

Webinar Discussion on
**REGIONAL CLEAN ENERGY
TECHNOLOGY INNOVATION**

September 29, 2016



U.S. DEPARTMENT OF
ENERGY



Mission Innovation

Lynn Orr

Under Secretary for Science and Energy

U.S. Department of Energy

September 29, 2016

Mission Innovation

Within the larger international context for climate change:

- ❖ Commitment of US and 19 other world leaders to commit to a doubling (\$6.4 billion in FY 2016 to \$12.8 billion in FY 2021) of public investment in clean energy R&D over next 5 years (FY 2017 President's budget request is \$7.7 b for 12 agencies; of this, \$5.865b for DOE)
- ❖ The 20 countries represent 75% of the world's CO2 emissions from electricity, and more than 80 percent of the world's clean energy R&D investment
- ❖ Within DOE, new funding in FY 2017 for MI will be focused on early stage research and development

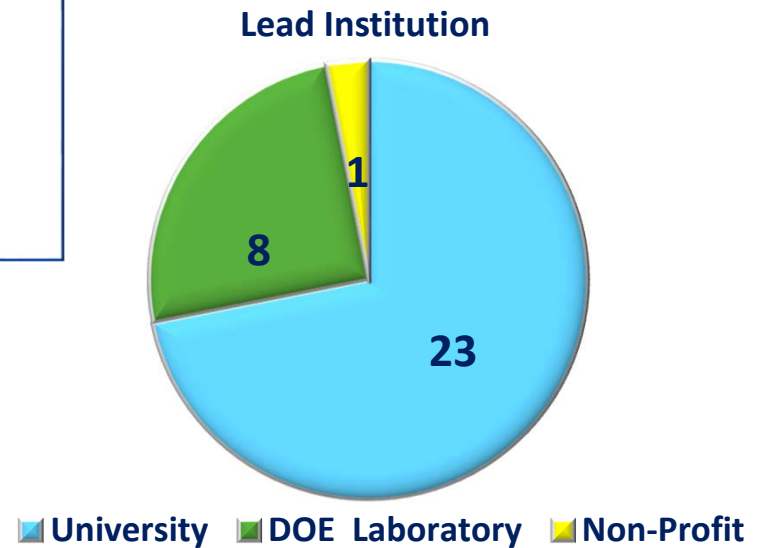
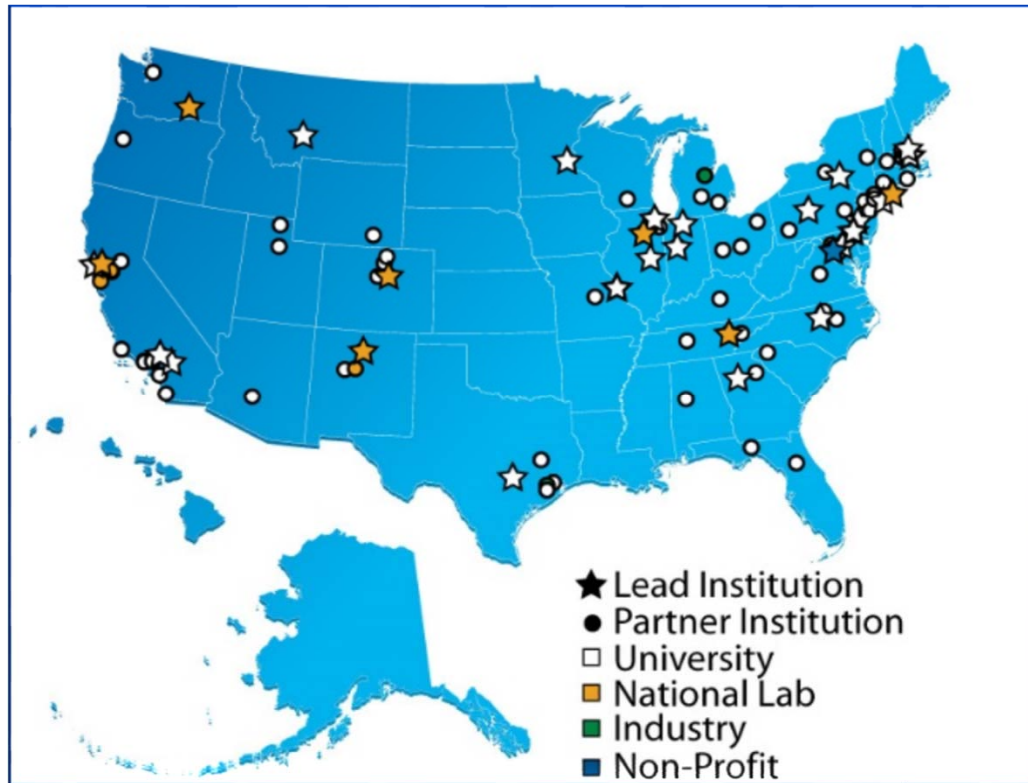


How do we advance clean energy R&D?

