We’ll be starting in just a few minutes….

Tell us…please send your response to the webinar organizers via the question box:

What topics are you interested in for future webinars?
Lab Partners:

How to Leverage DOE National Laboratories

Dec 5, 2017
3:00-4:00 PM ET
<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eli Levine</td>
<td>Better Plants, DOE</td>
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<tr>
<td>Rochelle Blaustein</td>
<td>Office of Tech Transitions, DOE</td>
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<tr>
<td>Bill Livingood</td>
<td>NREL</td>
</tr>
<tr>
<td>George Hernandez</td>
<td>PNNL</td>
</tr>
</tbody>
</table>
Rochelle Blaustein
Office of Technology Transitions, DOE
National laboratories (Sandia, Los Alamos, Livermore, and NETL - the National Energy Technology Lab) contributed to shale gas technology that significantly improved US energy independence.

National laboratories are drivers of new wind energy technologies.

Argonne National Lab’s battery cathode design helps powers the Chevy Volt.

The Ames Lab lead-free solder alloy is the world wide market leader.
Fermilab designed the first proton accelerator for cancer treatment.

Oak Ridge National Lab was an early leader in the use of ion implantation for semiconductor processing and artificial joint surface treatment.

Approximately 50 million nuclear medicine procedures are performed each year worldwide. Brookhaven National Lab developed the Tc-99m generator and FDG.
Federal R&D Generates Economic Outcomes

- Micro Hard Drive Storage
- Signal Compression
- Li-ion Battery
- LCD Display
- DRAM Cache

1988: "giant magnetoresistive effect" (GMR) is discovered, creating the field of spintronics
   - Basic research foundation: DOE funding for thin-film metallic multilayers

1990: development of the lithium-ion battery.
   - Basic research foundation: DOE funding for Electrochemistry

1988: Thin film transistor LCD displays emerge.
   - Basic research foundation: NIH, NSF, DoD fund liquid crystal research
   - Basic research foundation: IBM, DARPA funding

1960–70s: Very Large Scale Integration (VLSI) system and circuit design pioneered.
   - Basic research foundation: Army Research Office funding

1965: The "Fast Fourier transform" revolutionizes the field of signal processing.
   - Basic research foundation: Army Research Office funding

The **Office of Technology Transitions** expands the **commercial impact** of DOE’s R&D activities by

- **Coordinating** activities across DOE programs, federal agencies, and National Laboratories
- **Facilitating** industry engagement to transition expertise, capabilities and technologies from the National Laboratories to the private sector for commercialization
- **Accelerating** technology transfer by reducing barriers to industry engagement with the National Laboratory
OTT Facilitates Partnering with National Labs

Energy Investor Center (EIC)
Lab Partnership Service (LPS)

Technology Commercialization Fund (TCF)

Streamlining Lab Partnering (CRADAs, SPPs, Agreements for Commercializing Technology (ACTs), User Facility Agreements)

Industry-Focused Professional Development Programs for Scientists

Assisting Private Sector in Navigating DOE and Laboratories
EIC’s Laboratory Partnering Service (LPS)

- Online portal connects investors rapidly to DOE subject matter experts
- Facilitates access to DOE portfolio of investable energy opportunities
- Leads to Strategic Partnership Projects (SPP), Cooperative Research and Development Agreements (CRADAs), Technical Assistance and other lab-industry engagement
- Migrates Energy Innovation Portal resources to new platform
- Soft launched Q4 as part of EIC; full launch expected FY 2018
**Energy Innovation Portal**

Search for energy efficiency and renewable energy technologies available for licensing, patents and patent applications, and publications.

Find information about the energy efficiency and renewable energy technologies and intellectual property available for licensing, patents and patent applications, and publications from U.S. Department of Energy laboratories and other participating research institutions. If you have any questions about how to use this search feature, see Search Help.

<table>
<thead>
<tr>
<th>Category</th>
<th>Title and Abstract</th>
<th>Laboratories</th>
<th>Date</th>
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<tbody>
<tr>
<td></td>
<td>EnergyPlus is a building energy simulation program for modeling building heating,</td>
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<td>cooling, lighting, ventilating, and other energy flows. While it is based on the</td>
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<td>most popular features and capabilities of BLAST and DOE-2, it includes many</td>
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<td>innovative simulation capabilities such as time steps of less than an hour,</td>
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<td>modular systems and plant integrated with heat balance-based zone simulation,</td>
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<td>multizone air flow, thermal comfort, and photovoltaic systems.</td>
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<td>Energy Analysis</td>
<td>**SUNREL Software: An energy simulation program to aid in the design of energy-</td>
<td>National Renewable Energy</td>
<td>07/28/2010</td>
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<td></td>
<td>efficient residential buildings**</td>
<td>Laboratory</td>
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<td></td>
<td>Historically, building performance professionals have not had reliable tools</td>
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<td>for estimating energy usage. This information deficiency has led to building</td>
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<td>upgrade and retrofit recommendations which may not be reliable.</td>
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http://techportal.eere.energy.gov
Technology Commercialization Fund (TCF)

