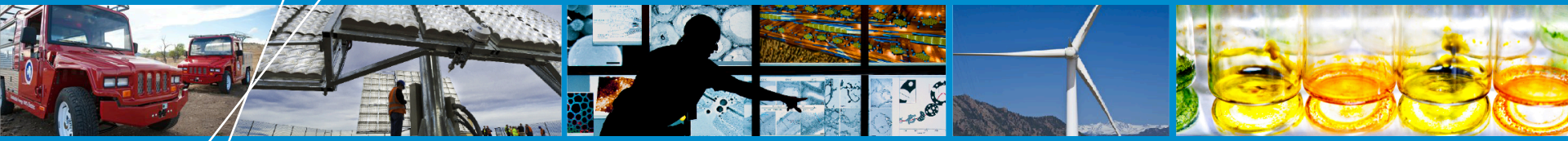
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

DOE Advanced Technology Demonstration Projects



Deepwind 2014

Senu Sirnivas

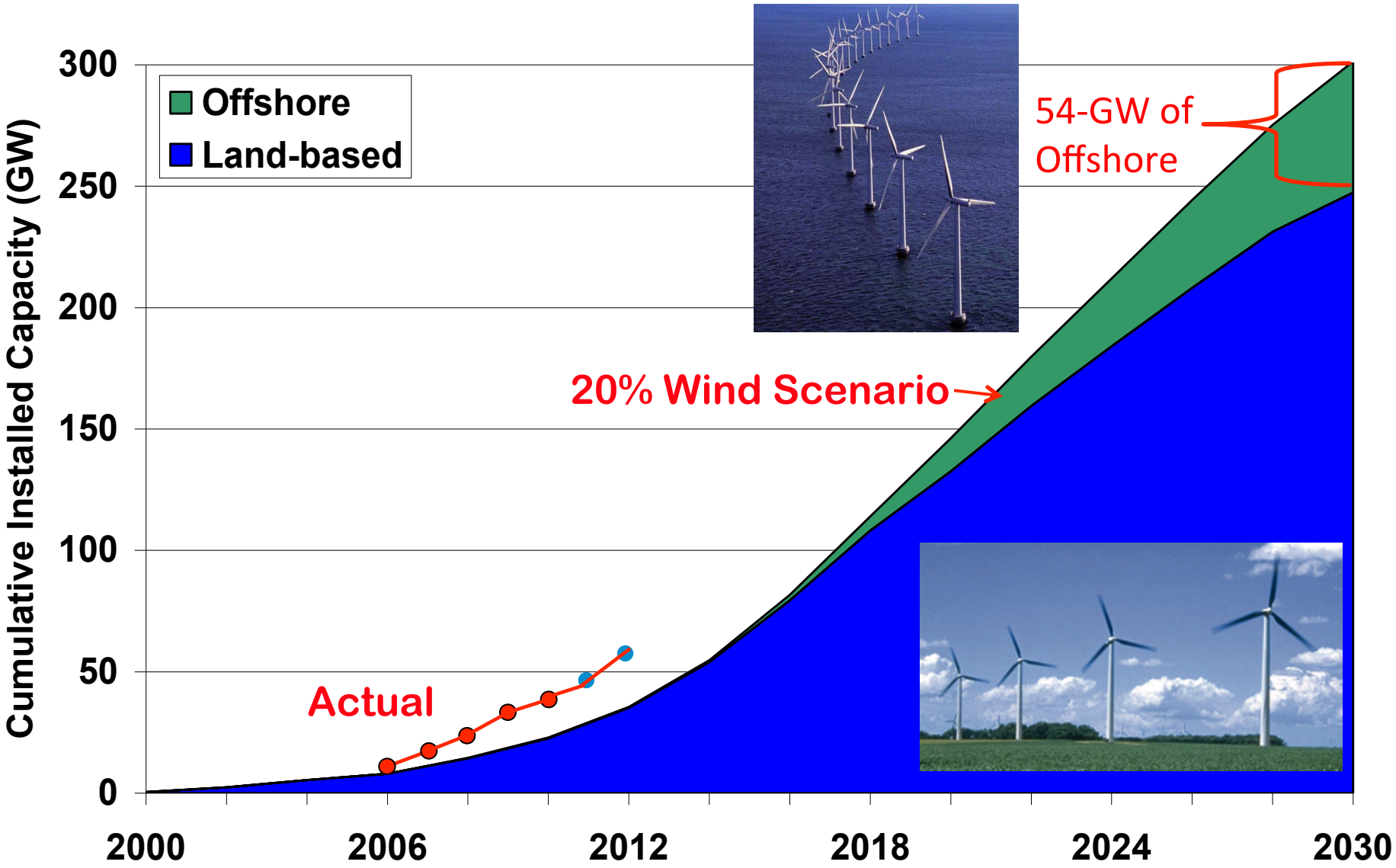
January 23, 2014

Outline

- **DOE**
  - Objectives
  - Offshore wind demonstration projects

- **Overview - 7 projects**
  - 4 fixed foundation
  - 3 floating foundation

20% Wind Energy (54-GW from Offshore)

