Today’s Presentation

- Renewable Power Industry in the U.S.
- Administration Goals
- DOE Efforts
- EERE Mission & Organization
- EERE Renewable Power Programs
Renewable Power in the U.S.

U.S. Electric Nameplate Capacity (2012): 1,168 GW

- 29.8% Coal
- 41.7% Natural Gas
- 14.0% Renewable Energy
- 9.2% Nuclear
- 0.4% Other
- 5.0% Petroleum

U.S. Renewable Capacity: 164 GW

- 6.7% Hydro
- 51% Wind
- 7% Solar
- 3% Geothermal
- 1.2% Biomass

U.S. Electric Net Generation (2012): 4,068 TWh

- 37.3% Coal
- 30.3% Natural Gas
- 18.9% Nuclear
- 12.4% Renewable Energy
- 0.6% Other
- 0.6% Petroleum

U.S. Renewable Generation: 504 TWh

- 6.6% Hydro
- 3.4% Wind
- 0.3% Solar
- 0.4% Geothermal
- 1.4% Biomass

Source: Renewable Energy Data Book 2012
Renewable Power in the U.S.

Cumulative Solar PV Deployment

Source: NREL
Energy Goals:
• Reduce oil imports by 50% by 2025 from 2008 levels.
• Derive 80% of America’s electricity from clean energy sources by 2035.
• Reduce greenhouse gas emissions by 17% by 2020 and 83% by 2050, from a 2005 baseline.

Climate Action Plan:
• By 2020, double wind, solar and geothermal electricity generation again. First doubling in 2012 from 2008 baseline.
• Federal government to consume 20% of its electricity from renewable sources by 2020.
• Expand and modernize the electric grid.
Strategic Objective 1
Supports the President’s Climate Action Plan with “all of the above” resources.

Strategic Objective 2
Strengthen U.S. energy infrastructure.

Strategic Objective 3
Strengthen the connection between advances science and technology innovation.

• Quadrennial Energy Review (QER)
• Cross-Cutting Tech Teams
Vision

A strong and prosperous America powered by clean, affordable, and secure energy.

Mission

To create and sustain American leadership in the transition to a global clean energy economy.
EERE
Strategic Plan

Vision
Mission
Principles
Strategic Goals
Sector Objectives
Success Indicators
GOALS

• Accelerate the development and adoption of sustainable transportation technologies.

• Increase the generation of electric power from renewable sources.

• Improve the energy efficiency of our homes, buildings, and industries.

• Stimulate the growth of a thriving domestic clean energy manufacturing industry.
EERE seeks to develop renewable energy technologies so that they are *cost-competitive* with traditional sources of energy without subsidies

**Major Strategies**

1. **Applied Research**: Cost reduction & performance improvement
2. **Development & Demonstration**: technology validation and risk reduction
3. **Focus on market barriers**
EERE
Organizational Structure

 Renewable Power

 Solar
 Geothermal
 Wind & Water

 Energy Efficiency

 Advanced Manufacturing
 Weatherization
 FEMP
 Buildings

 Transportation

 Vehicles
 Fuel Cells
 Bioenergy

 Clean Energy Manufacturing Initiative
SunShot Initiative's goal is to develop solar energy technologies to reduce the costs of solar photovoltaic (PV) and concentrated solar power (CSP) energy technologies to be cost-competitive without subsidies with conventional energy sources by 2020.

**Portfolio**

- **Photovoltaic R&D** - Advances R&D that has resulted in US leadership in world records, scientific publications, and patents to provide US industry technology advantages
- **Concentrating Solar Power R&D** - Develops advanced thermal storage to enable CSP to provide dispatchable electricity.
- **Systems/Grid Integration** - Develops technologies to enable integration of solar power with the grid for reliability and resiliency
- **Soft Balance of Systems** - Work with state and local governments to reduce red tape and soft costs which now can about 50% of residential costs
- **Innovations in Manufacturing** - Increase US market share for manufacturing value add commensurate with domestic market demand through manufacturing process R&D

**Challenges**

- Hardware cost advances have outpaced soft costs and soft costs have been difficult to reduce.
- With higher penetration of renewables, system-wide grid integration becomes increasingly critical.
- US-based manufacturers are facing stiff competition in a very intense global marketplace.

