 - Solar Time Shifting
 - Volt-Watt Operation



CHARGE/DISCHARGE CYCLE FOR TESTING VARIOUS METRICS



Charge/Discharge Cycle for Efficiency Tests

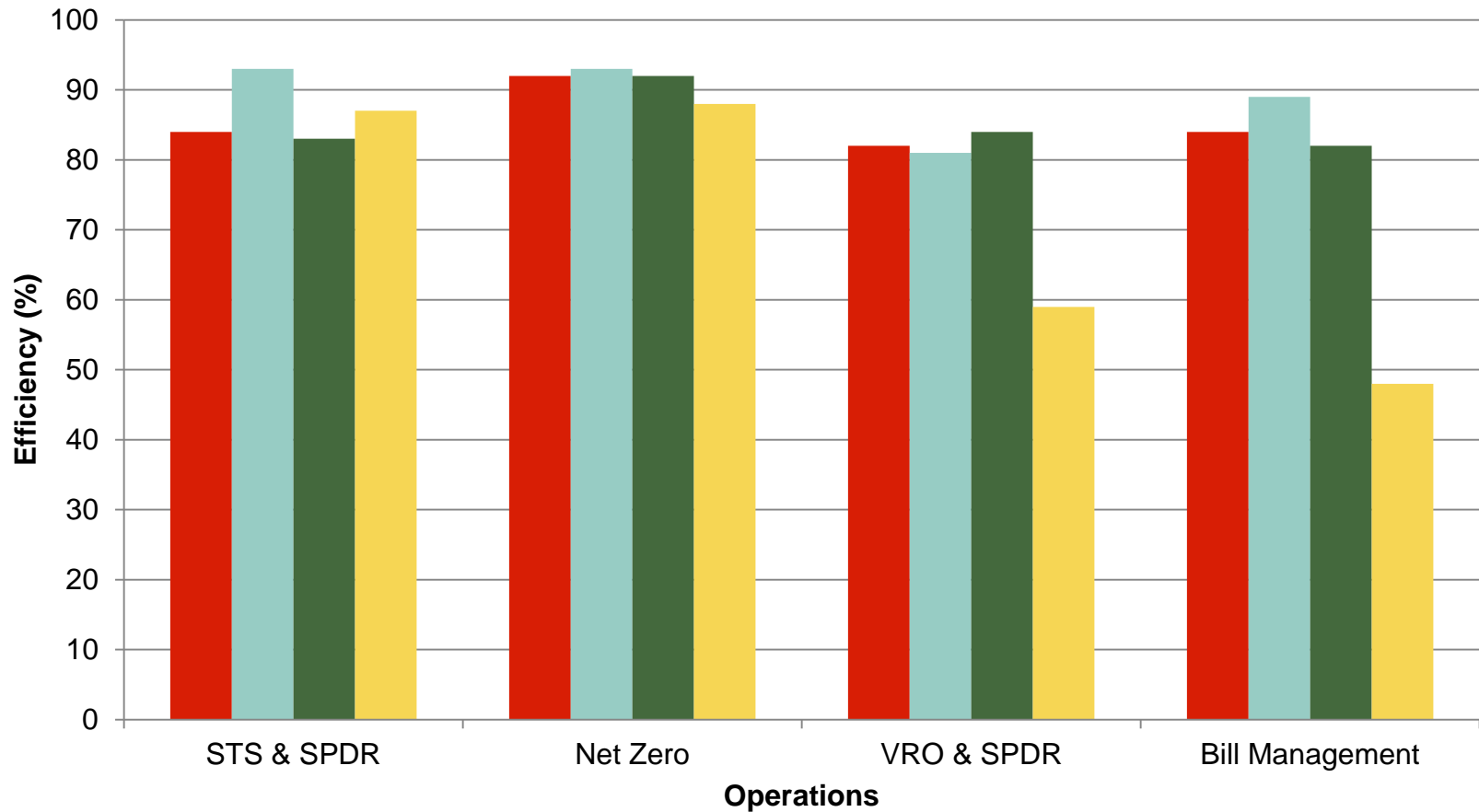


- A charge/discharge test with a fixed duty cycle test can be used to find:
 - Efficiency of the system
$$\eta = \frac{E_{discharge} - E_{aux-discharge}}{E_{charge} - E_{aux-charge}}$$
 - Charge/discharge capacity compared to the rated energy of system
 - Rated continuous charge and discharge power compared to the rated power of the system