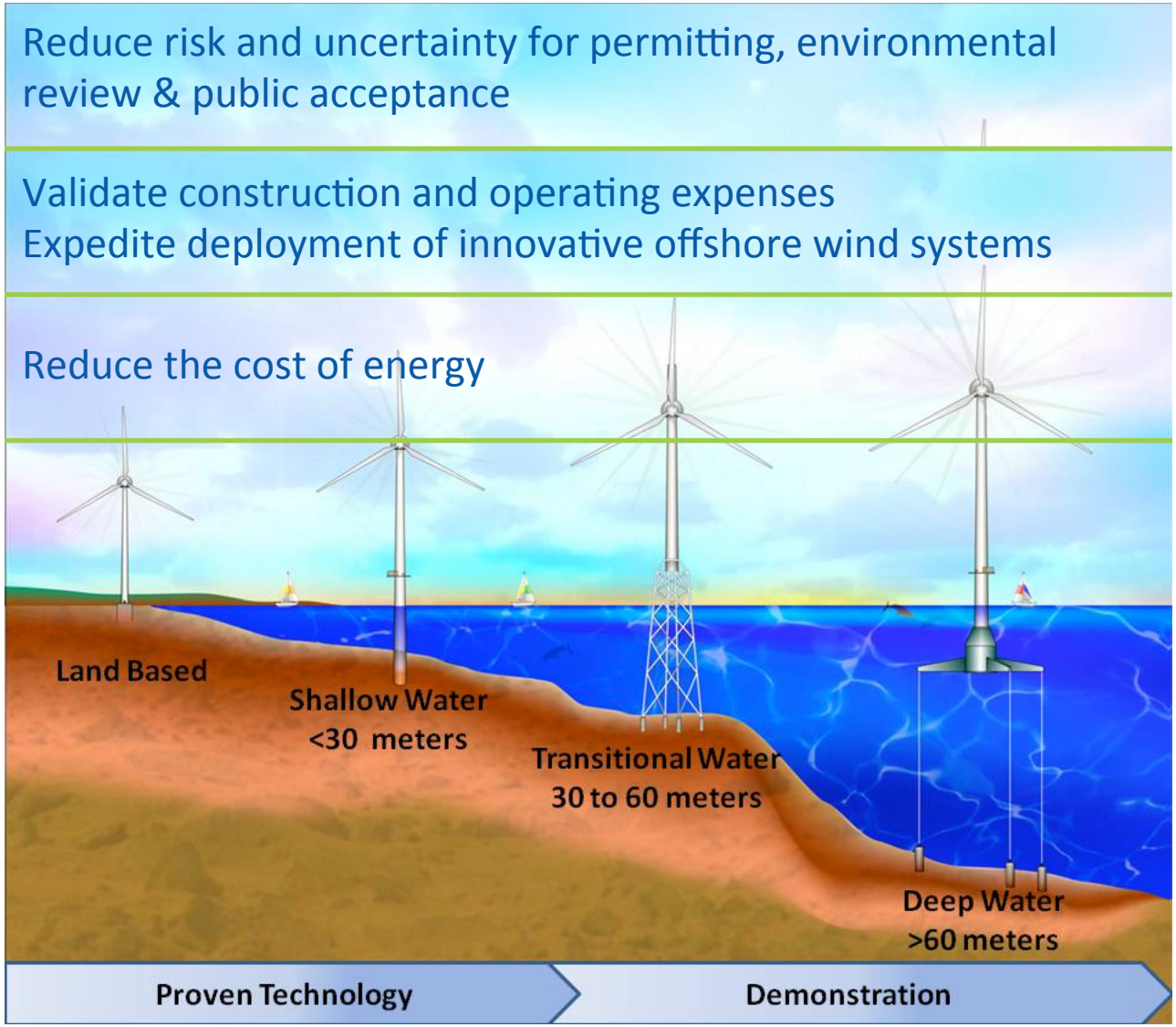


DOE FOA 410

Demonstrate Next Generation Technology

Advanced Technology Demonstration Projects

$168M
DOE
5 Years



DOE FOA 410

2012

- DOE 410 funding opportunity
