Monitoring Health and Performance of MW Scale Battery Installations Using OSIsoft's Connected Services

Presented by **Becca Gillespie**

UniEnergy Technologies

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Agenda

- About UET
- Remote Monitoring: Health and Performance
- Use Case Description: Weekly Health Reports for Service Monitoring
- Expected Savings in Time and Money
- Summary and Questions

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About UET

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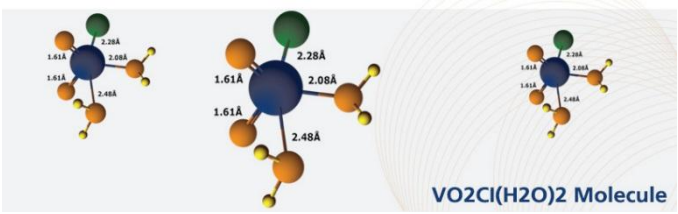
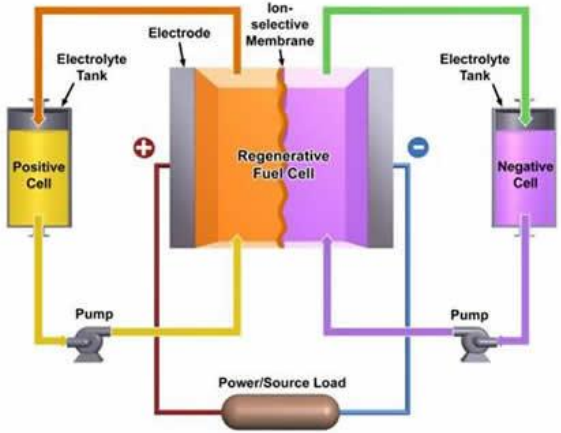
UniEnergy Technologies

- Large Scale Energy Storage
- Founded in 2012 by Gary Yang and Liyu Li
- Based in Mukilteo, WA
- Molecules to MW (2012-2014):
  - Licensed Advanced Vanadium Electrolyte from PNNL
  - Developed Energy Dense, Continerized Flow Battery with Advanced Stack and Electrolyte Technology
  - Manufactured and Deployed the First 1MW System in Q1 2015





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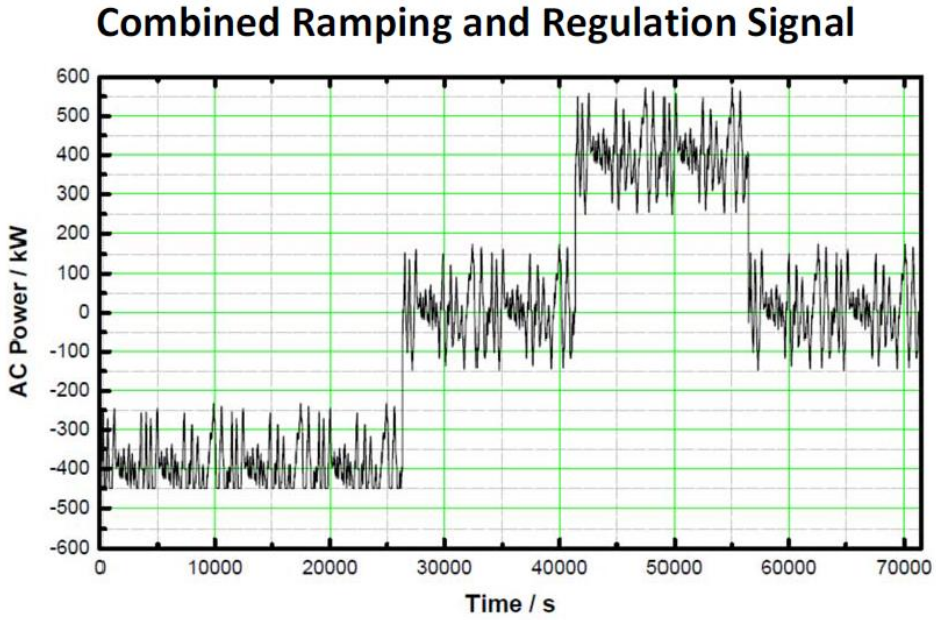
Uni.System – 4 Hour Integrated AC Battery

