WIND AND WATER POWER PROGRAM

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Briefing to Blade Workshop

July 20, 2010

Jacques Beaudry-Losique

Program Manager

Wind and Water Power Technologies

Goals Alignment

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Administration goals:
Reduce carbon emissions 50% by 2030, 80% by 2050
Reduce oil consumption 50% by 2030, 80% by 2050
Stimulate jobs and economic recovery through RE development

Department of Energy strategic goals:
Support R&D efforts to reduce the costs of RE technologies and accelerate large-scale use of carbon-free electricity sources

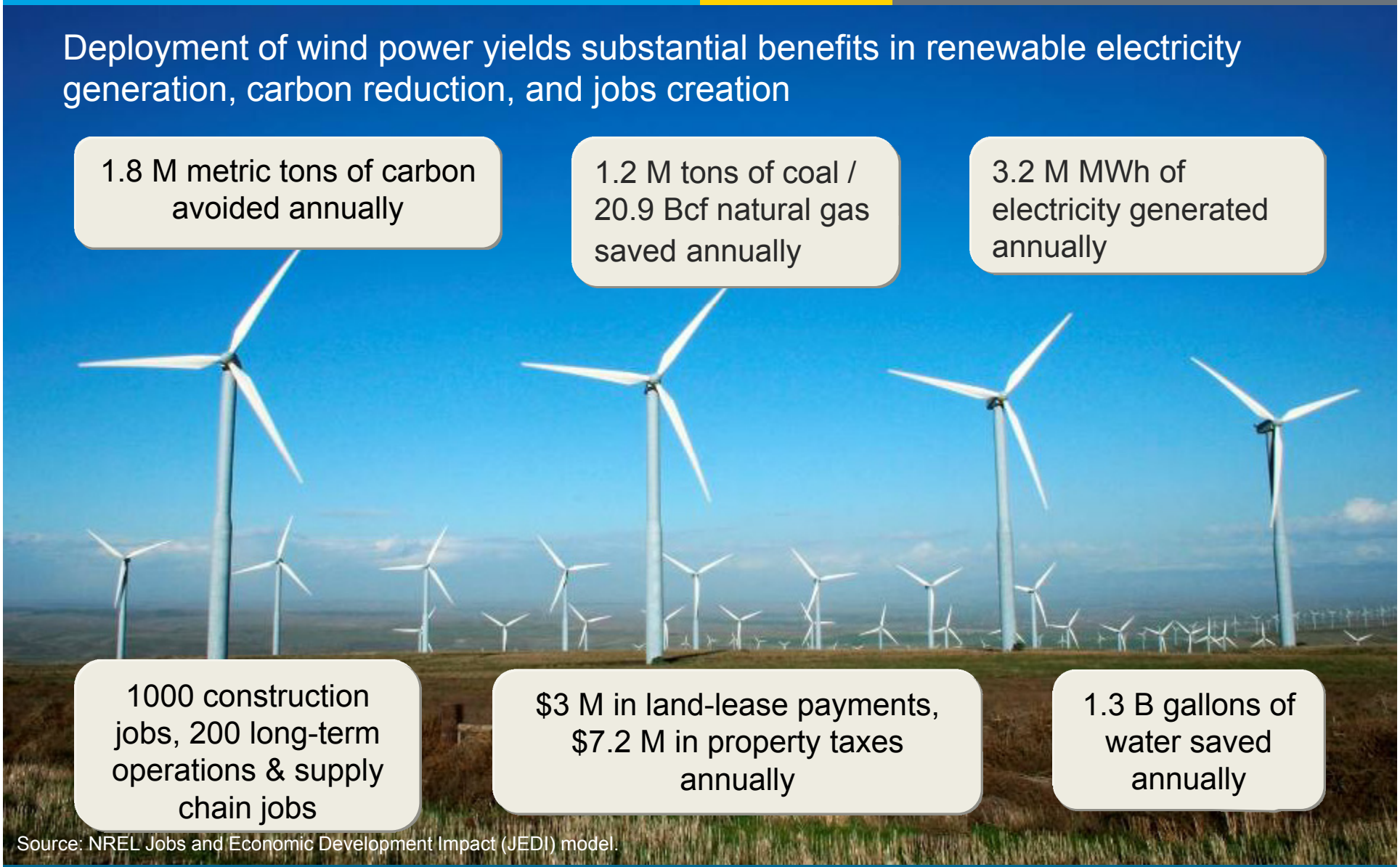
Energy Efficiency and Renewable Energy goals:
Strengthen U.S. energy security, environmental quality, and economic vitality through public-private partnerships

Wind Program goals:
Optimize growth and momentum of wind power deployment to meet the nation's energy needs:
- Improve COE through Innovation & Reliability Improvements
- Improve Integration
- Address major barriers (radar, environmental)
- Launch offshore wind

1 GW of New Wind Yields…

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Deployment of wind power yields substantial benefits in renewable electricity generation, carbon reduction, and jobs creation