**Opportunities**

- Creative ways to engage with stakeholders to realize reductions in soft costs
- Develop technologies to minimize integration costs
- Stronger partnerships with industry to assist US manufacturing competitiveness
Up to **50%** of the **64%** of the cost of a solar installation

**Source:** Second Annual Benchmarking..., Friedman et al., in preparation.
The mission of the Wind and Water Power Technologies Office (WWPTO) is to accelerate widespread U.S. development and deployment of clean, affordable, reliable, and domestic wind and water power to promote national security, economic growth, and environmental quality. WWPTO supports achieving the President’s goal of doubling renewable energy by 2020 by investing in high risk, transformative technology innovations that industry does not address.

**Portfolio**

- **Land-based Utility-scale Wind**
  - Reduce unsubsidized LCOE to $0.057/kWh by 2020 and $0.042/kWh by 2030*

- **Distributed Wind**
  - Develop a national strategy for distributed wind which leverages and promotes continued U.S. manufacturing

- **Offshore Wind**
  - Reduce unsubsidized LCOE to $0.167/kWh by 2020 and $0.136/kWh by 2030 for fixed-bottom systems*

  
  
  - **Marine and Hydrokinetic**
    - Achieve cost-competitiveness at local coastal hurdle rates of roughly $0.15/kWh by 2030*

- **Hydropower**
  - Deploy up to 70 GW of new hydropower to meet 15% projected U.S. electricity demand from Water in 2030, up from 7% today

  
  
  *All costs at a 7% discount rate

**Challenges**

- LCOE reduction for unsubsidized competition
- Technology reliability and readiness improvements
- Market barrier reduction for accelerated GW-scale deployment
  - Siting, regulatory and permitting, environmental (including avian and aquatic), human-use (including radar, public acceptance, and existing uses), transmission and interconnection
- Grid integration to enable high RE penetration
- International supply chain competition

**Opportunities**

- Optimize plant performance to reduce LCOE
- Provide essential test infrastructure to reduce technology risk and open markets
- Mitigate barriers and streamline permitting processes to speed deployment
- Optimize grid integration and transmission
- Strengthen U.S. competitiveness by maintaining and expanding domestic manufacturing
• Wind Farm level analysis

• Improved understanding of the complex physics governing wind flow into and through wind farms

• Develop high-fidelity simulation models.

• Impact the design process to accelerate the maturation of the innovative wind plant technology.

DOE wind turbine inflow measurement and modeling capabilities help determine the reasons for wind plant underperformance.

Turbine-wake interactions can reduce overall wind power plant efficiency by as much as 20% to 30%
Consistent with DOE/DOI’s the National Offshore Wind Strategy, Offshore Wind activities will support research that is expected to simultaneously improve offshore wind power plant performance, reduce capital and operational costs and reduce market barriers—directly contributing to the office goal of lowering the cost of energy. This activity supports a multi-year program to facilitate the creation of a U.S. offshore wind industry.

- Tremendous U.S. offshore wind resource, exceeding 50 quads (4,000 GW), which is approximately 4 times the nation’s current annual electricity production

- The Offshore Wind Demonstration Funding Opportunity is a 5-year initiative

- 2014: Down-selected 3 of 7 projects to move to final design, construction, and installation activities:
  - Virginia
  - Oregon
  - New Jersey

- Projects are expected to be in operation by the end of 2017, and will represent some of the very first at-scale deployments in the United States.
Marine and Hydrokinetic Technologies (MHK) capture the energy of waves and currents (e.g., tides or ocean current).

- MHK Research and Design
- Validate Open-Source Advanced Design Tools
- Monitoring Technology Testing and Research:

Ocean Power Technologies tests Power Buoy at Navy Wave Energy Site, HI

Output of Sandia National Laboratories’ Environmental Fluid Dynamics Code, a tool to predict optimum array configurations, in Cobscook, Maine

DOE aims to compress technology development timelines to reduce the LCOE for MHK devices to local coastal hurdle rates of $0.12-$0.15 per kilowatt-hour (kWh) by 2030.
The new *HydroNEXT* initiative will focus on accelerating the use of hydropower through development and demonstration of technologies to lower cost, improve performance, and reduce environmental impacts of hydropower.

- **HydroMax**: Capturing near-term growth opportunities through R&D on technologies to cost-effectively improve performance and increase sustainable generation at existing water resources infrastructure.

- **Low Impact New Development (LIND)**: A new set of hydro technologies is needed to capture the wide range of low impact development opportunities that are currently available from new stream-reach development.

