Shelter Solutions

blueplanet

ENERGY MANAGEMENT SYSTEM (EMS)

Shelter Solutions - The product

Solar Powered, Efficient, Relocatable

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Shelter Solutions - The system

- Energy efficient, lightweight, rigid
- Manual Deployment option
- Roof-integrated PV
- Integrated battery storage
- Mains power available to users
- Integral backup generator control

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EMS - The focus

- COTS components where possible
  - Choice of OE options
  - Spares and servicing availability
- High level of independence
- Blue Planet solution
  - Package the system
  - Develop integrated smart features

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Energy Management System

- Scope
  - Bridges the gap between
    - Small, field deployable kits
    - Larger Microgrids
  - 5 – 40 kW range
  - Serving range of demands

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Energy Management System

- Integrate into existing facilities
- Larger scale energy availability
- 72 hr platoon mission 32 kWh requirement

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Energy Management System

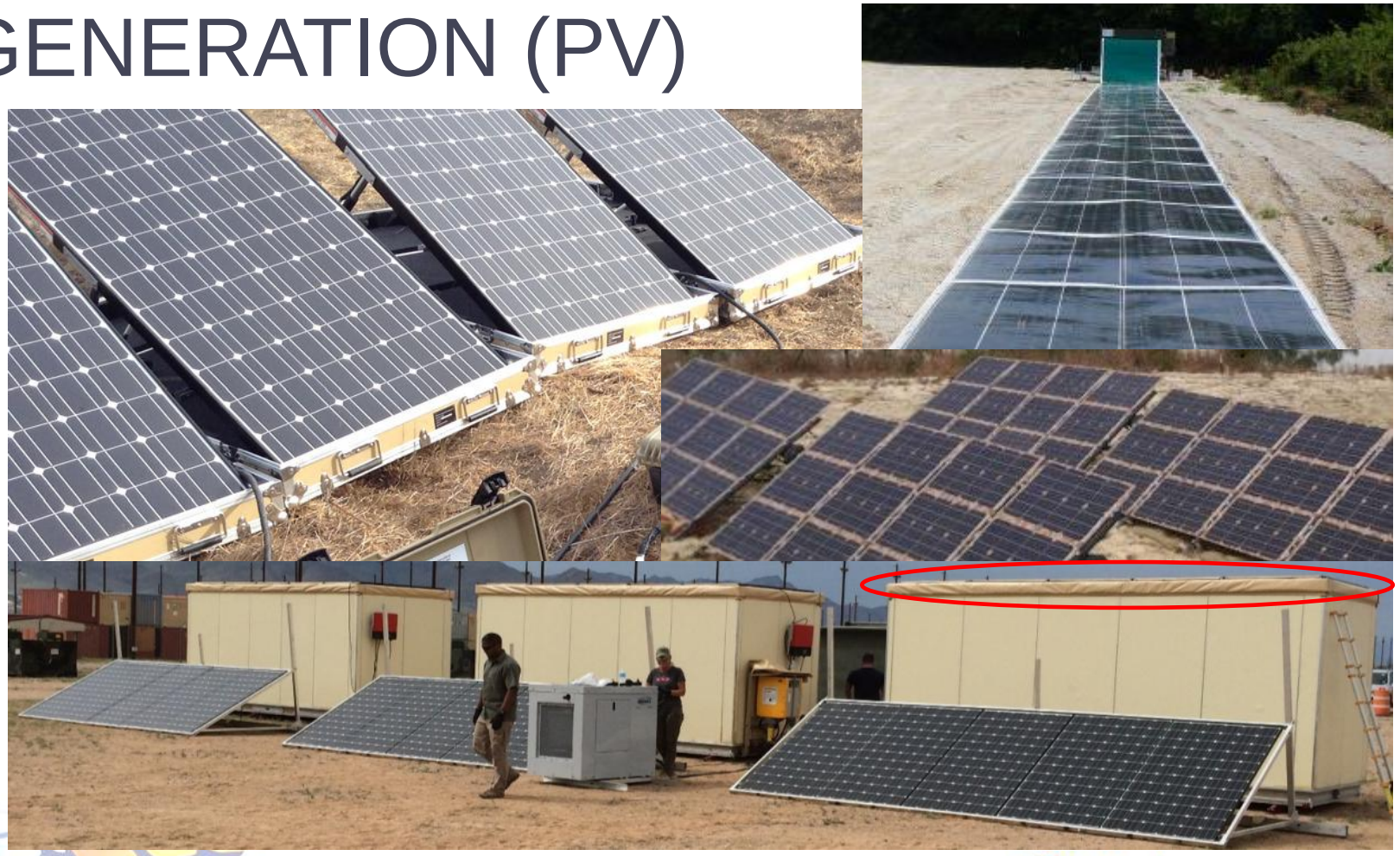
- Broader scope of use
  - HVAC / ECU power hungry
  - Water
    - Pumping / Purification / AWG
  - Waste – Incineration capability
  - Appliances
    - Refrigerator, microwave

System Objectives

- GENERATE energy locally (PV)
- STORAGE of excess for later use
- HARVEST any other available energy
  - Grid; Generator; PV; wind; water
- DISTRIBUTION of power to users
  - Fixed location and expeditionary

System Objectives

GENERATION (PV)