- **A fully stocked portfolio of energy R&D based on a solid foundation of fundamental science and computing**
- **Innovative research collaborations**
- **What interdisciplinary research modes are appropriate for MI research?**



Energy Frontier Research Centers



Energy Innovation Hubs

Energy Innovation Hubs

EERE: Critical Materials Institute (AMES)

Explores ways to address challenges in critical materials, including mineral processing, manufacture, substitution, efficient use, and end-of-life recycling.

EERE: Energy-Water Nexus Desalination Hub (TBD)

Will serve as a center of research focused on developing integrated technological system solutions and enabling technologies for de-energizing, de-carbonizing, and reducing the cost of desalination to provide clean and safe water.

NE: Modeling and Simulation of Nuclear Reactors (ORNL)

Creates a "virtual" version of an existing operating Pressurized Water Reactor, a modeling and simulation tool known as the Virtual Environment for Reactors Analysis (VERA) that is being used to create a better understanding of performance and safety issues with these reactors.

SC: Batteries and Energy Storage Hub (ANL)

Focuses on discovery of new energy storage chemistries through the development of an atomic-level understanding of reaction pathways and development of universal design rules for electrolyte function.

SC: Fuels from Sunlight Hub (LBNL)

Creates transformative advances in the development of artificial photosynthetic systems for converting sunlight, water, and carbon dioxide into a range of commercially useful fuels.

Advanced Manufacturing Initiative

GOAL

Reduce by 50% in 10 years the life-cycle energy consumption of manufactured goods by targeting the production and use of advanced manufacturing technologies

Develop and Demonstrate:

- Energy-efficient processing and materials technologies for manufacturers and spur investment.
- Manufacturing processes that reduce energy intensity and improve production.
- Materials technologies improving products to use less energy throughout their lifecycles.
- Technical assistance activities promoting advanced technologies and better energy management.

- **Oak Ridge Manufacturing Demonstration Facility**
- **Critical Materials Hub**
- **America Makes**
- **Power America**
- **Institute for Advanced Composites**



Advanced Research Projects Agency – Energy (ARPA-E) Unique Role to Complement DOE Applied Energy R&D

- Focus on early stage technologies
- Potential for meaningful advancement from concept to laboratory-scale prototype with a modest investment over a defined time period
- Project leads include companies, universities, national labs
- 475 projects from 29 focused and open solicitations, 35 new companies, 45 private sector follow on investments, 60 projects with follow on government funding for further development



MI Portfolio: New Cross-cutting Initiatives Proposed in FY 17 Budget

Regional Clean Energy Innovation Partnerships

- Establish regionally-based innovation partnerships focused on regional innovation capabilities, resources, markets, needs and opportunities (\$110M)
- Two principal issues: design of a partnership and establishment of regional boundaries

