HYDROGEN ENERGY STORAGE
FOR GRID AND TRANSPORTATION SERVICES

A Workshop Convened by
the U.S. Department of Energy and Industry Canada
Hosted by the National Renewable Energy Laboratory and the California Air Resources Board

Sheraton Grand Hotel, Sacramento, California, May 14–15, 2014

Workshop Goal:	*Identify challenges, benefits and opportunities for commercial hydrogen energy storage applications to support grid services, variable electricity generation, and hydrogen vehicles.*
Workshop Scope:	*A broad range of services from hydrogen storage systems in the near and long term.*
Workshop Focus:	*The four key topics shown as discussion panels in the agenda below.*

AGENDA OVERVIEW	
Wednesday, May 14: Lessons Learned, Demonstrations, and Market Opportunities	
1:00 – 2:00 PM	Opening Remarks
2:00 – 3:00 PM	**Discussion Panel:** Lessons Learned and Demonstration Status
3:00 – 3:20 PM	*Break*
3:20 – 4:45 PM	**Discussion Panel:** Market Opportunities and Business Models
4:45 – 5:00 PM	Review Breakout Group Topics and Process
Thursday, May 15: Technology R&D, Future Potential, and Policy	
8:30 – 9:55 AM	Breakout Session A: Lessons and Demos, Markets and Business Models
9:55 – 10:15 AM	*Break*
10:15 – 11:00 AM	Breakout Group Reports and Discussion
11:00 – 12:00 PM	**Discussion Panel:** Technology R&D and Near-Term Market Potential
12:00 – 1:15 PM	*Lunch (on your own/ coordinated phone orders if confirmed by 10 am)*
1:15 – 2:15 PM	**Discussion Panel:** Policy and Regulatory Challenges and Opportunities
2:15 – 3:40 PM	Breakout Session B: Policy and Regulatory Role for R&D and Opportunities
3:40 – 4:00 PM	*Break*
4:00 – 4:45 PM	Breakout Group Reports and Plenary Discussion
4:45 – 5:00 PM	Closing Remarks

DETAILED AGENDA

Wednesday, May 14: Lessons Learned, Demonstrations, and Market Opportunities

1:00 – 2:00PM **Opening Remarks**

Introduction: Monterey Gardiner, U.S. Department of Energy

- **Kevin Lynn**, Director, Energy Systems Integration, U.S. Department of Energy
- **Tim Karlsson**, Director, Emerging Technologies, Industry Canada
- **Analisa Bevan**, Chief, Sustainable Transportation Technology Branch, ECARS Division, California Air Resources Board
- **Fernando Pina**, Manager, Energy Systems Research, California Energy Commission

2:00 – 3:00 PM **Discussion Panel: Lessons Learned and Demonstration Status**

Moderator: Monterey Gardiner, U.S. Department of Energy

Key Panel Questions:

- *What have we learned from past workshops and studies on hydrogen and other energy storage systems?*
- *What is the current status of ongoing and proposed projects?*
- *What lessons can be passed on from existing demonstration projects to inform future projects, including unintended consequences?*

- **Monterey Gardiner**, U.S. Department of Energy's Fuel Cell Technologies Office
- **Dave Teichroeb**, Enbridge, Inc., Alternative & Emerging Technology, Business Development
- **Hanno Butsch,** National Organisation Hydrogen and Fuel Cell Technology
- **Mitch Ewan**, Hawaii Natural Energy Institute

3:00 – 3:20 PM *Break*

3:20 – 4:45 PM **Discussion Panel: Market Opportunities and Business Models**

Moderator: Timothy Lipman, UC Berkeley, Transportation Sustainability Research Center

Key Panel Questions:

- *What are the future market opportunities for hydrogen storage?*
- *What business model approaches capture the value and unique benefits of using hydrogen as an energy storage medium?*
- *How can hydrogen storage effectively interface with and improve the performance of regional electricity grids?*

- **Josh Eichman**, National Renewable Energy Laboratory
- **Patrick Balducci**, Pacific Northwest National Laboratory
- **Anna Lord**, Sandia National Laboratories
- **Brian Weeks**, Gas Technology Institute
- **Valri Lightner,** Loan Programs Office, U.S. Department of Energy

4:45 – 5:00 PM **Review Breakout Group Topics and Process (Marc Melaina, National Renewable Energy Laboratory)**

5:15 PM **Reception, Sheraton Grand Lobby**
Cash bar, with food compliments of the Breakthrough Technologies Institute

Thursday, May 15: Technology R&D, Future Potential, and Policy

8:30 – 9:55 AM **Breakout Session A: Lessons and Demos, Markets and Business Models**

See Breakout Session Topic and Rooms Assignment Handout

9:55 – 10:15 AM *Break*

10:15 – 11:00 AM **Breakout Group Reports and Discussion**

11:00 – 12:00 PM **Discussion Panel: Technology R&D and Near-Term Market Potential**

Moderator: Frank Novachek, Xcel Energy

Key Panel Questions:

- *Under what conditions and where will electrolytic-based hydrogen energy storage projects succeed in North America?*
- *What are the competitive advantages of electrolytic hydrogen storage compared to other technologies?*
- *Have the R&D priorities necessary to ensure market success changed from the Challenges-5X and R&D-10X needs captured at the last electrolyzer workshop in February at the National Renewable Energy Laboratory?*
- *What are the most important drivers which should influence R&D priorities (operations and maintenance, capital cost, efficiency, near- versus long-term market opportunities, regulations)?*

- **Bob Rose,** ITM Power
- **Hector Maza,** Giner
- **Steve Szymanski**, Proton OnSite
- **Rob Harvey,** Hydrogenics

