Virginia Offshore Wind Technology Advancement Project

(VOWTAP)

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Final Technical Report

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REPORT REVISION

Revision 1: - The Virginia Offshore Wind Technology Advancement Project (VOWTAP) Closeout Report, prepared for the Department of Energy (DOE), was originally submitted on August 24, 2016. As requested by DOE on January 12, 2017, Dominion has updated the Report to include an expanded description of the stakeholder review process. The updated report that follows, was resubmitted to DOE on January 26, 2017.

Revision 1a: - The Virginia Offshore Wind Technology Advancement Project (VOWTAP) Closeout Report, prepared for the Department of Energy (DOE), was originally submitted on August 24, 2016 and resubmitted on January 26, 2017. As requested by DOE on January 30, 2017, Dominion has updated the Report to include the Acknowledgement and Disclaimer on page ES-1.

EXECUTIVE SUMMARY

Virginia Electric and Power Company (Dominion), a wholly-owned subsidiary of Dominion Resources, Inc. (DRI), and its Team—Alstom (now GE); Kellogg, Brown, and Root (KBR); Keystone Engineering, Inc. (KEI); the Virginia Department of Mines, Minerals and Energy (DMME); the National Renewable Energy Laboratory (NREL); the Virginia Coastal Energy Research Consortium (VCERC) represented by Virginia Polytechnic Institute and State University (Virginia Tech); Tetra Tech, Inc. (Tetra Tech); and Newport News Shipbuilding (NNS), a division of Huntington Ingalls Industries (referred to herein collectively as the VOWTAP Team)—have prepared this closeout report for the Department of Energy (DOE) to fulfill its obligations under the DOE grant program.

In 2010, the DOE Energy Efficiency and Renewable Energy (EERE) Wind and Water Power Program instituted the Offshore Wind Innovation and Demonstration (OSWInD) Initiative to consolidate and expand its efforts to promote and accelerate responsible commercial offshore wind development in the United States (DOE 2011). This initiative is part of DOE's National Offshore Wind Strategy for creating an offshore wind energy industry in the United States. The primary objectives of OSWInD are to reduce deployment timelines and uncertainties, reduce the cost of energy through technology development, determine ways in which to remove market barriers, and demonstrate advanced technologies, including innovations in wind turbine generators (WTG) and foundation design, marine systems engineering, computational tools and test data, resource planning, siting and permitting, complementary infrastructure, and the development of advanced technology demonstration projects (DOE 2011). In 2012, DOE selected seven technology demonstration projects to further the objectives of OSWInD; the Virginia Offshore Wind Technology Advancement Project (VOWTAP) was selected as one of these proposed projects to receive $4 million. On May 8, 2014, DOE selected the VOWTAP once again as one of three technology demonstration projects to receive additional funding up to $47 million to support the advancement of the Project towards construction. At the completion of Budget Period (BP) 2, Dominion revised the regulatory filing process to include a separate Certificate of Public Convenience and Necessity (CPCN) filing. Dominion requested an extension to a Commercial Operation Date of 2020 so that a CPCN could be submitted to the Virginia State Corporation Commission. Ultimately, DOE decided to withdraw further project funding beyond BP 2.

The primary purpose of the VOWTAP was to advance the offshore wind industry in the United States (U.S.) by demonstrating innovative technologies and process solutions that would establish offshore wind as a cost-effective renewable energy resource. The VOWTAP Team proposed to design, construct, and operate a 12 megawatt (MW) offshore wind facility located approximately 27 statute miles (mi) (24 nautical miles [nm], 43 kilometers [km]) off the coast of Virginia. The proposed Project would consist of two Alstom Haliade™ 150-6 MW turbines mounted on inward battered guide structures (IBGS), a 34.5-kilovolt (kV) alternating current (AC) submarine cable interconnecting the WTGs (inter-array cable), a 34.5-kV AC submarine transmission cable (export cable), and a 34.5 kV underground cable (onshore interconnection cable) that would connect the Project with existing Dominion infrastructure located in Virginia Beach, Virginia (Figure 1). Interconnection with the existing Dominion infrastructure would also require an onshore switch cabinet, a fiber optic cable, and new interconnection station to be located entirely within the boundaries of the Camp Pendleton State Military Reservation (Camp Pendleton). The VOWTAP balanced technology innovation with commercial readiness such that turbine operations were anticipated to commence by 2018. Dominion, as the leaseholder of the Virginia Wind Energy Area (WEA), anticipated leveraging lessons learned through the VOWTAP, and applying them to future commercial-scale offshore wind development.

The primary project goals of the VOWTAP include:

Reducing the Cost of Energy through Innovation: The VOWTAP would provide a necessary step towards cost-effective, commercial-scale deployment. The proposed Project innovations would deliver significant

cost reductions, lowering the levelized cost of energy (LCOE) approximately 19 percent from the site-specific commercial baseline developed utilizing DOE's LCOE guidance.