Funds technology maturation and cooperative development of lab-developed technologies
(by congressional mandate requires matching private-sector funding)

**Topic Area 1:** Technology maturation of early-stage applied energy technologies

**Topic Area 2:** Cooperative development of early-stage applied energy technologies

**TCF Award Overview**

- 12 national labs participating in both FY 2016 and FY 2017
- More than 80 private-sector partnerships to date
- **FY 2018 opening mid-December**

https://energy.gov/technologytransitions/articles/secretary-energy-rick-perry-announces-nearly-20-million-help
Guide can be downloaded at https://energy.gov/technologytransitions

Energy.gov/technologytransitions

User Facility Agreements

Cooperative Research and Development Agreements

Strategic Partnership Projects

Technology Licenses (inventions and software)

Agreements for Commercializing Technology (ACT) & FedAct pilot to begin in 2018
Additional Partnering Agreement Option

Agreements for Commercializing Technology (ACT)
Federal Agreements for Commercializing Technology (FedAct)

Allows Laboratory Contractor to engage with industry using more industry-standard terms than traditional agreements

Pilot for FedACT, to be initiated in 2018, extends ACT to federally-funded work

The Wells Fargo Innovation Incubator (IN²)

• Enabled by ACT between NREL and Wells Fargo Foundation
• Supports clean energy buildings-related technologies and startup companies to overcome market gaps
• provides access to both technical assistance and business development resources.

http://in2.wf.com
Professional Development for Scientists

- **Energy I-Corps**: Providing laboratory scientists with intensive, hands-on skills to transition breakthrough discoveries to the private-sector for commercialization. In collaboration with industry mentors.

- Broader curriculum being planned to extend reach of this successful program
Technologist in Residence (TIR)

Pairs senior technical staff from National Laboratories and manufacturing companies to work together towards impactful manufacturing solutions.

• **Immediate Objectives:**
  • Identify areas of collaborative R&D
  • Develop a streamlined method for companies to establish long term relationships with laboratories that result in collaborative research and development
  • Long-term, strategic public-private partnerships

• **Additional Objectives:**
  • Enhance transparency into the national lab innovation infrastructure
  • Enhance awareness of high-impact industrially relevant technology challenges within the national laboratory system; and
  • Broaden and strengthen networks of Technologists in national laboratories and in industry to more effectively support industry needs and leverage the national laboratory enterprise.
For more information about DOE National Laboratory partnering opportunities
Contact the DOE Office of Technology Transitions or to find a lab representative directly, go to:
https://energy.gov/technologytransitions/who-do-i-contact-labs

Rochelle Blaustein
Acting Director
Rochelle.Blaustein@hq.doe.gov
202.586.9350
Bill Livingood

NREL
40 Years of Clean Energy Research

• Founded as Solar Energy Research Institute (SERI) in 1977
• Designated national laboratory in 1991 and renamed National Renewable Energy Laboratory
• Today managed by the Alliance for Sustainable Energy, LLC, for the U.S. Dept. of Energy
National Asset with a Global Mission

- World-class facilities, renowned scientists
- Nearly 1,700 employees
- Campus is a model of sustainable energy
- National economic impact of $872M annually
NREL advances the science and engineering of energy efficiency, sustainable transportation and renewable power technologies, and provides the knowledge to integrate and optimize energy systems.

