

# **Virginia Offshore Wind Technology Advancement Project**

**Virginia Task Force Meeting  
September 22, 2016**

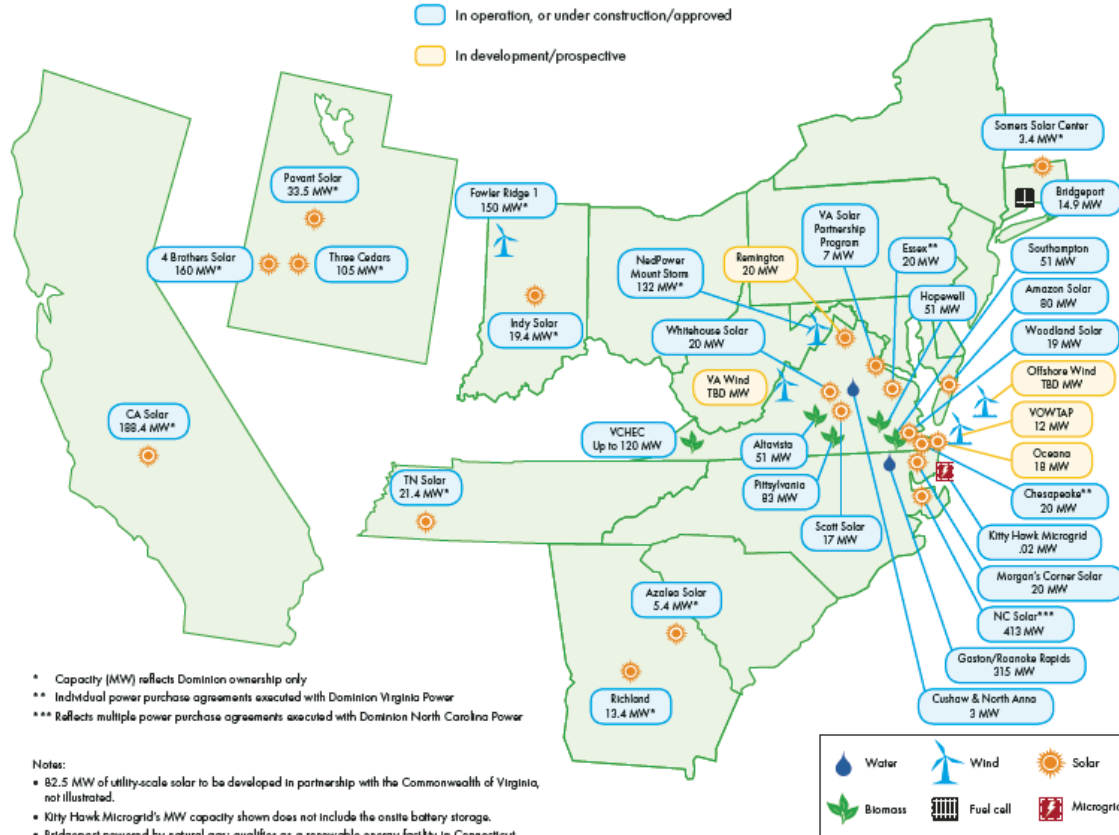
# Agenda

## ☐ Introductions

## ☐ Project Overview & Update

- Virginia offshore wind background and accomplishments
- VOWTAP project specifics

# Dominion's Commitment to Renewable Energy



# Dominion's Offshore Wind Energy Program



**BOEM Virginia  
Wind Energy Area  
Auction**  
Dominion is  
successful bidder

**VOWDA:**  
Established by Governor  
to facilitate the  
development of offshore  
wind energy industry,  
projects and vendors

**March**  
VOWTAP request  
for proposals  
received

**November**  
Multiple  
RFPs reissued

**May**  
RFP results

**June**  
DOE funding  
change

2011

2012

2013

2014

2015

2016

**VOWCRIS:**  
Virginia Offshore Wind  
Cost Reduction through  
Innovation Study

**VOWTAP BP 1 (7 Selected)**  
Phase 1 DOE Cost Share Award:  

- 50% FEED
- Conceptual planning and estimate
  - EPC /Installation
  - O&M
- Environmental studies
- Permitting activity

**VOWTAP BP2 (3 Selected)**  
Phase 2 DOE Cost Share Award:  

- 100% FEED
- EPC Request for Proposals
- Revised planning and estimates
  - EPC /Installation
  - O&M
- Geotech and Metocean studies
- Permitting activity

**June**  
Stakeholder  
Process Kickoff

**October**  
VOWDA Report



# Project Background

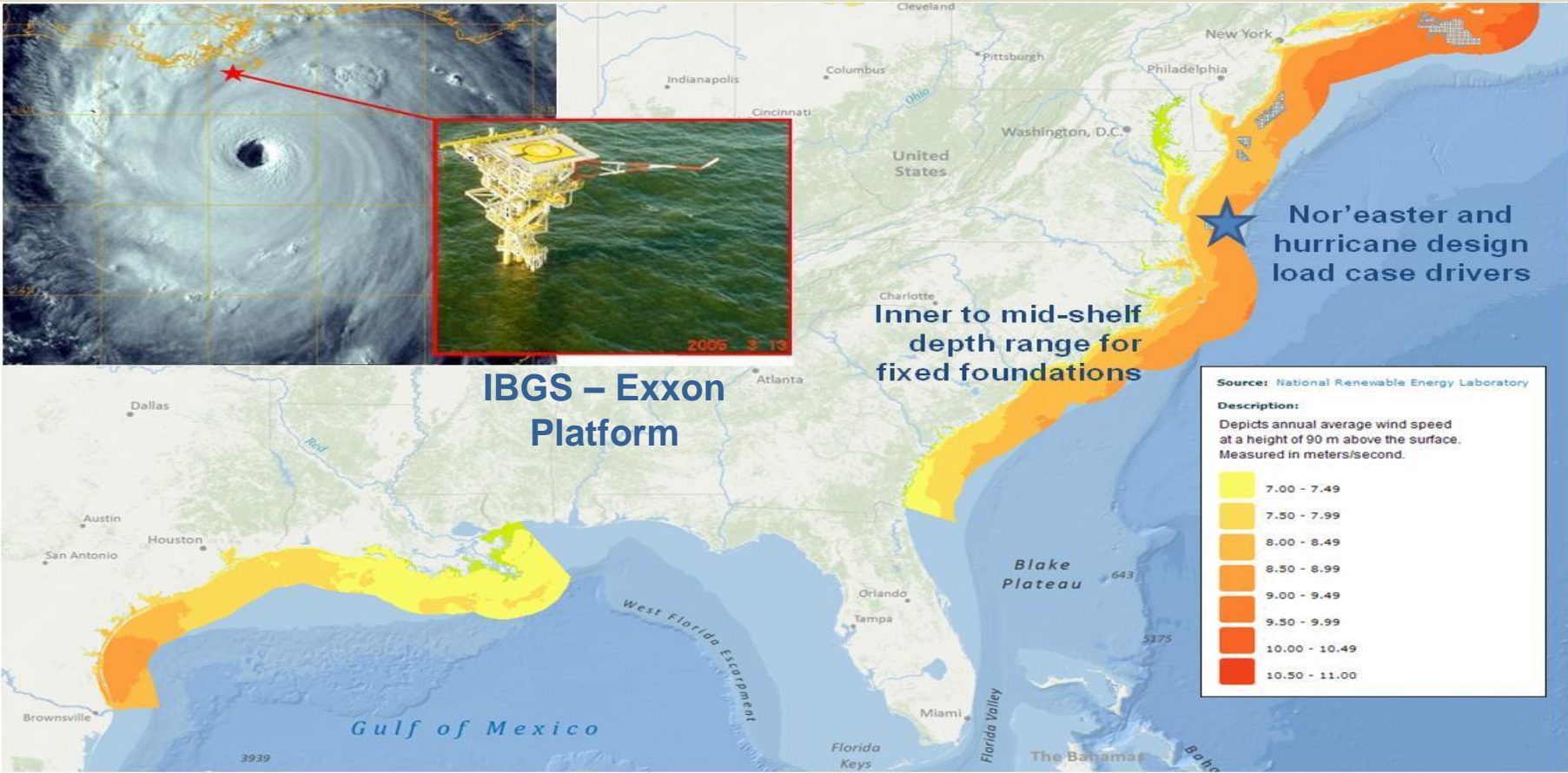
- ❑ In 2013, DOE selected 7 projects for initial engineering and environmental surveys
  - \$4 million per project
- ❑ In 2014, DOE selected 3 projects, including VOWTAP, for final design and construction
  - Up to \$47 million per project
- ❑ In 2015, DOE provided all 3 projects a one year no cost time extension for BP2 to May 31, 2016
- ❑ In May 2016, DOE withdrew further funding after Dominion decided to file for CPCN extending COD by up to 2 years.



