

# DOE/NOAA Wind Forecasting and Related Resource Efforts



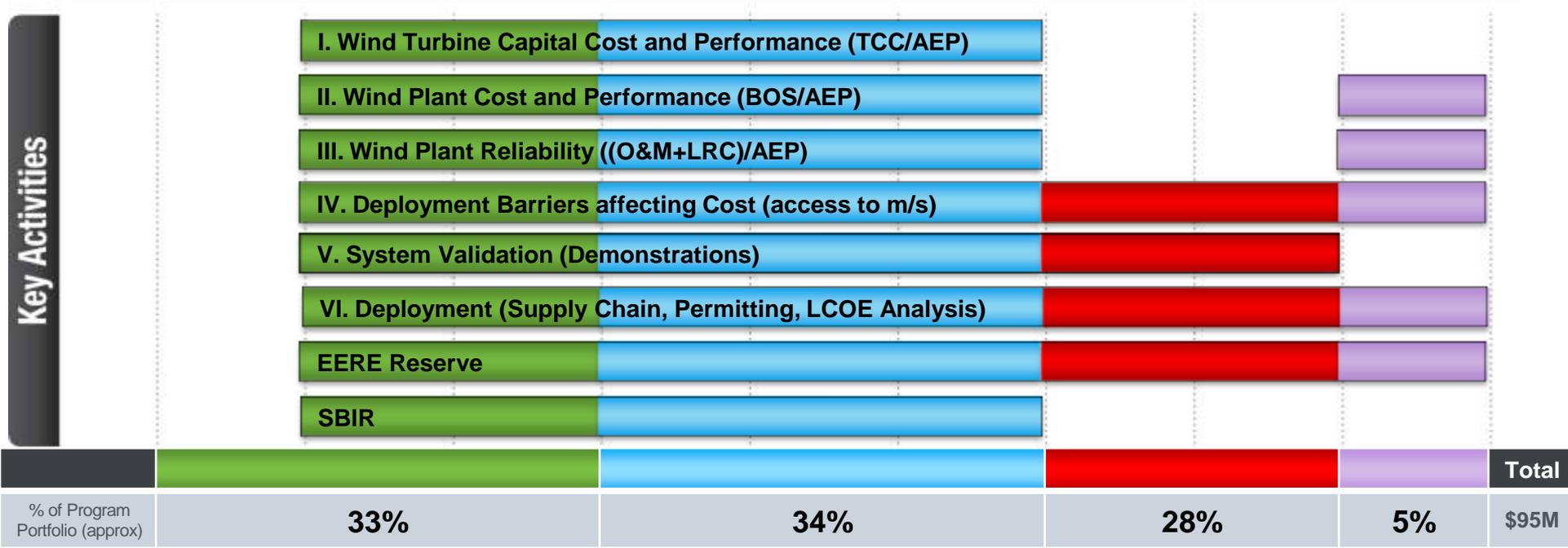
## ARPA-E Forecasting Workshop

Arlington, VA

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DOE Wind and Water Program

# Wind Program Context - RDD&D Breakdown (FY12)

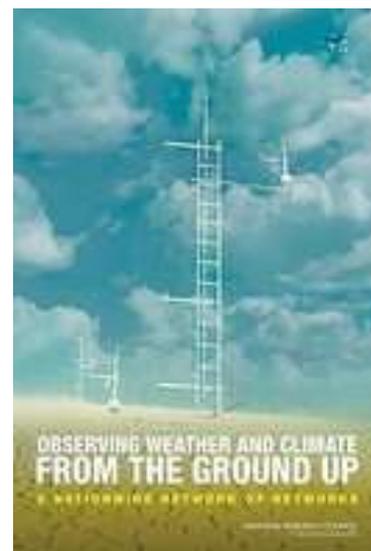


# Wind Resource Characterization Needs



- **Resource assessment** for financial viability and optimized siting
- Wind turbine **inflow/turbulence modeling** to allow better turbine design
- **Wind plant array modeling** for effective power prediction
- **Data sets, models, and forecasting** for efficient power system operation
- **National observations network** serving weather-driven renewables
- **Climate change assessment** for wind resource impacts