<table>
<thead>
<tr>
<th>Three Pillars</th>
<th>Analysis &amp; System Integration</th>
<th>Innovation &amp; Application</th>
<th>Foundational Knowledge</th>
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</thead>
<tbody>
<tr>
<td>Market-Relevant Solutions</td>
<td>Provides market insight and informs landscape</td>
<td>Responds to market challenges with solutions and identifies knowledge gaps</td>
<td>Scientific discovery that fills gaps and disrupts current-generation technology</td>
</tr>
</tbody>
</table>

We provide an Integrated Approach to Market-Relevant Solutions
## NREL Innovations

<table>
<thead>
<tr>
<th>Invention Records</th>
<th>2011-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invention Disclosures</td>
<td>638</td>
</tr>
<tr>
<td>Patents Issued</td>
<td>122</td>
</tr>
<tr>
<td>Patent Applications</td>
<td>159</td>
</tr>
<tr>
<td>Licensing Agreements</td>
<td>113</td>
</tr>
</tbody>
</table>
Partnering with Agencies, Institutions & Companies

- 696 active partnerships with industry, academia, and government
  - 236 new partnership agreements in 2015
  - $33M value of 2015 new partnership agreements
  - 696 currently active agreements
  - 136 unique new partners (as of December 2015)
  - 480 unique active partners

NREL maintains active partnerships with federal agencies, small and large business, educational institutes, and nonprofits, as well as state and local governments.
Partnering with Industry
Energy Systems Integration

Fortifying U.S. energy infrastructure at a pace and scale that matters.
What is an Energy System?

- **Energy system** = a set of interacting or interdependent resources, infrastructures and individuals organized specifically for the production, delivery or consumption of energy

- **Examples:**
  - Buildings
  - Vehicles
  - Industrial Parks
  - Communities
  - Electric grids
  - Pipeline networks
  - Transportation systems

[Diagram of Future Energy System]
What is Energy System Integration?

Energy system integration (ESI) = the process of optimizing energy systems across multiple pathways and scales.
Our Approach

Hardware Testing
- Load Banks
- Grid Simulator
- Devices Under Test (e.g. inverter, energy storage, EV, loads)

Modeling & Simulation
- PV Simulator
- Utility Substation
- Subdivision with PV at end of circuit

Field Deployment

Continuous Learning and Improvement
Energy Systems Integration Facility (ESIF)

Addressing the challenges of large-scale integration of clean energy technologies into the energy systems infrastructure

http://www.nrel.gov/esif

“This new facility will allow for an even stronger partnership with manufacturers, utilities and researchers to help integrate more clean, renewable energy into a smarter, more reliable and more resilient power grid.”

- Energy Secretary Ernest Moniz

- NREL’s largest R&D facility (182,500 ft² / 20,000 m²)
- NREL’s first DOE-designated User Facility
- Space for ~200 NREL staff and research partners
- Petascale HPC and data center supports the entire DOE mission
- Labs focus on R&D of integrated energy systems
  - Electricity
  - Fuels
  - Transportation
  - Buildings
- Integrated electrical, thermal, fuel, water, and data infrastructure
ESIF – A Self-Contained Energy System
DOE’s Goals for the Ecosystem
“The best way to predict your future is to create it.”

–Abraham Lincoln

At NREL, we believe we can help create the future through our core capabilities, market-relevant solutions and their impacts.
George Hernandez

PNNL
Pacific Northwest National Laboratory
Energy and Environment Directorate

GEORGE HERNANDEZ, P.E.
Pacific Northwest National Laboratory
Lab Partners: How to to Leverage DOE National Laboratories
Better Buildings
December 5, 2017
EED’s Diverse Capabilities & Research Portfolio

► 1,000 staff
► Five Divisions
► 18 Technical Groups
► Seven EED Mission Sponsors
► Perform research ranging from fundamental science to field deployment
► Most laboratory-intensive directorate at PNNL
► 200 staff support National Security Mission
Electricity Infrastructure & Buildings Division

Provide integrated solutions for improving the security, resiliency, reliability, and efficiency of the nation’s energy infrastructure.

**BUILDING ENERGY RESEARCH & ANALYSIS**
- Building Energy Simulation
- Energy Code and Appliance Standard Analysis
- Large-scale building energy simulation infrastructure in PIC and AWS

29 staff (5 PhD, 17 Masters, 5 Bach)
25 direct FTEs
6 Pubs, Natl. Leadership in Sust. & EE Award

**BUILDINGS & CONNECTED SYSTEMS**
- Performance Evaluation & Controls Optimization
- Site resilience planning
- HVAC Test Lab
- Energy Performance Lab
- Facility Energy Decision Support (FEDS)

37 staff (4 PhD, 16 Masters, 13 Bach, 4 HS)
35 direct FTEs
14 Pubs

**ELECTRICITY INFRA.**
- Grid Resilience Systems Engineering
- Modeling & Simulation
- Transactive Energy
- EIOC
- Power Electronics Lab
- Interoperability Lab & PowerNET

71 staff (35 PhD, 15 Masters, 12 Bach)
66 direct FTEs
4 direct FTEs
4 Patents, 17 Pubs