TENTATIVE RESULTS EFFICIENCY (SEPT – OCT TESTING)



Efficiency of SIS Units with Different Operations

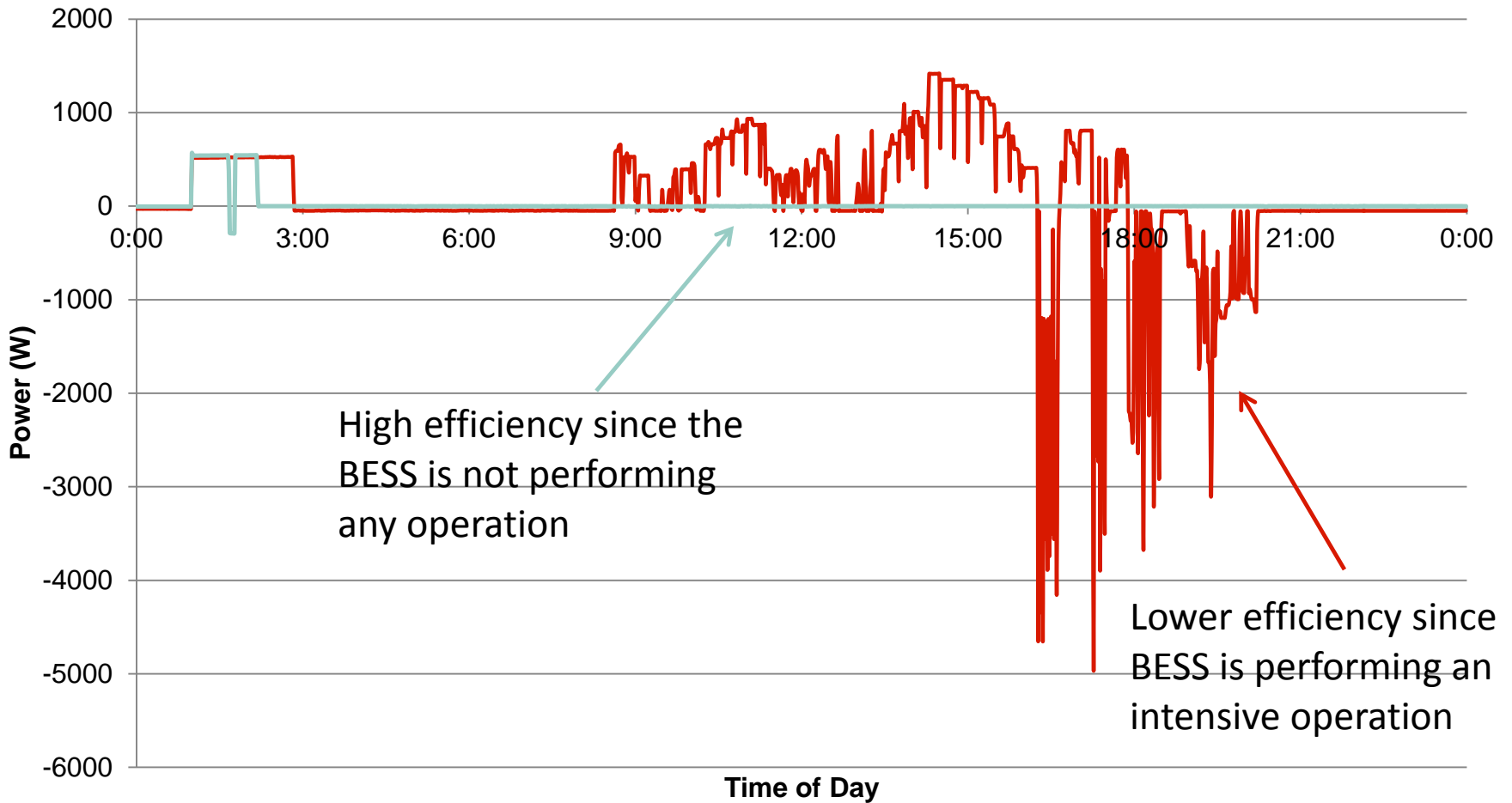


STS – Solar Time Shifting, SPDR – System Peak Demand Reduction, VRO – Voltage Regulation, Net Zero – Set the Home to have Net Zero

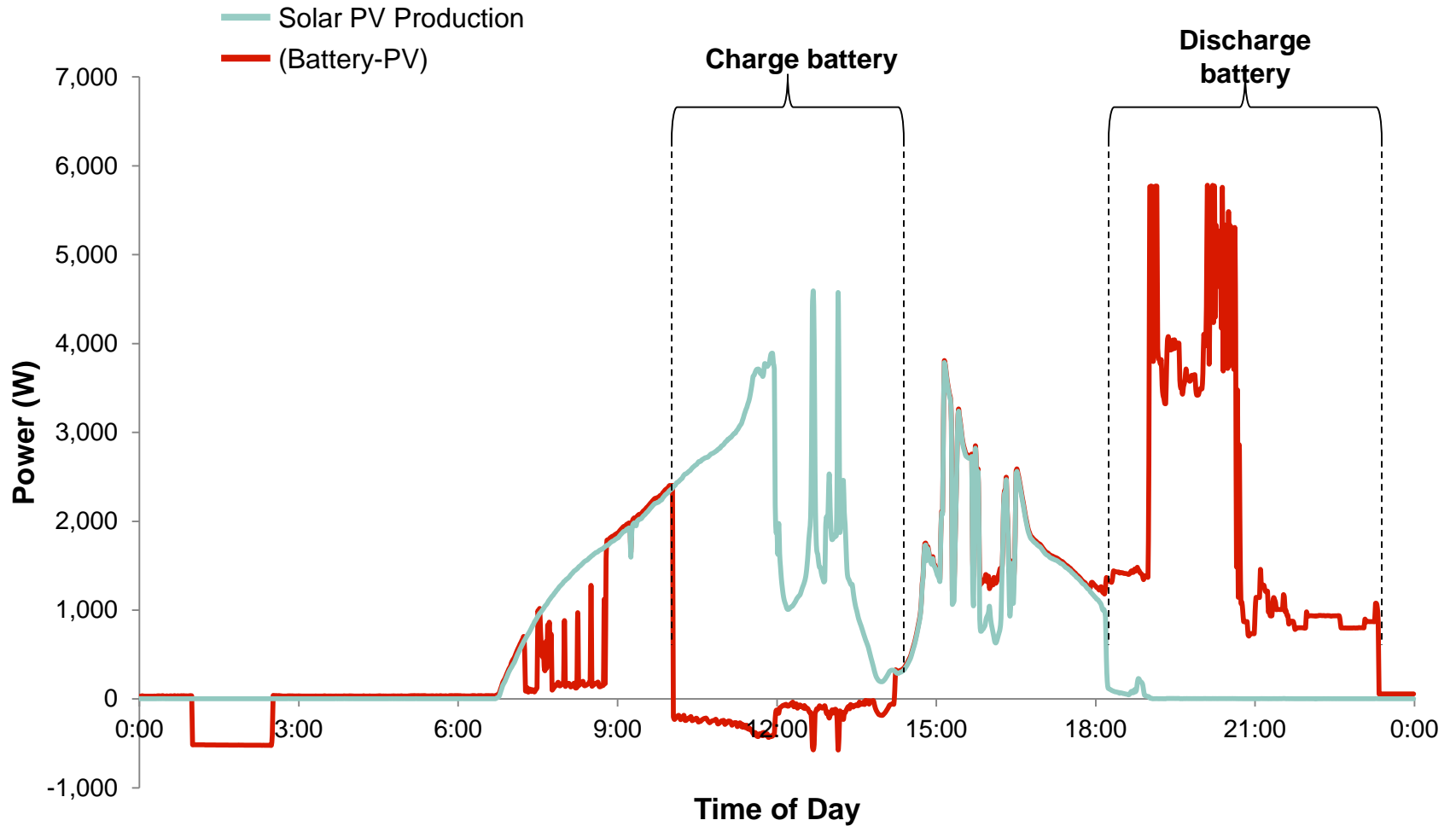
BESS POWER OUTPUT WITH DIFFERING EFFICIENCY