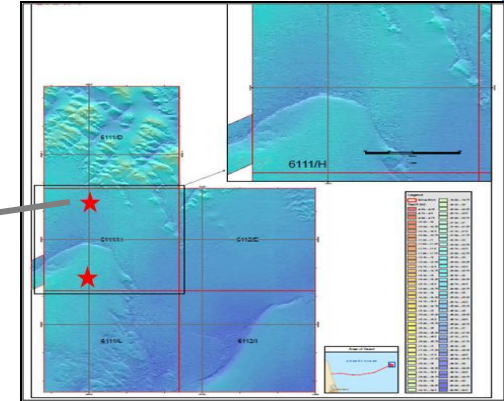
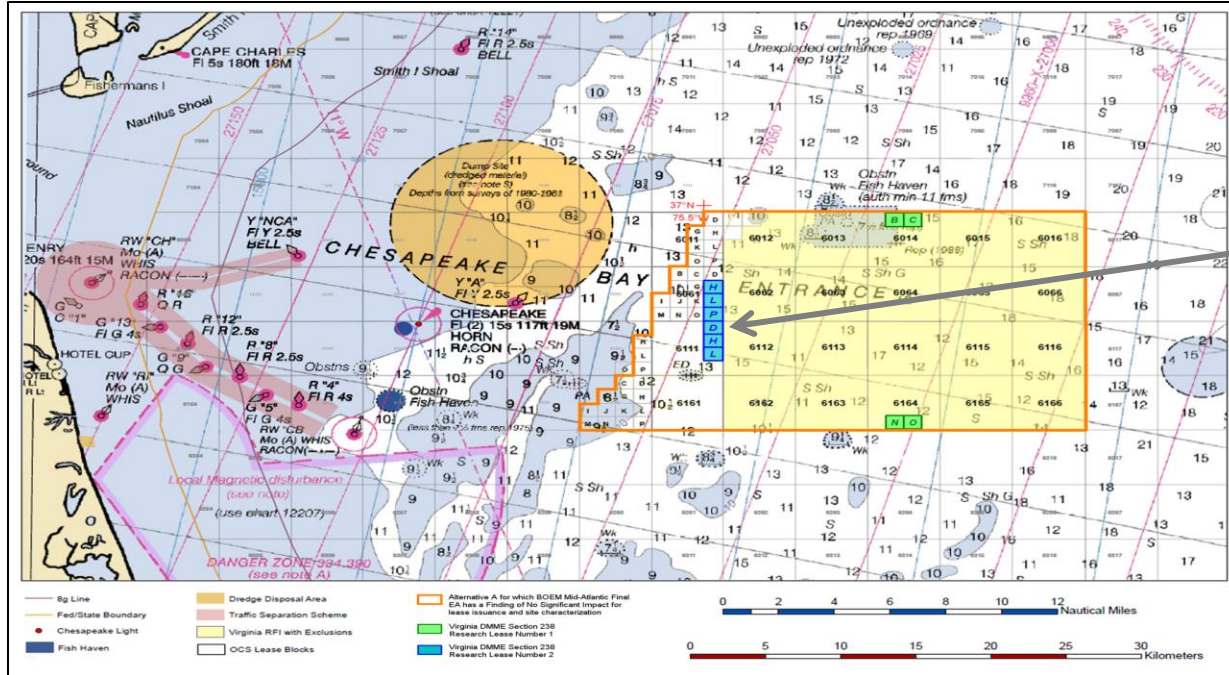
# VOWTAP Goals & Objectives

- ❑ Reduce the cost of offshore wind energy
  - Crucial First Step Toward Commercial-Scale Development
  
- ❑ Maintain commitment to safety
  - Shared commitment and excellent record among team members
  
- ❑ Advance the state of the art
  - Hurricane-resilient design
  - Highly instrumented to quantify performance
  
- ❑ Reduce deployment timelines and uncertainties
  - BOEM leasing and approval process
  - Permitting (Federal, State and Local)