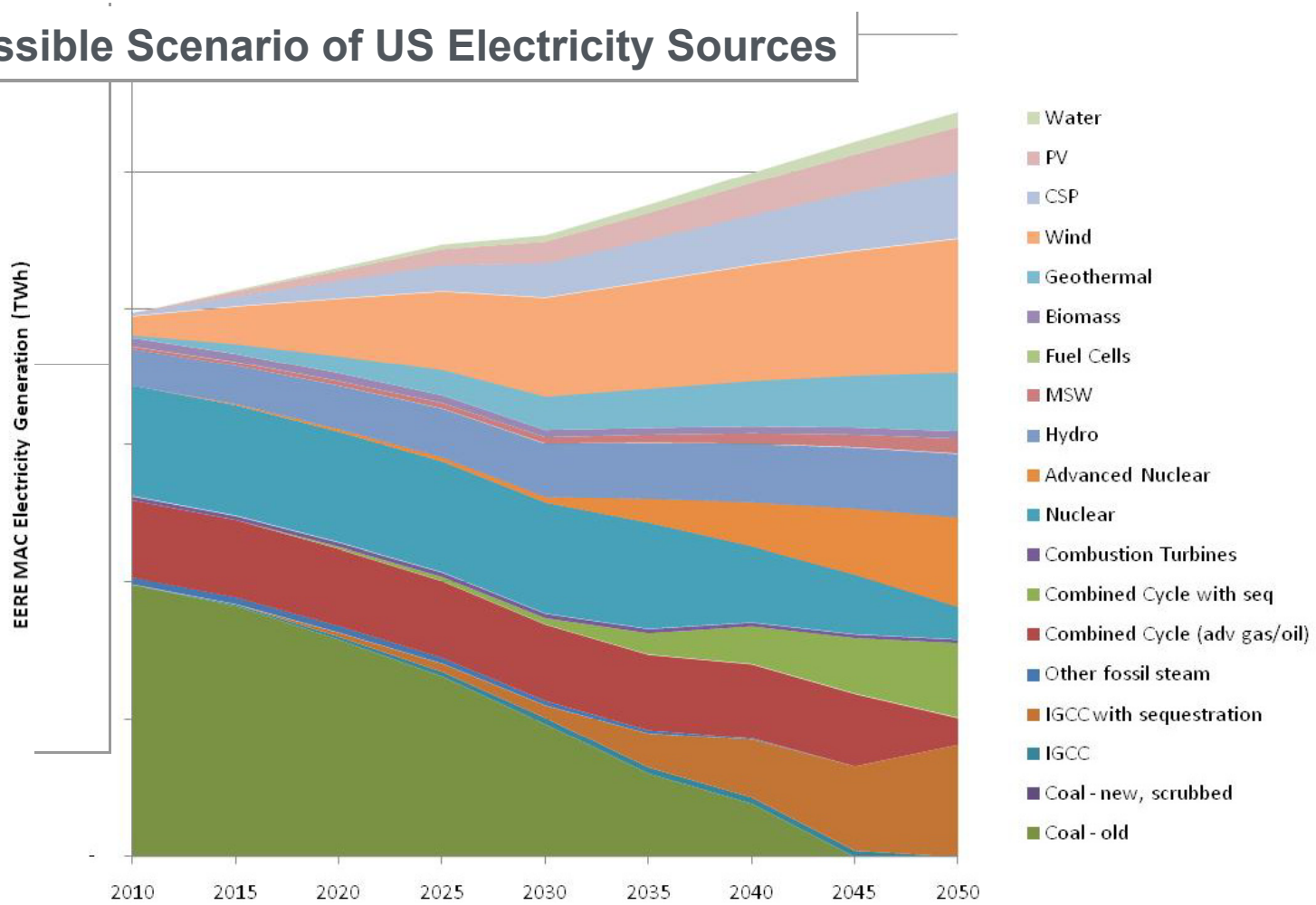
- 1.8 M metric tons of carbon avoided annually
- 1.2 M tons of coal / 20.9 Bcf natural gas saved annually
- 3.2 M MWh of electricity generated annually
- 1000 construction jobs, 200 long-term operations & supply chain jobs
- $3 M in land-lease payments, $7.2 M in property taxes annually
- 1.3 B gallons of water saved annually

Source: NREL Jobs and Economic Development Impact (JEDI) model.

EERE Energy Mix Analysis

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Possible Scenario of US Electricity Sources