- Many applicants (~ 30)
- 12 selected for oral presentation

2013

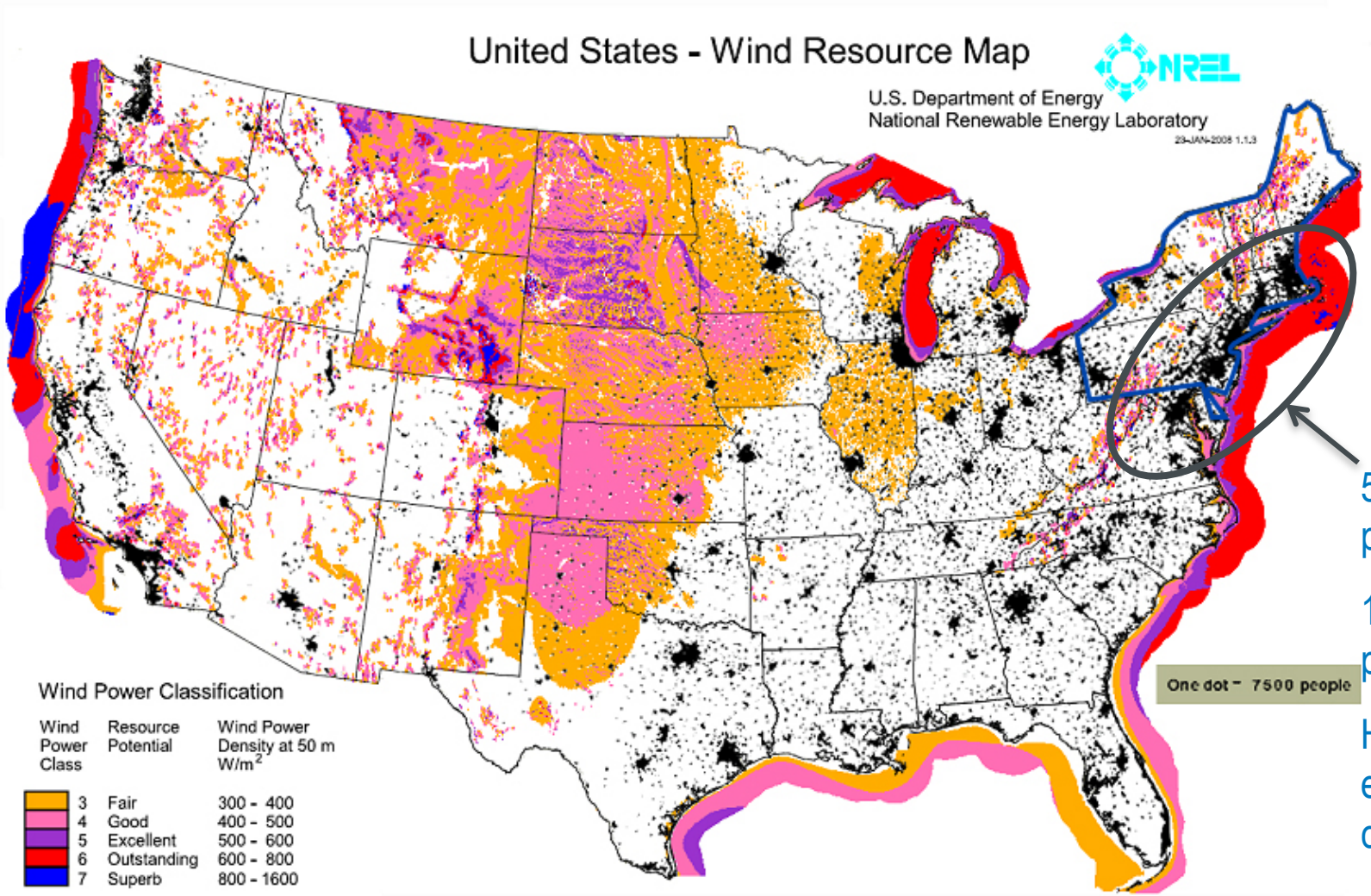
- 7 projects awarded
- $1M applicant + $4M DOE per project
- Develop 50% FEED