Reducing Deployment Timelines and Uncertainties: By locating the Project within a WEA and being a recipient of a federal research lease, the VOWTAP was one of the first offshore wind projects to test the Bureau of Ocean Energy Management's (BOEM) leasing and approval process on the Outer Continental Shelf (OCS) established under 30 Code of Federal Regulations (CFR) 585. Lessons learned, including experience with regard to the National Environmental Policy Act (NEPA) and the Certified Verification Agent (CVA) process, could be disseminated to the industry to reduce regulatory uncertainty and establish the framework for the project permitting process and deployment schedule for future projects.

Advancing the State of the Art: The VOWTAP struck the optimal balance among technology maturity, commercial readiness, and innovation. This was exemplified by its two major innovations: the Alstom 6 MW offshore wind turbine and the Keystone IBGS substructure and foundation. Already successfully demonstrated separately in marine environments, the VOWTAP would be the first integration of these two components. The VOWTAP would be one of the most highly instrumented offshore wind facilities installed in the world and would provide an "ocean laboratory" for testing technology innovations, including advanced wind plant and hurricane ride through controls. The Data Measurement and Testing Plan was carefully designed to quantify the performance of the VOWTAP innovations. Results could be disseminated to offshore wind stakeholders through Project reports, user group interactions, and conference presentations.

Commitment to Safety: The VOWTAP Team have a shared commitment to safety and an excellent record in safety performance. The Team recognizes the significant challenges associated with safely executing a complex project in a marine environment. To mitigate hazards associated with deploying offshore wind, the Project Team prepared a preliminary Safety Management System. The VOWTAP is dedicated to the concept that all accidents are preventable. No task is so important as to justify injuring employees, damaging property, or harming the environment.

The primary Project goals were met through a series of tasks and sub-tasks as defined in the Statement of Project Objectives. The sub-tasks were grouped according to the four overall Project objectives, which include:

- Design
- Installation, Operations, and Maintenance
- Environmental
- Interconnection and Regulatory Approvals

The fulfillment of these Project Objectives is discussed in the body of this report.

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LIST OF ABBREVIATIONS AND ACRONYMS

AC	alternating current
AEP	Annual Energy Production
BoD	Basis of Design
BP	Budget Period
BOEM	Bureau of Ocean Energy Management
Camp Pendleton	Camp Pendleton Military Reservation
Capex	capital expenditure
CBM	condition-based maintenance
CFR	Code of Federal Regulations
CPCN	Certificate of Public Convenience and Necessity
CRA	Commercial Risk Assessment
CVA	Certified Verification Agent
DAS	data acquisition system
DLC	design load case
DMME	Department of Mines, Minerals, and Energy
DOE	Department of Energy
DNV	Det Norske Veritas
Dominion	Virginia Electric and Power Company, doing business as (d/b/a) Dominion Virginia Power
DONCI	Determination of No Competitive Interest
DRI	Dominion Resources Inc.(referenced as Dominion)
DVP	Dominion Virginia Power
EA	Environmental Assessment
EERE	Energy Efficiency and Renewable Energy
EPC	Engineering, Procurement, Construction
FAST	Fatigue, Aerodynamics, Structures and Turbulence (Code)
FEED	front-end engineering and design
G&G	geophysical and geotechnical
HDD	horizontal directional drilling
IA	Interconnection Agreement
IBGS	inward battered guide structure
JPA	Joint Permit Application
KBR	Kellogg, Brown, and Root
KEI	Keystone Engineering, Inc.
km	kilometer
kV	kilovolt
LCOE	levelized cost of energy
LiDAR	light detection and ranging
LNTP	Limited Notice to Proceed
mi	miles
MOC	Market Operating Center
MW	megawatt
M	million
NEPA	National Environmental Policy Act
nm	nautical miles
NNS	Newport News Shipbuilding
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NREL	National Renewable Energy Laboratory