- Energy Battery with Power Battery Capabilities
- Prime Applications
  - Micro-Grids especially for renewable integration
  - Transmission or Generation Deferral
  - Peak Shaving
  - Layered Applications
    - Backup Power
    - Frequency Regulation



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Uni.System Basics

1 MW installation in Pullman, WA for Avista

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Remote Monitoring

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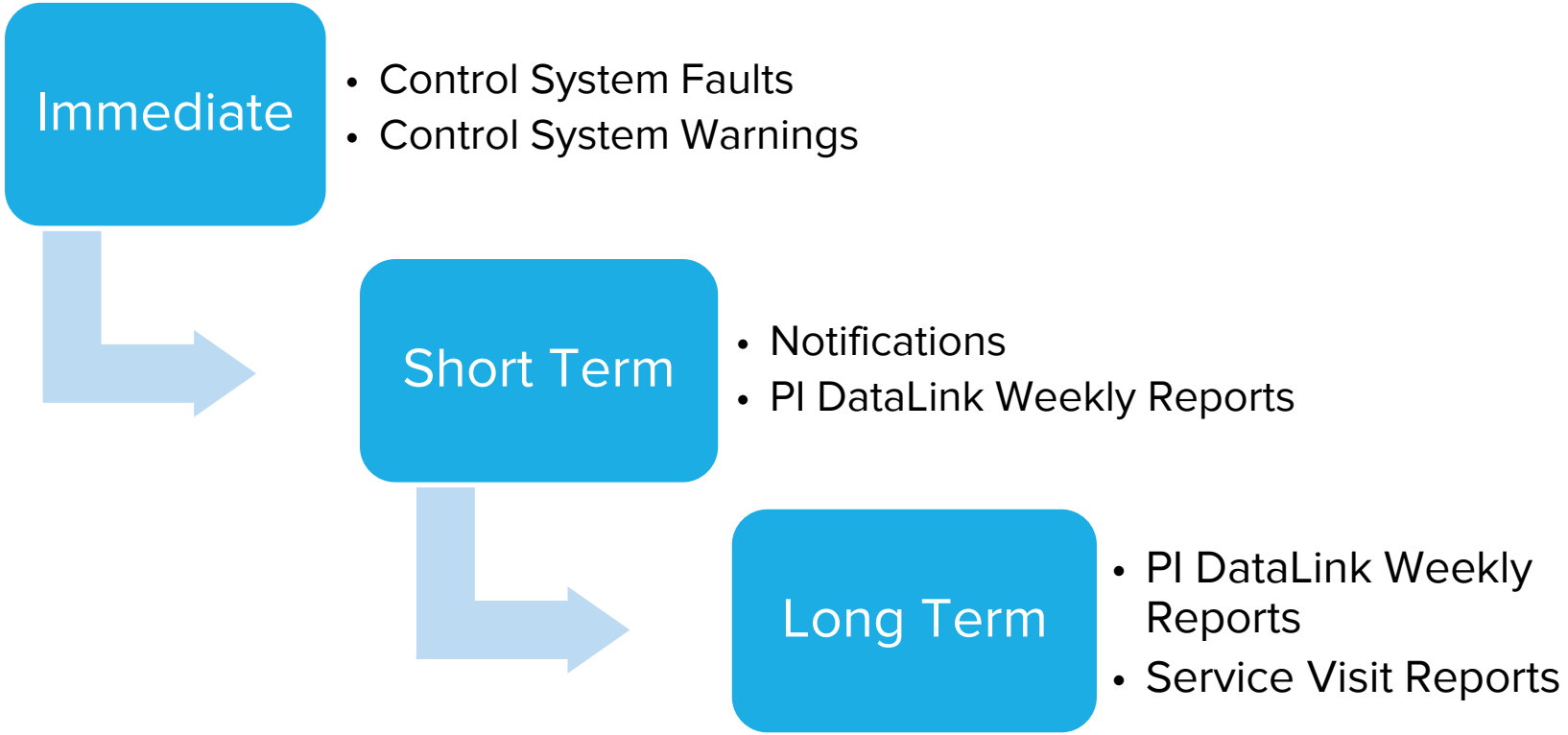
Tiered Response