National Laboratory Small Business Partnerships

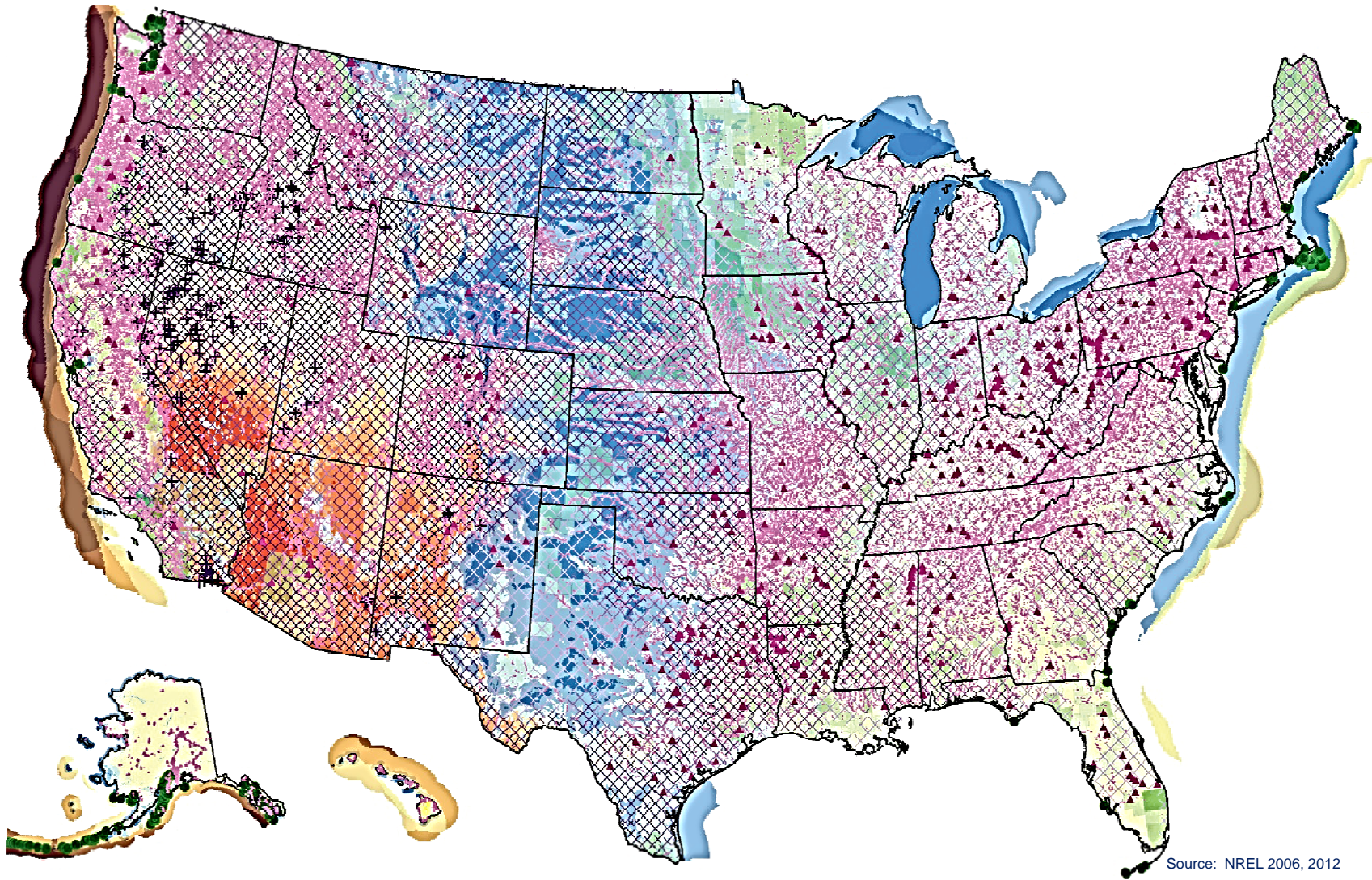
- Expansion of EERE small business voucher pilot program

National Laboratory Energy Technology Innovation Accelerators

- Provide clean energy entrepreneurs with seed funding, technical support, and access to lab researchers and capabilities; modeled after LBNL Cyclotron Road Partnership



