



# Peer Review and Update Meeting 2014

## U.S. Department of Energy

### Energy Storage Systems Program (ESS)

## Overview of ARRA Smart Grid Energy Storage Demonstrations

Kim Nuhfer – National Energy Technology Laboratory

DOE Smart Grid Demonstration Program





# The Program At a Glance

Recipient	Demo/Pilot Test Location	Storage Capacity	Storage Technology Provider	Storage Technology	Utility	Federal Funding	Total Project Value
<b>AREA OF INTEREST 2.1 - Battery Storage for Utility Load Shifting</b>							
Southern California Edison	Kern County, CA	8MW	LG Chem	Lithium-ion	Southern California Edison	\$24.9M	\$54.8M
Primus Power	Modesto, CA	25MW	Primus Power	Zinc-Halogen	Modesto Irrigation District	\$14.0M	\$46.7M
Duke Energy	Notrees Windfarm, TX	24MW	Xtreme Power	Advanced Lead Acid	Duke Energy	\$21.8M	\$43.6M
<b>AREA OF INTEREST 2.2 - Frequency Regulation Ancillary Services</b>							
Hazle Spindle, LLC	Hazle Township, PA	20MW	Beacon Power	Flywheel	PJM/PPL	\$24.0M	\$48.1M
<b>AREA OF INTEREST 2.3 - Distributed Energy Storage for Grid Support</b>							
East Penn Manufacturing Co.	Lyon Station, PA	3MW	East Penn/Ecoult	Advanced lead-acid / ultracapacitor	PJM/PPL	\$2.5M	\$5.0M
Public Service of New Mexico	Albuquerque, NM	2.8MWh	East Penn/Ecoult	Advanced lead-acid / ultracapacitor	Public Service of New Mexico	\$2.5M	\$6.3M
The Detroit Edison Company	MI	1.5MW	Dow KoKam	Lithium-ion	Detroit Edison	\$4.9M	\$10.8M
City of Painesville	Painesville, OH	1MW	Ashlawn Energy	Vanadium redox	Painesville Municipal Power	\$4.2M	\$9.6M
Vionx Energy	Everett, MA Worcester, MA	1MW	Vionx/United Technologies Corporation	Vanadium redox	National Grid	\$6.0M	\$12.5M
<b>AREA OF INTEREST 2.4 - Compressed Air Energy Storage (CAES)</b>							
New York State Electric & Gas	Reading, NY	150MW	N/A	CAES	NYSEG	\$29.5M	\$125.0M
Pacific Gas & Electric	TBD, CA	300MW	TBD	CAES	PG&E	\$25.0M	\$355.9M
<b>AREA OF INTEREST 2.5 - Demonstration of Promising Energy Storage Technologies</b>							
Seeo, Inc	Hayward, CA	<25kWh	Seeo	Lithium ion polymer electrolyte	NA	\$6.2M	\$12.3M
Aquion Energy	Pittsburgh, PA	> 10kWh	Aquion Energy	Sodium ion	NA	\$5.1M	\$10.3M
SustainX, Inc.	Seabrook, NH	1.5MW	SustainX	CAES	NA - Pilot Test @ SustainX	\$5.3M	\$10.7M
Amber Kinetics, Inc.	San Diego, CA	500kW	Amber Kinetics, Inc.	Flywheel	UCSD Microgrid	\$3.6M	\$10.0M
Raytheon Ktech	Turlock, CA	250kW	EnerVault	Fe/Cr redox-flow	Valley View Ranches Almond Farm	\$4.8M	\$9.5M

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# Project Storage Technologies



Lithium Ion Batteries	Flow Batteries	Advanced LABs	Other	CAES	Flywheels
Detroit Edison (Kokam)	Ktech (Enervault)	East Penn	Aquion (Sodium-Ion)	NYSEG	Amber Kinetics
So Cal Edison (LG Chem)	Painesville (Ashlawn)	Public Service of NM (East Penn/Ecoult)		PG&E	Hazle Spindle (Beacon Power)
Seeo	Vionx	Duke (Xtreme*)		SustainX	
	Primus Power				

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# Primary Storage Applications of Projects



Capacity/ Arbitrage	Renewable Firming/ Shifting	Grid Support/ Distributed Storage	Frequency Regulation	NA/TBD
NYSEG	Duke	Detroit Edison	Amber Kinetics	Aquion
PG&E	Ktech	Painesville	East Penn	Seeo
	Primus Power	Vionx	Hazle Spindle	SustainX
	Public Service of NM			
	So Cal Edison			

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# Status of Demonstration Projects



Completed/Ended	Operational	Still in Development/ Construction
Aquion	Detroit Edison	Amber Kinetics
Duke Energy	Hazle Spindle	Painesville
East Penn	SoCal Edison	PG&E
Ktech/Enervault		Primus Power
NYSEG*		Vionx
Public Service of New Mexico		
Seeo		
SustainX		