- **Environmental Performance Analysis + Regulatory Process Improvement**: High-level, predictive analysis is needed to assess LIND designs and inform future design requirements to meet environmental performance needs and ease the permitting processes for future deployments of LIND technologies. DOE will also develop a tool to reduce permitting barriers and increase efficiency and transparency of federal permitting processes.

Through *HydroNEXT*, the Energy Department aims to **double hydropower generation in the U.S.** by 2030 (an additional 300 TWh) to create a large and enduring economic and environmental benefit to the U.S.
The mission of the Geothermal Technologies Office is to accelerate the development and deployment of clean, domestic geothermal resources that will provide valuable, stable and secure electricity and thermal energy and support a cleaner environment.

**Portfolio**

- **Enhanced Geothermal Systems (EGS):** Creating and developing long-life, economic and sustainable fractured reservoirs which have overall potential to add 100-500 Gwe at competitive costs.
- **Low Temperature/Co-Produced (LT):** Demonstrating co-production, cascading system and strategic material technologies at working scale.
- **Innovative Exploration Technologies (IET):** Developing tools and technologies which lower the cost and risk of geothermal drilling, development and measurement.
- **Systems Analysis (SA):** Lowering barriers to geothermal development through accurate analysis, and engagement on non-technical barriers such as regulatory and financial.

**Challenges**

- **EGS:** Risk-averse private sector unable to advance EGS at required scale
- **LT:** To date, no commercial co-pro projects have been advanced
- **IET:** Low risk geothermal fields have been identified, next challenge is finding and economically drilling “blind” systems
- **SA:** Unacceptably lengthy permitting and regulatory timelines, coupled with low investor confidence in geothermal system reliability

**Opportunities**

- DOE-led demonstration projects and EGS Field Laboratory project (FORGE), building upon 2013 EGS success at Desert Pk
- First Co-pro working project in a working oil and gas field
- First geothermal “play fairway” analysis and mapping, following by proof of concept validation and drilling
- Implementation of best practices resulting from geothermal regulatory roadmap, combined with timeline surety
Promote transformative science and engineering to:

- Validate and optimize enhanced geothermal systems (EGS) technology
- Perfect access and creation of productive and sustainable reservoirs
- Capture and disseminate high fidelity data in real-time to all stakeholders
- Ensure reproducibility for commercial scale-up

Federal Role:

- Test technologies/take technical risks not possible in private sector
- Work under aggressive timeframe

Partnerships:

- Facilitate broad collaboration among all stakeholders and scientific communities
- Welcome a wide-range of R&D performers provided technology advance EGS development and deployment.

Direct benefits to multiple areas of subsurface research

Selection  Set Up  Implementation  Closeout

7 Years
Grid Integration

Energy Systems Integration Facility (ESIF)

- NREL’s largest R&D facility (182,500 ft² / 20,000 m²)
- Space for 200 NREL staff and research partners
- 15 state-of-the-art hardware laboratories
- Integrated megawatt-scale electrical, thermal and fuel infrastructure
- High performance computation and data analysis capabilities
- 2-D/3-D advanced visualization

http://www.nrel.gov/esi/esif.html
**EERE Engagement with the States**

- **“Living Laboratories”**
  - New approaches
  - Regional economies

- **Cities, States and Associated Institutions**
  - PUCs, State Universities, State Energy Offices

**EERE Support:**

- Direct Funding through EERE’s State Energy Program and Weatherization Assistance Program
- Competitive Funding across Tech Offices
- Development of Best Practices and Targeted Technical assistance
- Provision of information resources and tools
  - Regulatory Roadmaps, Analysis Reports, Online Databases (DESIRE)
DOE Energy Information Administration

http://www.eia.gov/state/?sid=WV

EERE State and Local Solutions Center:

The State and Local Solution Center and Technical Assistance Program (TAP) provide resources, events, and assistance to state, local, tribal, and K-12 school district leaders working to unlock a clean energy economy.

http://www1.eere.energy.gov/wip/solutioncenter/

EERE POC for West Virginia:

Gordon Gore, Energy Project Specialist  
gordon.gore@go.doe.gov
Department of Energy – EERE
Renewable Power Initiatives

Rob Anders
Chief of Staff, Renewable Power
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

robert.anders@ee.doe.gov
### Energy Efficiency and Renewable Energy
#### Solar, Geothermal, Wind, Water: FY 2012 to FY 2015 Funding