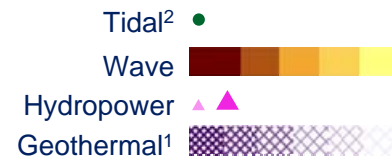
Mapping of U.S. Renewable Resources



Source: NREL 2006, 2012



Resource
Dark =
Higher
Light =
Lower

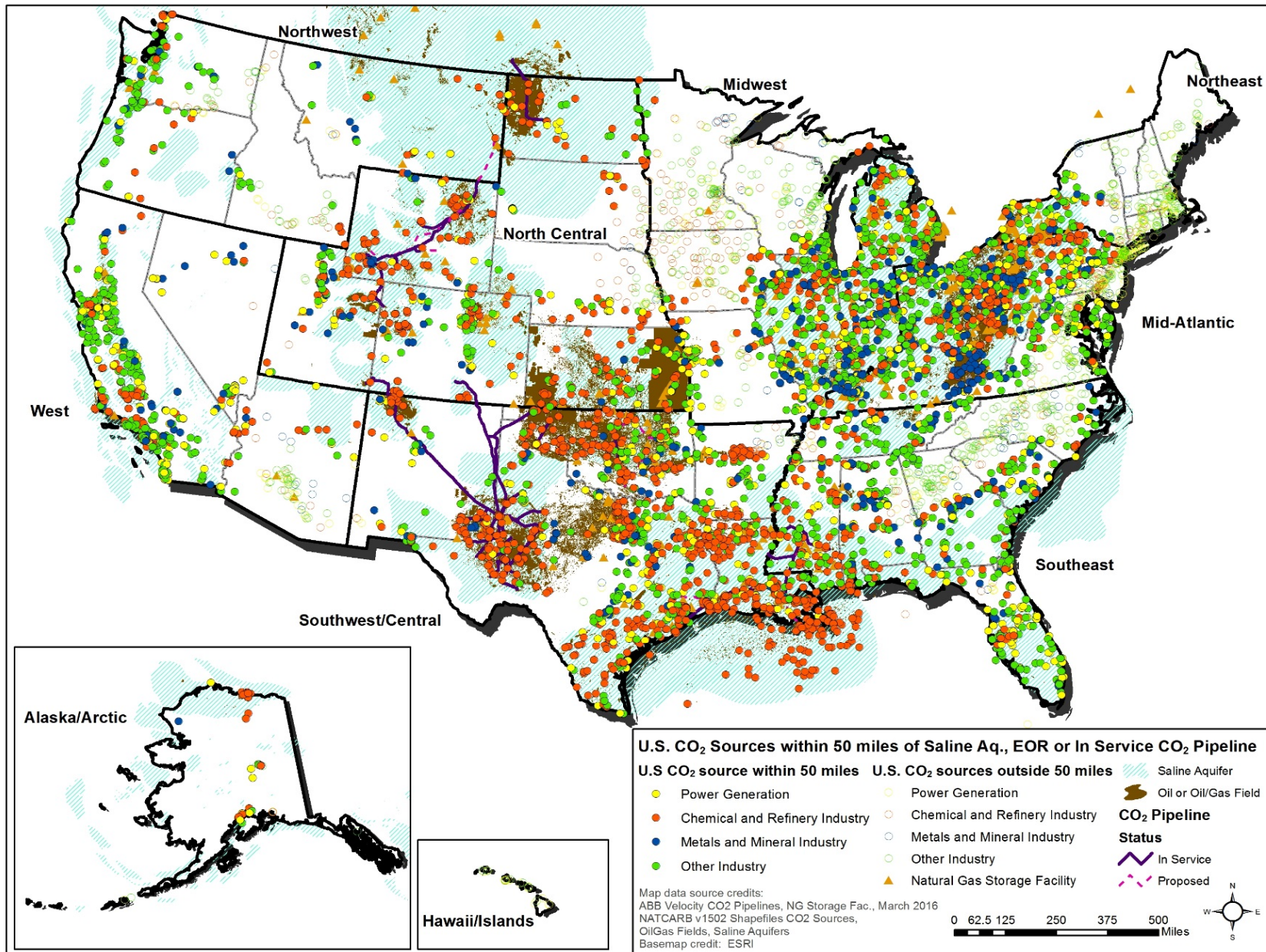


¹ Does not include Alaska or Hawaii

² Does not include Hawaii



Regional CO₂ Sources with Access to Sequestration Options or Associated Infrastructure





Arizona State University (Tempe, Arizona)



Betsy Cantwell

*Vice President for Research Development, Knowledge Enterprise Development
Interim Chief Operating Officer, Arizona State University Research Enterprise*

Area of Discussion: Water-Energy Nexus in the Southwest



COLORADO SCHOOL OF MINES



Western Area
Power Administration



THE UNIVERSITY of
NEW MEXICO



Utah State
University



NATIONAL RENEWABLE ENERGY LABORATORY



Southern Nevada
Water Authority

Major Takeaways: Arizona State University

Event Overview

- September 8, 2016: ASU hosted the Southwestern Regional Water-Energy Nexus Event in Tempe, AZ to address the water-energy megachallenge. Speakers and attendees included stakeholders from six states (AZ, CA, CO, NM, NV, and UT); 3 tribal entities (Gila River Indian Community, Fort Mojave Indian Tribe, and the Navajo Nation); 4 national labs (Lawrence Livermore, Los Alamos and Sandia National Labs, and the National Renewable Energy Laboratory); 2 utilities (Southern Nevada Water Authority and Western Power Administration); 7 universities (Arizona State University, New Mexico Tech, University of Arizona, University of California – Irvine, University of Colorado – Boulder, University of New Mexico, and Utah State University); as well as major industry leaders such as Coca Cola and Intel in addition to hydropower startup Natel Energy. Leaders from the U.S. Department of Energy attended and U.S. Senator Flake (R-AZ) prepared a welcome video.

Key Takeaways

- The greatest threat to southwestern regional sustainability is at the intersection of water and energy– the use of water in energy generation via coal, fracking/natural gas, hydropower, nuclear, biofuels, etc., and the use of energy for water – most notably represented by the energy being used to deliver water, especially for municipal use, agriculture, and irrigation across the region.
- The southwest regional ecosystem has everything needed to innovate at the water-energy nexus:
 - advanced technological expertise via our national labs and universities;
 - regulatory knowledge via our advanced partnerships with utilities and regulatory agencies; and
 - major industry centers with an interest in water-energy, especially for manufacturing.