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# COMPLETED – Aquion Energy Sodium Ion Battery for Grid Level Application



## Supporters

**KPCB** | KLEINER  
PERKINS  
CAUFIELD  
BYERS



**BRIGHT**  **CAPITAL**



DoE high voltage  
demonstration at Aquion

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# COMPLETED - Duke Energy Notrees Wind Storage Demonstration Project



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# COMPLETED – East Penn Manufacturing Ancillary Services Using UltraBattery Technology



***EAST PENN manufacturing co., inc.***



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# COMPLETED – Raytheon Ktech Redox Flow Battery Demonstration



## Raytheon Ktech

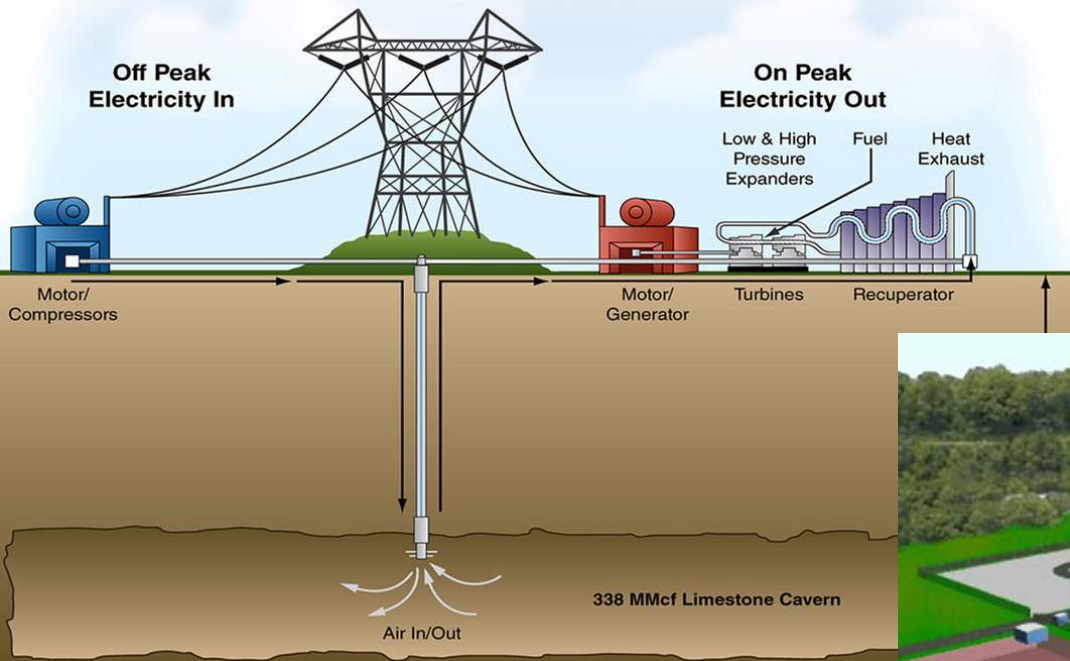


**EnerVault**  
Safe, Reliable, Cost-Effective Energy Storage

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# COMPLETED - New York State Electric and Gas Seneca Compressed Air Energy Storage Project



**WorleyParsons**  
resources & energy



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# COMPLETED – PNM Resources Prosperity Energy Storage Project



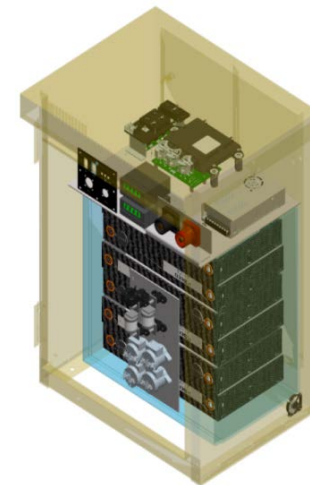
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# COMPLETED – Seeo Solid-State Batteries for Grid-Scale Energy Storage