2014 - 2018

- Down select to 3 projects
- $47M applicant + $47M DOE per project
- 100% FEED, fabrication, and deployment

Offshore Wind Potential (Over 4000GW)

No Projects have yet been installed in The United States

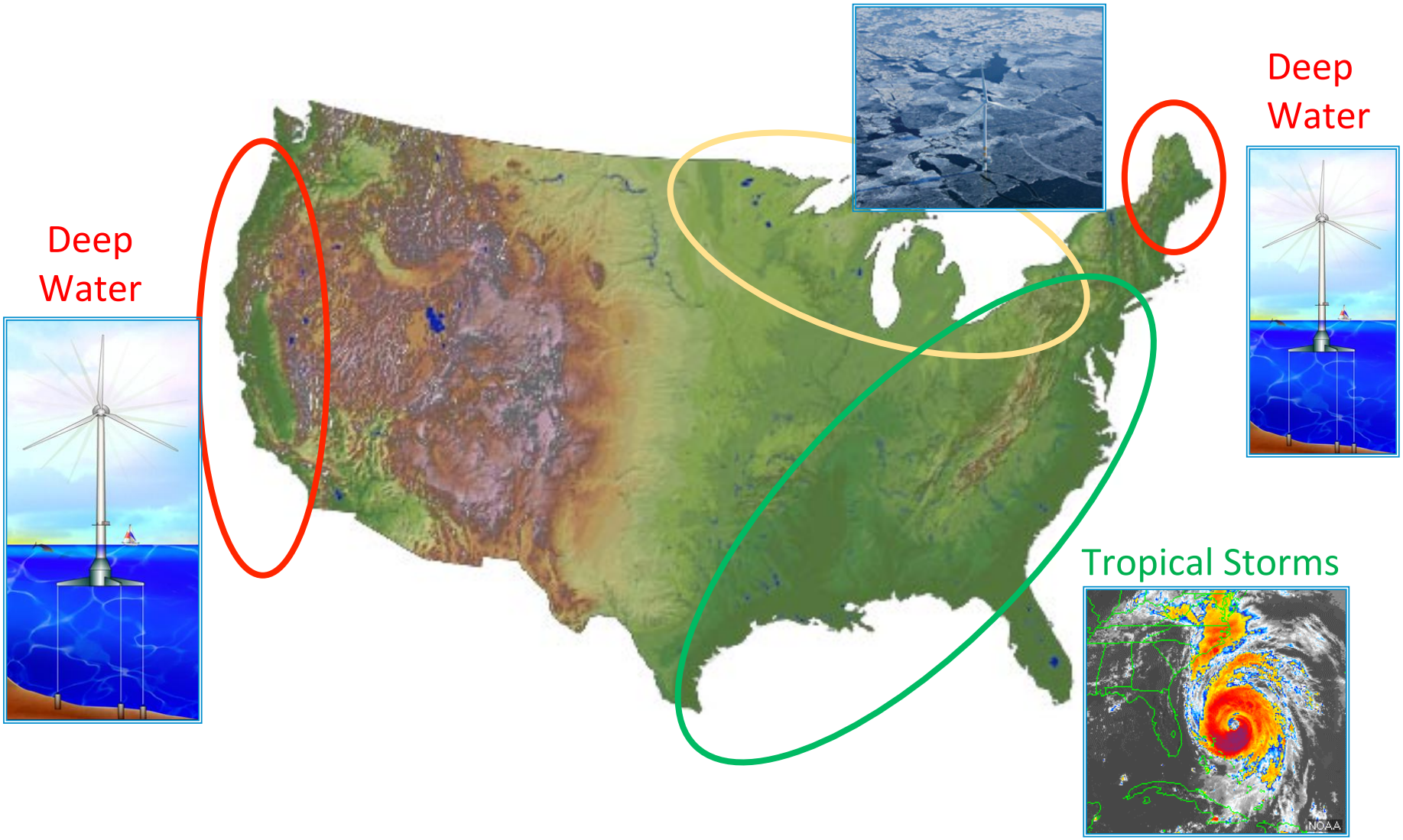


55 million people in NE

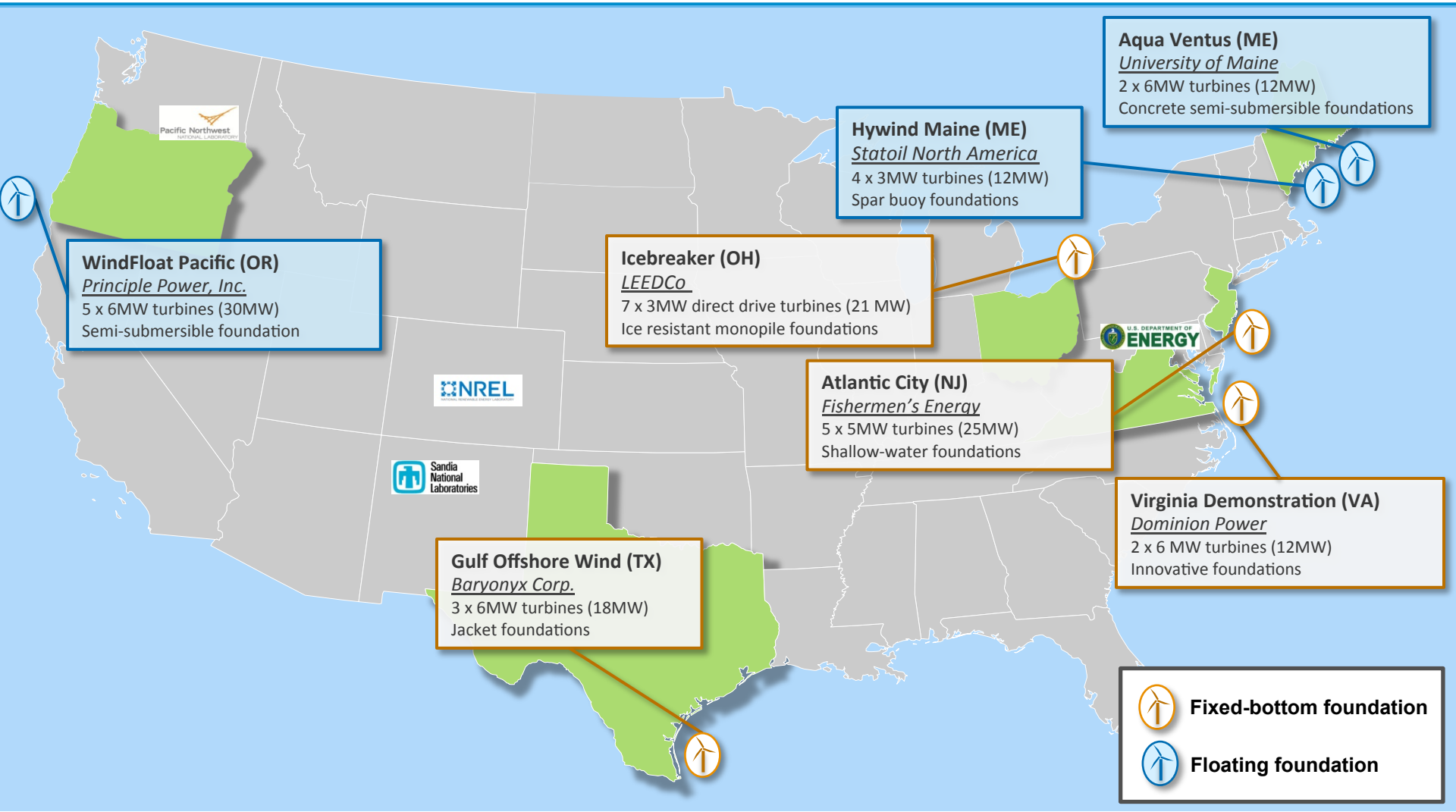
18% of US population

Highest electricity costs

Regional Technology Barriers



DOE FOA 410 Demonstration Projects



DOE's ATD FOAs will bring next generation of technology to U.S

Projects announced in Dec 2012 will receive $4M for initial planning and design phases. Three will be selected to complete the follow-on design and deployment phases by 2017.

GoWind – Baryonyx

Project Highlights:

- Oil & Gas experience and Ormonde wind farm (30 Jacketed REpower 5MW)
- Mix of a power purchase agreement, merchant market sales and an agreement with an industrial user.
