Offshore Wind
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Dominion Profile

- ~28,200 MW of electric generation
- 6,200 miles of electric transmission
- 11,000 miles of natural gas transmission, gathering and storage pipeline
- 947 billion cubic feet of natural gas storage operated
- Cove Point LNG Facility
- 2.4 million electric customers in VA and NC
- 1.3 million natural gas customers in OH & WV
- 2.2 million non-regulated retail customers in 15 states
Dominion’s Renewable Energy Facilities

- **Prairie Fork**: 300 MW
- **Fowler Ridge I**: 150 MW\(^1\)
- **Bath Pumped Hydro**: 2772 MW\(^2\)
- **VCHEC**: Up to 117 MW
- **Altavista**: 51 MW
- **Mt. Storm**: 132 MW\(^1\)
- **Cushaw & North Anna**: 3 MW
- **Hopewell**: 51 MW
- **Southampton**: 51 MW
- **Pittsylvania**: 83 MW
- **VA Wind**: 248 MW
- **Gaston/ Roanoke Rapids**: 315 MW
- **Cushaw & North Anna**: 3 MW
- **Community Solar**: Up to 30 MW

**Note:** Facilities in **RED** are in Development or Construction. Facilities in **BLACK** are in Operation.

\(^1\) Megawatt capacity represents Dominion’s 50% capacity only
\(^2\) Pumped hydro does not qualify as renewable energy in the VA RPS
Dominion Offshore Wind

Dominion’s Involvement

- Dominion responded 3/19 to Bureau of Ocean Energy Management (BOEM) Call Indicating interest in leasing ocean blocks

- Leading Department of Energy (DOE) grant team on offshore wind cost reduction study

- Dominion participating in various initiatives at state level
  - Virginia Offshore Wind Development Authority – reducing development barriers
  - Virginia Offshore Wind Coalition

- Completed two transmission studies evaluating onshore and offshore transmission options

- Submitted Comments to BOEM
  - Offshore Wind Commercial Lease Form
  - Auction design for ocean block leasing
  - Atlantic Wind right-of-way request for offshore transmission
Offshore Wind Policy Activity

**Federal**


- **2010** - BOEM and the Department of Energy (DOE) announced “Smart from the Start” initiative.

- **2011**
  - DOE unveiled the National Offshore Wind Strategy to reduce offshore wind cost and speed deployment.
  - DOE announced grants for 41 projects across 20 states totaling $43 million.
  - BOEM further refined the Wind Energy Areas in Virginia.

- **2012**
  - BOEM issued Call for Information and Nominations in Virginia.
  - DOE announced $180 million in grants for Advanced Technology Demonstration Projects.

**Virginia**

- **2007** - Virginia Coastal Energy Research Consortium (VCERC) established to foster research and development of coastal energy technologies.

- **2009** - BOEM federal-state-local task force formed in Virginia.

- **2010** - Virginia Offshore Wind Development Authority (VOWDA) created.

- **2011** - Joint Resolution in VA General Assembly to support of 3,000 MW of offshore wind by 2025.

- **2012** - Budget proposal for DMME includes $500,000 for offshore wind data collection.
Levelized Cost of New Generation: 2016 Commercial Operation

Source: U.S. Energy Information Administration (EIA), report on the Annual Energy Outlook, April 2011

- CC = Combined Cycle
- PV = Photovoltaic

* PPA prices are levelized.
Offshore Wind
Trend of Rising Costs

Capital Cost/kW for European and U.S. Projects

- Costs still increasing on European Projects
- Announced US projects using low cost assumptions

Source: NREL Database
The Crown Estate
Offshore Wind Cost Reduction Paths

Technology

Supply Chain

Finance

Increase Output
Reduce Installed cost
Risk & Contracting
Standardization
Assurance of volume
Perception and management of risk
Capital
Insurance
“OSWInD Initiative will help reduce the cost of offshore wind energy through technology development to reduce capital costs; applied research to decrease installation, operations, and maintenance costs; turbine innovation to increase energy capture; and codes and standards development to reduce technical risks and financing costs.”
Offshore Wind Accelerator (OWA) – Collaborative R&D program aiming to reduce the cost of offshore wind 25% through innovation by 2020.

Cost Reductions through Innovation

- US Department of Energy
- UK Carbon Trust
Dominion offshore wind cost estimates at the high-end of EIA cost projections

Dominion leading DOE grant team to identify offshore wind innovations to reduce cost of energy by 25 percent
  - Partners include Alstom, Moffatt & Nichol, Virginia Tech & National Renewable Energy Lab

DOE goal to reduce cost to 10 cents/kWh by 2020

Potential cost reduction categories
  - Larger turbines
  - Increased capacity factor
  - Innovative foundations
  - Installation techniques
  - Supply chain impacts
Site Characterization

- Baseline site and cost assumptions – Virginia Wind Energy Area
  - 500 MW- 600 MW project, monopile foundation, 35m water depth
- Reference sites with sensitivity analysis – North Carolina and Maryland
Turbine Innovations

- Parterned with Alstom
  - 6 MW Haliade™ 150 m advanced offshore wind turbine
  - Permanent magnet direct drive (PMDD) generator
  - Drivetrain architecture
  - Rotor Design
  - Other: O&M, advanced controls
Foundation Design Elements

Gravity Base Suction Assist

Keystone’s Inward Battered Guide System ‘twisted jacket’

Source: Keystone, Universal Foundation 2012
Installation Options

Conventional Jack-up

Specialized Equipment

Assembled Tower and Nacelle
Offshore Wind
DOE Advanced Technology Demonstration Project

- Proposals to DOE due May 31, 2012
- Commissioning must occur in 2015-2017
- DOE expects to select up to 5 projects
- DOE to fund up to 80% of initial engineering & permitting
- DOE to fund up to 50% of final engineering, procurement & construction
Virginia Offshore Wind Transmission Study – Onshore Interconnection

– Study completed in November 2010.

– Landstown substation onshore interconnection point.

– Integrating up to 1,500MW of injected capacity (4,500 MW installed turbine capability) would not be expected to create transmission deficiencies.

– As the actual output of wind farms increase above 1500MW, relatively minor transmission upgrades would be required.
  
  • 2700MW - $30M
  • 4500MW - $70M

*Study based on known system conditions at that time and subject to change, based on actual detailed engineering analysis and onshore right of way.

Virginia Offshore Wind Transmission Study – Offshore Solution

- Analysis divided the Wind Energy Area into four zones with approximately 650 MW per zone to represent phased build-out.

- Consists of four platforms serving four 650 MW grids (at 34.5 kV).

- Two cables per platform, two platforms per interconnect (at 230 kV).

- Transmission cost for this approach approximately $1000/kW.

- Uncertainty remains in route selection and siting.

Why Not High Voltage Direct Current (HVDC)?

– HVDC option consists of two to three platforms serving 2,200 - 3,300 MW, respectively.

– Two cables to shore per platform for redundancy (±320 kV).

– HVDC reduces line losses, but has significantly higher capital costs.

*Figure S4: HVDC Light Concept*

*Virginia Wind Energy Area is ~24 miles to shore, the breakeven distance for HVDC is significantly greater.*