*(Dollars in Thousands)*

<table>
<thead>
<tr>
<th>Program/Subprogram</th>
<th>FY 2012 Appropriation</th>
<th>FY 2013 Appropriation</th>
<th>FY 2014 Appropriation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From FY12 Col of FY14 Req</td>
<td>From FY13 Col of FY15 Req</td>
<td>From FY14 Col of FY15 Req</td>
</tr>
<tr>
<td><strong>Solar Energy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrating Solar Power</td>
<td>44,922</td>
<td>43,080</td>
<td>48,571</td>
</tr>
<tr>
<td>Photovoltaic R&amp;D</td>
<td>75,563</td>
<td>150,580</td>
<td>56,641</td>
</tr>
<tr>
<td>Systems Integration</td>
<td>47,916</td>
<td>45,773</td>
<td>52,816</td>
</tr>
<tr>
<td>Balance of Systems Soft Cost Reduction</td>
<td>31,897</td>
<td>29,617</td>
<td>42,558</td>
</tr>
<tr>
<td>Innovations in Manufacturing Competitiveness</td>
<td>84,404</td>
<td>0</td>
<td>44,472</td>
</tr>
<tr>
<td>NREL Site Wide Facility Support</td>
<td>0</td>
<td>0</td>
<td>12,000</td>
</tr>
<tr>
<td><strong>Geothermal Technologies</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced Geothermal Systems</td>
<td>15,556</td>
<td>20,103</td>
<td>27,084</td>
</tr>
<tr>
<td>Low Temperature and Coproduced Resources</td>
<td>4,940</td>
<td>2,942</td>
<td>4,708</td>
</tr>
<tr>
<td>Hydrothermal</td>
<td>12,483</td>
<td>8,092</td>
<td>10,285</td>
</tr>
<tr>
<td>Systems Analysis</td>
<td>4,000</td>
<td>3,888</td>
<td>3,698</td>
</tr>
<tr>
<td>NREL Site Wide Facility Support</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Wind Energy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology Development and Testing</td>
<td>73,054</td>
<td>62,399</td>
<td>61,006</td>
</tr>
<tr>
<td>Technology Application</td>
<td>18,759</td>
<td>23,730</td>
<td>18,120</td>
</tr>
<tr>
<td>Resource Characterization and Technology RD&amp;T</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Technology Validation and Market Transformation</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mitigate Market Barriers</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Modeling and Analysis</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NREL Site Wide Facility Support</td>
<td>0</td>
<td>0</td>
<td>9,000</td>
</tr>
<tr>
<td><strong>Water Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine and Hydrokinetic Technologies</td>
<td>33,684</td>
<td>35,456</td>
<td>41,275</td>
</tr>
<tr>
<td>Hydropower Technologies</td>
<td>24,392</td>
<td>19,231</td>
<td>17,290</td>
</tr>
<tr>
<td>NREL Site Wide Facility Support</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>471,570</td>
<td>444,891</td>
<td>449,524</td>
</tr>
</tbody>
</table>
## FY 2015 Budget Summary Table

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Energy Technologies</td>
<td>269,050</td>
<td>257,058</td>
<td>282,300</td>
<td>+25,242</td>
</tr>
<tr>
<td>Wind Energy Technologies</td>
<td>86,129</td>
<td>88,126</td>
<td>115,000</td>
<td>+26,874</td>
</tr>
<tr>
<td>Water Power Technologies</td>
<td>54,687</td>
<td>58,565</td>
<td>62,500</td>
<td>+3,935</td>
</tr>
<tr>
<td>Geothermal Technologies</td>
<td>35,025</td>
<td>45,775</td>
<td>61,500</td>
<td>+15,725</td>
</tr>
<tr>
<td><strong>EERE Total</strong></td>
<td>1,691,757</td>
<td>1,900,641</td>
<td>2,316,749</td>
<td>+416,108</td>
</tr>
</tbody>
</table>
## FY 2015 Budget Summary Table