Major Takeaways: Arizona State University (continued)

Key Takeaways (continued)

- Opportunities & Priorities
 - Wastewater and desalination are major R&D goal areas to address water supply challenges in the future
 - In addition to continued effort to use existing infrastructure more efficiently, evidenced-based reports indicate citizens in the region are willing to adjust troubling use trends to address demand changes in the future, but this must be done locally and in collaborative, community-based discussion
 - Integrated low water use-clean energy testbed opportunities should be leveraged to streamline the connection between ideation and market-readiness
 - Given advances in solar and related micro-grids, innovation in energy storage is critical to minimize the intermittency often associated with renewable energy deployment (including wind, solar, etc)
- Challenges
 - Industry is making progress in water-neutral use policies related to manufacturing, but progressive water and carbon programs are often isolated even within sustainability offices of the same company
 - Governance systems for utilities must evolve to support increasing decentralization; the boundaries that formerly governed utilities are no longer relevant for future needs
- Next Steps
 - Real change is possible at the municipal and tribal jurisdictional level
 - Regional participants are convening again around three important forward leaning steps: data sharing, shared technology development opportunities and regional testbed assets

Purdue University (West Lafayette, Indiana)



Purdue President Mitchell Daniels welcoming Under Secretary Lynn Orr and other participants

In Association with
Argonne National
Laboratory

Pankaj Sharma

Managing Director, Energy Center, Discovery Park

Area of Expertise

Sustainable Energy Development

Major Takeaways: Purdue University

Event Overview

- 195 attendees; Midwestern States: IA, IL, IN, MI, MO, MN, OH, WI
- National Labs (ANL, AMES, SNL); Universities (PU, MN, MSU, ND, UIUC)
- Industry (Alcoa, Duke Energy, Energy Systems Network, Navitas, Enginuity Worldwide, GE, MISO, Whirlpool)
- Indiana State Government (Lieutenant Governor; Office of Energy Management; Indiana Geological Survey; Indiana Economic Development Corporation)
- Non-profits (Citizens Energy Group; Battery Innovation Center)
- USDA-ARS; Naval Surface Warfare Center, Crane, IN
- DOE (Office of Under Secretary, AMO)

Format: Key notes and five panels

1. Energy Storage *Plus Student Poster Session
2. Biomass/Synthetic Biology
3. Critical Materials/Advanced Manufacturing
4. Wind Energy/Grid Integration
5. Public Private Partnership



Mark Johnson, DOE Advanced Manufacturing Office and other panelists discussing energy storage challenges

Major Takeaways: Purdue University (continued)

Key Takeaways

- **Current Regional Innovation Ecosystem**
 - The Midwest has very strong research universities, national labs and industries focused on clean energy but there is no coordinated approach at the regional level to exploit abundant renewable resources (e.g. biomass, wind) and develop the talent pool of the future.
- **Building a Broader Ecosystem**
 - Efficient energy generation and utilization has both a regional and national basis. The time has come to address clean energy which is most appropriate for a given geographical area and for which solutions and living laboratories to test and prove the solutions, is best done on a regional basis. In our case, the pertinent region is IA, IL, IN, MI, MO, MN, OH, WI.
- **Opportunities & Priorities**
 - There is a compelling case to be made for a Midwest Regional Clean Energy Center whose scientific/engineering plus entrepreneurial expertise would address the bioeconomy, wind and solar energy, advanced materials and manufacturing, and energy storage technology. A partnership in the Midwest could act as a lens to focus regional activities on robust and internationally relevant solutions in clean energy.
- **Challenges**
 - It is important to speed up transfer from discovery to development to the market, and work with industry partners to define gaps and challenges before the translation process starts.
 - The challenges in carrying out the work under the auspices of a public/private partnership appear to be communication, intellectual property, and at times, differences in culture (i.e., timelines and expectations).
- **Next Steps**
 - Provide resources for each region for planning purposes to respond to future DOE RFPs for Regional Energy Innovation Centers.
 - These resources will allow: (1) a lead organizer of the forum to work with key stakeholders across the region to pull a team together; (2) engage a 501c.3; (3) hold workshops, meetings; (4) set a communication infrastructure (e.g. web site). This money is for planning purposes only and not for R&D.