**ENERGY POLICY & ECONOMICS**
- Economics & Policy Analysis
- Energy Efficient Advanced Lighting
- Energy Technology Integration
- PNNL Lab Homes
- Lighting Metrology Lab (APEL)
- Connected Lighting Test Bed (Portland)

57 staff (6 PhD, 25 Master, 17 Bachelors)
44 direct FTEs
1 Patent, 11 Pubs

**OPTIMIZATION & CONTROLS**
- Control and Optimization of Distributed Systems
- Data Analytics for Energy Systems
- Building Controls Lab
- Building Diagnostics Lab

32 staff (19 PhD, 8 Masters, 3 Bach, 2 AA)
25 direct FTEs
1 Patent, 14 Pubs
Autonomous Self Configuring Agent Based Data and Control Systems
What is VOLTTRON?

VOLTTRON is an application platform (e.g. Android, iOS) for distributed sensing and control applications.

VOLTTRON is not a protocol.

A protocol, such as SEP2.0. or OpenADR, are implemented as applications.

VOLTTRON is not an application such as demand response.

Demand response can be implemented as an application on top of VOLTTRON.

VOLTTRON is open, flexible and scalable.
VOLTTRON Attributes

Open, flexible and modular software platform

Easy application development
Enables interoperability across vendors and applications
Simplifies power and control system complexities for developers
Object oriented, modern software development environment
Language agnostic. Does not tie the applications to a specific language
VOLTTRON Attributes (cont.)

Broad device and control systems protocols support built-in
- ModBUS, BACNet, and others
- Multiple types of controllers and sensors
- Low CPU, memory and storage footprint requirements
- Supports non-Intel CPUs

Secure
- Security libraries and cryptography built-in
- Manage applications to prevent resource exhaustion (CPU, memory, storage)
- Robust against denial-of-service (e.g. does not crash when scanned via NMAP)
- Supports modern application development environments
The CETC project connects the PNNL, UW, and WSU campuses to form a multi-campus testbed for transactive energy management solutions to demonstrate:

A regional flexibility resource and a research and development platform for buildings/grid integration solutions

A testbed that will support the integration of renewables and other regional needs, using the flexibility provided by loads, energy storage, and smart inverters for batteries and photovoltaic (PV) solar systems, at four physical scales: multi-campus, campus, microgrid, and building
ILC: Capacity/Demand Bidding Program

VOLTTRON

Market | PriceCap Bidding | CBP Baseline |
-------|------------------|-------------|
Target | Report | Meter | Forecasting |

Open ADR Client | Intelligent Load Control |

Resource Monitor

Command Line
Data Collection
Platform Management
Platform Logging
Process Control

Command Module

Security Module

Web User Interface

Information Exchange Bus

Weather Service | Scheduler | Drivers | Actuator |

Historian | Database

Target Load | Web Interface

December 6, 2017
Energy Data Intersects Social Data

Who are you with and how far from home?

Just posted photo from race with friends 60 miles away... not likely to come home for another 30 min... maintain the thermostat setback.

VOLTTRON Platform commingles all the available home data with the available control and device data.

Data about networks will help identify resources?

You’re following NFL and NFL tonight is on the TV tonight ... likely to watch TV at home ... charge EV after the NFL game.

What information are you receiving that may affect your future pattern?

Hi! I don’t think you will take a shower until 9PM. I will reduce your hot water temperature and save a few bucks. I noticed that you have been coughing. I increased the humidity in the house.
Undergoing Evolution

If you show people the problems and you show them the solutions they will be moved to act.

Bill Gates

https://volttron.org/
Additional Resources

- **DOE’s Energy Innovation Tech Portal**
- **Guide to Partnering with DOE’s National Laboratories**
- **The Wells Fargo Innovation Incubator (IN2)**
- To find a lab representative directly, please click [here](#).
Data traffic has grown tremendously in recent years, with no signs of slowing. Close to half of all the servers handling that data live in data centers less than 5,000 square feet; however these smaller data centers are often overlooked when it comes to energy efficiency. There are compelling benefits for deploying energy saving strategies in small data centers for institutions, state and local governments, utilities, and private companies. Learn about why effective energy management is worth your attention in small data centers, and which low-cost, high-win strategies can reduce energy demand.
Additional Questions? Please Contact Us

**betterbuildingswebinars@ee.doe.gov**

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|-------------------|-------------------------------------------------|
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| Program Support | Kendall Sanderson  
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JDM Associates  
bryan@jdmgmt.com |

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