# Paving the Way for Offshore Wind on Hurricane-Prone Outer Continental Shelf



# Project Informs Commercial Development



**Commercial Lease  
executed with a  
November 1, 2013  
Effective Date**

**Project site directly adjacent to Dominion's Commercial Wind  
Energy Area**



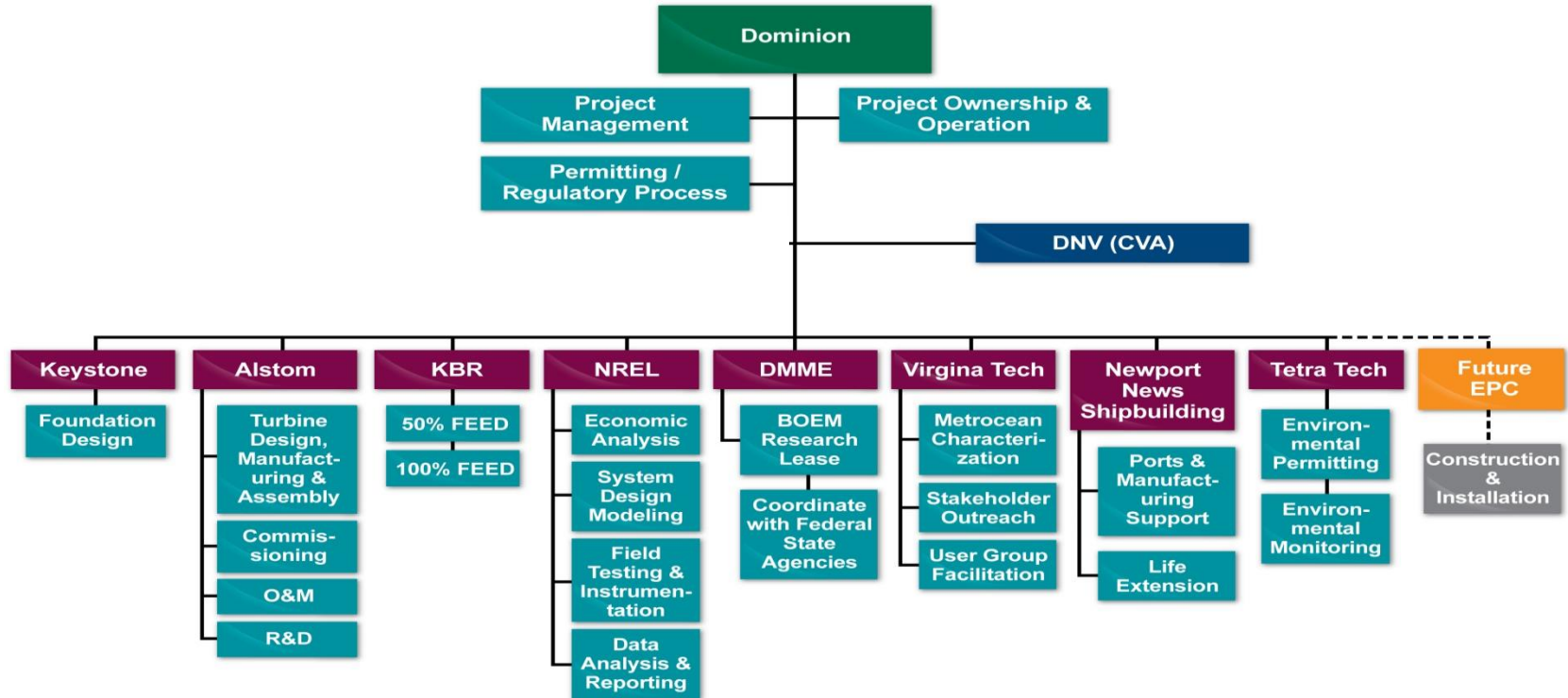
# VOWTAP

## Convened Industry-Led Team

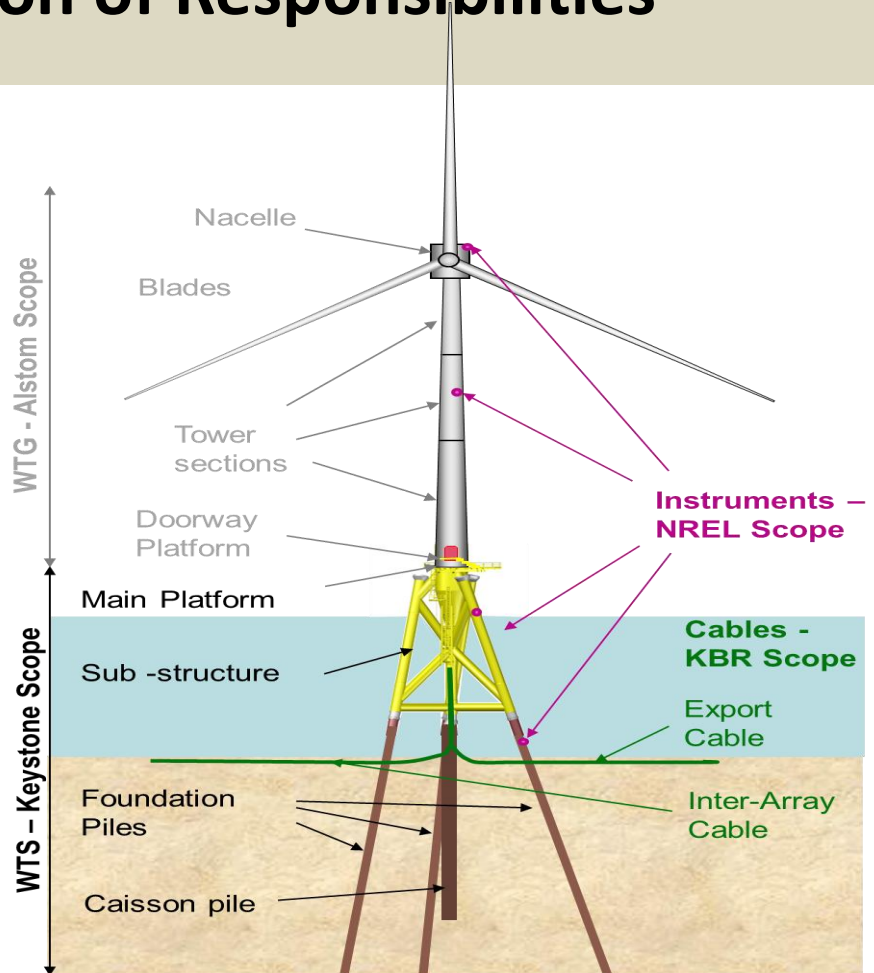
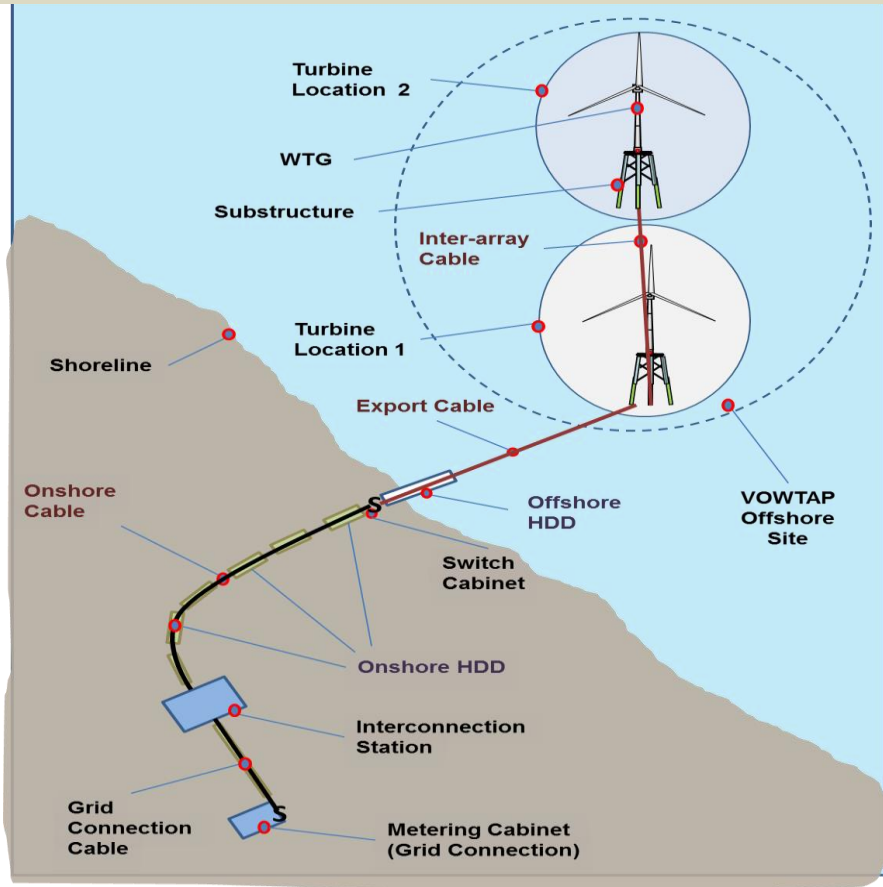


Top left, clockwise: Met tower on Keystone jacket, Beatrice Wind Farm (KBR), Alstom Belwind turbine, Dominion NedPower project

# International Project Team of Subject Matter Experts

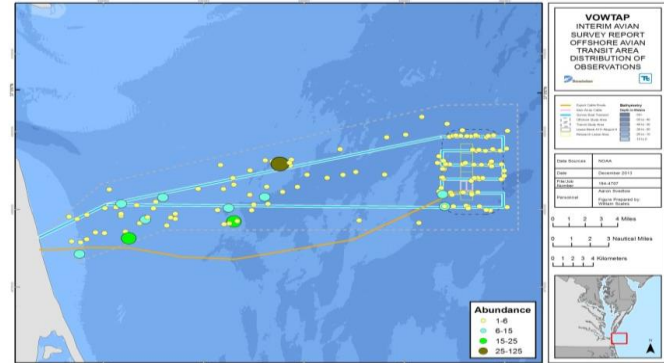


# General Layout – Division of Responsibilities



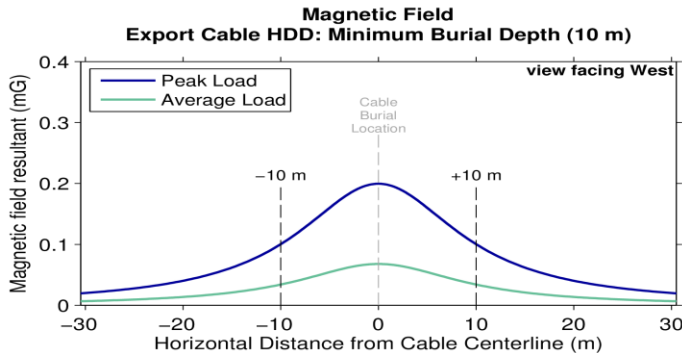
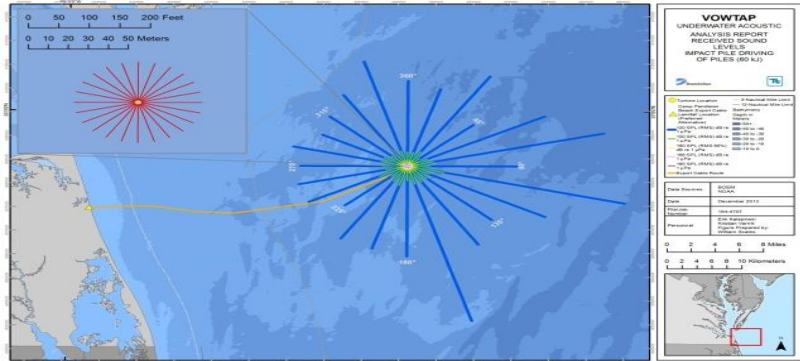
# Environmental and Site Characterization Surveys & Studies

- Terrestrial Archaeology Survey
- Visual Impact Assessment
- Historic Structures Survey
- Avian Surveys (ship-based and onshore point counts)
- Onshore Wetland and Waterbody Surveys



# Environmental and Site Characterization Surveys & Studies

- In Air and Underwater Acoustic Analysis
- Air Emissions Analysis
- Aviation Assessment
- EMF Analysis
- Fisheries Assessment
- Marine Mammal and Sea Turtle Assessment
- Navigational Risk Assessment
- Sediment Transport Analysis
- Threatened and Endangered Species Assessment