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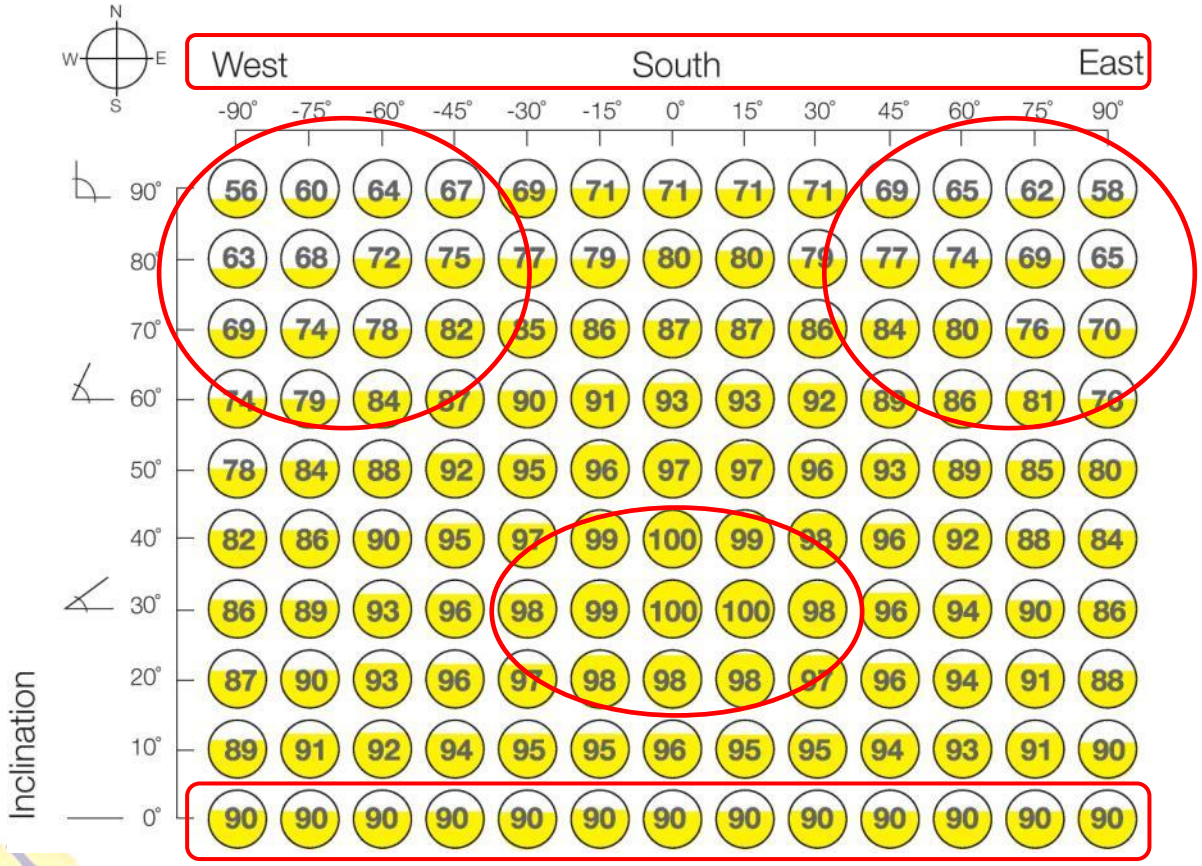
Generation – PV array

Flat mounted - performance



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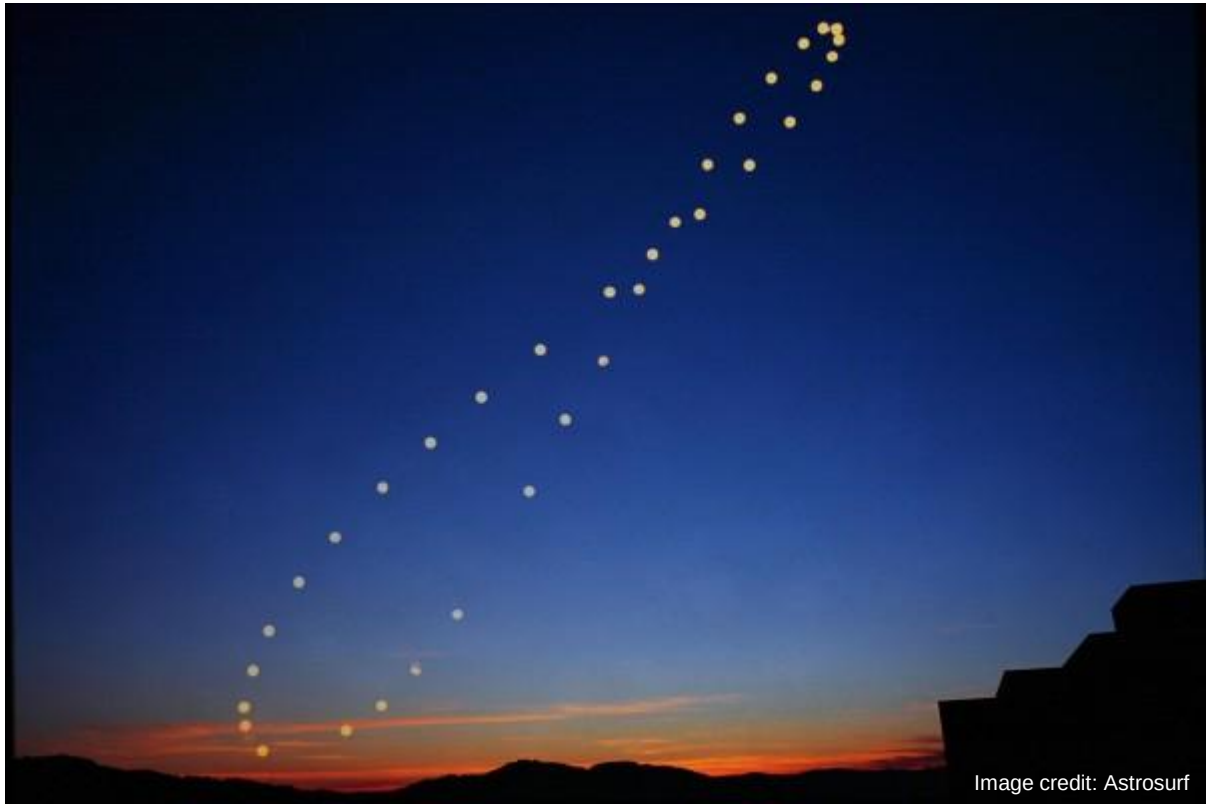
Generation – PV array