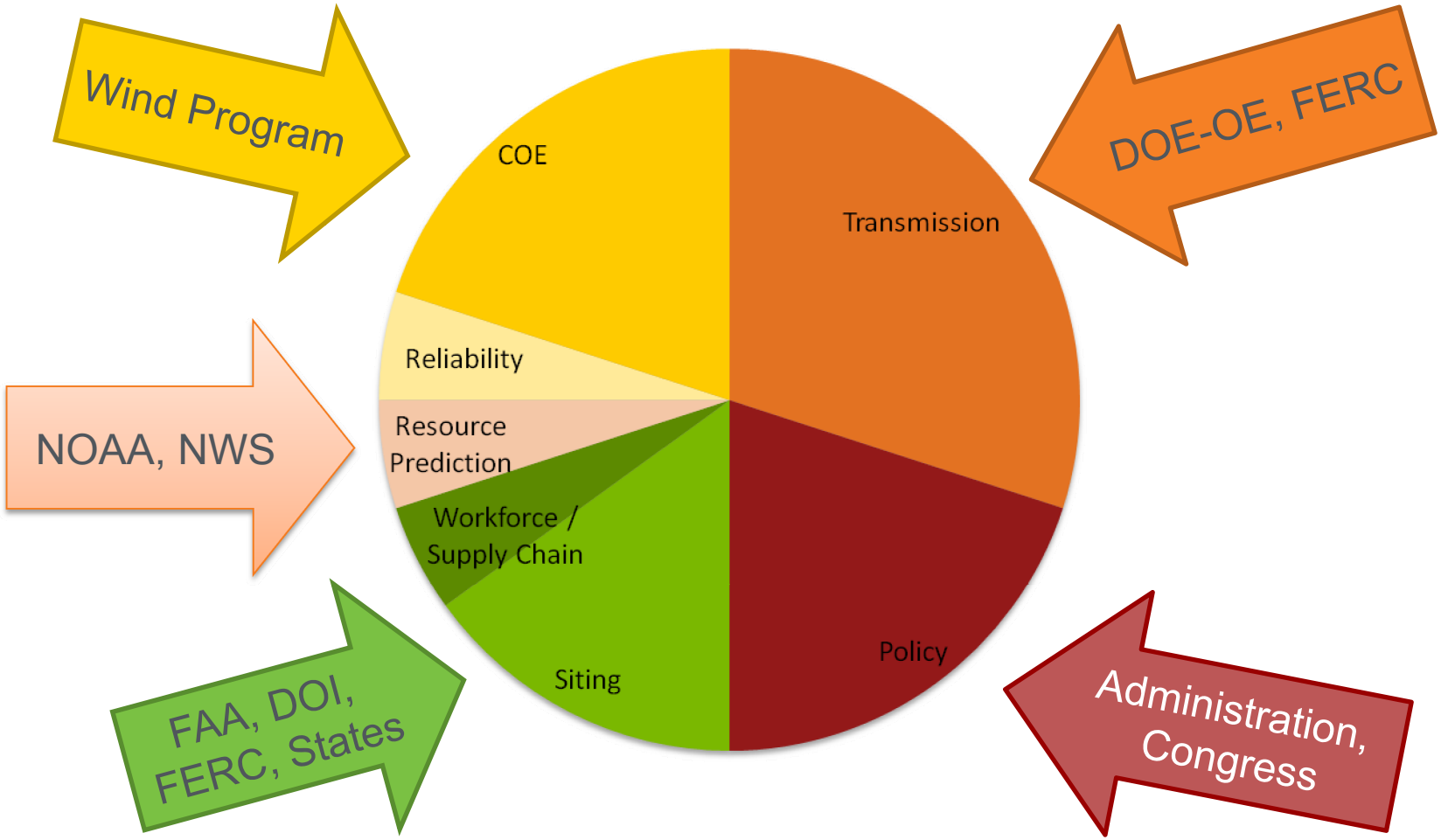
- **Wind is the predicted largest source of renewable electricity in 2030 and 2050, and is the lowest cost renewable resource!**

Source: Baldwin analysis dated December 2009

Major Barriers

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Addressing Barriers to Widespread Wind Deployment