# Environmental and Permitting

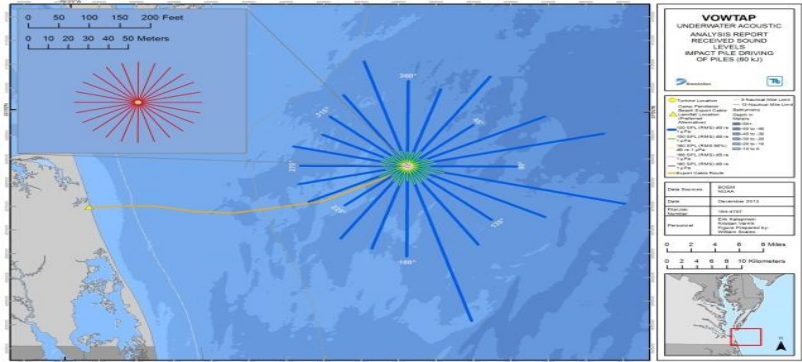
Permit/Consultation Title	Agency	Purpose	Filed	Anticipated Approval/ Completion Date
Virginia Water Protection Permit	VDEQ	Pursuant to Section 401 of the CWA, 9 VAC 25-660 et seq.	Dominion filed the Joint Permit Application (JPA) on 7/2/2014	Confirmation of no permit required received from DEQ 05/27/15
Submerged Lands Permit	VMRC	Pursuant to Code of Virginia § 28.2-1200 through 28.2-1213, 4 VAC 20	Dominion filed the JPA on 7/2/2014	Received Draft permit 03/30/15 - payment for the VMRC permit has been put on hold pending the outcome of stakeholder outreach.
Individual Permit	USACE	Pursuant to Section 404 CWA and Section 10 Rivers and Harbors Act	Dominion filed the JPA on 7/2/2014	404 Individual Permit issued 12/04/2014
Incidental Take Authorization (IHA)	NOAA NMFS	Pursuant to MMPA	Dominion to file Application for Incidental Take Authorization Q4 2015	Q4 2016, pending stakeholder process
PATON and LNM	USCG	Pursuant to 33 CFR 66	Dominion to file Private Aids to Navigation Application and Local Notice to Mariners Request 4 months prior to Construction	3 weeks prior to construction
OCS Air Permit	VDEQ	Pursuant to 40 CFR Part 55, VDEQ 9 VAC 5-80 et seq.	Dominion filed the OCS Air Permit Application on 10/8/2014	Q4 2015, pending stakeholder process
Construction Stormwater General Permit	VDEQ	Pursuant to VAR10, 9 VAC 25-880	Dominion to file Construction Stormwater General Permit Application Q3 2016	Q1 2017, pending stakeholder process
Section 7 Consultation	USFWS	50 CFR 402 Section 7 of the Endangered Species Act (ESA)	N/A	Section 7 consultation completed. Final EA/FONSI issued by BOEM on 07/22/2015
Section 106 Consultation	VDHR, Native American Tribes	Section 106 of the National Historic Preservation Act (NHPA)		Section 106 consultation completed. Finding of No Adverse Effect issued by BOEM on 04/06/2015.

# Broad Outreach and Evaluation to Optimize VOWTAP



# Environmental and Site Characterization Surveys & Studies

- In Air and Underwater Acoustic Analysis
- Air Emissions Analysis
- Aviation Assessment
- EMF Analysis
- Fisheries Assessment
- Marine Mammal and Sea Turtle Assessment
- Navigational Risk Assessment
- Sediment Transport Analysis
- Threatened and Endangered Species Assessment







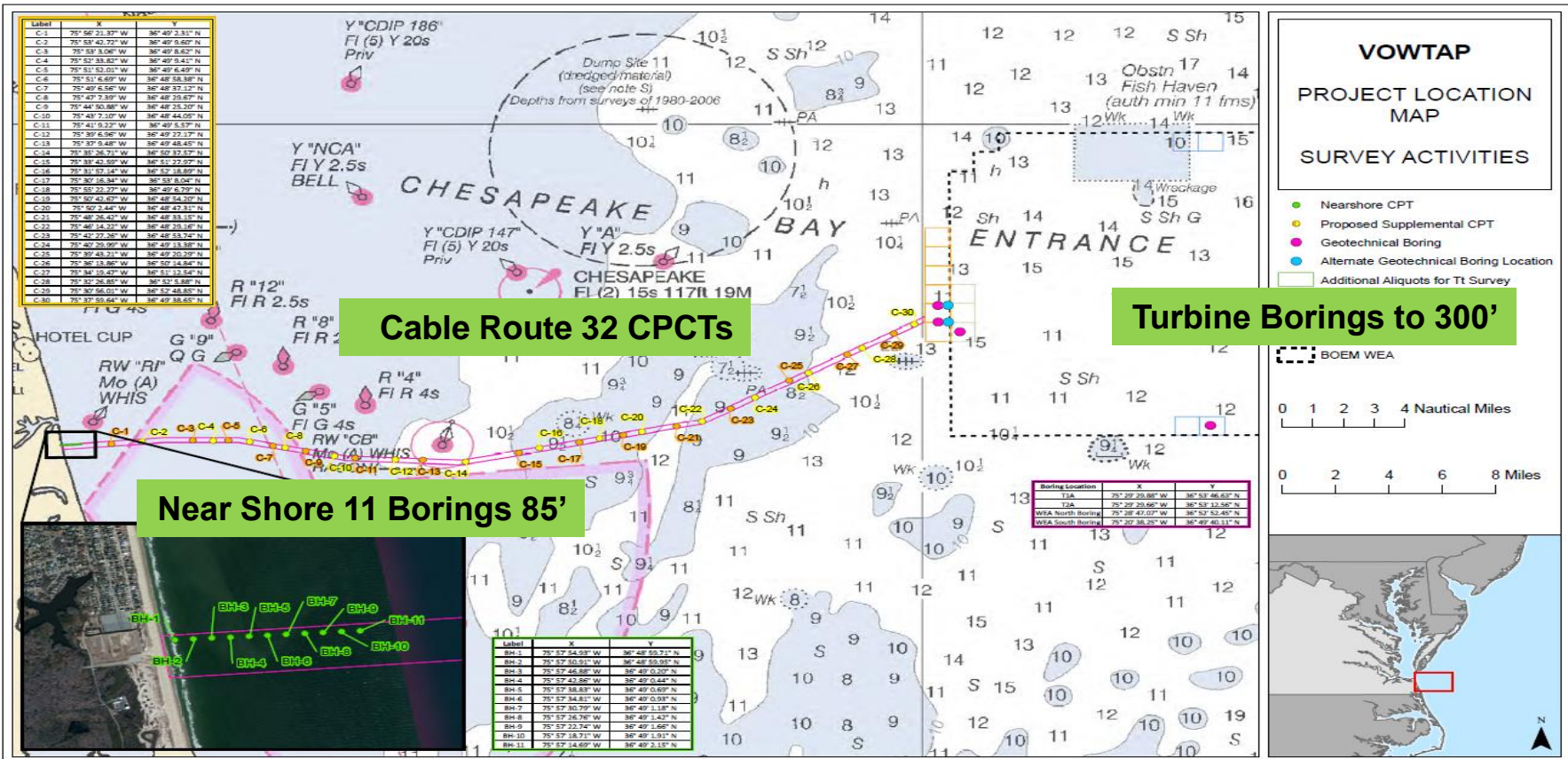
# Geotechnical Investigation Required to Design Offshore Foundations

- ❑ Turbine Site
  - 4 borings (300' deep)
  
- ❑ Distribution Cable Corridor
  - 32 Pressure Tests (15' deep)
  
- ❑ Near Shore
  - 11 borings (85' deep)
  
- ❑ Onshore
  - 3 borings ([1] 80' and [2] 15' deep)
  - 6 test pits (7' deep)