Issues manually tracking solar activity



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Generation – PV array

Elevation of PV Panels

- Minimizes...

  footprint; shading; visibility

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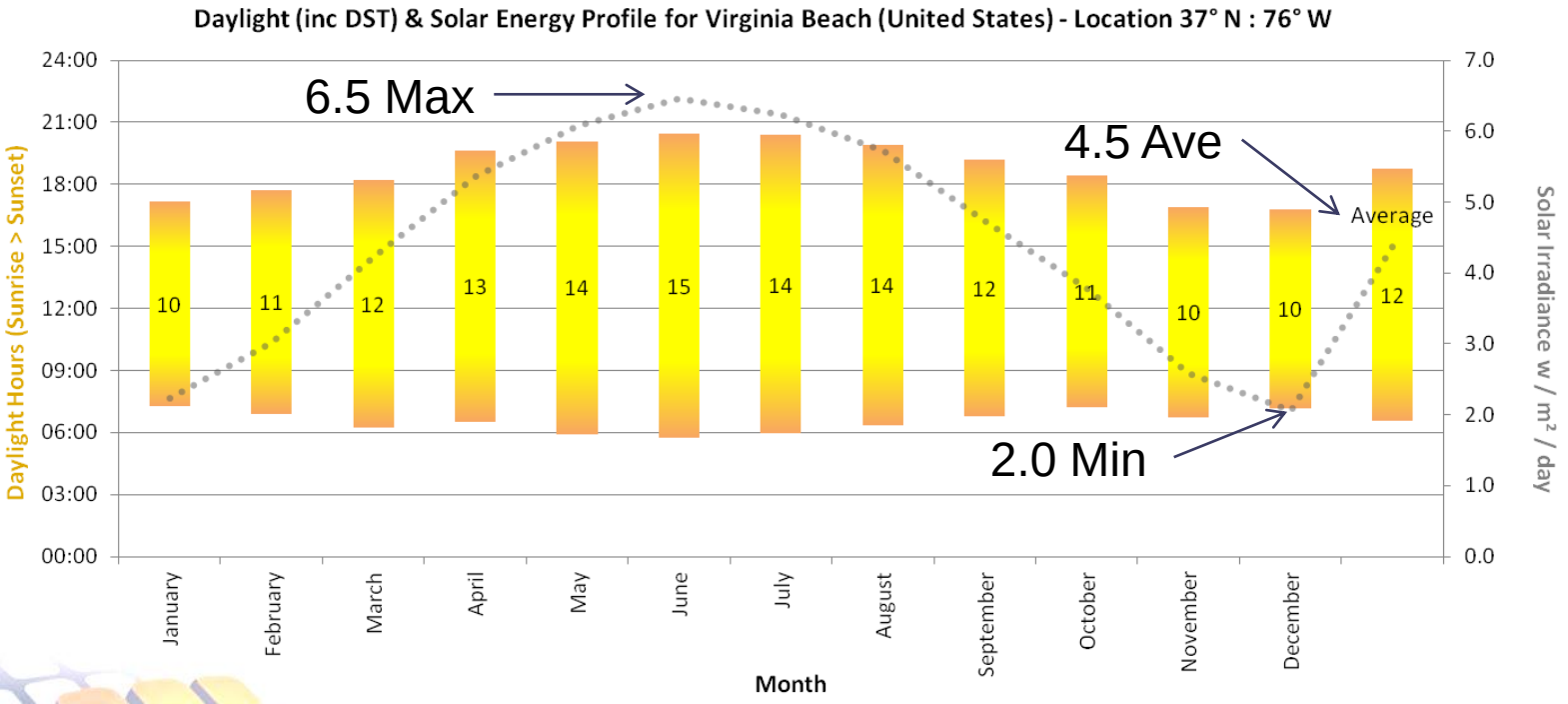
Generation – PV array

Maximizing solar yield

- Accounting for seasonality



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Generation – sizing the system

When PV is significant (~30kW / day)

- Optimizing the system...
  - What are the loads?
  - Variation in solar energy?
  - What size battery is needed?
  - Generator? If so, what size?