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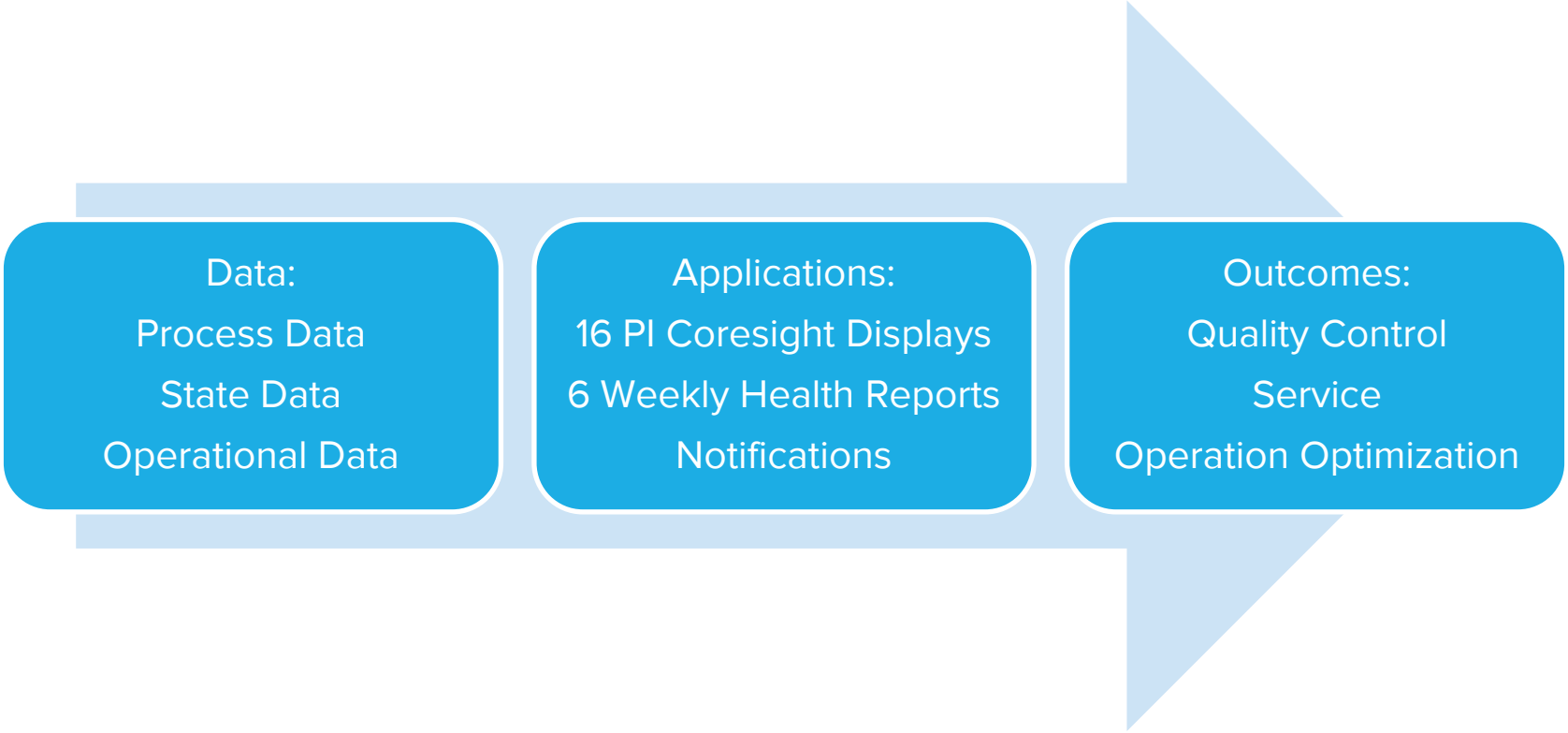
PI Data and OSI Applications



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Use Case Description: Service Monitoring