THE UNIVERSITY OF NEW MEXICO

ALBUQUERQUE, NEW MEXICO



Vice President for Research Gabriel P. López

Area of Expertise: Materials Science & Engineering

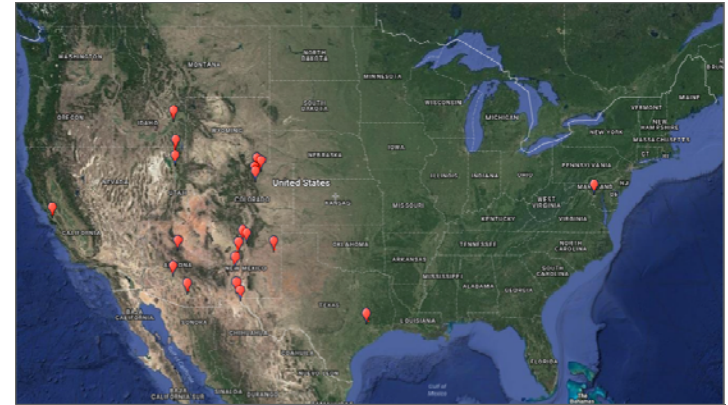
Major Takeaways: The University of New Mexico Forum

Forum Overview

- >136 participants from academia (70), national laboratories (25), industry (23), government (15), non-governmental organizations (3) and 5 panels of experts from all these sectors
- Southwest Mountain Region (NM, AZ, CO, UT, ID)
- Keynote comments by DOE Secretary Moniz, US Senators Udall and Heinrich
- Discussed revolutionary new approaches to clean energy production and utilization based on new materials technologies (hydrogen, photovoltaics, energy storage, advanced nuclear energy systems).

Key Takeaways

- Opportunities & Priorities
 - Transformative, disruptive technologies will be needed to allow Mission Innovation to succeed.
 - Materials research, development, translation and commercialization is the best technological opportunity in transformational clean energy.
- Current Regional Innovation Ecosystem
 - The Southwest Region is uniquely poised intellectually, technologically and geographically, is a national leader in materials research and development for energy applications and is an established hub for energy materials innovation and commercialization.



MATERIALS TECHNOLOGIES FOR CLEAN ENERGY



Hydrogen



Photovoltaics



Energy Storage



Advanced Nuclear
Energy Systems

The University of New Mexico: Key Takeaways (continued)

- Building a Broader Ecosystem
 - The Southwest Region demonstrates a strong presence of existing and well established public/private partnerships that can be leveraged and further enhanced.
- Challenges
 - Determining the promise of proposed technological advances will require linkage to economic models and climate modeling capability.
- Next Steps
 - Regional Summits & Workshops hosted by:
 - US Senator Heinrich's Energy Summit – Energy Storage Strategies for Industry & National Security
 - Sandia National Laboratories – New Mexico Regional Energy Storage & Grid Integration Workshop
 - Arizona State University – Water-Energy Nexus Event
 - Colorado Energy Research Collaboratory – North Central / Inter Mountain West Regional Clean Energy Innovation Summit
 - Innovate New Mexico – Technology Showcase
 - Los Alamos National Laboratory / New Mexico Consortium efforts in clean renewable bioenergy
 - Regional Stakeholders developing concept papers



University of Tennessee, Knoxville (Knoxville, Tennessee)

Left to Right:

- 3D printed replica Shelby Cobra made at DOE's Manufacturing Demonstration Facility at ORNL
- AIME 3D printed house and vehicle additive manufacturing integrated energy system
- 3D printed tool (world record) for Boeing



Taylor Eighmy

Vice Chancellor, Research and Engagement

Area of Expertise: Government-University-Industry-National Lab Collaboration, Rapid Innovation, Tech to Market



Major Takeaways: University of Tennessee, Knoxville

Event Overview:

- May 23rd with 150 attendees from seven states (TN, AL, FL, GA, MS, NC, SC), with six panel discussions targeting industry, university, entrepreneurship and graduate education, technology and regional capabilities, and pathways to commercialization.

Key Takeaways:

- **Current Regional Innovation Ecosystem**
 - **Strong technology-based ecosystems** in (1) advanced manufacturing and automotive, aerospace and land-based turbine sectors, (2) grid stability, grid cyber security, scaled grid distribution, power electronics and regional energy suppliers, (3) biomaterials and carbon management strategies and industry, (4) nuclear energy, and (5) smart cities and the built environment.
 - **Accelerated Collaborations:** two DOE-AMO NNMI (IACMI for composites manufacturing, PowerAmerica for wide band gap power electronics); two DOE hubs (BESC for bioenergy and CASL for nuclear energy).
 - **National Laboratories** (ORNL in TN, SRNL in SC, Jefferson Lab in VA) including many **SC-supported specialized user facilities** (e.g., materials characterization, high performance computing, transportation, manufacturing, carbon fiber).
 - **Engaged Universities** with strong records of R&D, commercialization, and collaboration.
 - **Energy utilities** (e.g., TVA, EPRI, Southern, Duke, FPL, EPB) and **collaboratories** (e.g., NEI, EWI, SRI, RTI, ORAU).
 - **OEMs** (e.g., Boeing, Lockheed, GM, VW, BMW, Volvo, Honda, Nissan, Daimler, Mercedes Benz, GE, Siemens, MHI, Hitachi, Alstom, Mitsubishi, John Deere, Cummins, ABB, Westinghouse), **their supply chains** (e.g., Eastman, DuPont, BASF, PPG, Alcoa), and **SMEs** (e.g., Local Motors, Cincinnati Inc., Ingersoll, MVP, Techmer).
 - **Tech to Market:** Strong connectivity (e.g., Council on Competiveness, Brookings, Innovation Crossroads, Triangle Angel Partners, Nashville's 36/86 conference, Cleantech Open Southeast).
 - **International:** CRADAs and MOUs (e.g., ARCAM AB, Concept Laser GmbH, Boeing AMRCs, Fraunhofer).
- **Building a Broader Ecosystem:** Generally Southeastern (e.g., TN, IN, OH, PA, WV, KY, VA, NC, SC, GA, AL, FL, MS, LA)