Source: Ed DeMeo, Co-Lead, *20% Wind Energy by 2030*

Accelerating Widespread Deployment

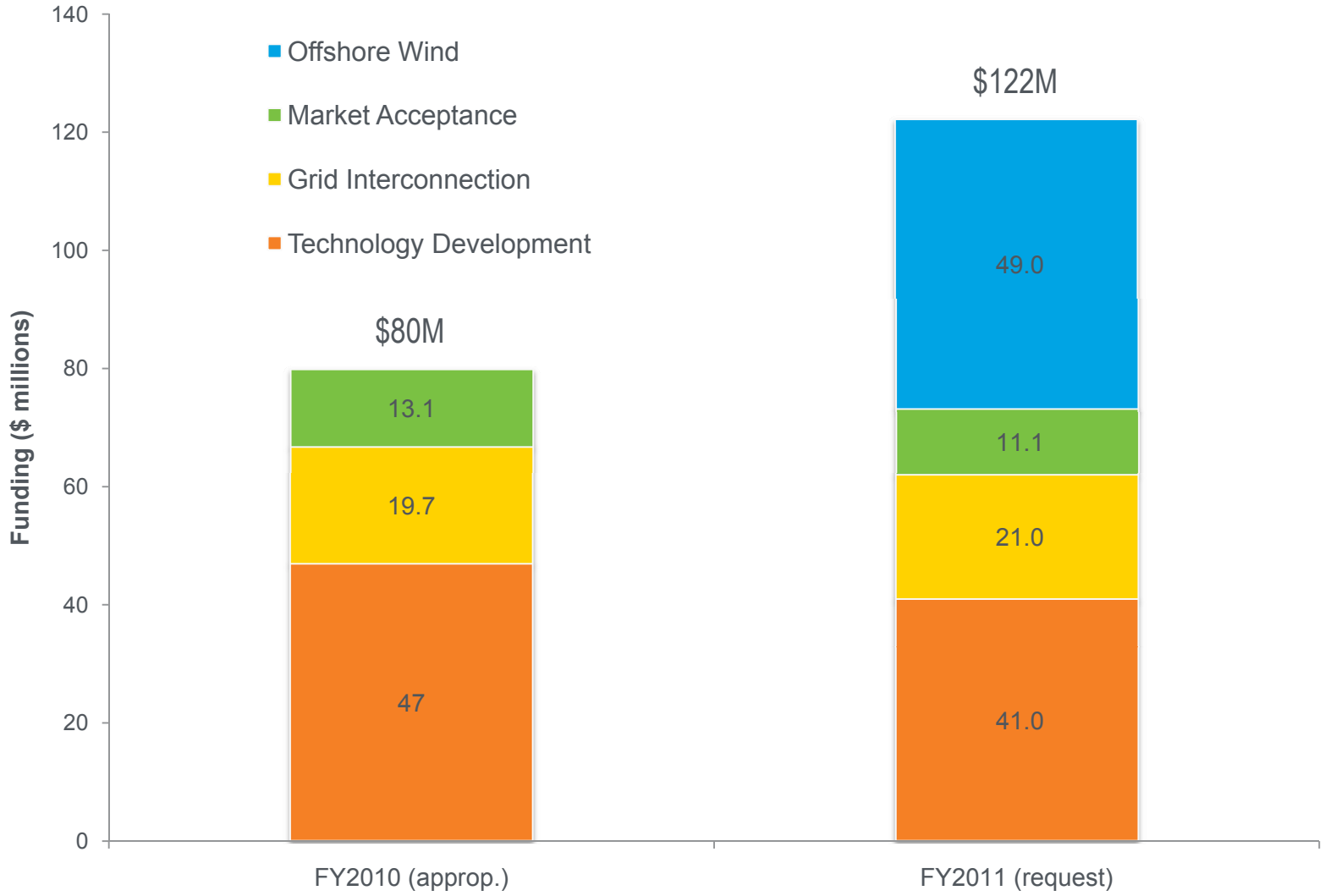
I. **Reduce Cost of Wind Energy**
   - Lower turbine capital costs
   - Increase energy capture
   - Improve reliability (lower O&M costs)

II. **Address Grid Integration Barriers**
   - Facilitate integration of wind energy into grid
   - Address transmission access constraints

III. **Promote Market Adoption**
   - Mitigate wildlife, radar, and other siting barriers
   - Increase public acceptance
   - Promote workforce & supply chain development

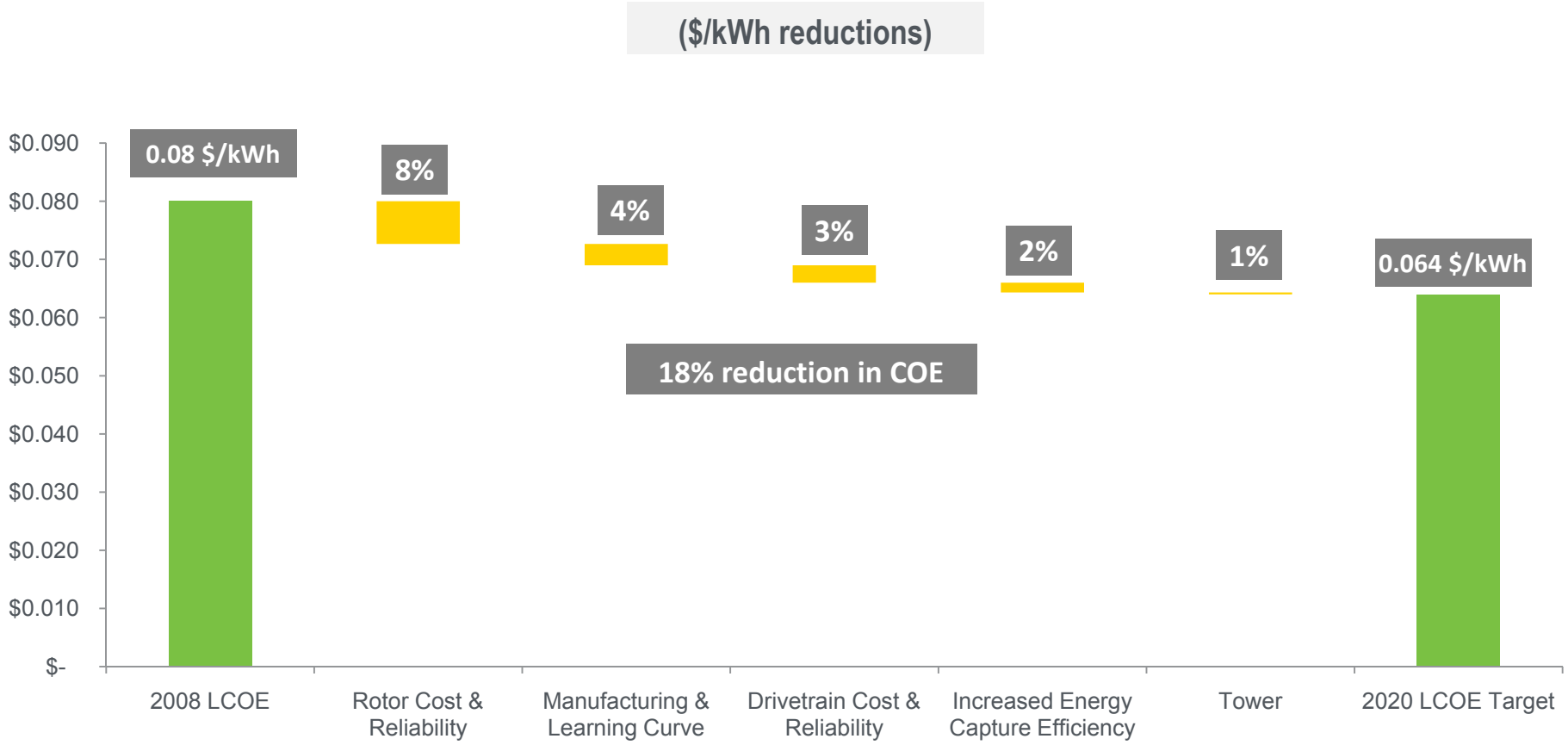
IV. **Facilitate Offshore Wind Development**