BESS Power Output

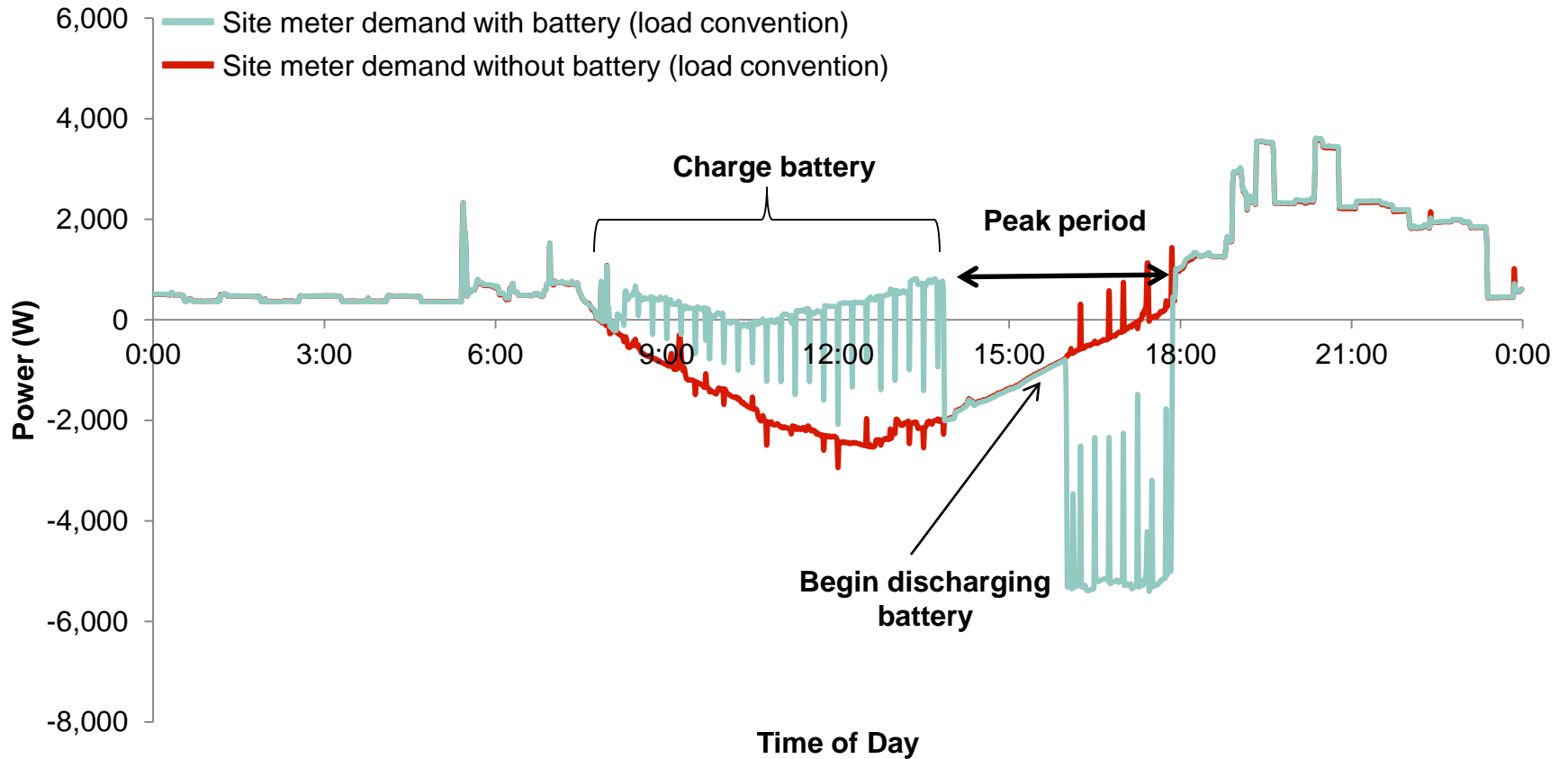


SAMPLE TEST SOLAR TIME SHIFTING

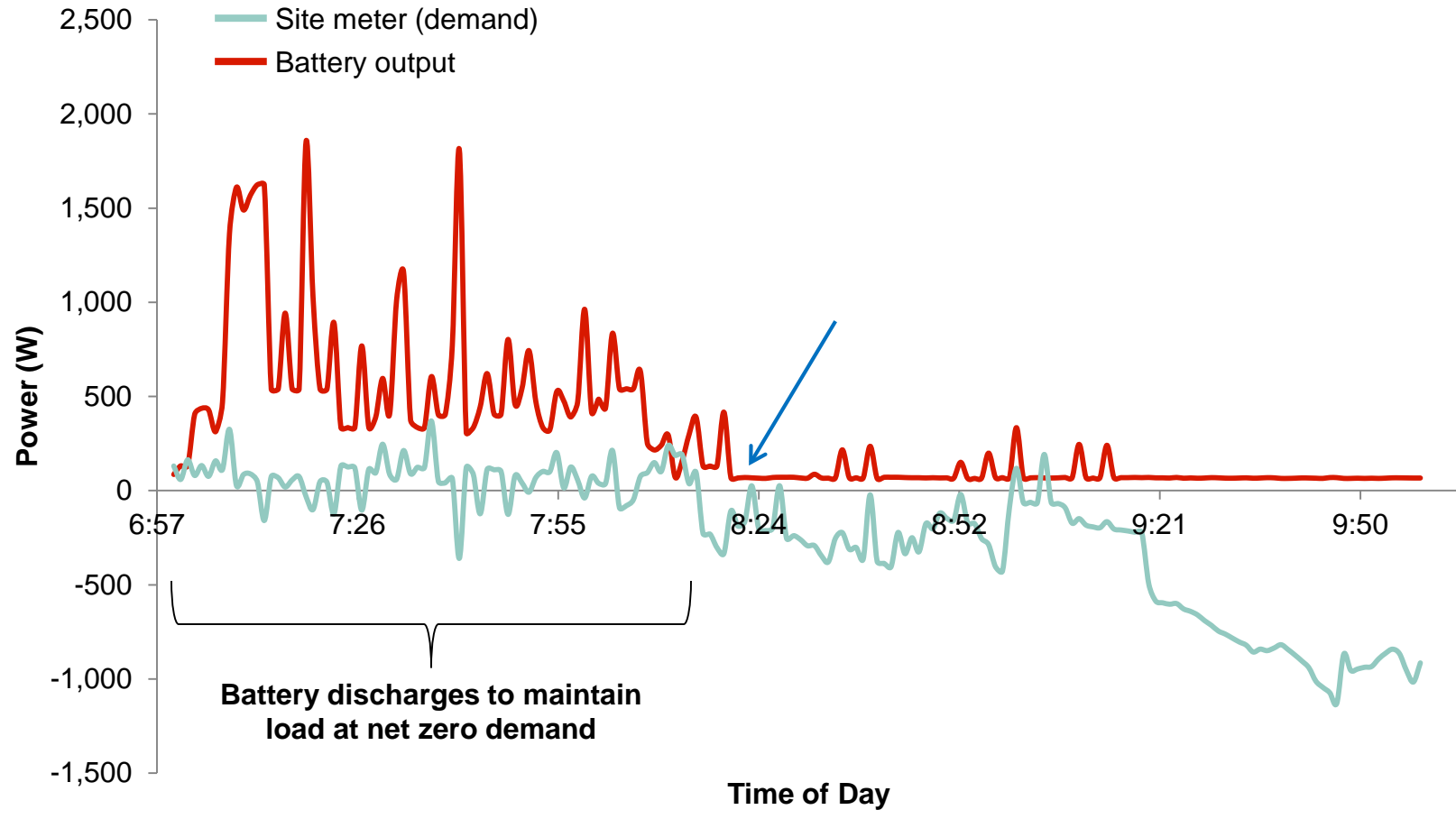


PRELIMINARY TEST RESULT

TIME-OF-USE BILL MANAGEMENT

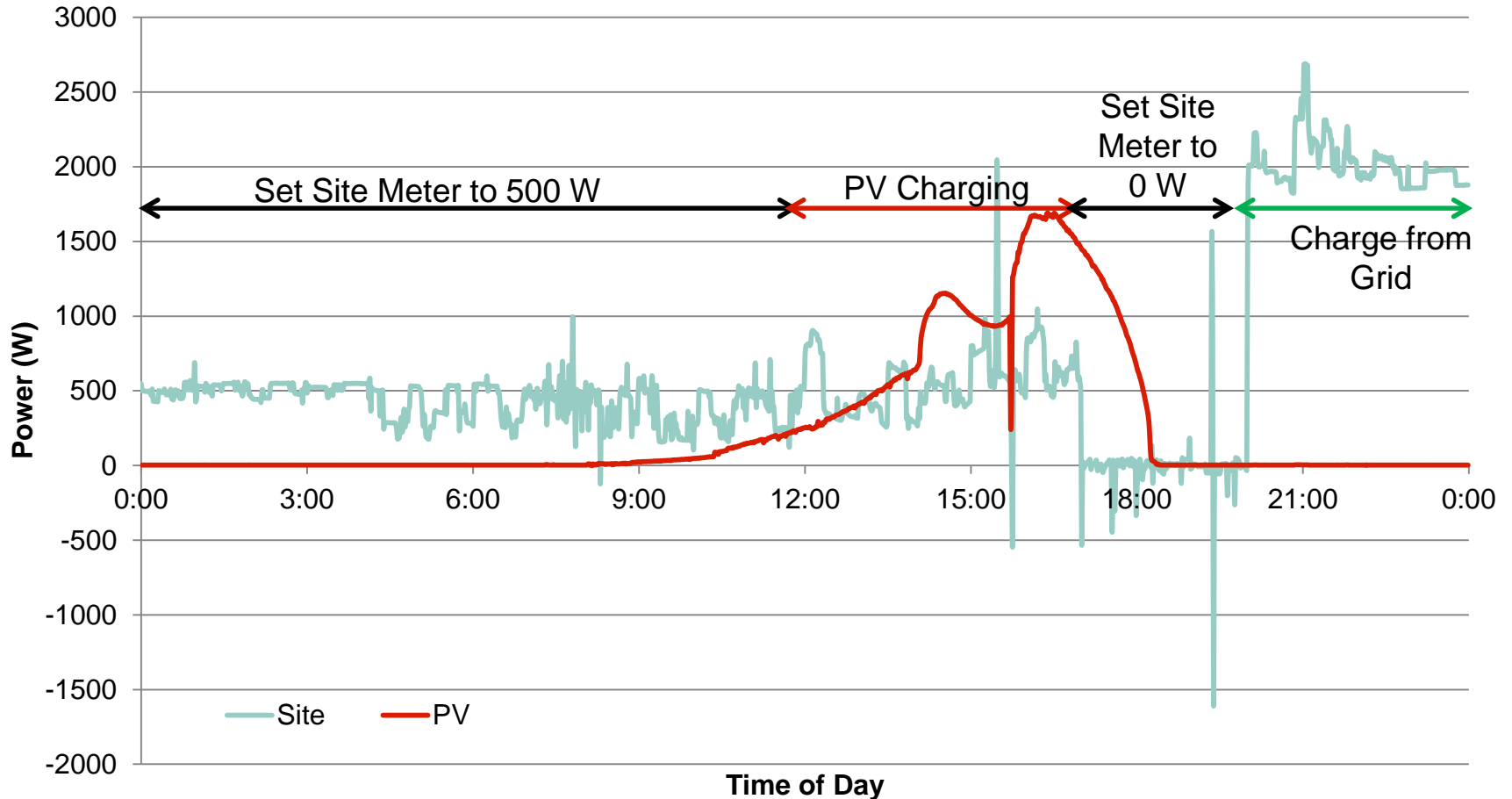


PEAK DEMAND REDUCTION TEST SAMPLE



TEST SAMPLE RESULTS

Test Results for BTM Unit