Generation – sizing the system

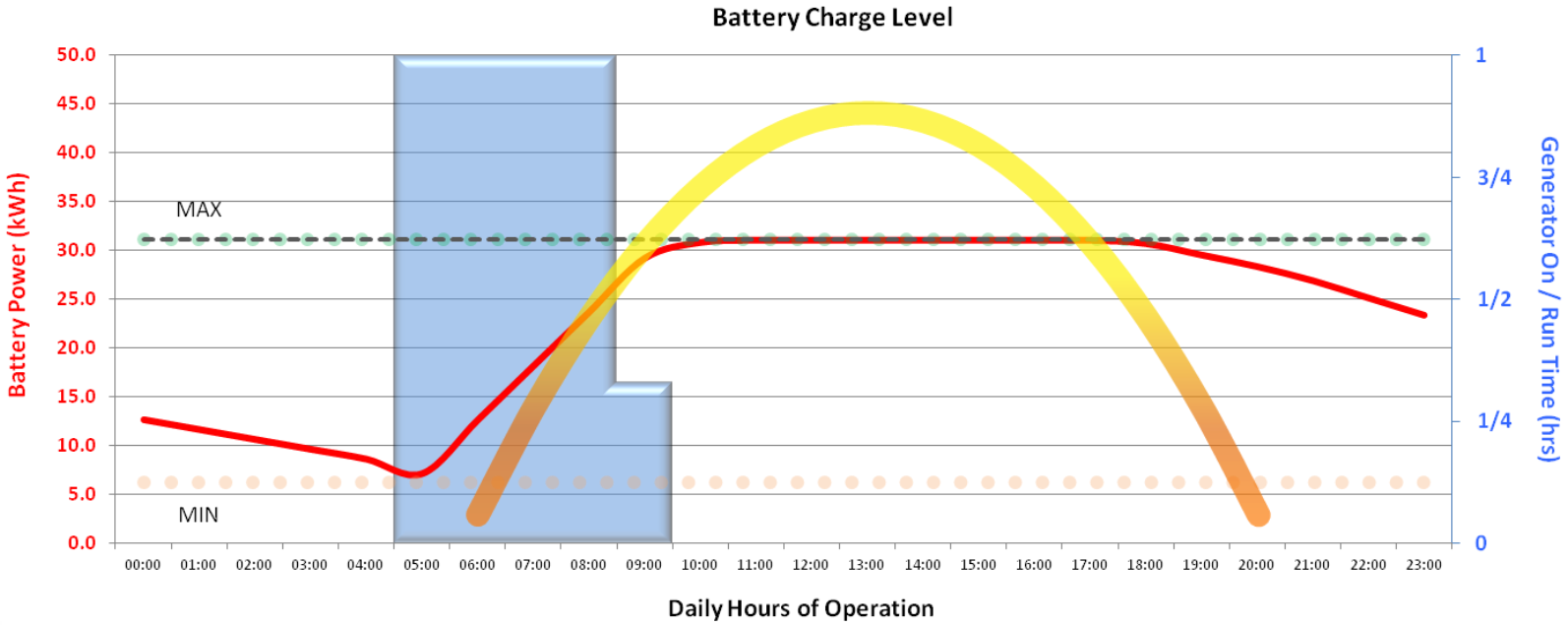
Maximizing solar yield

- Configuration based on PV yield...
  - Minimum ? Over-specified
  - Maximum? Under-specified
  - Average ? “Best Bet”

Generation – sizing the system

Maximizing solar yield

- Averaging has its problems...



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Reconfigure based on seasons

Maximizing solar yield - solution

- Blue Planet EMS control unit
  - Optimises system to utilise maximum available solar energy
  - Allows dynamic reconfiguration based on location

System Objectives

STORAGE of energy (**BULK**)

- Battery sets : ~10kw modules
  - Normally Li-Ion (LiFePO4)
    - Capacity / Low Losses / High charge & discharge rates
  - Lead Acid compatible
    - Availability / Cold operating

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Storage – secondary option

- **BoB** add-on
- **B**reak **o**ut **B**atteries
  - Smaller modules - expeditionary
    - Used as capacity when parked
    - Fully charged when needed
  - Highly flexible I/O options

Storage – secondary option

BoB modules : 3 variants

- Battery (DC)
  - 400 Wh
  - Output : 3 – 80V
  - Input : 6 – 80V
  - 3.9 × 3.2 × 12 in : Weight < 8lb

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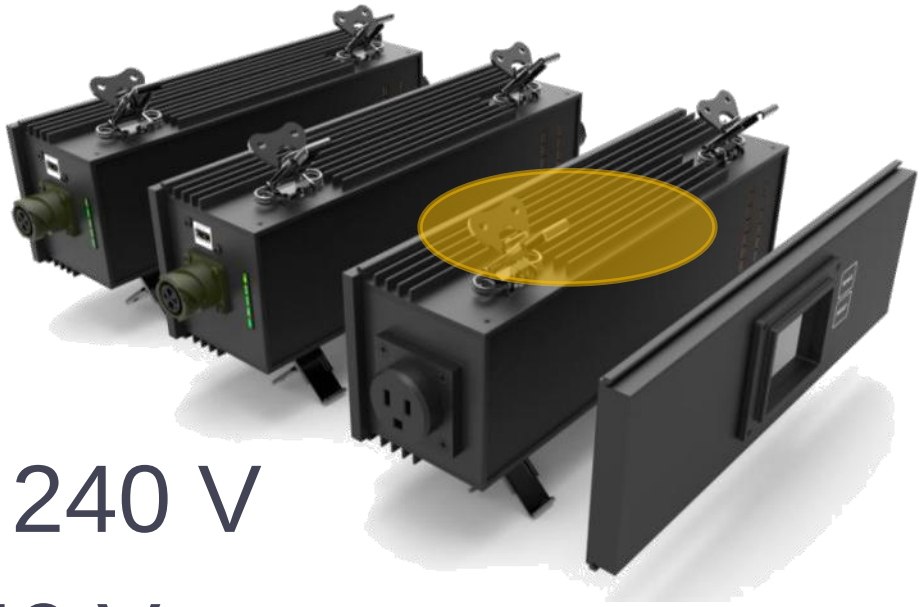
Storage – secondary option