FY11 Budget


Offshore Wind
Market Acceptance
Grid Interconnection
Technology Development
Funding ($ millions)
140
120
100
80
60
40
20
0
$80M
13.1
19.7
47
$122M
49.0
11.1
21.0
41.0
FY2010 (approp.)
FY2011 (request)

Land-based Wind COE Reduction

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

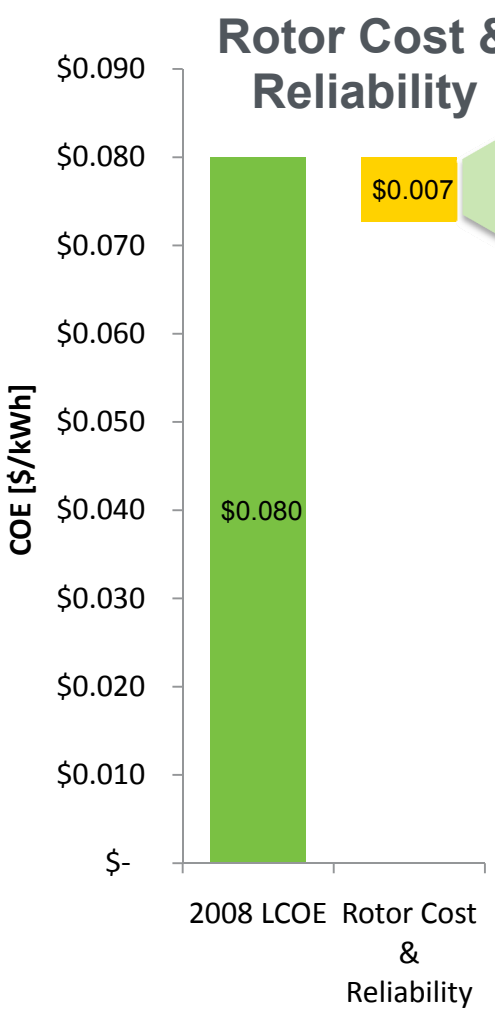


FY10 Budget for COE reductions	**$15.1M**	**$10.1M**	**$3.9M**	**$4.5M**	**$2.9M**	**Total: $36.4M**

Modeled cost of energy to reflect impact of DOE R&D; lower than actual market prices

Rotor Cost and Reliability

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

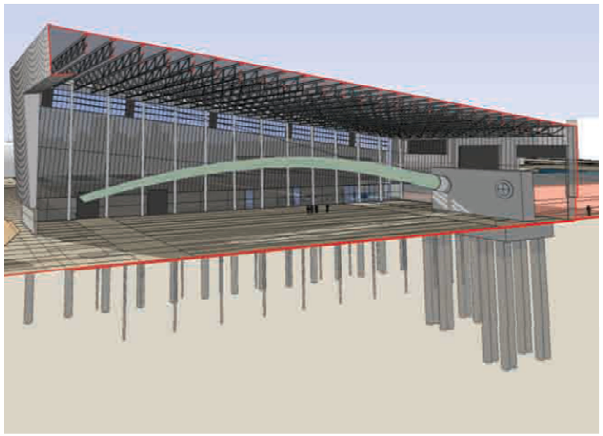


Challenges
Increasing blade cost & weight
Blade failures & reliability concerns
Wind project underperformance

Benefits
Increased turbine performance
Increased blade reliability
Innovative products