- 9-month LIDAR campaign for resource assessment

Innovations:

- Jacket foundation design
- Blimp tethered to buoy for wind measurement

Installation:

- Retrofit an existing jack-up or other vessel

Team Partners:

- Offshore Design Engineering, ODE, Keppel AmFELS

Site Characteristics	
Location	Texas, State Waters
Number of Turbines	3
Turbine	6 MW, Direct Drive
Foundation Type	Jacket
Depth	18 m (54 ft)
Distance from Shore	8 km (5 miles)

VOWTAP - Dominion

Project Highlights:

- Alstom Haliade 150 wind turbine
  - Large LM 73.5-m GloBlade
  - PureTorque system
- Leveraged Carbon Trust Offshore Wind Accelerator (IBGS foundation – Hornsea Metmast)

Innovations:

- Innovative foundation and installation methods
- Offshore-specific wind turbine with advanced control
- Integrated system design for hurricane survivability

Installation:

- Heavy lift vessel

Team Partners:

- DMME, Alstom, NREL, KBR, Virg. Coastal Energy Research Consortium, Newport News Shipbuilding, TETRA TECH

Site Characteristics	
Location	Virginia, Federal Waters
Number of Turbines	2
Turbine	6 MW, PMDD
Foundation Type	Jacket
Depth	?
Distance from Shore	?

Atlantic City Windfarm – Fisherman's Energy

Project Highlights:

- Unique need to balance conflicting goals of key stakeholders (NJBPU and USDOE)
- Demonstrating validity of LIDAR and OSW

Innovations:

- Shallow-water foundations

Team Partners:

- XEMC, Keystone, Mott MacDonald, NREL, Weeks Marine, Marmon Utilities, DCO Energy, ABS

Site Characteristics	
Location	New Jersey, State Waters
Number of Turbines	5
Turbine	Darwind 5MW
Foundation Type	?
Depth	?
Distance from Shore	4.5 km (2.8 miles)

Icebreaker - LEEDCo

Project Highlights:

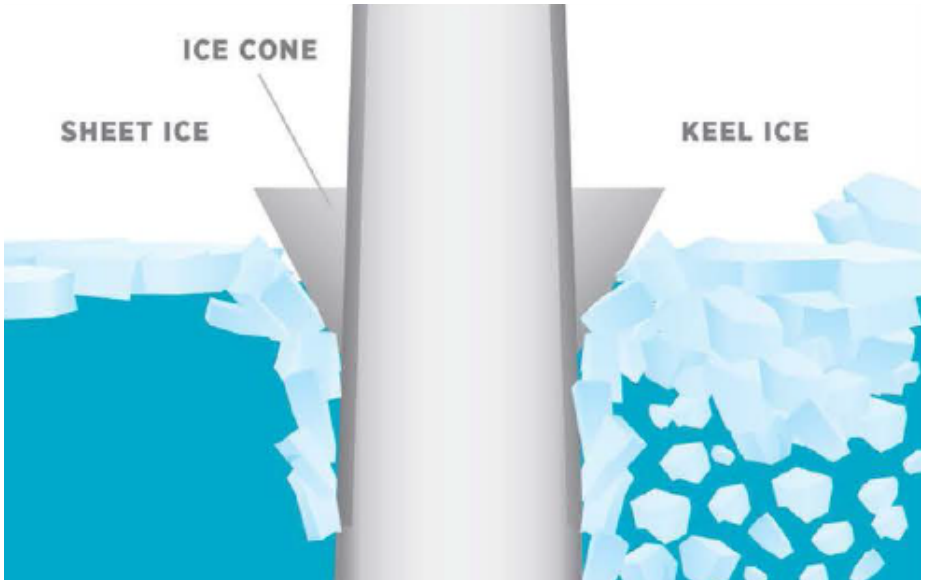
- Adapted from monopile concept well-proven in North Sea
- Designed to withstand harsh winters
- Integrates innovative technology for Lake Erie soil conditions
- Creates an artificial reef

Innovations:

- Design to withstand ice conditions

Team Partners:

- Siemens, DNV GL, Green Giraffe, Ariel Ventures, Freshwater Wind, Bayer Materials, NREL, CWRU, ode, OCC/COWI, Eranti Engineering, GLWN, McMahon DeGulis, Environ, PNNL, PMC



Site Characteristics	
Location	Great Lakes, State Waters
Number of Turbines	6
Turbine	3 MW
Foundation Type	Adapted monopile
Depth	18 m (60 ft)
Distance from Shore	11 km (7 miles)

WindFloat Pacific Project – Principle Power

Project Highlights:

- Project builds off single smaller turbine project off Portugal
- Only project in the Pacific
- Quayside construction and assembly
- Power Purchaser: Jordan Cove

Innovations:

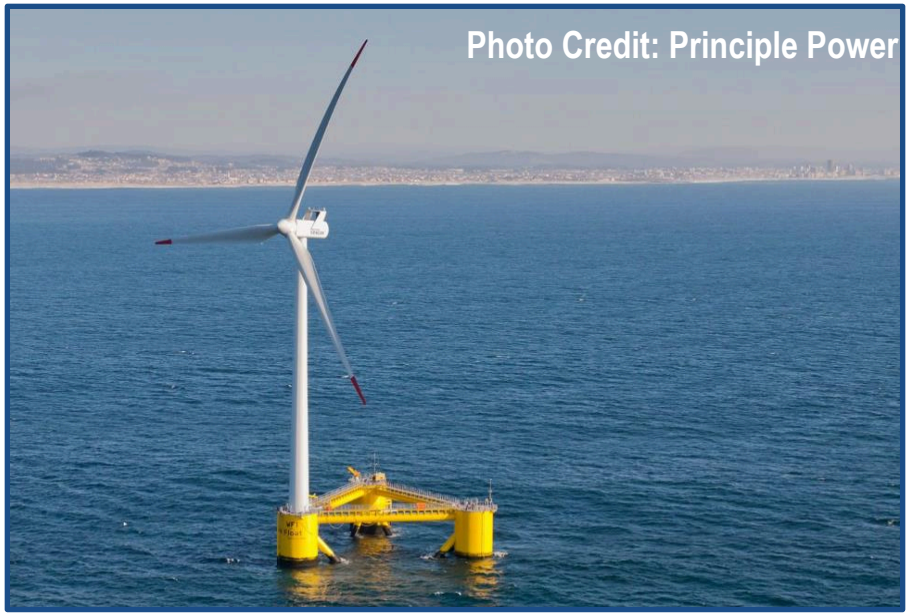
- Floating semi-submersible foundation with moveable ballast
- Virtual MET towers using LIDAR
- Potential for modular construction