BoB modules : 3 variants

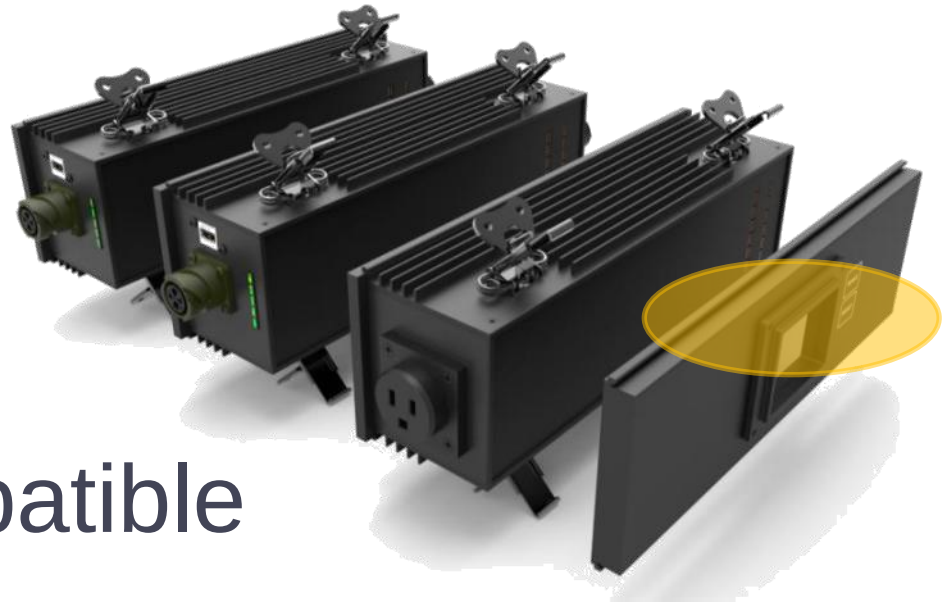
- AC Module
  - 1.2 kW
  - 50 / 60 Hz
  - Output : 120 / 240 V
  - Input : 90 – 240 V



Storage – secondary option

BoB modules : 3 variants

- CDM
  - Configurator
  - Touchscreen
  - DC / AC compatible
  - Module parameter programmer



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System Objectives

- HARVESTING
  - Main System
    - Grid / Generator if available
    - Generator used at peak loading
  - Sub System (BoB)
    - Ad hoc AC / DC

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System Objectives

- DISTRIBUTION of power
  - Dual Voltage Dual Frequency
    - AC mains at :-
      - “US” supply (120 V / 60 Hz)
      - “EU” supply (230 V / 50 Hz)
    - Each split into 2 legs
      - Essential and non-essential

DVDF

- Dual Voltage Dual Frequency
  - Universal device connection
- EU leg works with PV (native)
  - Ideally EU powers HVAC
    - Minimizes impact on US supply and battery state

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Dual supply phases

- Battery preservation
  - Below a defined level of charge non-essential loads disconnected
  - User decides what's essential
  - Swap standard plugs to reconfigure

Energy Management System

- Central Control Unit (CCU)
  - Connectivity station
  - System configuration & setup
  - Rapid reconfiguration
  - System performance & status
  - System monitoring (remotely)

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Energy Management System

- Central Control Unit (CCU)
  - Battery optimisation & calibration
  - Generator “exercise”
  - Generator call criteria
  - Generator activity mapping

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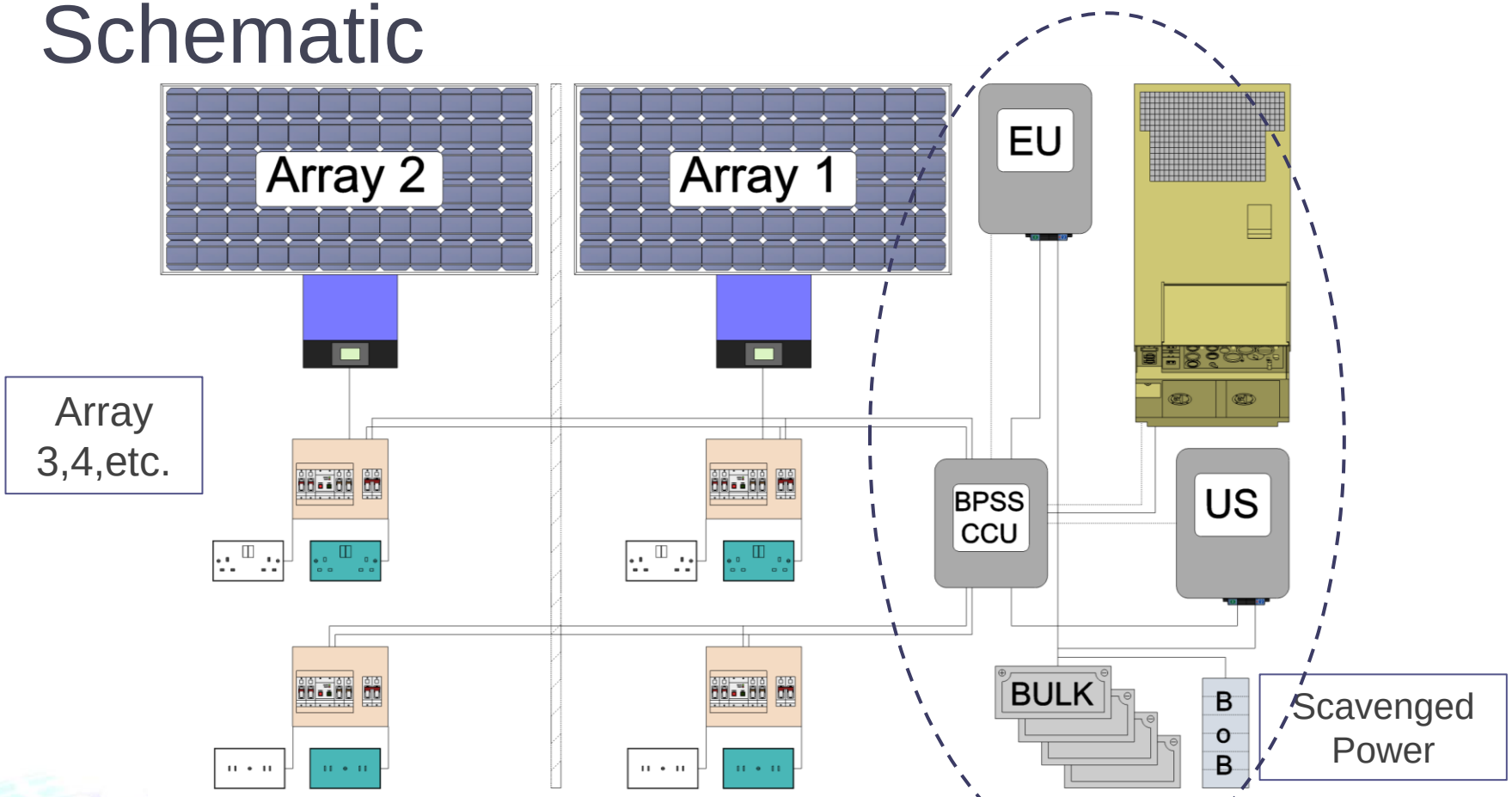
Energy Management System