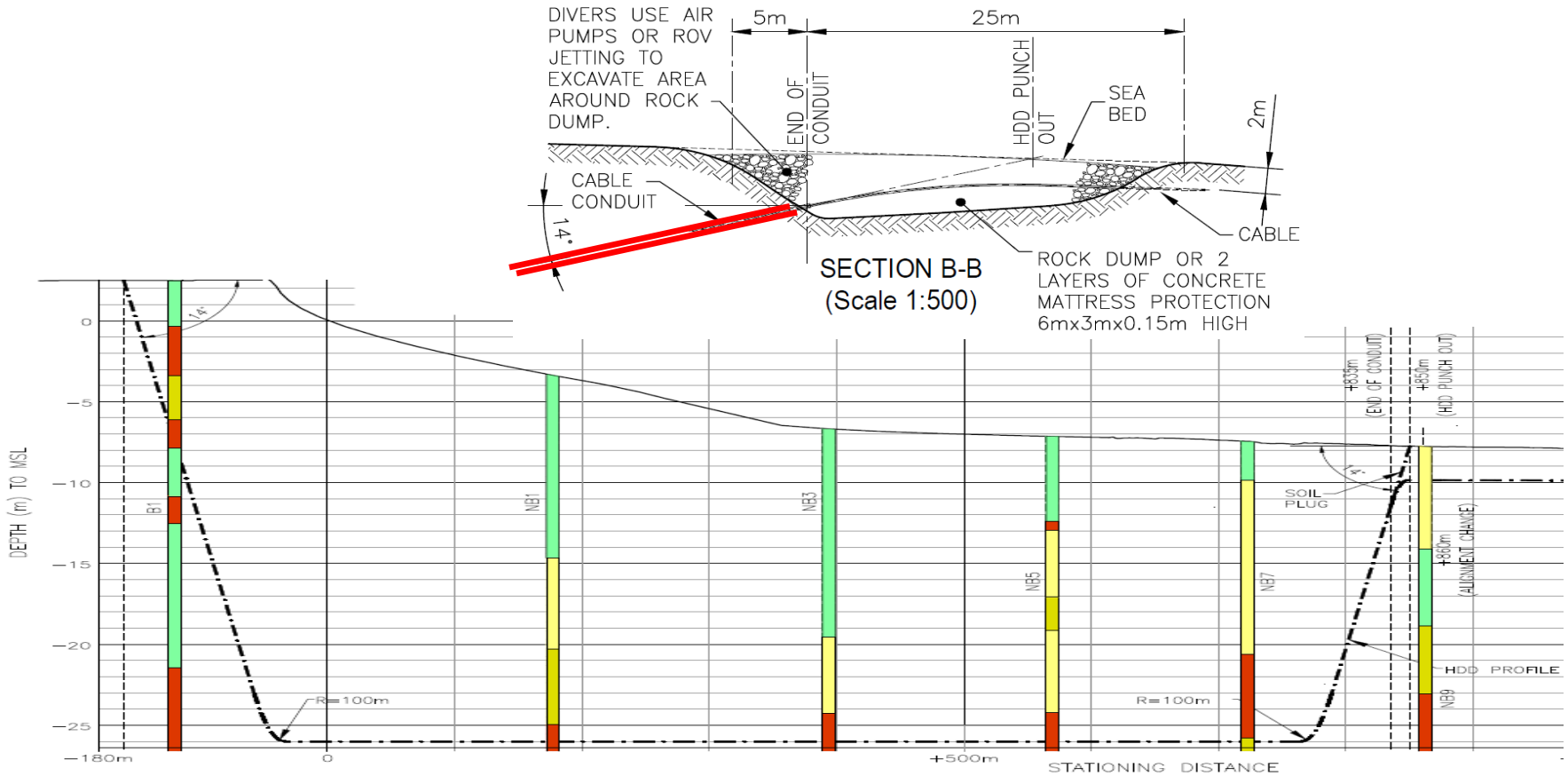


# VOWTAP

## Offshore Geotechnical Investigation – July 2014



# Cable pull-in

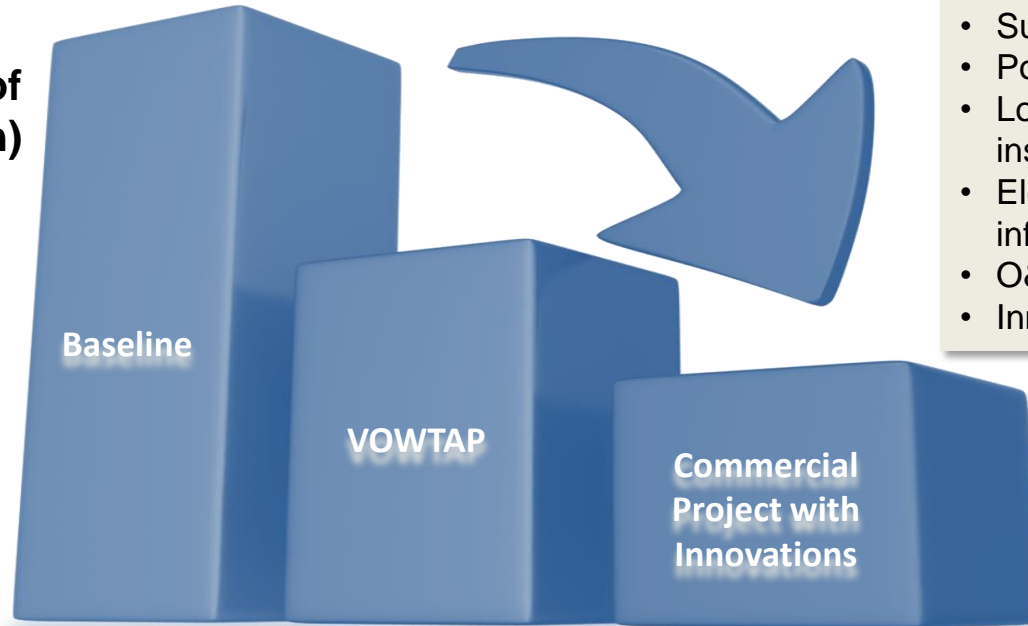


# BOEM- Permitting

Application	Date of Completion/Forecast
Research Activities Plan (RAP)	Initial RAP Submittal – December 2013 Final EA - July 2015 BOEM approved FONSI – July 2015 RAP Approval - March 2016
Site Assessment Plan (SAP)	SAP Submitted February 2014 Received BOEM comments June 2015 Responded to BOEM comments August 2015 Final Comments Accepted – Q1 2016

# Levelized Cost of Energy Cost Reduction Opportunities

Levelized Cost of  
Energy (\$/kWh)

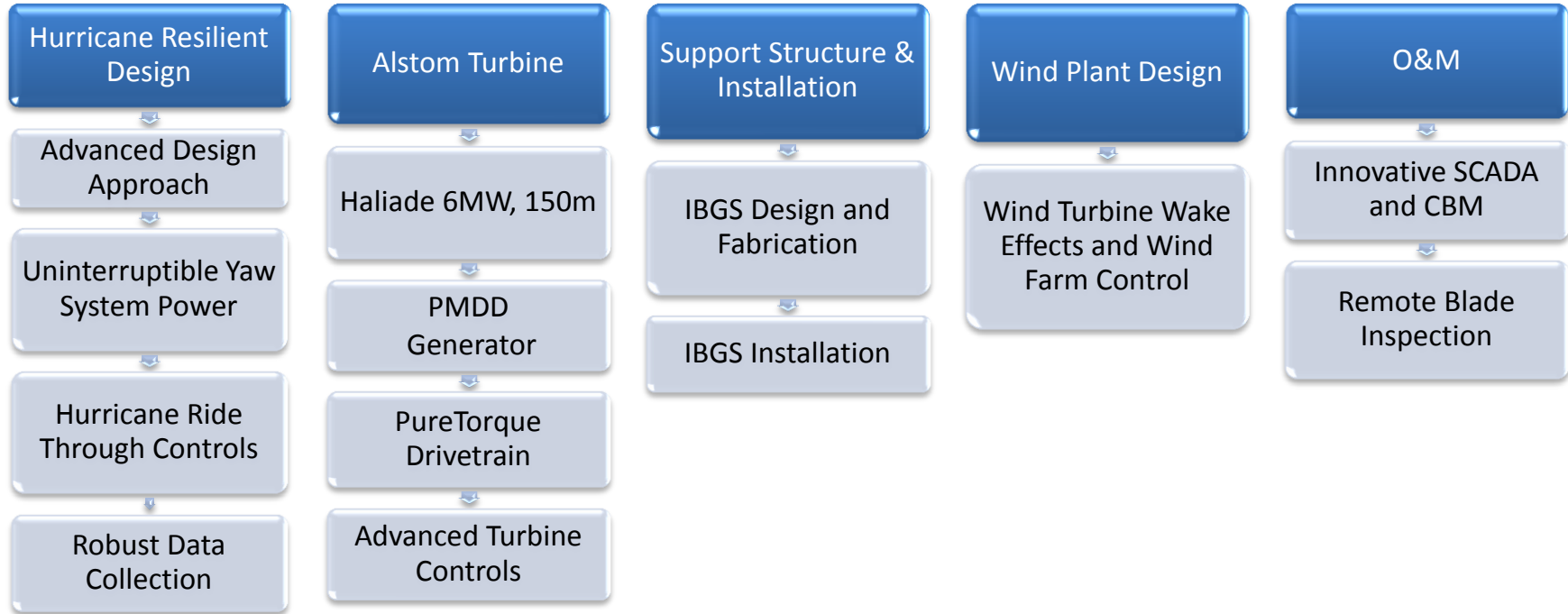


- Turbine
- Project management
- Support structure
- Ports & Staging
- Logistics & installation
- Electrical infrastructure
- O&M cost
- Innovative controls

Depiction not to scale.