*Key Emphasis – Leveraging national weather enterprise capabilities*



# Weather-dependent Renewables



## Wind



Large Onshore

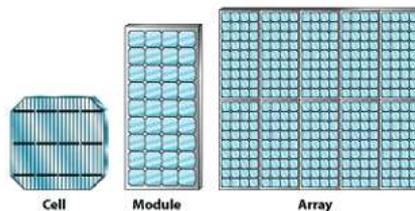


Distributed Onshore



Offshore

## Solar

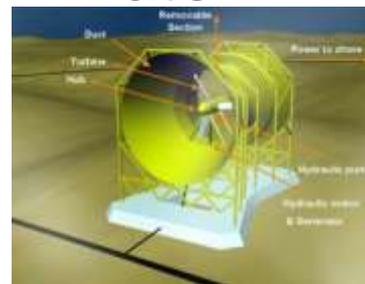


Photovoltaic (PV)



Concentrating Solar Power (CSP)

## Water



Marine Hydrokinetic

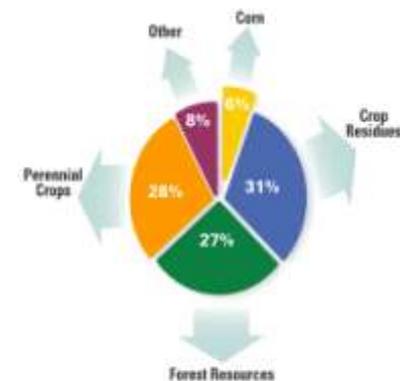


Ocean Thermal



Conventional

## Biopower



Projected U.S. Biofuel Sources  
Source: Biomass as Feedstock for Cellulosic and Ethanol Production: Technical Feasibility of a Billion Dry Tons Annual Supply 2005, DOE and USDA.

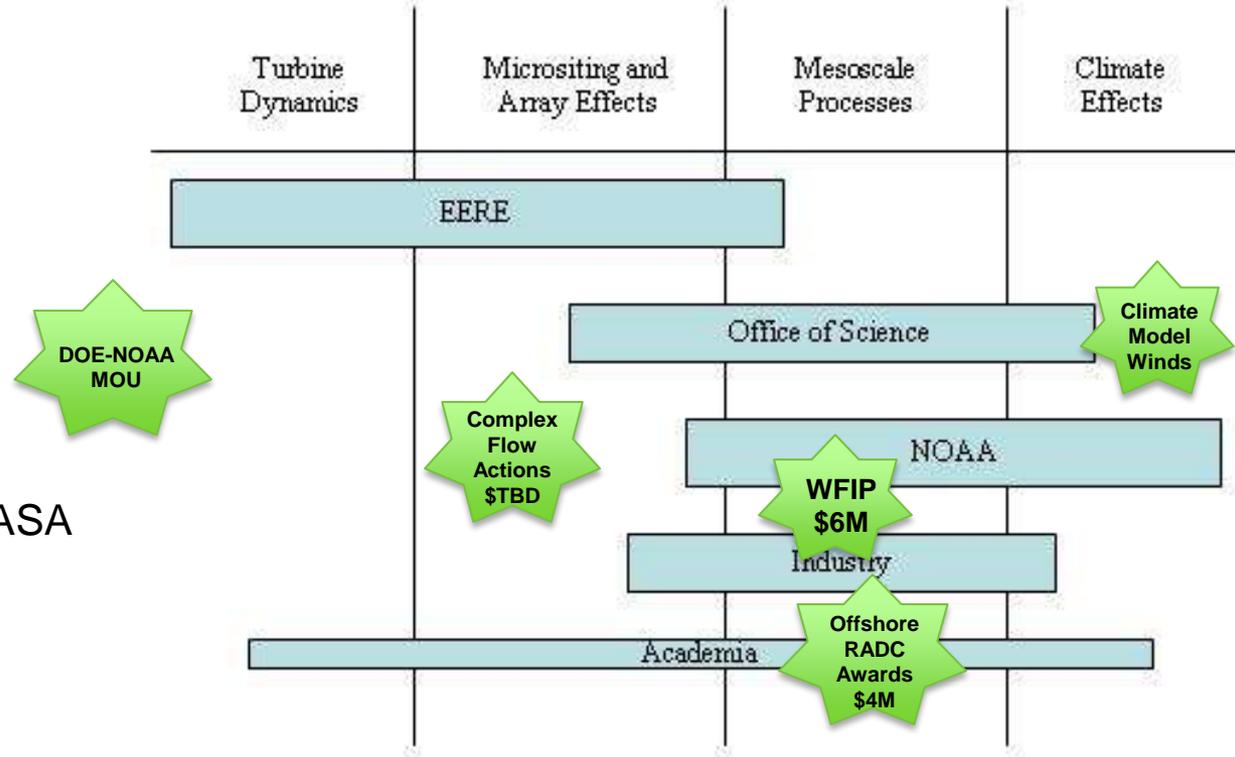


# Public/Private Collaboration on Wind Characterization Needs



## Developing sustained collaboration with:

- Commerce/NOAA
  - Oceanic and Atmospheric Research
  - National Weather Service
  - National Ocean Service
- DOE Office of Science
- Other agencies
  - DOI, Army Corps, Navy, NASA
- Academia
  - National Center for Atmospheric Research
  - Universities
- Industry