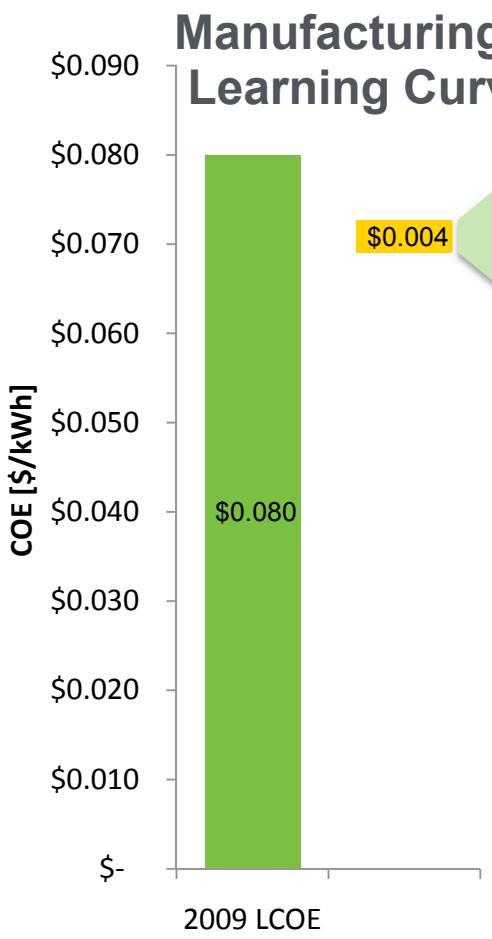
Activities
Blade Reliability Collaborative
Large blade structural testing
Developing "smart" blades (embedded sensors, active aerodynamic controls)
Developing new airfoil geometries
Incorporating advanced materials
Aerodynamics & aeroacoustics analysis
Developing "stealth" blades
Non-destructive inspection methods
Lighter/stronger materials and coatings
Blade wear/soiling prevention

Partners
OEM blade manufacturers
National laboratories
NIST, supply chain NGOs
FAA



Manufacturing / Learning Curve

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Challenges
Cost of domestic manufacturing
Quality control
Availability of materials

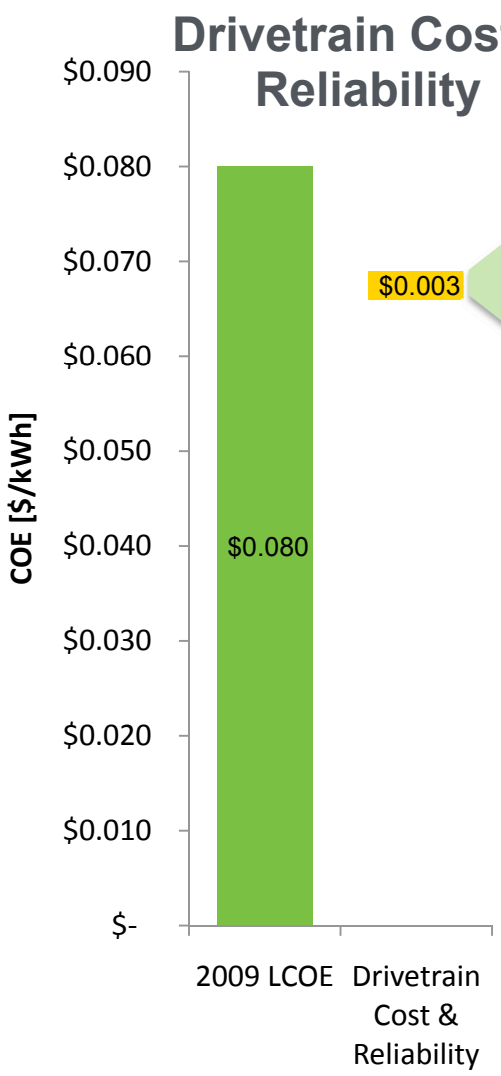
Benefits
Improved component quality
Decreased turbine costs
Innovative products and processes

Activities
Advanced Manufacturing Initiative
Composite manufacturer project
Fabrication automation R&D
Non-destructive inspection methods
Integrated advanced design/manufacturing
Manufacturing components R&D
Manufacturing processes R&D
Critical Materials Initiative

Partners
DOC Manufacturing Extension Program
DOE Industrial Technologies Program
National/Regional/State supply chain facilitation programs
Turbine & component OEMs
Universities, national laboratories

Drivetrain Cost & Reliability

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Challenges

Drivetrain / gearbox failures (high O&M, replacement costs)
Potential for efficiency improvements

Benefits

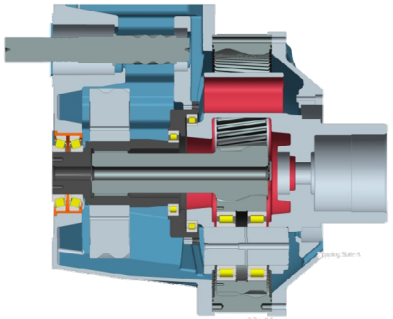
Increased turbine reliability
Increased capacity factors
Innovative products

Activities

Gearbox Reliability Collaborative
Large Drivetrain Testing Facility
Dynamometer performance testing
Direct-drive, permanent-magnet R&D
Component failure analysis
CREW reliability database
Lubricant R&D
Drivetrain condition health monitoring
Wear prevention R&D
Materials (high wear) investigation
Field loads measurement campaign