<table>
<thead>
<tr>
<th>Category</th>
<th>FY 2013 Current</th>
<th>FY 2014 Enacted</th>
<th>FY 2015 Request</th>
<th>FY 2015 vs FY 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Vehicle Technologies</td>
<td>303,165</td>
<td>289,737</td>
<td>359,000</td>
<td>+69,263</td>
</tr>
<tr>
<td>- Bioenergy Technologies</td>
<td>185,190</td>
<td>232,290</td>
<td>253,200</td>
<td>+20,910</td>
</tr>
<tr>
<td>- Hydrogen and Fuel Cell Technologies</td>
<td>95,844</td>
<td>92,983</td>
<td>92,983</td>
<td>+55</td>
</tr>
<tr>
<td>Renewable Electricity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Solar Energy Technologies</td>
<td>269,050</td>
<td>257,058</td>
<td>282,300</td>
<td>+25,242</td>
</tr>
<tr>
<td>- Wind Energy Technologies</td>
<td>86,129</td>
<td>88,126</td>
<td>115,000</td>
<td>+26,874</td>
</tr>
<tr>
<td>- Water Power Technologies</td>
<td>54,687</td>
<td>58,565</td>
<td>62,500</td>
<td>+3,935</td>
</tr>
<tr>
<td>- Geothermal Technologies</td>
<td>35,025</td>
<td>45,775</td>
<td>61,500</td>
<td>+15,725</td>
</tr>
<tr>
<td>End-Use Efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Advanced Manufacturing</td>
<td>114,254</td>
<td>180,471</td>
<td>305,100</td>
<td>+124,629</td>
</tr>
<tr>
<td>- Building Technologies</td>
<td>204,601</td>
<td>177,868</td>
<td>211,700</td>
<td>+33,832</td>
</tr>
<tr>
<td>- Weatherization and Intergovernmental Programs</td>
<td>188,234</td>
<td>230,862</td>
<td>304,700</td>
<td>+73,838</td>
</tr>
<tr>
<td>Corporate Support Programs</td>
<td>208,889</td>
<td>231,513</td>
<td>237,779</td>
<td>+6,266</td>
</tr>
<tr>
<td>Subtotal, Energy Efficiency and Renewable Energy</td>
<td>1,773,333</td>
<td>1,913,441</td>
<td>2,321,962</td>
<td>+408,521</td>
</tr>
<tr>
<td>- Use of Prior Year Balances</td>
<td>-81,576</td>
<td>-2,382</td>
<td>-5,213</td>
<td>N/A</td>
</tr>
<tr>
<td>- Rescission of Prior Year Balances</td>
<td>0</td>
<td>-10,418</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Total, Energy Efficiency and Renewable Energy</td>
<td>1,691,757</td>
<td>1,900,641</td>
<td>2,316,749</td>
<td>+416,108</td>
</tr>
</tbody>
</table>
Federal Policy

*Production Tax Credit (PTC)*: 2.2¢/kWh tax credit for wind, geothermal, and closed-loop biomass; 1.1¢/kWh for other eligible technologies.

*Investment Tax Credit (ITC)*: 30% tax credit for solar, fuel cells and small wind; 10% for geothermal, microturbines, and CHP.

*Accelerated Depreciation (MACRS)*: enables wind project owners to depreciate the vast majority of their investments over a five- to six-year period for tax purposes. An even-more-attractive first-year “bonus depreciation” schedule was enacted in 2008.

*Note: Under current law, the PTC, ITC, and bonus depreciation will expire for new wind projects at the end of CY 2012*

State Policy

*Renewable Portfolio Standard (RPS)*: Obligates utilities to procure a percentage of electricity from renewable sources. 29 states (plus DC and Puerto Rico) have an RPS on the books.
EERE Cross-Cutting Initiative: Grid Integration

Understanding (Knowledge)
- Databases
- Planning Tools
- Models and Simulators
- Analyses and Assessments

Institutional Factors (Markets, Regulations, Policies, Standards)
- Visualization
- Large Data Processing and Management
- Forecasting
- AMIs
- PMUs
- Other Sensors and Relays
- End-Use Energy Management Systems
- IT/Control/Protection Architectures
- Cyber-Physical Security
- Smart Devices
- Communications Hardware and Protocols

Flexibility (Physical)
- HVDC
- Power Flow Controllers
- Energy Storage
- Cables and Conductors
- Protection Devices
- Transformers

Visibility (Informational)
ESIF will complete the first full year of RD&D in FY14.

Numerous projects will be conducted with a variety of participants including DOE, Federal and State government, academia, not-for-profit enterprises and commercial businesses.

A major DOE cross-cutting project titled INTEGRATES was begun with EERE support and continues to deliver results.

In FY 2015, ESIF will continue normal operations and expand investments to function as a DOE User Facility supporting a group of peer reviewed competitively selected projects addressing a scope of work defined by DOE.
Renewable Power in the U.S.

Cumulative Wind Deployment

Source: NREL