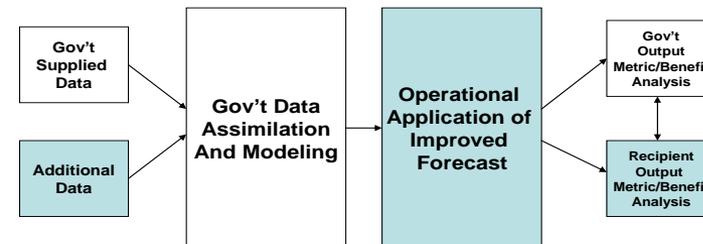
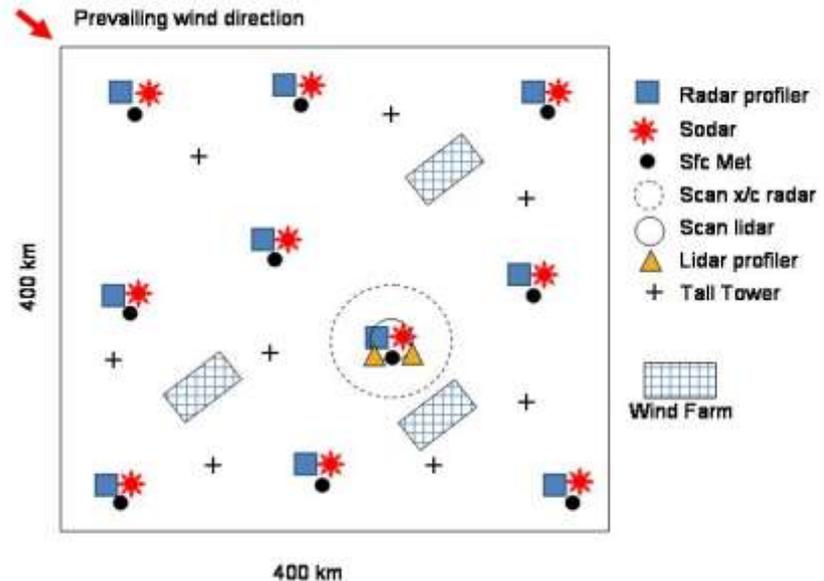


**Outcomes – Expanded public and private sector contribution to renewables - new observations, research, modeling, and renewable energy data services**

# DOE-NOAA Wind Forecasting Improvement Project (WFIP)



- Public/private project with NOAA, industry
- Objectives
  - Test system of large area weather data collection and modeling to enhance short term (0 to 6 hour) wind forecasting
  - Identify observational requirements for wind energy and inform weather network development
- Two partnership teams, lead by AWS Truepower and WindLogics