# **VOWTAP Innovations and Accomplishments**

# Innovations to Advance the State of the Art and Reduce Levelized Cost of Energy





# Hurricane Resilient Design Features

North Wind Turbine



6 MW ALSTOM  
Haliade 150  
Offshore Wind Turbine  
(South Turbine)

Continuous  
yaw and  
control  
authority

Rugged high velocity sonic anemometer and  
redundant controls



135 kW diesel generators for uninterruptable  
yaw system power

Keystone IBGS  
Jacket Foundation

Substructure design  
to meet API RP 2A  
Hurricane Design  
Standards

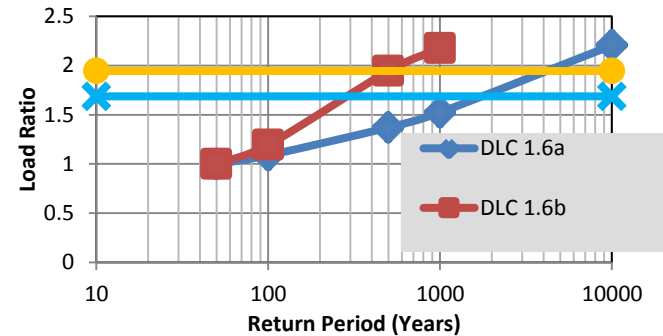
# Offshore Projects Have Complex Basis of Design (BOD)

- ❑ Design Basis Documents, Studies and Design Briefs:
  - Basis of Design Task
    - Site Conditions and General Requirements BOD (Metocean, Hurricane, Scour, Breaking Wave Studies)
    - Substructure and Foundation BOD
    - Cable Structural BOD
    - Electrical BOD
    - On Shore Civil BOD
    - Wind Turbine BOD including Design Load Cases
  - Coupled Loads Analysis (CLA) Model Calibration Methodology
  - CLA Model Calibration Report
  - Marine Growth and Load Assessment Report
  - Finite Element Model (FEM)
  - Seabed Mobility and Cable Burial Risk Assessment



# Hurricane Resilience Required Advanced Modeling to Demonstrate Design Adequacy

- ☐ Coupled Loads Analysis
  - Two loop iteration complete
    - Aerodynamics, Hydrodynamics, Controls, Structural Dynamics
  - Final design model complete
  
- ☐ Electrical Design
  - All electrical studies completed for grounding, load flow & short circuit, harmonics stability and electrical system dynamic study
  - All single-line diagrams issued
  - All on shore/ off shore electrical load lists issued
  - Commissioning plan issued



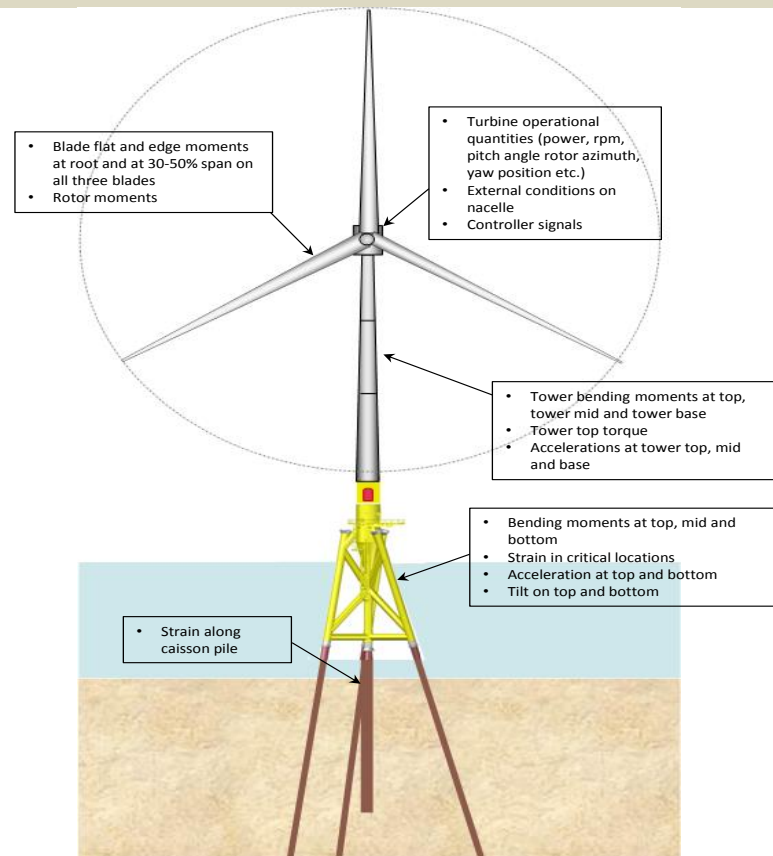
SACS Model



Bladed Model

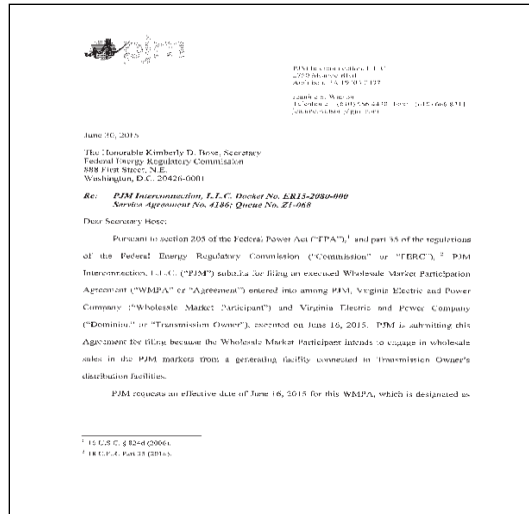
# Data Measurement and Testing Plan will Validate VOWTAP Innovations

- VOWTAP will establish a database of structural and environmental measurements that will:
  - Validate the dynamic design loads acting on the coupled system.
  - Characterize extreme and fatigue loads.
  - Provide high-quality data for the validation of modeling and design tools.
  - Inform certification rules and offshore wind design standards.
  - Characterize the environmental conditions.
  - Provide the first measurements of a wind turbine's response in an actual hurricane.



# Grid Interconnection

- ✓ The System Impact Study and Interconnect Service Agreement (ISA) are complete. Dominion has signed and received co-signed Interconnection Agreement (6/11/15).
- ✓ The Wholesale Market Participation Agreement (WMPA) has been signed by Dominion's executive on 6/1/15. Final PJM co-sign received 6/16/15.



IN WITNESS WHEREOF, Transmission Provider, Wholesale Market Participant and Transmission Owner have caused this WMPA to be executed by their respective authorized officials.

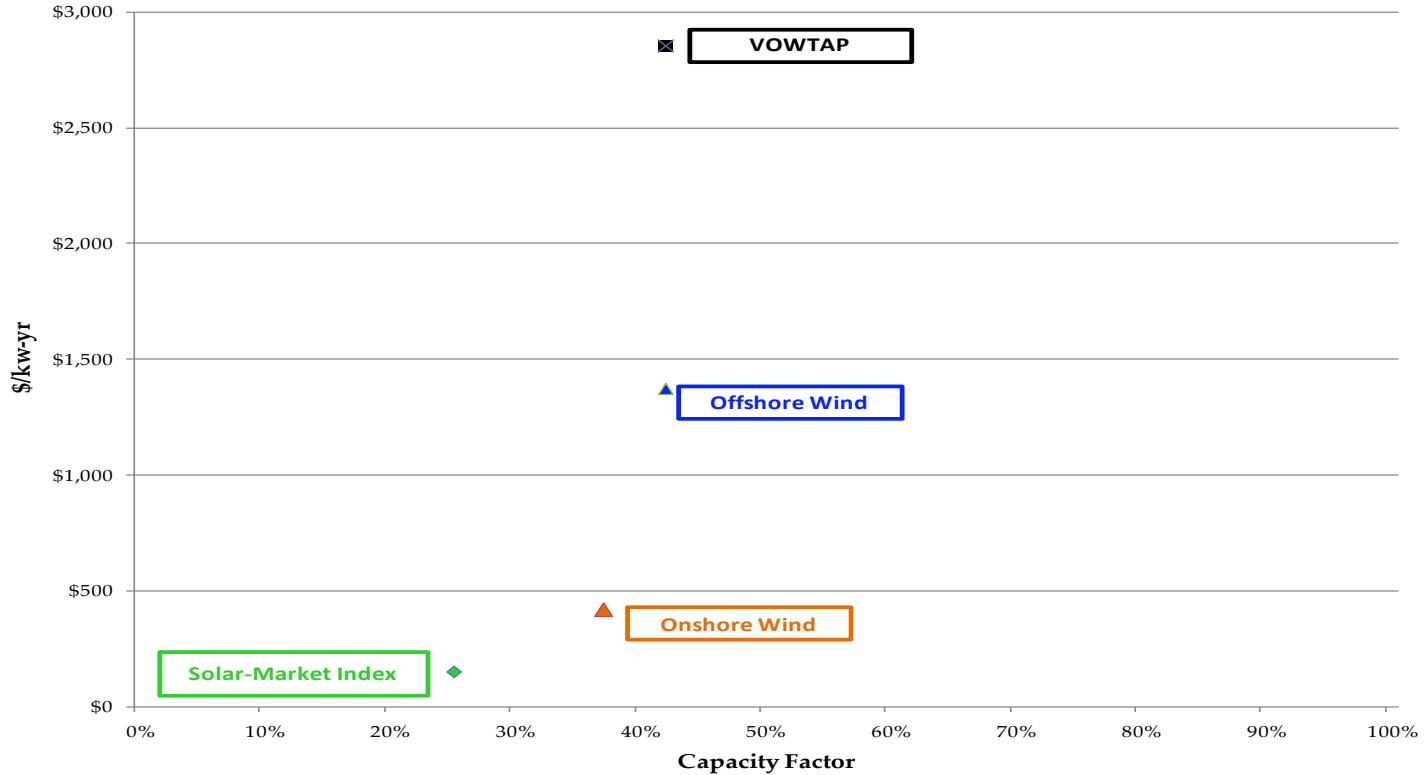
(PJM Queue #Z1-069)

