



ARPA-E GRID SCALE ENERGY STORAGE WORKSHOP
(Hosted by ARPA-E and the DOE Office of Electricity Delivery & Energy Reliability)
- Executive Summary -

Purpose of Workshop:

- The purpose of this workshop is for ARPA-E to gather input from ~45 leading experts in the grid scale energy storage field as it considers the creation of targeted funding programs in this topic area.
- Specifically, the goal will be to gain a deeper understanding of which grid scale energy storage applications have the highest potential to impact ARPA-E's mission areas of greenhouse gas emissions reductions and improvements in the efficiency of generation and delivery of electric power, the critical performance and cost metrics required for widespread adoption of promising grid scale storage technologies in these high impact applications, and emerging opportunities/challenges for transformational "over the horizon" new technology approaches that may be ripe for ARPA-E support.

Meeting Structure:

- The meeting will consist of brief introductory remarks by ARPA-E Program Manager David Danielson and Imre Gyuk, Program Manager, Energy Storage Systems in the DOE's Office of Electricity Delivery & Energy Reliability, followed by two breakout sessions and reports back to the larger group summarizing the breakout sessions' output addressing our key questions. David Danielson will also be available for scheduled 20-30 minute one-on-one meetings from 3:30-9:30pm immediately after the workshop. Please contact Dawson Cagle, dawson.cagle@hq.doe.gov, to schedule a meeting.

Meeting Output/Outcomes:

- The purpose of the workshop will be for ARPA-E to elicit feedback from leading experts on the most promising opportunities for high impact program areas and optimal program structures (i.e. application and technology focus, performance/cost targets, program/project size) for ARPA-E to support the development of transformational new grid scale energy storage technologies. The output of the workshop will be to inform ARPA-E as it considers potential program formation in this topic area.
- A workshop summary document will be prepared after the meeting which will include all materials presented at the meeting as well as a summary of key ARPA-E takeaways and learnings from the workshop. This workshop summary document will be posted publically on ARPA-E's website after the meeting.



GRID SCALE ENERGY STORAGE WORKSHOP

- AGENDA -

Hosted by ARPA-E and the DOE Office of Electricity Delivery & Energy Reliability

Co-Chairs:

David Danielson (ARPA-E)

Imre Gyuk (DOE Office of Electricity)

Seattle Renaissance Hotel

Sunday, October 4, 2009

4th Floor

8:30 AM - 9:00 AM	Registration & Continental Breakfast 4th Floor Foyer
9:00 AM – 9:20 AM	Welcome and Opening Remarks Dr. David Danielson, ARPA-E Seneca Room
9:20 AM – 9:50 AM	Grid Scale Energy Storage Overview and Overview of Office of Electricity Storage Program Dr. Imre Gyuk, Office of Electricity Seneca Room
9:50 AM – 10:00 AM	Introduction of Breakout Session #1: Energy Management: “Hours/Diurnal” Dr. David Danielson Seneca Room
10:00 AM – 10:45 AM	Breakout Session #1: Energy Management: “Hours/Diurnal” Seneca, Columbia, Marion & Spring Rooms
10:45 AM – 11:00 AM	Coffee Break 4th Floor Foyer
11:00 AM – 12:10 PM	Briefing of the Full Group by Each Breakout Group Chairperson (10 min per breakout group) and Discussion Seneca Room
12:10 PM – 12:20 PM	Introduction of Breakout Session #2: Power Applications: “Seconds/Minutes” Dr. David Danielson Seneca Room
12:20 PM – 1:20 PM	Breakout Session #2: Power Applications: “Seconds/Minutes” (Working Lunch) Seneca, Columbia, Marion & Spring Rooms



- 1:20 PM – 2:20 PM Briefing of the Full Group by Each Breakout Group
Chairperson (10 minutes per breakout group) and
Discussion
Seneca Room
- 2:20 PM – 2:30 PM Concluding Remarks
Dr. Imre Gyuk
Dr. David Danielson
Seneca Room
- 2:30 PM – 3:30 PM Coffee and Informal Discussion
Seneca Room
- 3:30 PM – 9:30PM David Danielson available for scheduled 20-30 minute one-
on-one meetings
(Email Dawson Cagle, dawson.cagle@hq.doe.gov to
schedule a meeting)
Location TBD



GRID SCALE ENERGY STORAGE WORKSHOP - BREAK OUT SESSIONS DESCRIPTION -

A chairperson will be appointed for each breakout session. The chairperson will moderate the discussion, ensure that as many key questions are addressed by the group as possible, and will provide a 10 minute report of the results of the breakout session to the full workshop group.

Breakout Session #1:

Energy Management: “Hours/Diurnal”

Breakout Groups:

- 1.) Compressed Air Energy Storage (CAES)
- 2.) Bulk Electrochemical Storage: liquid metal/flow batteries/metal-air/etc
- 3.) Advanced Batteries: Advanced Li-ion/NiCd/Pb-acid/Pb-C/beyond Li-ion/etc
- 4.) Other Bulk Storage Approaches: underground pumped hydro/chemical storage/etc
- 5.) Power Conditioning Systems and Balance of Plant

Breakout Session #2:

Power Applications: “Seconds/Minutes”

Breakout Groups:

- 1.) Bulk Electrochemical Storage: liquid metal/flow batteries/metal-air/etc
- 2.) Advanced Batteries: Advanced Li-ion/NiCd/Pb-acid/Pb-C/beyond Li-ion/etc
- 3.) Ultracapacitors/SMES
- 4.) Flywheels and Other Power Focused Storage Applications

Key Questions to Be Addressed in Each Breakout Session:

Highest Impact Applications:

For the relevant technology area and power delivery timescale, what are the grid storage applications that have the highest potential impact on greenhouse gas emissions reductions and improved efficiency of power generation and delivery? Please explain why these are the highest potential impact applications.

Required Performance/Cost for Significant Adoption:

What are the required performance and cost targets to enable significant adoption of the relevant technology in these highest impact applications relative to the current state of the art?

Key Technical Barriers:

What are the most significant technical barriers preventing current technology from reaching these targets required for significant adoption?



Promising Emerging Technical Approaches:

What are some of the most promising emerging technical approaches/pathways for overcoming existing technical limitations to enable reaching these targets? What are critical technical barriers/risks for these approaches?

Holy Grails:

Does the group have any ideas for highly unconventional “left-field” kinds of solutions that could have a completely transformational impact on the relevant technology field? (i.e. materials with new properties/cost profiles that do not currently exist, new types of manufacturing processes that have never been applied to the field before, a system design that relieves a key constraint that appears insurmountable today, “what if” kind of ideas, etc)

Funding Gaps:

Where are the most significant gaps in the existing U.S. funding environment for the relevant technology? (government, venture capital, corporate research)

Where would the group like to see ARPA-E and the Office of Electricity Delivery & Energy Reliability, respectively, focus their programmatic efforts so that they are complementary and synergistic?

Level of Development Required for Private Sector Hand-Off:

What level of technology validation/demonstration is required for a successful hand-off from an ARPA-E funded project to continued financial support by the private sector/other funding entities?

Required Levels of Funding for Meaningful Progress:

What levels of funding over ~3 years are required to 1.) provide proof of concept for a new technology concept, 2.) provide a meaningful bench scale prototype, and/or 3.) provide a meaningful small-scale demonstration project.