Schematic



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Energy Management System

- Coverage
  - Typical DVDF system 14kW power
    - 10 kW PV / 30kW battery
  - 3-4 shelters
    - First cut load levelling
  - Utilizes PV from low-power shelters

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Energy Management System

- Modularity
  - System can be paralleled
  - 3-40 kW single phase capacity
  - 3-phase capability

Final specification dependent on SOW

Performance Test

- 1 week; 24 / 7 operation
- HVAC / recirculating air / lighting
- Additional loads introduced

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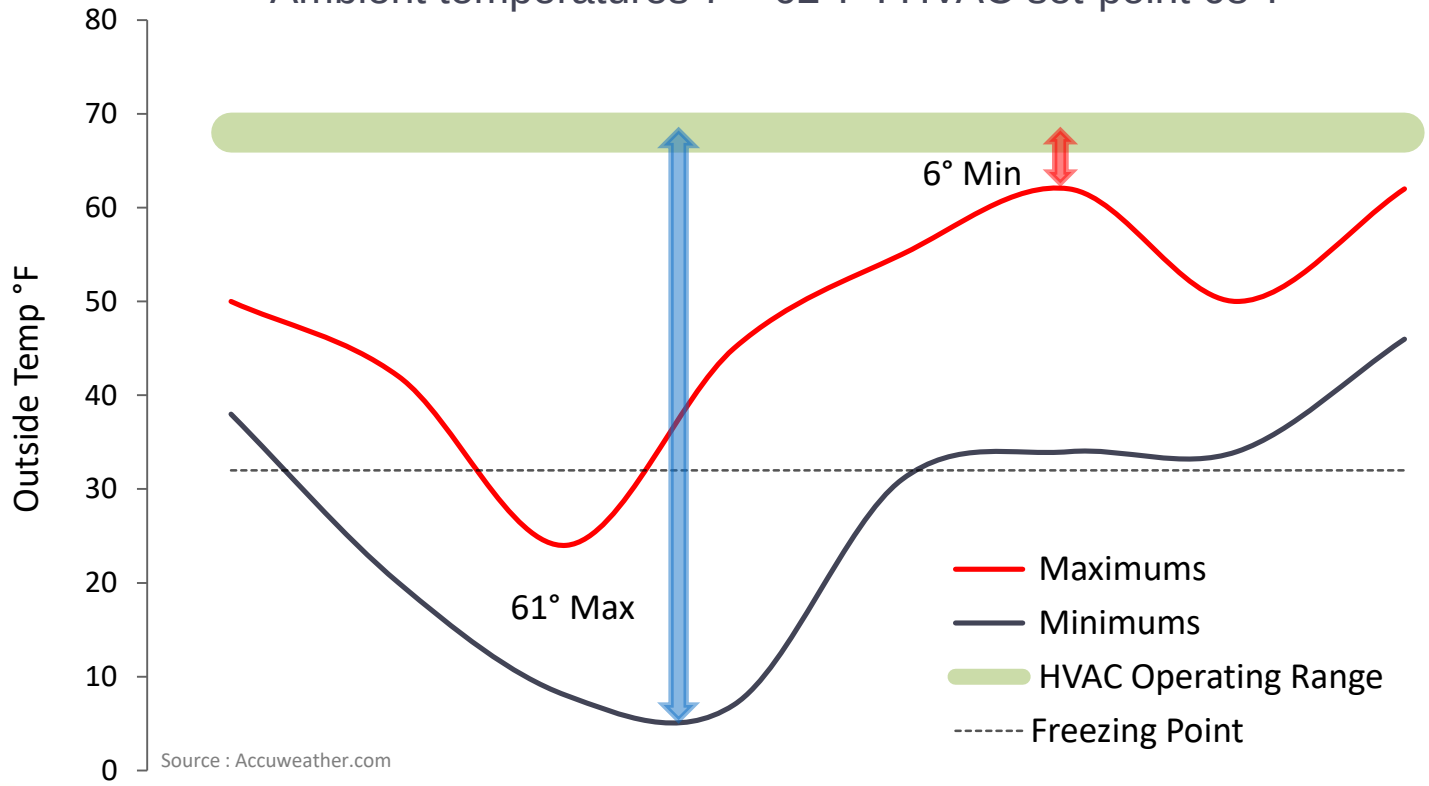
Test Environment

Worst case – constant demand, all heating
Location : MD, March
Ambient temperatures 7 – 62°F : HVAC set-point 68°F