Transmission Provider: PJM Interconnection, L.L.C.  
By: David M. Egan **Manager, Interconnection Planning** 6/16/15  
Name Title Date  
Printed name of signer: \_\_\_\_\_

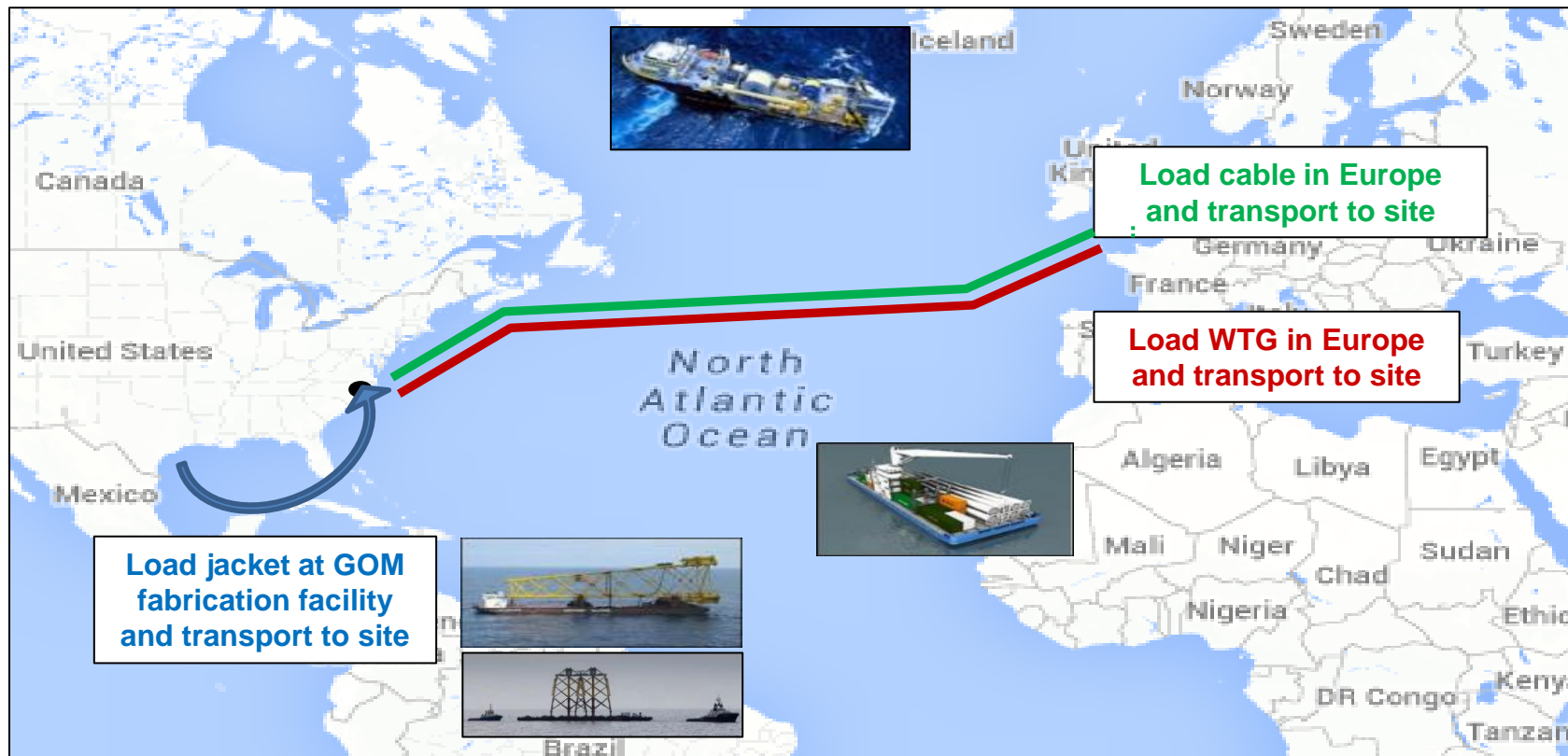
Wholesale Market Participant: Virginia Electric and Power Company  
By: Blaise D. Mitchell **Vice President, Connection Coordination** 6/16/2015  
Name Title Date  
Printed name of signer: Blaise D. Mitchell

Transmission Owner: Virginia Electric and Power Company  
By: Keneth Baiker **VP, Tech. Sales** 6-11-15  
Name Title Date  
Printed name of signer: Keneth Baiker

# Non-Dispatchable Levelized Busbar Costs (2022 COD) From 2016 IRP

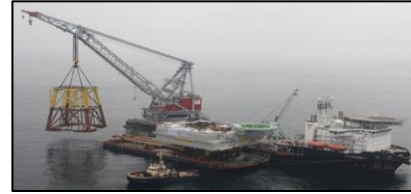


# Supply Chain and Installation Vessels Present Challenging Global Logistics



# Installation – Construction Sequence

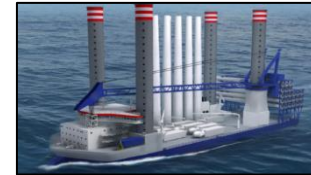
Foundations



Cables



Tower and turbine



Construction completion & commissioning





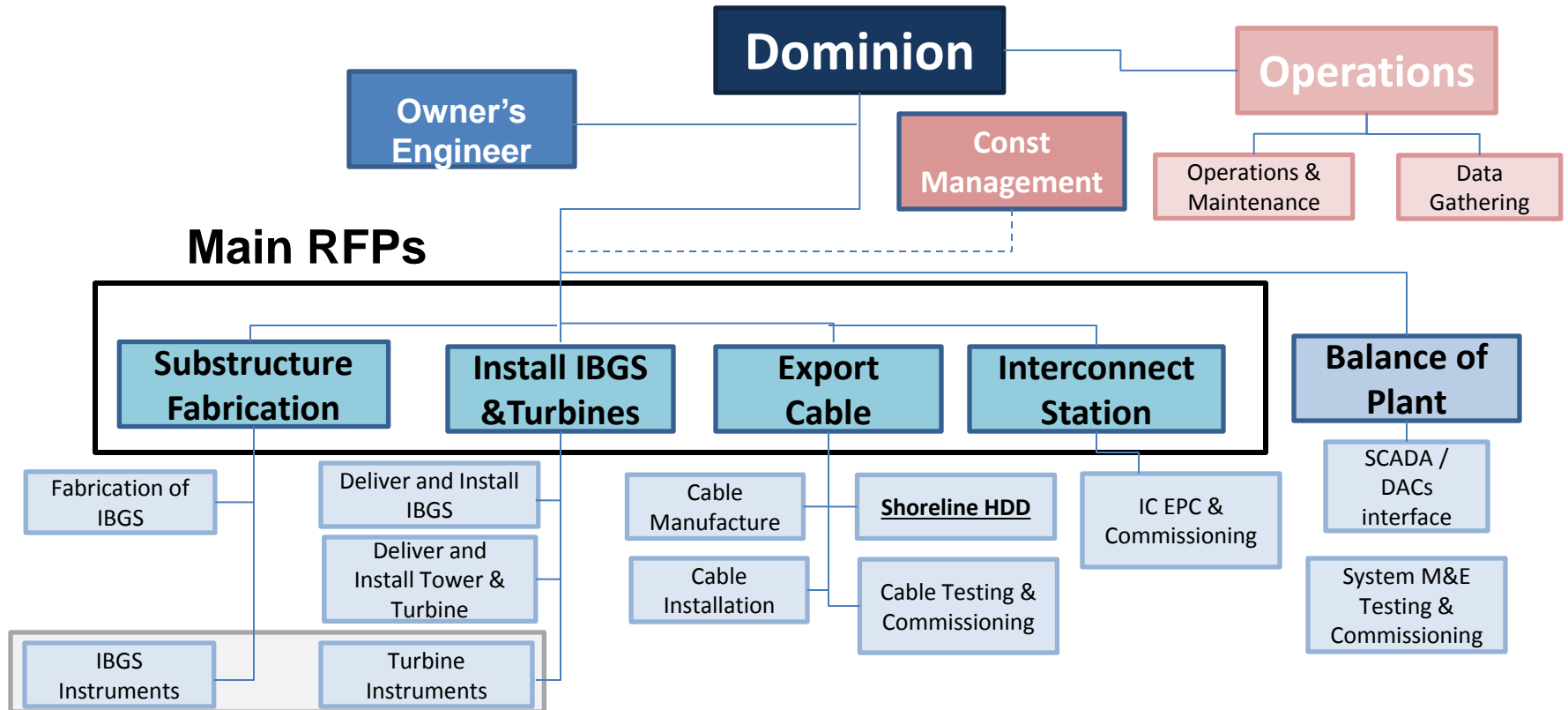
# Stakeholder Input Process

- ❑ **Over 80 participants including**
  - Industry experts
  - Engineers
  - Academicians
  - Environmental and renewable energy advocates
  - Regulatory and oversight agencies
  