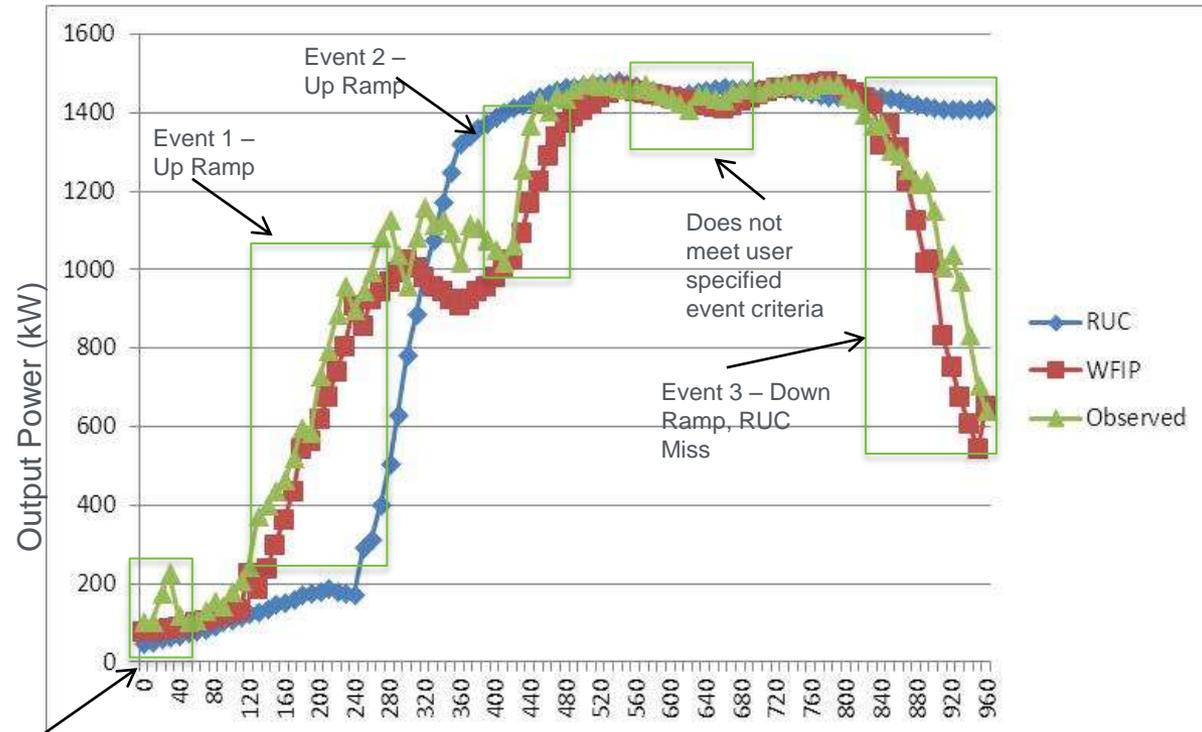
 = Areas of Recipient Participation

**Halfway through one year field operation period – initial analyses underway**

Conventional aggregate error statistics (MAE, RMSE) not suitable for wind ramps

Utility operator perspective essential in assessing ramp performance

Several lab and industry efforts focusing on advanced analytical methods



Not an event - under 250 kW user specified minimum

\* Not Actual Data

**DOE – NOAA ramp metric method in development for analysis of WFIP results**

# Hawaii Electric Company Forecasting Project



## Objectives

Deploy sensor (i.e. sodar, lidar, doppler) units to address logistics of operating, tuning, integrating and maintaining a *WindNET*

Design responsive grids with real-time information and controls so operator can “sense,” measure and reliably respond to variability



## Partner

AWS Truepower



***Project Complete – forecast uncertainties reduced, final report available soon***





## Lawrence Livermore National Lab – **WindSense**

- Focus on identifying locations and sensor types required to improve short-term and extreme-event forecasts, via Ensemble Sensitivity Analysis (ESA)
- Partnered with California ISO, Southern Cal Edison, Bonneville Power Administration

## Argonne National Lab – **Argus Prima**

- Novel computational learning algorithms for wind power point and uncertainty forecasting
- Information theoretic learning (ITL) for neural network training

## Ames Laboratory/Iowa State University – **Wind Forecast Model Validation and Improvement**

- Characterize atmospheric flow in all seasons from one year of past data from four wind-farm locations in Iowa
- Improve theoretical and numerical descriptions of the atmosphere on time scales critical for improving power plant performance



## **University of Colorado - *Upstream Measurements of Wind Profiles with Doppler LIDAR for Improved Wind Energy Integration***

- Objective – Produce long range, high quality measurements of wind profiles over the altitude range of wind turbines using a scanning Doppler lidar (LM WindTracer)
- Focus on measurements for improved wind power forecasts, especially ramping events.

***Project Completion in October 2012 – extensive data available, further research required. Paper submitted for publication.***

## **NREL – *Remote Sensing Testbed***

- Compare and validate accuracy of commercial remote sensing devices (e.g. lidars) relative to industry-accepted tower based measurement standards
- Reference measurements from NREL NWTC highly instrumented tall tower

***FY 12 project just getting underway – currently four industry participant prospects***



- **Key Forecasting Actions**

- Follow WFIP with research on **planetary boundary layer physical processes** critical to forecasting
  - *Potential for additional field experiments*
- Support integration of new physical understanding into **NWP models**
- **Define observation network needs**, engage network development efforts
- Promote **data sharing** and integrated **data delivery** schemes

- **Offshore**

- SBIR Topic (April 3 release): “Standard” Offshore Renewable Energy Met-Ocean Observation System Development
- Develop offshore reference measurement station for validation and research
- Completion of marine boundary layer modeling research projects
- Resource data campaign initiatives