Questions

YOUNICOS ENERGY STORAGE PARAMETERS



Description	Value
Rated Apparent Power	1,000 kVA
Rated Real Power	1,000 kW
Rated Energy	2,100 kWh
Available Energy	1,690 kWh
Round-Trip Efficiency	85.5 %
Voltage Range	432-528 V
Rated Continuous AC Current	1,200 A
Operating Temp. Range	-10°C - 45°C
Physical Dimension	42' x 10'



NRI ENERGY STORAGE PARAMETERS



Description	18 kW System	36 kW System	54 kW System
Rated Apparent Power	18 kVA	36 kVA	54 kVA
Rated Real Power	18 kW	36 kW	54 kW
Rated Energy	69 kWh	138 kWh	207 kWh
Round-Trip Efficiency	N/A		
Voltage Range	172 – 264 V		
Rated Continuous AC Current	94 A	187 A	281 A
Operating Temp. Range	-30°C -50°C		
Physical Dimension	56" x 52.75" x 53"	112" x 52.75" x 53"	159" x 52.75" x 53"

SUNVERGE SIS UNIT



Hybrid Inverter
(4.5kW or 6kW rated)

IO Board

Solar Charge Controller
(150V or 600V MPPT)

Distribution Panel

Application Gateway

Outdoor rated cabinet

Lithium-ion Battery
(Scaleable to 19.4 kWh)