Major Takeaways: University of Tennessee, Knoxville (continued)

Key Takeaways (continued):

- **Opportunities:**
 - Excellent existing government-university-industry national lab collaborations to leverage.
 - Supportive industries and their supply chains.
 - Supportive State government.
 - Supportive investment community and innovator (tech to market) ecosystems, NGOs.
- **Priorities (Clean Energy R&D Focus Areas):**
 - *Advanced manufacturing* for light-weighting in the vehicles and transportation sector (**Vehicles and Transportation**).
 - *Integrated grid management* and new *power electronics* (**Electricity Grid**).
 - *Bio-derived fuels and Carbon Conversion* (**Bio-Based Fuels and Materials; CO₂ Capture, Utilization, Storage**)
 - *Nuclear energy*, advanced manufacturing and materials (**Nuclear Energy**).
 - *Sustainable smart communities* with net neutral energy and water consumption, resilient infrastructure (**Industry and Buildings; Energy Storage; Renewables**).
- **Challenges:**
 - Need for improved business processes around speed of connecting industry to science & technology. Building upon existing models such as IACMI are essential for improving the speed of business.
- **Next Steps:**
 - Directed strategic collaborations tied to regional innovation needs, workforce needs, and especially innovation accelerators and private/foundation/investment efforts in the clean energy technology space.

Northwest Regional Clean Energy Innovation Workshop

University of Washington
Seattle, Washington



Michael B. Pomfret

Assistant Director

Clean Energy Institute

University of Washington

Area of Expertise: University-Industry Partnerships, Testbed Facilities

Major Takeaways: University of Washington Workshop

Event Overview

- 120 participants and speakers from Idaho, Montana, Oregon, and Washington
- Strong representation from Northwest Tribes, National Labs, Research Universities, Small and Medium Sized Enterprises, Cleantech Investors, Fortune 500 Tech & Industrial companies, Utilities, Policy Makers and Regulators.
- Panels explored the Research Ecosystem, Innovation in Large and Small Enterprises, Regional Policy & Investment
- Keynote talks by Secretary Moniz, Senator Cantwell, Governor Inslee, and Representative Kilmer

Key Takeaways

- **Current Northwest Regional Innovation Ecosystem : VERY PROMISING**
 - NW clean energy start-ups are getting exits to market; some NW states have dedicated clean energy public investment funds; regional coordination has resulted in the formation of Cascadia Cleantech Accelerator, a 501(c)(3).
 - Globals in the NW like Amazon, Boeing, Freightliner, GE Grid Solutions, Itron, McKinstry, Microsoft, Paccar, Schweitzer, SolarWorld, and others have know-how to launch market-leading or market-making energy & efficiency products & services.
 - Region is an “all of the above” testbed for deep decarbonization, and an energy gateway to Canada and Asia.
 - Invaluable experience in social/environmental issues of Energy-Water nexus from 8 decades of hydropower development.
- **Building a Broader Northwest Ecosystem: ROADMAPPING needed to ACCELERATE INNOVATION**
 - Ingredients for a supercharged ecosystem are present in the Northwest.
 - A regional roadmap with coordination of public and private funds, strategic partners, testbed facilities, researchers and students will enable next-level performance.