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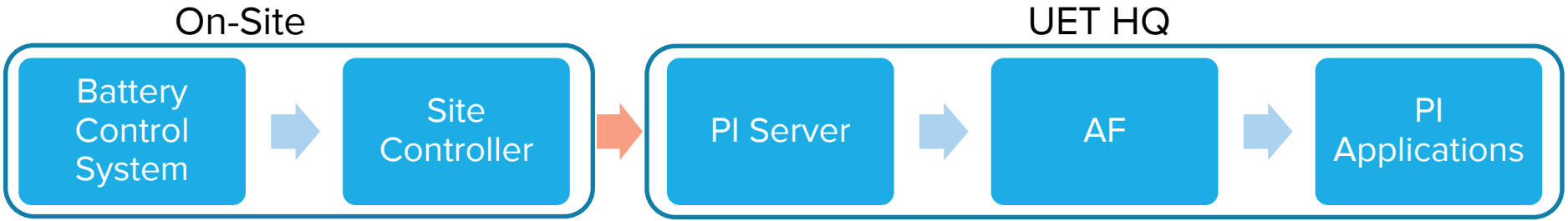
Data Flow



- New data points feed directly to AF
- Freedom to specify PI Points (edges for events, smooth for integration)
- AF performs simple calculations, creates Event Frames needed for PI DataLink, and sends Notifications
- PI Applications
  - PI Coresight references AF for HTML coding
  - PI DataLink References AF to include Event Frames and calculations, for ease of replication

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Health Reports

- 1 page weekly summary per 0.5 MW battery string
- Subsystem analysis calculated and compared to known failure or low performance parameters
  - Cooling System
  - Pump
  - Stacks (2 page report)
  - Gas Management
  - Matching
  - PCS

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Health Report: Cooling System

HEX/Radiator System - Health Report (8/17/14 to 8/23/14)

Site	Johnny Cash
String	String1
Week Begin	8/17/2014
Week End	8/24/2014

Overall Assessment: OK

Checks for 1) Usage deviat… above/below average usag… draws during on/off steps … Lack of separation between anaolyte and Catholyte Temperatures after the HEX turns on 4) Conductivity above 100 5) Life

			This wk	last wk	2 wks	Life Use	Flags
HEX/ Radiator System Usage	Time Discharging		22%	19%	19%		
	Avg. Ambient Temp		18	19	19		
	Total Discharge (KWh)						
	Battery1	%Time On	27%	29%	29%	22 hr	OK
	Battery2	%Time On	29%	30%	30%	22 hr	OK
	Battery3	%Time On	24%	25%	25%	22 hr	OK
	Battery4	%Time On	23%	26%	26%	22 hr	OK

		Step On		Step Off		
		Avg ΔP (kW)	Count	Avg ΔP (kW)	Count	Conduct-ivity
Power Usage & Conductivity	Battery1		3		6	40
	Battery2		3		6	29
	Battery3		2		5	39
	Battery4		4		5	38

One Word Summary

Simple Time-Filtered Data

Event Trigger, Excel Filter, Average

	Anolyte Temp-Catholyte Temp					
	Start	30 min	1 hr	2 hr	3 hr	
Separation	Battery1	0.1	0.7	1.2	1.5	1.6	OK
	Battery2	0.2	0.8	1.3	1.6	1.6	OK
	Battery3	0.0	0.6	1.1	1.4	1.4	OK
					1.6	1.2	OK

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Health Report: Cooling System

HEX/Radiator System - Health Report (8/17/14 to 8/23/14)

Site	Johnny Cas					
String	String1					
Week Begin	8/17/2014					
Week End	8/24/2014					

						Flags
HEX/ Radiator System Usage	Time Discha					
	Avg. Ambient Temp	18	19	19		
	Total Discharge (KWh)					
	Battery1					OK
	Battery2					OK
	Battery3					OK
	Battery4					OK

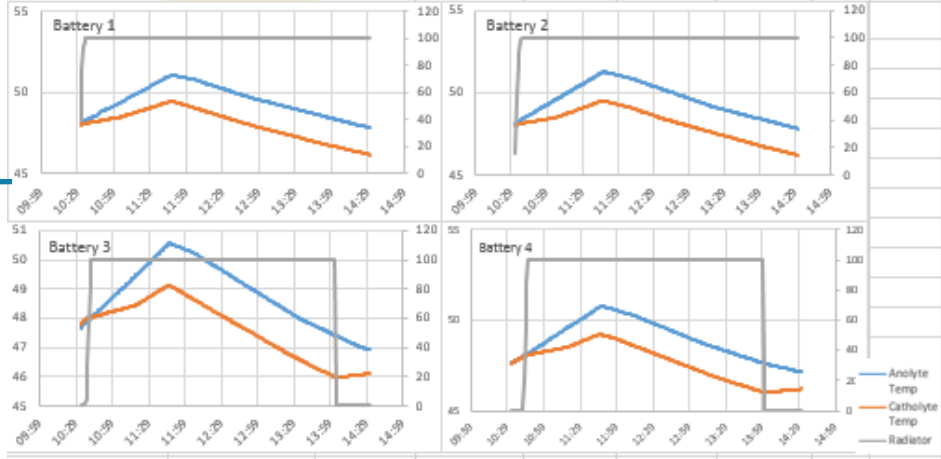
		Avg ΔP (kW)	Count	Avg ΔP (kW)	Count	Conduct-ivity	
Power Usage & Conductivity	Battery1		3		6	40	OK
	Battery2		3		6	29	OK
	Battery3		2		5	39	OK
	Battery4		4		5	38	OK