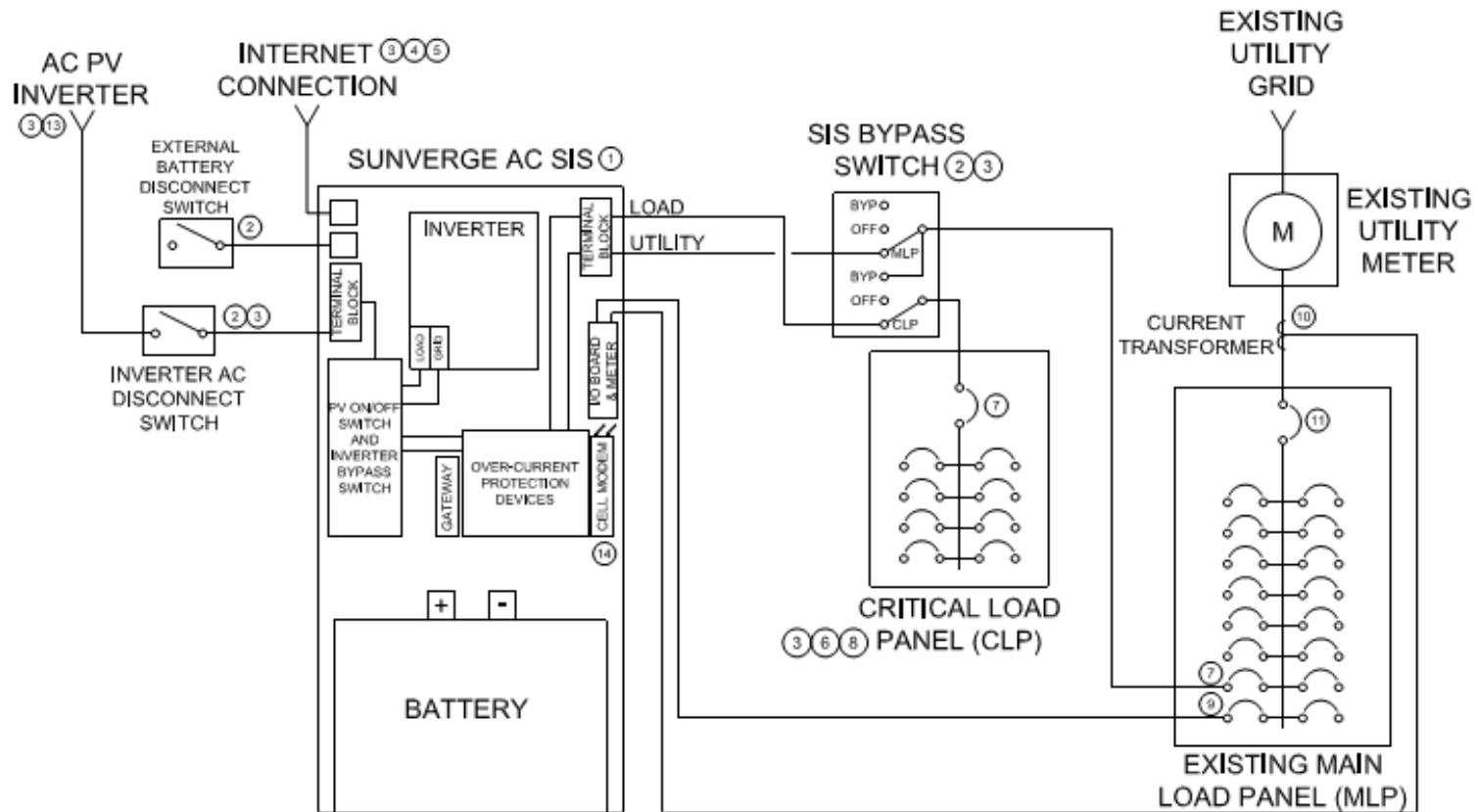
Polycrete pad

SUNVERGE ENERGY STORAGE PARAMETERS



Description	Value
Rated Apparent Power	6 kVA
Rated Real Power	6 kW
Rated Energy	15.5 kWh
Available Energy	11.64 kWh
Round-Trip Efficiency	92.5 %
Voltage Range	233 – 247 V
Rated Continuous AC Current	25 A
Operating Temp. Range	-20°C - 50°C
Physical Dimension	76" x 34" x 14 "

SUNVERGE "BACK COUPLED" AC SIS SINGLE LINE DIAGRAM



- | | | |
|--|--|--|
| ① SUNVERGE AC SOLAR INTEGRATION SYSTEM (SIS). | ⑥ NEW PANEL (OPTIONAL). | ⑪ MUST NOT EXCEED 200A. |
| ② NOT ALWAYS REQUIRED. CONSULT LOCAL CODE AND AHJ. | ⑦ 50A CIRCUIT BREAKER. | ⑫ NO = NORMALLY OPEN; NC = NORMALLY CLOSED. |
| ③ NOT INCLUDED WITH SIS UNIT. | ⑧ TOTAL LOAD CANNOT EXCEED RATING OF SIS INVERTER. | ⑬ MAX CAPACITY 6KW. |
| ④ MUST BE POWERED BY CLP. | ⑨ 15A CIRCUIT BREAKER FOR VOLTAGE REFERENCE. | ⑭ OPTIONAL 3/4G MODEM FOR INTERNET CONNECTION. |
| ⑤ HARDWIRED CONNECTION TO INTERNET. | ⑩ SPLIT-CORE AC CURRENT SENSOR. | |