Major Takeaways: University of Washington Workshop (continued)

Key Takeaways (continued)

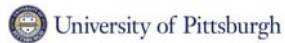
- NW Opportunity: Create the nation’s premier “all of the above” deep decarbonization testbed
 - Currently about 75% of NW electricity generation has no carbon emissions.
 - Energy efficiency and renewables are expected to meet future growth in the region’s electrical load.
 - NW science and technology strengths in materials, computing, large data analytics, system analysis supports deeper decarbonization of the grid, transportation, building, and industrial sectors.
 - Deeper decarb: RD&D partnerships using regional and national testbeds to expand deployment of small modular nuclear, wind, geothermal, marine energy, energy efficiency, and grid modernization hardware and software.
 - Deeper decarb: RD&D partnerships to accelerate biofuels, electrification, & lightweighting for aviation & vehicles
 - Deeper decarb: RD&D partnerships using regional & national testbeds to accelerate clean energy smart manufacturing
- NW Opportunity: Leverage the region’s energy and trade integration with Canada and Asia to accelerate global progress.
- NW Challenge: Coordination & communication across the region to focus on highest impact areas.
- NW Priority: Strategy and funding that mobilizes the partnerships & facilities needed to transition high impact innovations from research to prototypes and scalable demonstration projects.
- Next Step: Develop a roadmap to strategically align regional assets with globally impactful goals & milestones in order to accelerate prototype development and technology demonstrations at scale.

Mid-Atlantic Region Energy Innovation Forum

hosted by West Virginia University

September 12, 2016

Morgantown, West Virginia



Brian Anderson

Director



Areas of Expertise: Sustainable Energy Portfolio Development, Academic-Industry-Government Partnerships

Major Takeaways: Mid-Atlantic Region Forum at West Virginia University

Event Overview

- 112 participants from 7 states (KY, OH, PA, VA, MD, NJ, WV) and DC from academia (32), national laboratories (8), industry (35), government (22), and non-governmental organizations (15).
- Keynotes from Secretary Moniz, Senator Joe Manchin, and Congressman David McKinley
- Regional cooperation panels:
 - Regional Challenges and Opportunities (NETL, CMU, Battelle, Benedum Foundation)
 - The Tri-State Governor's Regional Cooperation (WV, PA, OH)
- Topical Panels
 1. Innovation opportunities for fossil fuels in a future low carbon economy (ExxonMobil, Battelle, B&W, Siluria)
 2. Innovation opportunities in other clean energy technologies (GE, PPPL, SMLC, DOE NE)
 3. Policies Facilitating Sustainable Clean Energy Development (PJM, RFF, NRECA, Spilman Thomas & Battle)
 4. Regional Innovation Investment and Commercialization (InnovationWorks, HarbourVest Partners, DOE CFO)

Key Takeaways

- Current Regional Innovation Ecosystem
 - The Mid-Atlantic Region is a tale of two halves, fewer population but energy resources in the west and population density in the east. As such, there are currently two disconnected innovation ecosystems. WV, PA, and OH have created the Tri-State Coalition and the Pittsburgh/Cleveland/N. WV region has the Power of 32.
- Building a Broader Ecosystem
 - Coordinating across the entire 8 state region and multiple sub-regional efforts.

Major Takeaways: Mid-Atlantic Region Forum at WVU (continued)

Key Takeaways (continued)

- Opportunities

- Large (55 million ppl), diverse, energy-rich region with **engaged stakeholders from all sectors**

- Priority Innovation Focus Areas

- **Clean fossil**: advanced power cycles, fuel cells, CCUS, and increased natural gas utilization
 - NETL, Industry partners (i.e. B&W, ExxonMobil, Siluria, Battelle), and Universities strong in this area (OSU, UK, WVU, PSU, Princeton, VT, etc)
 - Strong state-level support and momentum in the industry, e.g. current infrastructure developments underway
- **Grid modernization** – smart grid and grid-scale electric storage (NEES EFRC, PJM, FirstEnergy, Exelon, AEP, NRG)
- **Energy Efficiency** – building and industrial efficiency (CBEI Hub, Energy4P32)
- **Nuclear Energy** – fission and fusion energy sciences (PPPL, WVU, Westinghouse, WastePD)
- **Advanced and Smart Manufacturing** (NNMIs: America Makes, IACMI, SMLC-CESMII)

- Challenges

- **Funding** for large-scale demonstration of technologies - CCUS, power cycles, NG conversion demonstrations cost \$100s of millions
- Diverse region and **broad priority focus** areas

- Next Steps

- **Five follow-on events** coordinated by the TrUE Alliance
 - **Grid**: EPIC Meeting Pittsburgh, 11/14-11/15; **Storage**: Center of Excellence in Ohio meeting on Energy Storage end of October in Cleveland;
 - **NG Utilization**: AIChE Natural Gas Utilization Workshop on November 1-3, 2016 in Morgantown and technical workshop Tri-State, November 30
 - **Efficiency**: CMU and Energy for the Power of 32
- PJM Interconnect will be working with WVU on **regional planning and innovation efforts**
- Coordinate with **sub-regional consortia** in developing a Mid-Atlantic Region Energy **Innovation Roadmap**





Kevin Knobloch

Chief of Staff, Office of the Secretary

**Mission Innovation Website
www.energy.gov/mission-innovation**

THE END