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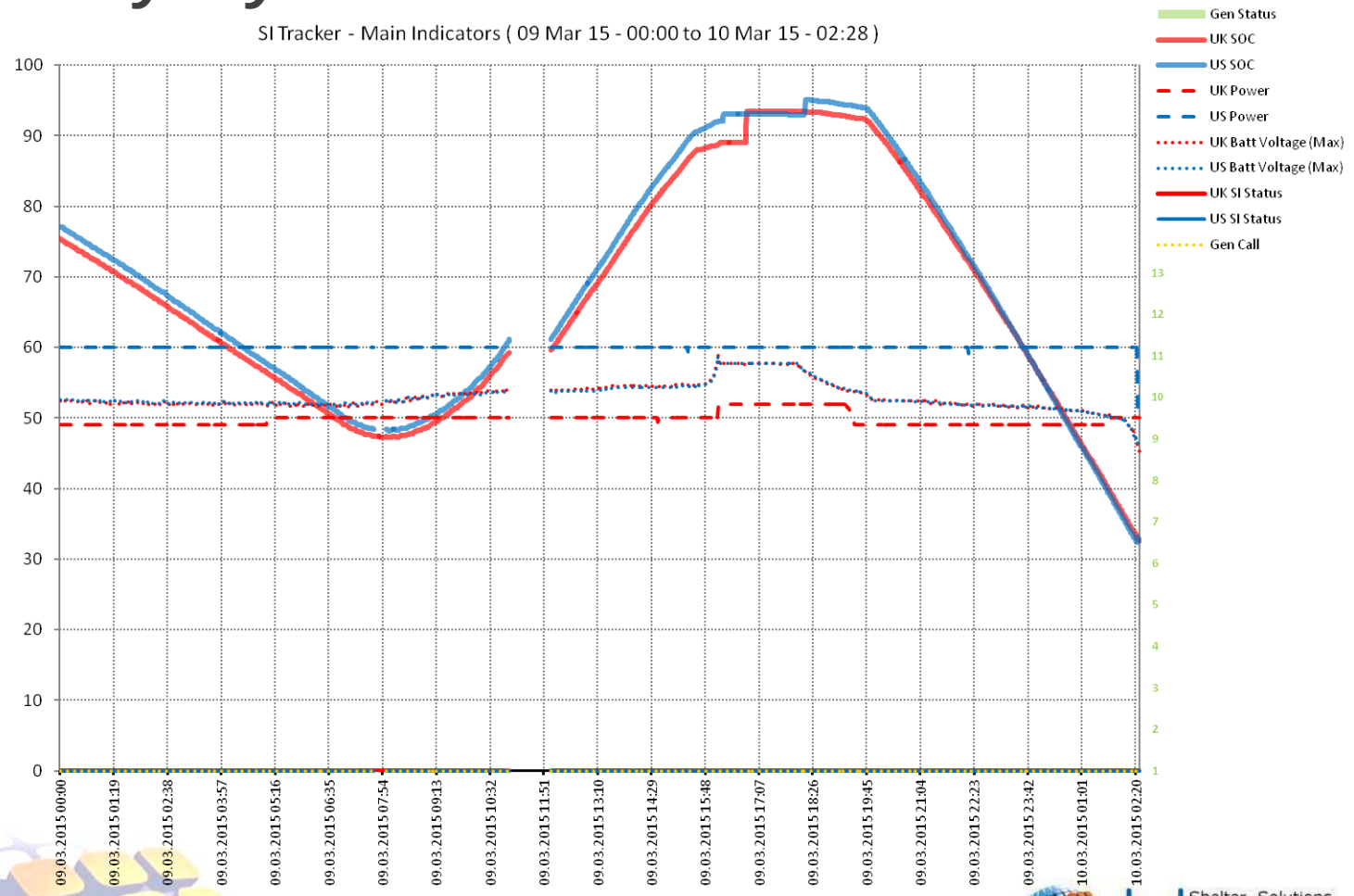
Performance Analysis

Battery synchronisation



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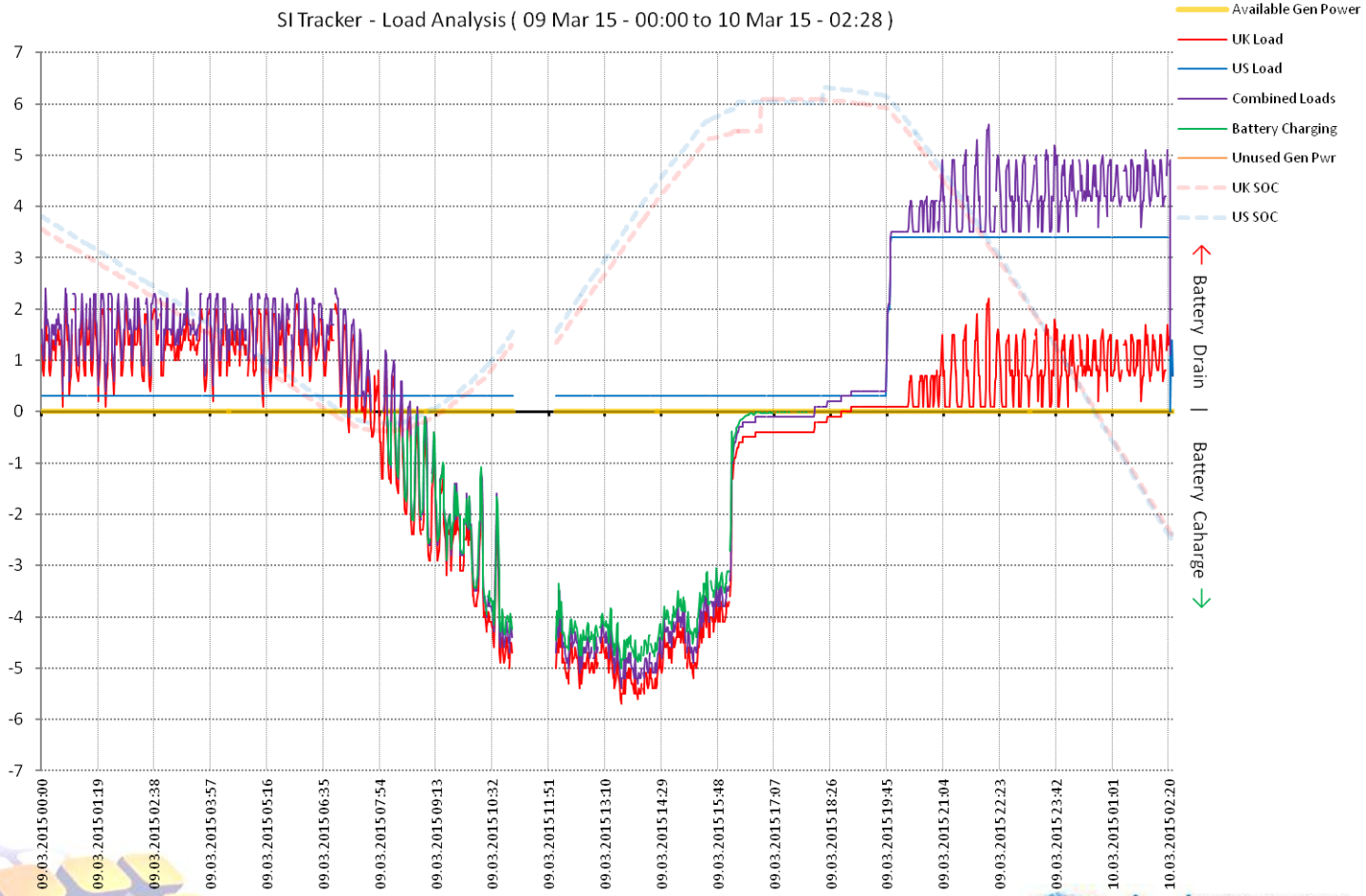
Performance Analysis

