For What it’s Worth
The Value of Storage on the Grid
Leading edge hybrid lead-acid

John Wood, CEO
For What it is Worth
The Value of Storage on the Grid
Ecoult UltraBattery® Projects

- Island Grid
- Wind Smoothing
- Solar Smooth. & Shift
- Reg. Services

- Remote Telecom
- 100% renewable grid
- Light industrial
- Microgrid
Cost

ARRA Grants

Value
US Department of Energy ARRA grant
East Penn Manufacturing
Regulation Services using UltraBattery®
21st Century lead-acid
VRLA for stand-by. Ultra Battery for cycling.

UltraBattery® Technology

Lead-Acid Cell

PbO₂ + Pb → PbO₂

UltraBattery

PbO₂ + Pb → PbO₂

Ultracapacitor

Carbon Electrode

UltraBattery Carbon Electrode

Pb + PbO₂ → PbO₂ + Pb
US Department of Energy ARRA grant

Lead-acid providing accurate provision of Regulation Services

Dynamic PJM Regulation Services Signal, 22 May 2014
Trust and Safety
Leadership in safe energy storage with trusted dispatchability
Understanding, monitoring, interpretation, prediction, control, reporting

SAFETY

UltraBattery Safe working ranges

Voltage (V) | Temperature (°C)
---|---
1.50 | 0
1.60 | 10
1.70 | 20
1.80 | 30
1.90 | 40
2.00 | 50

CUSTOMER REQUIREMENT

ADAPTIVE CONTROL

kW
Momentum

New UB700 formats since ARRA Grant

- 2 V and 12 V formats in identical form factor
- Large (2x) increase in power handling
- Continuing to increase power rates
- Continuing to increase RoC
- Reducing need for parasitic loads (air conditioning)

New HMI and control designs and software

- Development of web-based reporting, control and HMI
- Individual battery sensing and monitoring
- Adaptive control
Momentum

Battery monitoring
- Safety and reliability
- Scope beyond UltraBattery
- Data transformed to information
- Reporting over internet

Automatic equalisation
- Narrowing cell-voltage spread in long strings
- Allowing highly accurate dispatch

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<th>CELL VOLTAGE (AVERAGE AND SPREAD)</th>
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**Cost**

**Cost Leadership for Lead Acid in terms of $/kW,$/kWh and LCOE**

Scope for cost leadership through Performance Enhancement

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**Improved SoC, C-rate and Longevity**

Costs fall as SoC band expands.

SoC band already maximized.

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<tr>
<th>State of Charge Band Used</th>
<th>LCoE</th>
<th>$/kWh</th>
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**Ultra Battery**

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**Lithium-ion**
Large MW-scale dual-purpose US project underway

Value

Conventional Battery in Partial State of Charge

Battery Reserve Event

Facility Online
Partial State of Charge
The New Dimension in a Lead Acid World

- **Starter Battery**: Market Size: $15B
- **Motive Battery**: Market Size: $3.5B
- **Standby Battery**: Market Size: $6B
- **PSOC Ultra Battery**: New Lead-Acid Market

State of Charge

- 1881
- 1960
- 1980
- Today
Toward Large Format PSoC

Lead-acid
- Large-format ✓
- PSoC ✗

Li-ion
- Large-format ✗
- PSoC ✓

Ultra Battery
Exceptional Large Format PSoC Performance

Seeks Large Format PSoC Market
Lead-acid technology has recycling and full-reuse perfected and priced-in

Both markets are growing, but the much larger lead-acid market is growing sustainably

High Efficiency in Partial State of Charge Use

State of Charge

- UltraBattery®: highly efficient & high longevity
- 93% - 95% DC to DC
- Lower Efficiency in Partial State of Charge Use
- Lower Efficiency and higher rate of degradation here

20%

80%

100%
Ambient Temperature advantages of PSoC

Average Voltages lower using PSoC reducing temperature based degradation.
MWkW

Monitored
12UB700 and 2UB700
Building Blocks

Products

Ultra Flex

Ultra Max

Ultra Ra x

Services

ekW

MW
Ecoult’s mission
Energy Storage for a Cleaner Planet

Wind Smoothing
Solar Smooth. & Shift.
Diesel Hybrid Support
Telecoms
Light industrial