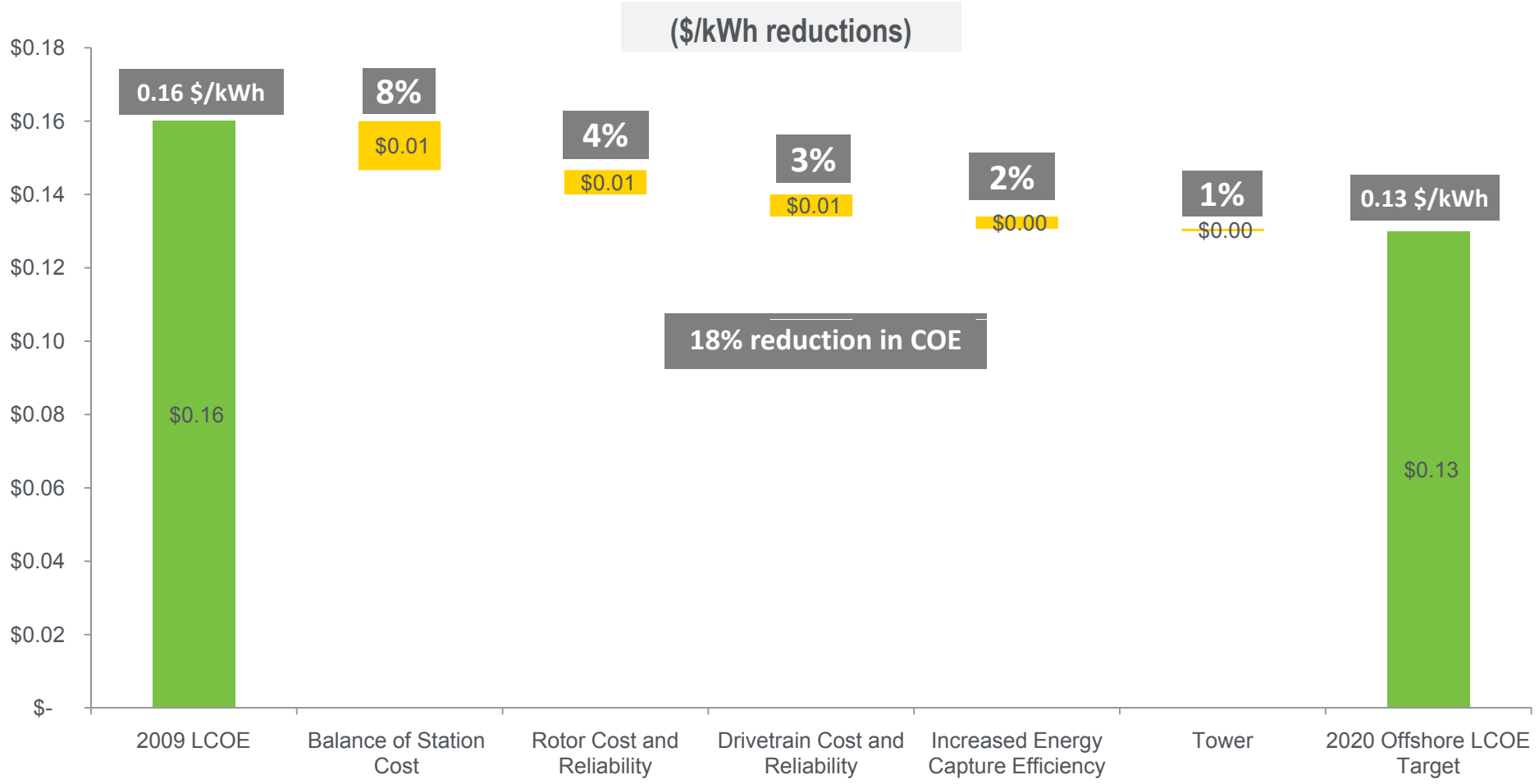
Partners

OEM drivetrain & component manufacturers
Universities
National laboratories



Offshore Wind COE Reduction

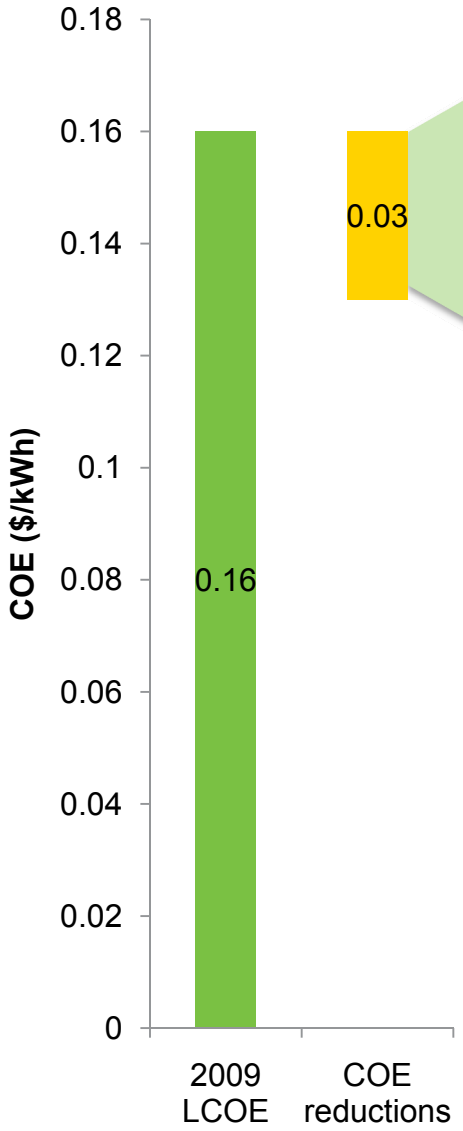
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