12:00 – 1:15 PM **Lunch (on your own)**

1:15 – 2:15 PM **Discussion Panel: Policy and Regulatory Challenges and Opportunities**

Moderator: Tim Karlsson, Director, Emerging Technologies, Industry Canada

Key Panel Questions:

- *What policy/regulatory objectives drive energy storage systems (e.g., environmental goals, permitting issues, aging infrastructure) and how does hydrogen use fit in this environment?*
- *What is the role of the policy/regulatory decisions compared to current market drivers in the business case for hydrogen use?*
- *How might future policies/regulations on energy storage and management change the business environment and how could hydrogen fit into this future?*

- **Melicia Charles**, California Public Utilities Commission
- **Jeff Reed**, Sempra Utilities
- **Gerhard Achtelik,** California Air Resources Board
- **Kourosh Malek**, National Research Council Canada

2:15 – 3:40 PM **Breakout Session B: Policy and Regulatory Role for R&D and Opportunities**

See Breakout Session Topic and Rooms Assignment Handout

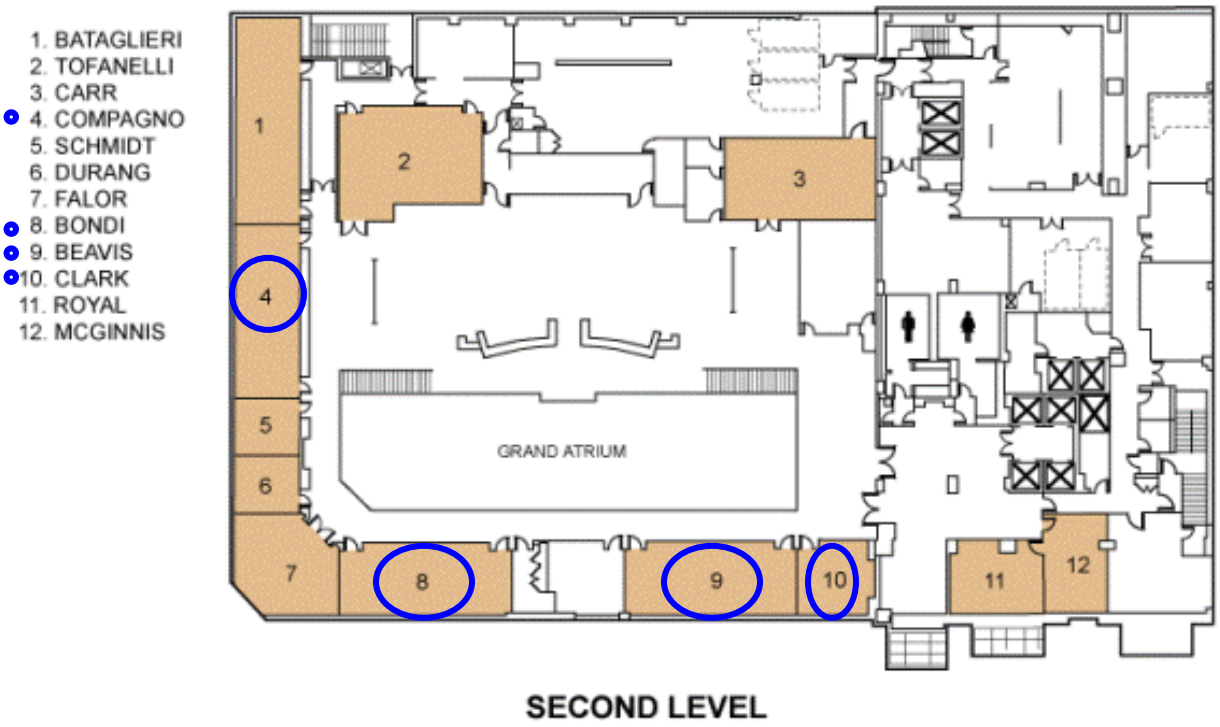
3:40 – 4:00 PM *Break*

4:00 – 4:45 PM **Breakout Group Reports and Plenary Discussion**

4:45 – 5:00 PM **Closing Remarks**

BREAKOUT SESSIONS

Breakout Session Numbers and Rooms	#1 Compango	#2 Beavis	#3 Bondi	#4 Clark



AM Breakout TOPIC: Demonstration Criteria and Opportunities

1. **CRITERIA:** What criteria should be used to identify promising near-term (next 1 to 3 years) demonstration projects with high potential for learning and early commercial success?
    a. What criteria will distinguish competitive hydrogen energy storage projects in the long term (next 5 to 15 years)?
2. **POLICIES:** What existing or proposed policies/regulations can (or could) enable opportunities for successful near-term demonstrations of hydrogen energy storage?
    a. How can the unique benefit of hydrogen storage systems be appropriately valued?
3. **NEXT STEPS:** What actions, analyses, or demonstrations are needed to best inform industry and government decision makers to build support for a broader rollout of hydrogen as an energy storage medium?
    a. Is your suggestion applicable in the near term (next 1 to 3 years) or the long term (next 5 to 15 years)?

PM Breakout TOPIC: Transportation, Renewables, and Other Synergies

1. **BARRIERS:** What technical and policy barriers are hindering integration across multiple energy sectors using hydrogen energy storage (i.e., heating fuel, transportation fuel, electric grid)?
2. **POLICIES:** What existing or proposed policies/regulations can (or could) enable cross-sector synergies that strengthen the (near- or long-term) business case for hydrogen energy storage?
3. **NEXT STEPS:** What actions, analyses, or demonstrations are needed to inform key stakeholders of the potential for cross-sector synergies using hydrogen storage?