**Seeo 10kWh system  
installed in the field with  
a photovoltaic array**

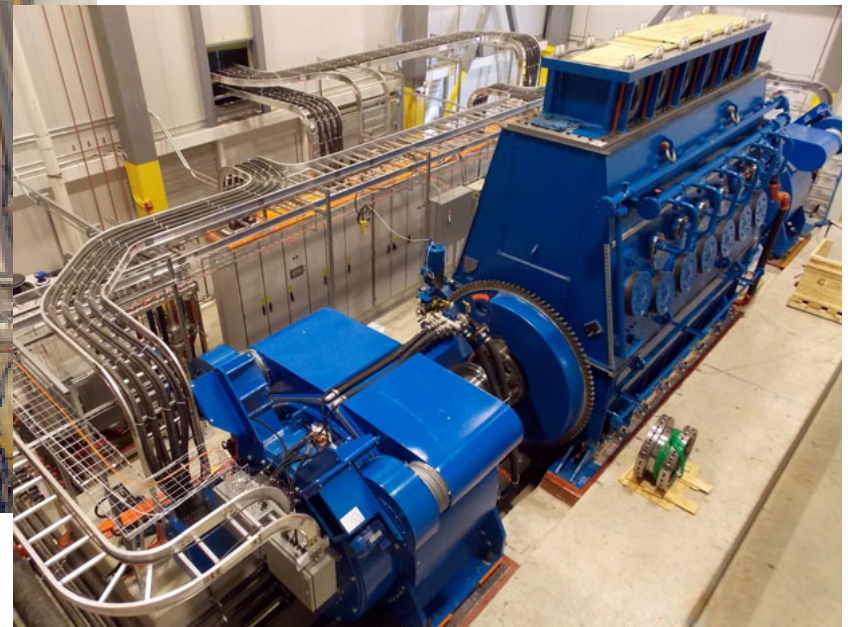


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# COMPLETED – SustainX MW-Scale Isothermal CAES System



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# OPERATIONAL - Detroit Edison Advanced Community Energy Storage for Grid Support



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# OPERATIONAL - Hazle Spindle LLC Beacon Power 20 MW Flywheel Plant



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# OPERATIONAL - Southern California Edison Tehachapi Wind Energy Storage Project



**LG Chem**



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# DEVELOPMENT – Amber Kinetics Flywheel Energy Storage Demonstration



## AMBER KINETICS



**SIEMENS**

BERKELEY  
ENERGY  
SCIENCES  
CORP



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# DEVELOPMENT - Painesville Municipal Electric Power Vanadium Redox Battery Demonstration Project



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# DEVELOPMENT – PG&E

## Compressed Air Energy Storage In California



*Pacific Gas and  
Electric Company*



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# DEVELOPMENT - Primus Power Wind Firming EnergyFarm™



2012 - 13: EnergyCell



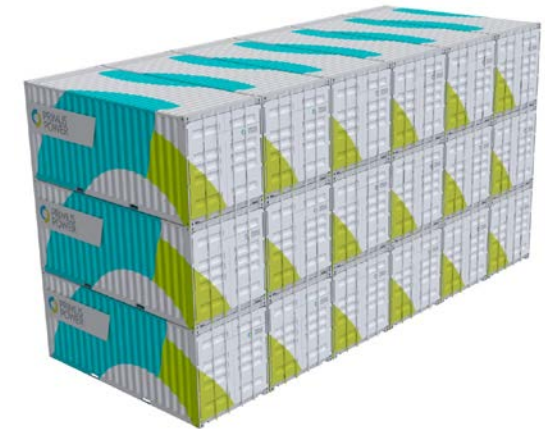
20 kW  
80 kWh

2013 - 14: EnergyPod™



250 kW  
1,000 kWh

2014 - 15: production starts



MegaWatt  
Deployments



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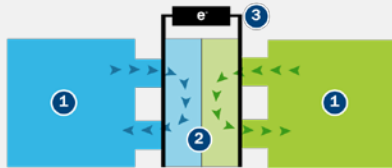




# DEVELOPMENT – Vionx Energy Corporation Distributed Energy Storage System Demonstration

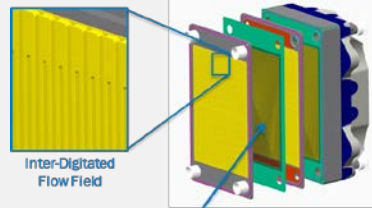


## Vanadium Redox Flow Battery



- 1 Electrolyte is pumped from two tanks to a cell stack
- 2 A membrane keeps the electrolytes from mixing
- 3 Electrons are transferred from the electrolyte through a current collector

## Advanced Stack Technology



Advanced Electrode & Ion-Exchange Membrane  
**X-FLOW™ TECHNOLOGY** delivers 2X the power and  
½ the stack cost of conventional flow batteries



Exclusive Technology  
License, R&D, Equity  
Partner

**JABIL**

Manufacturing  
Partner

**SIEMENS**

EPC & PCS Equipment  
Partner

**3M**

Advanced Membrane  
Technology Partner

**nationalgrid**



Demonstration  
Partners

## Wind Integration

(Holy Name High School  
Worcester, MA)



## 500kW 6-hour VNX-C Series

- ✓ Wind Integration (600kW Wind)
- ✓ Time-of-Use Rate Reduction
- ✓ Demand Charge Reduction



## Solar Integration

(Everett Solar Power Project  
Everett, MA)



## 500kW 6-hour VNX-C Series

- ✓ PV Integration (605kW Solar)
- ✓ Voltage Support
- ✓ Load Following



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# For Further Information



- Visit [SmartGrid.Gov](http://SmartGrid.Gov) for more information on the SGDP energy storage demonstration projects
  - Build Metrics for installed equipment are posted as they are deployed
  - Technology Performance Reports (TPRs) will be published on the site as they become available.

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