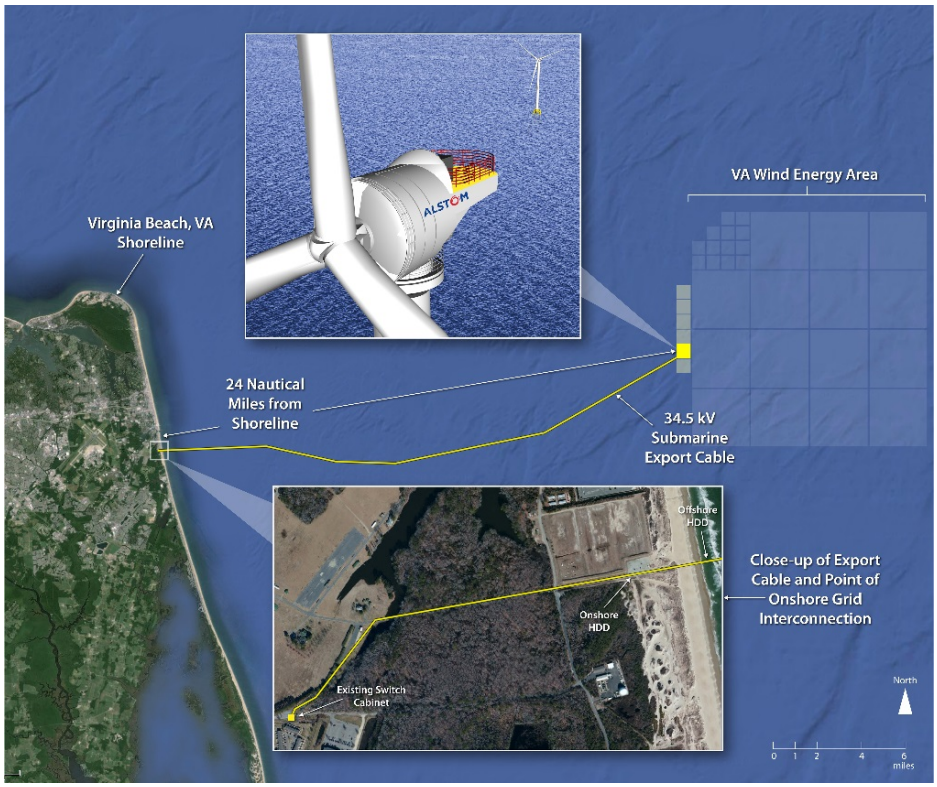
OCS	Outer Continental Shelf
Opex	operating expenditure
O&M	operations and maintenance
OSWInD	Offshore Wind Innovation and Demonstration Initiative
PCMP	Post-Construction Monitoring Plan
PJM	Pennsylvania, New Jersey, Maryland (State Authority)
PMDD	permanent magnet direct drive
PPA	Power Purchase Agreement
PQQ	Pre-qualification Questionnaire
RAP	Research Activities Plan
RFP	request for proposal
ROC	Regional Operating Center
ROV	remotely operated vehicle
SAP	Site Assessment Plan
SCADA	Supervisory, Control and Data Acquisition
SCC	State Corporation Commission
SMA	Service Maintenance Agreement
SMS	Safety Management System
SOPO	Statement of Project Objectives
Tetra Tech	Tetra Tech, Inc.
TIC	Total Installed Cost
U.S.	United States
USACE	U.S. Army Corp of Engineers
VCERC	Virginia Coastal Energy Research Consortium
VDEQ	Virginia Department of Environmental Quality
Virginia Tech	Virginia Polytechnic Institute and State University
VOWDA	Virginia Offshore Wind Development Authority
VOWTAP	Virginia Offshore Wind Technology Advancement Project
WEA	Wind Energy Area
WFOCC	Wind Farm Operational Control Center
WMPA	Wholesale Market Participation Agreement
WTG	wind turbine generator

1.0 VOWTAP DEMONSTRATION PROJECT

Virginia Electric and Power Company (Dominion), a wholly-owned subsidiary of Dominion Resources, Inc. (DRI), and its Team—Alstom (now GE); Kellogg, Brown, and Root (KBR); Keystone Engineering, Inc. (KEI); the Virginia Department of Mines, Minerals and Energy (DMME); the National Renewable Energy Laboratory (NREL); the Virginia Coastal Energy Research Consortium (VCERC) represented by Virginia Polytechnic Institute and State University (Virginia Tech); Tetra Tech, Inc. (Tetra Tech); and Newport News Shipbuilding (NNS), a division of Huntington Ingalls Industries (referred to herein collectively as the VOWTAP Team)—are pleased to submit this closeout report to the Department of Energy (DOE) to fulfill its obligations under the DOE grant program.

The primary purpose of the Virginia Offshore Wind Technology Advancement Project (VOWTAP) was to advance the offshore wind industry in the United States (U.S.) by demonstrating innovative technologies and process solutions that would establish offshore wind as a cost-effective renewable energy resource. The VOWTAP Team proposed to design, construct, and operate a 12 megawatt (MW) offshore wind facility located approximately 27 statute miles (mi) (24 nautical miles [nm], 43 kilometers [km])[1] off the coast of Virginia (Figure 1). The proposed Project would consist of two Alstom Haliade™ 150-6 MW turbines mounted on inward battered guide structures (IBGS). VOWTAP balanced technology innovation with commercial readiness such that turbine operations were anticipated to commence by 2018. Dominion, as the leaseholder of the Virginia Wind Energy Area (WEA), anticipated leveraging lessons learned through the VOWTAP and applying them to future commercial-scale offshore wind development.