Installation:

- Pre-lay of moorings and setting of anchors
- Fully assembled turbine and platform towed to site

Team Partners:

- Houston Offshore Engineering, PNNL, NREL, Jordan Cove Energy



Site Characteristics	
Location	Oregon, Federal Waters
Number of Turbines	5
Turbine	6 MW, Direct Drive
Foundation Type	Floating, Semi-Sub
Depth	365 m (1,200 ft)
Distance from Shore	28 km (17 miles)

Hywind - Statoil

Project Highlights:

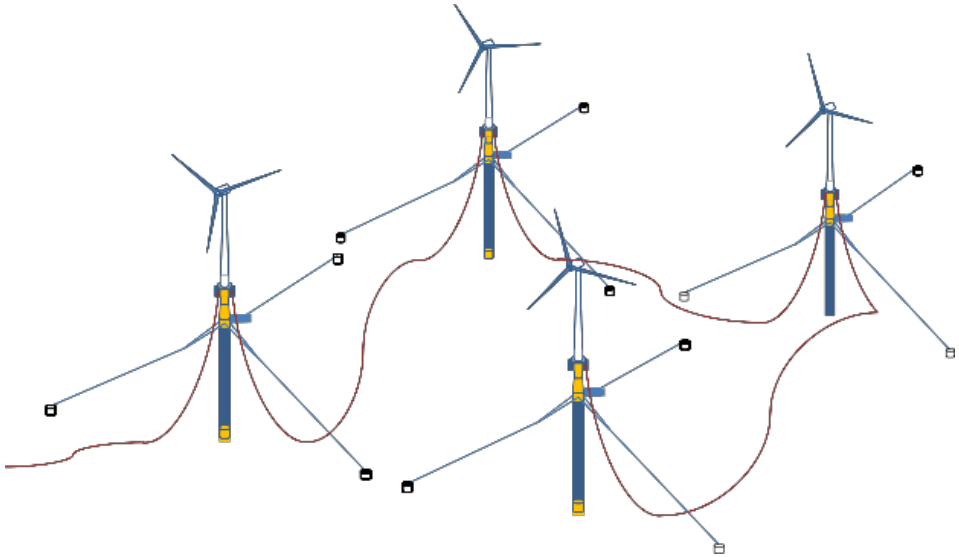
- Project builds off single smaller turbine project off Norway
- Conventional technology, used in a new way
- Beneficial motion characteristics

Innovations:

- Optimized design – larger turbine, lighter substructure with reduced draught
- Blade pitch control to dampen out motion

Installation:

- Simple and safe construction, assembly, and installation



Site Characteristics	
Location	Gulf of Maine, Federal Waters
Number of Turbines	4
Turbine	3 MW
Foundation Type	Floating, Spar
Depth	145 m (475 ft)
Distance from Shore	22 km (14 miles)

Aqua Ventus I – University of Maine

Project Highlights:

- Build upon VolturnUS 1:8 scaled prototype experience
- First installed U.S scaled floating wind turbine

Innovations:

- Concrete semi-submersible
- Composites

Team Partners:

- Iberdrola, Technip, ABS, NREL, FYLIN, AWS Truepower, CIANBRO, University of Massachusetts, Maine Maritime Academy, ERSHINGS, Goldwind, Senergy, HDR/DTA

Site Characteristics	
Location	Maine, State Waters
Number of Turbines	2
Turbine	6 MW, Direct Drive
Foundation Type	Floating, Semi-Sub
Depth	?
Distance from Shore	?

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Thank You for Your Attention

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