FY11 Proposed Offshore Wind Budget | **Total $49M**

Offshore R&D Opportunities

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Challenges
High capital costs
Marinization
Foundations & infrastructure
Installation & staging facilities
Reliability & maintenance

Benefits
Lower capital costs
Innovative turbines & foundations
Reduced need for maintenance

Activities
Large component test facilities
Design codes & tools development
Foundations & platforms R&D
Innovative turbine designs
Certification & standards
Marine grid interconnection R&D
Resource & design condition characterizations

Partners
National laboratories
Federal agencies: MMS, NOAA, NCAR, FWS, DOD, DHS, ACOE
Turbine OEMs
Universities (U of Maine, U Delaware)
State agencies

Transmission & Integration

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- **Challenges**
  - Integration of variable wind energy into electrical grid
  - No transmission access at high-quality wind resources
- **Benefits**
  - Safe & reliable integration of wind energy
  - Improved consideration of wind energy in transmission planning
- **Activities**
  - Improving wind forecasting techniques to improve integration
  - Developing wind generator & power plant models for grid operators' use
  - Improving wind resource characterization
  - Developing grid operations methods & strategies
  - Large-scale high wind penetration studies (EWITS, WWSIS)
  - Informing transmission planning efforts
- **Partners**
  - DOE lead: Office of Electricity (OE)
  - Electricity sector: utilities, public power entities, RTOs/ISOs
  - Federal agencies: NOAA, National Weather Service, FAA, FERC, BPA, WAPA
  - National laboratories

Project Siting

- **Challenges**
  - Radar interference
  - Potential wildlife effects (NEPA, MBTA, etc)
  - Social acceptance barriers
- **Benefits**
  - Reducing time and cost of siting / permitting new projects
  - Increase size of resource available for development
- **Activities**
  - Engagement with federal radar agencies (FAA, DOD, DHS)
  - Wind-wildlife impact and mitigation studies
  - Studies on potential human impacts (property values, etc)
  - Collaborative engagement with stakeholders
- **Partners**
  - DOI (FWS, BLM, MMS, BIA, NPS)
  - Radar agencies (FAA, DOD, DHS)
  - State and local governments
  - Environmental orgs.

Recovery Act projects

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- **Large Drivetrain Testing Facility, $45M**
  - Clemson University, Charlestown, SC
  - Awarded on December 30, 2009
  - Ground breaking scheduled for building shell upgrades Q2 2011
- **Large Blade Test Facility, $25M**
  - Massachusetts Clean Energy Center, Boston, MA
  - Groundbreaking ceremony on Dec 1st, 2009
  - Commissioning target: September 2011
- **University-Industry Wind R&D Consortia, $24M**
  - Awardees: Illinois Institute of Technology; U-Minnesota; U-Maine
  - Awards made on Jan. 15, 2010
- **Wind Technology Partnerships, $14M**
  - 27 awardees receiving funding
  - All awards made by Jan. 31, 2010
  - Technology R&D, manufacturing projects, transmission & integration
- **NWTC Dynamometer and electrical upgrade, $10M**
  - National Wind Test Center
  - Awarded September 1, 2009
  - Design work underway, ground breaking scheduled for June 2011

Collaboration

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

National Laboratories	Federal Agencies	University Partnerships	Industry
National Renewable Energy Laboratory	Federal Energy Regulatory Commission	National Marine Renewable Energy Centers	MOU on collaboration with 6 major wind turbine manufacturers
Sandia National Laboratories	Mineral Managements Service	(U-Hawaii, U-Washington, Oregon State University)	GE: helped develop 1.5MW turbine; most widely-installed design in U.S.
Oak Ridge National Laboratory	National Park Service	Large Blade Test Facilities in Massachusetts, Texas	Clipper: helped develop innovative 2.5MW Liberty turbine
Pacific Northwest National Laboratory	National Oceanic and Atmospheric Administration	(U-Mass. Amherst, MIT)	Gearbox Reliability Collaborative to improve wind turbine reliability
Idaho National Laboratory	U.S. Fish and Wildlife Service	University research consortia: U-Maine, U-Minnesota, Illinois Institute of Technology	Verdant Power: tidal current turbine improvements
Lawrence Berkeley National Laboratory	U.S. Environmental Protection Agency	20% Wind FOA: multiple university partners	TPI Composites: manufacturing process improvements
Lawrence Livermore National Laboratory	Army Corps of Engineers	Wind for Schools: multiple university partners	EPRI: fish-friendly turbine design
Los Alamos National Laboratory	Department of Defense	Advanced Water Power FOA: multiple university partners	Pacific Energy Ventures: siting protocols for marine energy projects
Argonne National Laboratory	Federal Aviation Administration		Multiple FOA award winners for wind, water topics

Questions?