Event Trigger and Excel analysis of future Time

Graph of Events

Anolyte Catholyte Temp Separation Stats		Anolyte Temp-Catholyte Temp					
		Start	30 min	1 hr	2 hr	3 hr	
	Battery1	0.1	0.7	1.2	1.5	1.6	OK
	Battery2	0.2	0.8	1.3	1.6	1.6	OK
	Battery3	0.0	0.6	1.1	1.4	1.4	OK
	Battery4	0.2	0.8	1.3	1.6	1.2	OK

Cycle on graph **Cycle 2** Start: 8/20 10:32 End: ########



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Health report: Pump

Time-filtered averages for current time period and for baseline time period

Current period graphs

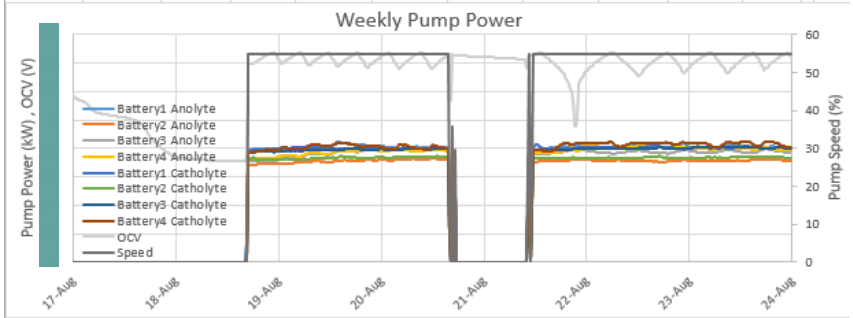
Electrolyte Pumps - Health Report (8/17/14 to 8/23/14)

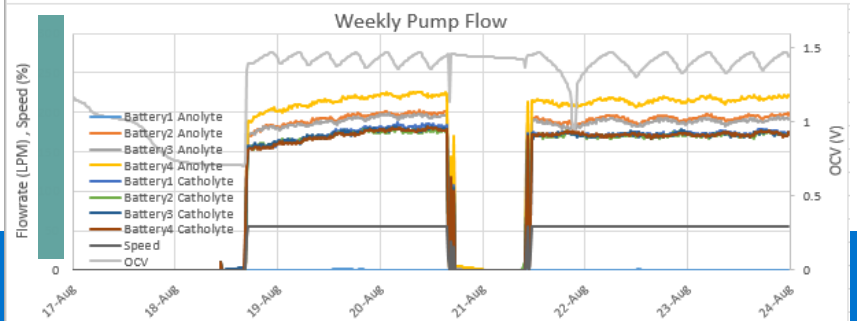
Site	Johnny Cash
String	String1
Start	8/17/2014
End	8/24/2014

Overall Assessment: OK

Checks that none of the averages (Flow, Power, Pressure) deviated from the baseline average for that average speed by more than 20%

		% Time on	Avg. Speed (%)	Average Power (kW)	Expected Avg. Power (kW)	Avg. Flow (LPM)	Expected Avg. Flow (LPM)	Avg. Pressure (psi)	Expected Avg. Pressure (psi)	Life-time Use (days)	Flag
Battery1	Anolyte	65%	55					16.8	16.8	49	OK
Battery2	Anolyte	65%	55					16.6	16.6	50	OK
Battery3	Anolyte	65%	55					16.1	15.8	50	OK
Battery4	Anolyte	65%	55					16.5	16.5	50	OK
Battery1	Catholyte	65%	55					16.9	16.6	48	OK
Battery2	Catholyte	65%	55					17.0	16.7	50	OK
Battery3	Catholyte	65%	55					16.6	16.3	50	OK
Battery4	Catholyte	65%	55					16.9	16.7	50	OK