- ❑ **Divided into cohorts based on expertise**
  
- ❑ **Mark Rubin served as facilitator**

# Invited Participants

A2 SEA	DONG Energy	Kerr Strategies	Piedmont Environmental Council	The Business Network for Offshore Wind
Alstom	EDF Renewables	Keystone	PMSS	The Port of Virginia
Apex	EEL	Kiewit	PNNL	The Renewables Consulting Group
AWEA	Environment Virginia	LeedCo	Prysmian	Timmons Group
Bacon's Rebellion	EPRI	Lt. Governor's Office	Rep. Randy Forbes (R-4th)	TWIN Brothers Marine
BOEM	Fluor	Maine Ocean Wind and Industry Initiative	Rep. Scott Rigell (R-2nd)	U.S. Offshore Wind Collaborative
BVG Associates	Fred Olsen	Mass Clean Energy Center	RES Americas	University of Delaware - Special Initiative on Offshore Wind
Camp Pendleton	Fugro Consultants	Moffatt & Nichol	RI Office of Energy Resources	US Wind Maryland
Center for Innovative Technology	GDS Associates	National Wildlife Federation	RI Public Utilities Commission	VA Chamber of Commerce
Chesapeake Climate Action Network	Georgia Public Service Commission	Navy	Richmond Times-Dispatch	VA Tech
Clean Energy States Alliance	German Offshore Wind Energy Foundation	NC Dept. of Environment & Natural Resources	Saipem	VCFUR Representative
Coast Guard 5th District Portsmouth	Governor's Office	NC Utilities Commission	Santee Cooper	Virginia Advanced Energy Industries Coalition
Colonna's Shipyard	Green Sail/Arcadia Wind	Newport News Shipbuilding	SCC	Virginia Beach Economic Development
Conservation Law Foundation	GULF Island	Nexans	SELC	Virginia Conservation Network
Consulate General of Denmark	Hampton Roads Econ Dev. Alliance	NRDC	Senator Mark Warner	Virginia League of Conservation Voters
DE Shaw & Co.	HII-NNS	NREL	Senator Tim Kaine	VMRC
Delegate Charniele Herring	Iberdrola/Scottish Power	Oceana	SEWC	VOW
Delegate Mark Sickles	Interested Party	ODEC	Sierra Club	VOWDA
Department of Military Affairs	James Madison University	Office of the Attorney General	Sound & Sea Technology	Weeks Marine
DMME	JDR Cable Systems Ltd	Offshore Design Engineering, Ltd.	Southern Alliance for Clean Energy	Wind Energy Foundation
DNV GL	K2 Management	Offshoreenergy DK	Statoil	
DOE	KBR	Paragon Asset Group	Tetra Tech	

# Multiple Contracts Proposal Strategy



# 2016 Multi Contract RFP Results

- ❑ New RFP process based on Stakeholder Recommendation – breakout into multiple packages vs. single EPC Project Scope
  - Marine supply
    - Six bidders – only one conforming bid received
    - Significant delta between one conforming bid & one indicative bid (5x difference)
  - Cable Supply / Install
    - Four bidders – only one bid received
    - Bid in line with project estimates
  - IGBS Fabrication
    - Six bidders
    - Four conforming Bids
    - Competitive results –in line with estimate
  - On Shore Electrical
    - Six Bidders
    - One Bid Received
  
- ❑ High Level Results (before DOE funding and tax benefit)
  - Prior estimate reduced from ~\$400M to ~ \$300M using low marine estimate
  - Using high marine estimate ~\$370M



# Industry Contributions

## □ Design

- The VOWTAP’s results in the area of hurricane-resilient design will also expand the future development potential of offshore wind into the hurricane-prone regions of the mid- and south Atlantic and Gulf of Mexico.
- Data collected during the course of surveys, studies and analysis not only supported permit acquisition and engineering design, but provide a baseline of information that characterizes the environmental and loading conditions within the Virginia WEA that can be utilized for future commercial offshore wind development. Some of the surveys and studies conducted in support of the VOWTAP that will inform future offshore wind development in the U.S. include:
  - Hurricane Studies;
  - Breaking Waves Studies;
  - Seabed Mobility Studies,
  - Scour Assessment Study;
  - Metocean Conditions Studies;
  - Geotechnical Campaign Surveys; and
  - Laboratory Analysis.

# Industry Contributions

## ❑ Environmental

- BOEM issued the first Wind Energy Research Lease in Federal Waters to DMME for the VOWTAP, making it the first offshore wind project to test the BOEM's OCS leasing and approval process.
- The VOWTAP team prepared and submitted a first of its kind RAP to BOEM to support NEPA analysis and permit acquisition. BOEM approved the RAP and is now utilizing it as a template for all future commercially viable offshore wind development projects in federal waters on the OCS.
- The VOWTAP Team successfully negotiated and navigated the permitting process and NEPA evaluation process for the VOWTAP resulting in issuance of all major regulatory permits and receipt of an Environmental Assessment and Finding of No Significant Impact from BOEM.
- The VOWTAP team leveraged existing studies and data collected (avian studies and previously collected sediment cores) to minimize surveys and studies to be performed for the VOWTAP, while still accurately and thoroughly characterizing the site and identifying potential impacts.

# Lessons Learned

Category	Description of Issue/Approach	Resolution/Impact/ Lesson Learned
Regulatory	Regulatory process is not mature, which led to extended delays in approval of RAP and other permits.	Government agencies must be held to specific timelines for reviews and consultations so the Developer can manage and rely on the approval process schedule.
Supply Chain	The U.S. supply chain is currently non-existent for major offshore wind components resulting in expensive foreign suppliers and manufacturers.	The U.S. supply chain must mature in order to reduce the LCOE of offshore wind.
Installation Contractors	There are a limited amount of vessels and experience globally that can support U.S. windfarm installation.	The U.S. supply chain must mature in order to reduce the LCOE of offshore wind.
Installation Contractors	The European offshore industry is busy and so there is little motivation for transatlantic crossing and market risk to support US installation.	The U.S. supply chain must mature in order to reduce the LCOE of offshore wind.
Health and Safety	Capture of H&S issues that have occurred on previous European projects.	Review of available reports and positive measures to address/improve for the VOWTAP

# Lessons Learned

Category	Description of Issue/Approach	Resolution/Impact/ Lesson Learned
Installation Contractors	Currently, there is no EPC type experience for U.S. windfarm installation.	A multi-prime contractor arrangement was more beneficial to reduce cost of installation. Additional interface oversight is required.
DOE Funding	Some Contractors refused work due to flowdown of DOE audit requirements	Minimized number of contractor options.
Installation Contractors – Vendor Fatigue	The start/stop nature of the U.S. market has resulted in vendor fatigue. Various vendors have spent a lot of money to support the RFP process for various proposed projects which did not result in actual work.	Gaining interest in the bidding process can be difficult until a project is shown to be ready to actually begin LNTP work.
First of a Kind Work (FOAK)	The VOWTAP design process touched many areas in the design basis development and coupled loads analysis that were FOAK and therefore actually took longer than forecast due to unknown problems.	Continued development of US offshore wind projects will expand industry experience.



# SCC Approval Process for Cost Recovery

- ❑ Virginia Electric Utility Regulation Act of 2007
  - Generation facility construction and operation costs recovered through rate adjustment clauses “riders” or “RAC” (Virginia Code Section 56-585.1.A6).
  - Utilities can petition for a RAC to recover costs on a timely and current basis
  - Recoverable costs include construction work in progress and allowance for funds used during construction
  - As incentive, Act provides enhanced return for offshore wind investments
  
- ❑ SCC Review
  - SCC issue orders on cost recovery within 9 months of a complete application
  - RAC application must include detailed cost estimates – SCC considers reasonableness and prudence of costs
  - Cost estimates must include reasonable level of certainty
  - For renewable energy resources, SCC must consider the extent to which the project furthers the objectives of the Commonwealth Energy Policy.
    - Economic and job creation objectives.
    - Whether cost will result in unreasonable increases in rates paid by customers.