Transforming the Nation’s Energy Infrastructure

TransTech Energy Business Development Conference

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DOE’s Science and Technology Enterprise

National Renewable Energy Laboratory is operated for the U.S. Department of Energy by the Alliance for Sustainable Energy, LLC.
## Scope of Mission

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NREL’s Vision for the Energy System

**2050 Energy System Target**
Oil use is reduced to 15% of current levels, CO₂ reduced by 80%

- Electricity Generation and Delivery Systems: Distributed and Utility-Scale Renewable Power
- The Built Environment: Highly Efficient • Integrated Renewables
- Integrated Energy Systems: Sustainable Design
- Transportation Systems: Highly Efficient • Fuel Flexible
- Fuel Production Systems: Renewable Fuels

**2030 Subsystem Target**

- 25% of U.S. electricity generation comes from renewable resources
- Building fleet is 50% more efficient
- Sustainable communities are the standard for new development
- 50% of LDVs are EV/PHEV/FCEV
- 60 million gallons of biofuels in system (cellulosic ETOH and advanced fuels)
The Power System Today

• Highly reliable
• Affordable
• Carbon intensive
• Physical assets aging and antiquated
• Low overall utilization of assets
• Congested in critical locations
• Limited utility/customer interaction
• Increasingly vulnerable delivery systems
• Limited access to best renewable resources
The Power System Today

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Renewable and Efficiency Technology Integration

Future Power System

- Increasing penetration of variable RE in grid
- Increasing ultra high energy efficiency buildings and controllable loads
Future Power System

- Sensors
- Data
- Communications
- Controls

Renewable and Efficiency Technology Integration
Future Power System

- Transportation electrification
- Storage

Diagram showing integration of various energy sources:
- Geothermal Power Plant
- Rooftop PV
- Smart Grid Sensor/Control
- Wind Farm
- Ultra High Efficiency Building
- Energy Storage
- Solar Arrays
- Power Plant
- Smart Substation
- Monitor Energy Use
- Industry
- Plug-in Car
NREL’s Energy Systems Integration Facility (ESIF)

- NREL’s largest R&D facility (182,500 ft²)
- Space for 200 NREL staff and research partners
- Focus of the ESIF is to conduct R&D of integrated energy systems (Electricity, Fuels, Transportation, and Buildings & Campus systems)

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

http://www.nrel.gov/eis/facilities_esif.html
Current Status

- October 2012 – substantial completion
- November 2012 – commissioning and move-in
- January 2013 – complete move

- **DOE Programs moving into ESIF**
  - Solar – Systems Integration, CSP
  - Wind - Systems Integration
  - Fuel Cell Technologies
  - Buildings
  - Vehicles (lab testing)
  - Office of Electricity
  - Scientific Computing
ESIF - Office Area

National Renewable Energy Laboratory
Energy Systems Integration Facility

Office Space

- Energy Target (Site EUI): 26.7 kBtu/sf/yr
- National Average Site EUI: 90 kBtu/sf/yr (CBECS)
- Energy Efficiency over National Average (w/server): 74%
- Energy Efficiency over National Average (w/out HPC): 87%
Renewable and Efficiency Technology Integration

ESIF - High Performance Computer

Showcase Facility
- Use evaporative rather mechanical cooling.
- Waste heat captured and used to heat labs & offices.
- World’s most energy efficient data center, PUE 1.06!

20 year planning horizon
- 5 to 6 HPC generations.

Energy Data Hub
- Data mgmt, mining, analytics
- Smartgrid.gov
- High frequency data from technology deployment

Insight Center
- Scientific data visualization
- Collaboration and interaction.

PUE = Power Usage Effectiveness
ESIF - Energy System Simulated Operations

*A Flight Simulator for Energy System Operators*

“connecting integration studies to operations”

Operations techniques development for:
- High renewables and energy efficiency penetrations
- New systems configurations and contingency response
- High storage / DR penetrations
- Resource forecast integration

Transmission  
Distribution  
Campus Energy Dashboard
Renewable and Efficiency Technology Integration

High Performance Computing, Data Analysis, and Visualization

16. ESIF Control Room
17. Energy Integration Visualization
18. Secure Data Center
19. High Performance Computing Data Center
20. Insight Center Visualization
21. Insight Center Collaboration

Electrical Systems Laboratories
1. Power Systems Integration
2. Smart Power
3. Energy Storage
4. Electrical Characterization
5. Energy Systems Integration

Thermal Systems Laboratories
6. Thermal Storage Process and Components
7. Thermal Storage Materials
8. Optical Characterization

Fuel Systems Laboratories
9. Energy Systems Fabrication
10. Manufacturing
11. Materials Characterization
12. Electrochemical Characterization
13. Energy Systems Sensor
14. Fuel Cell Development & Test
15. Energy Systems High Pressure Test
THANKS!
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