Health Report: PCS

Messages with dates/times and code interpretation based on error codes

"Pivot" efficiencies using and AF calculation, ranges and averaging with a complex filtering statement for current period and baseline

Site	Johnny Cash
String	String1
Start	8/24/2014
End	8/31/2014

Overall Assessment: OK

OK Assessment indicates no PCS system Trips and efficiencies no less than 2% below baseline efficiency for that power voltage combination or any efficiency below 95% at 200-600 kW power

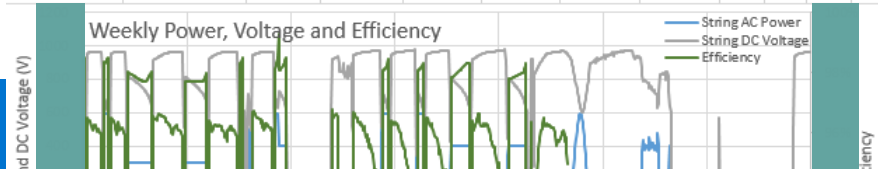
System Trips:	
PCS Trips:	
Details of PCS warnings and Trips:	
PCS Temp deratings:	

Charging

Throughput		This week (kWh):		24,757	Lifetime (MWh):		256	95% Flag	BL Flag
Time		This week (h):		80	Lifetime (days):		22		
Efficiency Averages:		Charging Power (+/- 10kW)							
		100 kW	200 kW	300 kW	400 kW	500 kW	600 kW		
DC Voltage range	800V - 850V								OK
	850V - 900V	93.4%	95.8%					OK	OK
	900V - 950V			96.1%	95.9%			OK	OK
	950V - 1000V		95.9%	95.8%	96.4%			OK	OK

Discharging

Throughput		This week (kWh):		16,041	Lifetime (MWh):		165		
Time		This week (h):		41	Lifetime (days):		11		
Efficiency Averages:		Discharging Power (+/- 10kW)							
		100 kW	200 kW	300 kW	400 kW	500 kW	600 kW		
DC Voltage range	550V - 600V			98.0%	98.4%		98.4%	OK	OK
	600V - 650V			97.9%	98.2%		98.2%	OK	OK
	650V - 700V			97.7%	98.1%		98.1%	OK	OK
	700V - 750V			97.8%	97.9%			OK	OK
	750V - 800V			97.9%	97.8%			OK	OK



Health Report: Stack

- Automatically Generate PI Coresight HTML for in-depth study on a cell by cell basis
- Key health parameters:
  - Max CV – Min CV
  - Resistance
- More multi-parameter filtering with various summary statistics reported (average, max)
- Event triggers to watch for outlying cells or BOC/EOC specific parameters

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Expected Savings in Time and Money

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Using Health Reports

- Implementation
  - Automated 7 page report generation for each string
  - Human review
  - Where possible create notifications from insight gained through reports and experience

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Benefits

- Automate to the extent reasonable
- Create visuals and summary KPIs that allow quick review and interpretation
- Reduce service visits through predictive maintenance
- Feedback to reduce service
  - Improve maintenance Schedules
  - Improve design
  - Create operation- specific design

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Summary

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UniEnergy Technologies

UniEnergy Technologies: Actionable Health and Performance Parameters

Business Challenges

A. Remote monitoring for long-term health and performance

B. Minimize service costs by predicting service needs

C. Ensure contractual performance compliance

D. Design, operations, and marketing direction

Solution

A. Implement PI System – Notifications and PI DataLink reports for automated alerts to low, medium, and high priority issues

B. Automate monitoring and response

C. Automate asset utilization and performance reports.

D. Facilitate management feedback

Results and Benefits

A. Publish six weekly health reports for each 0.5MW/ 2MWh battery, and issue alerts for higher priority items

B. Offer 12 PI Coresight displays for in-depth analysis for efficient in-depth study

C. Improved service results at a lower cost

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Becca Gillespie

Becca.Gillespie@uetechnologies.com

Applications Manager

UniEnergy Technologies

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Questions

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THANK YOU

And remember to “Go with the Flow”

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