Load & charging profile



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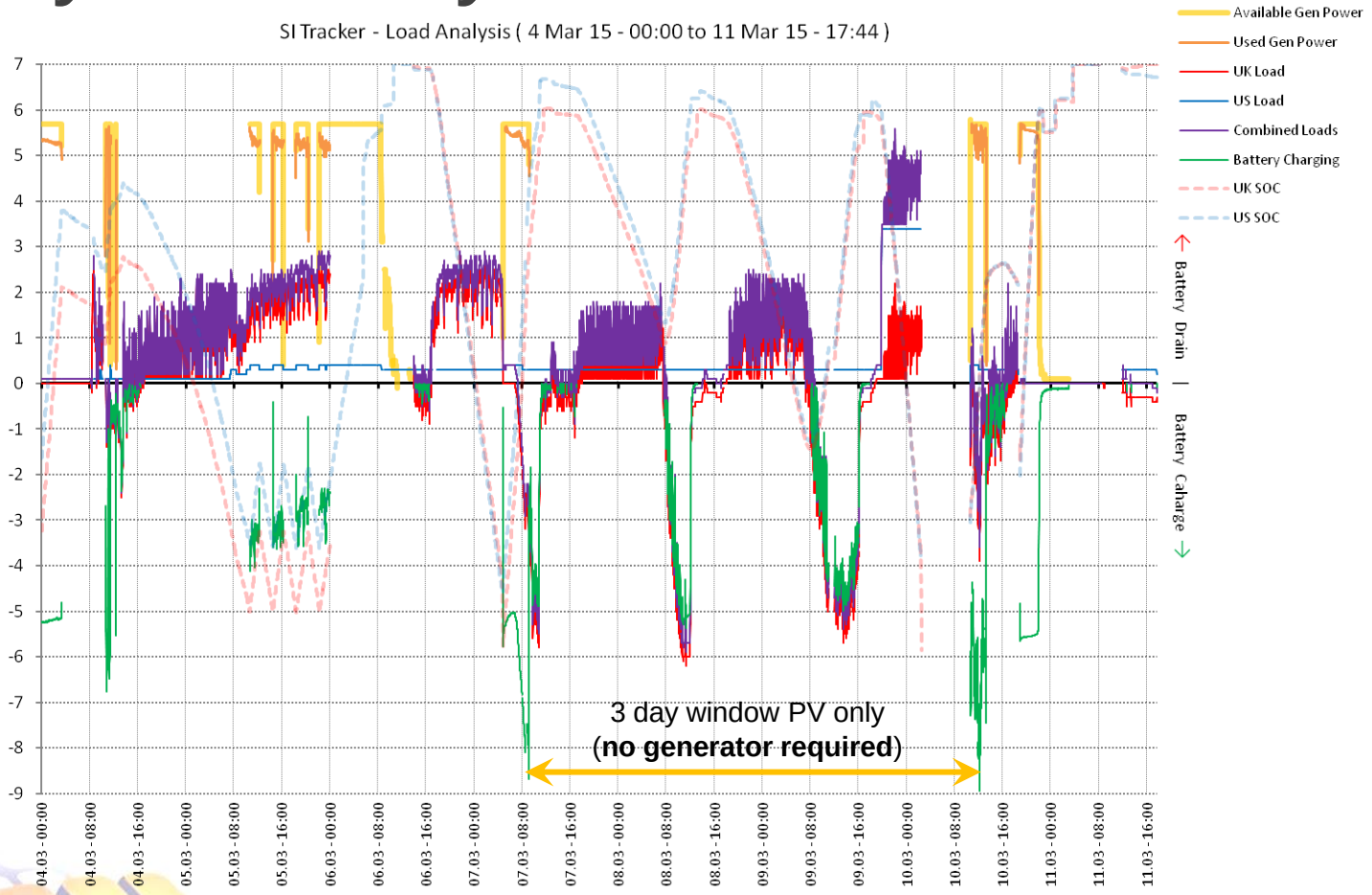
Performance Analysis

7-day summary



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Performance Summary

- 75% generator runtime reduction
- Generator optimal loading (60% FL)
- Independent of generator for 3 days
  - only modest solar activity

…as part of efficient shelter system

The takeaways..

- Broad scale energy availability
  - Occupants and expeditionary
- Wide variety of inputs & outputs
- Ease of deployment
  - No constraints on setup
- SMART system
  - Class-leading fuel savings

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