Figure 1: Project Location



[1] Distances throughout this document are provided as statute miles (mi) or nautical miles (nm) as appropriate, with kilometers in parentheses. For reference, 1 mi equals approximately 0.87 nm.

The body of this report is structured to follow the Statement of Project Objectives (SOPO) provided by the DOE. Section 1.1 explains the objectives of the DOE grant program and provides a description of the VOWTAP. Section 1.2 describes the overall process from project inception, including the goals of the DOE grant program and the VOWTAP, as well as the significant activities undertaken in each budget period (BP). Section 2.0 provides an overview and detailed discussion of what the VOWTAP Team did to achieve the objectives of the BP1 and BP2 SOPOs. Section 3.0 provides an overview of major regulatory processes as designated by the metrics in the SOPO and the stakeholder outreach process, Section 4.0 provides an overview of the Request for Proposal (RFP) process and stakeholder review of project costs and methodology. Section 5.0 provides a summary of funds expended through BP 1 and BP 2. Section 6.0 categorizes issues encountered during the course of the Project, the resolution that was implemented, and recommendations for future projects. Section 7.0 provides a summary of the key points and significant accomplishments achieved by the VOWTAP Team.

1.1 Introduction and Purpose

In 2010, the DOE Energy Efficiency and Renewable Energy (EERE) Wind and Water Power Program instituted the Offshore Wind Innovation and Demonstration (OSWInD) Initiative to consolidate and expand its efforts to promote and accelerate responsible commercial offshore wind development in the United States (DOE 2011). This initiative is part of DOE's National Offshore Wind Strategy for creating an offshore wind energy industry in the United States. The primary objectives of OSWInD are to reduce deployment timelines and uncertainties, reduce the cost of energy through technology development, determine ways in which to remove market barriers, and demonstrate advanced technologies, including innovations in wind turbine generators (WTG) and foundation design, marine systems engineering, computational tools and test data, resource planning, siting and permitting, complementary infrastructure, and the development of advanced technology demonstration projects (DOE 2011). In 2012, DOE selected seven technology demonstration projects to further the objectives of OSWInD; VOWTAP was selected as one of these proposed projects to receive $4 million in funding. On May 8, 2014, the DOE selected the VOWTAP once again as one of three technology demonstration projects to receive additional funding up to $47 million to support the advancement of the Project towards construction.

The Commonwealth of Virginia enacted legislation (Title 67, Chapter 12, Code of Virginia) in 2010 that created the Virginia Offshore Wind Development Authority (VOWDA). The expressed mission of the VOWDA is to facilitate, coordinate, and support the development of the offshore wind energy industry, offshore wind energy projects, and supply chain vendors within the state of Virginia by:

- Collecting metocean and environmental data;
- Identifying regulatory and administrative barriers;
- Working with local, state, and federal governmental agencies to upgrade port and logistic facilities and sites;
- Ensuring development is compatible with other ocean uses and avian/marine wildlife; and
- Recommending ways to encourage and expedite offshore wind industry development (VOWDA 2013).

In July 2010, the Commonwealth of Virginia also provided a response to DOE's Request for Information (RFI; DE-FOA-EE00038) supporting the OSWInD Initiative, and documenting the Commonwealth's interest in developing a new offshore wind power industry in Virginia.

The VOWTAP was designed to satisfy the needs identified by the OSWinD Initiative and the Commonwealth of Virginia, as follows:

- **Technical Innovation and Validation** – The VOWTAP was intended to support one of the first U.S. offshore deployments of the Haliade™ 150 6MW WTG. The Haliade™ 150 is a three-bladed,

upwind oriented WTG whose rotor, nacelle and tower assembly establishes a new paradigm for the offshore wind market with a permanent magnet direct drive (PMDD) generator, optimum power density, and significantly reduced tower head mass compared to other offshore WTGs of the same class. This innovative WTG also incorporates a new state-of-the-art supervisory control and data acquisition system (SCADA) that can observe the operation of the WTG in real-time and detect changes before failure or damage can occur, thus reducing the potential for unscheduled outages and improving the planning of preventive maintenance. The VOWTAP would also be one of the first applications of the Keystone IBGS as a foundation for an offshore wind project. This foundation technology has been proven in the oil and gas sector as suitable under a wide range of seabed conditions. Application of this foundation at the VOWTAP site would support the demonstration of this known design concept to offshore WTGs in water depths and extreme weather conditions that are common to the mid- and south-Atlantic regions.

- **Cost Reduction** – The VOWTAP was intended to provide a necessary step towards future cost effective, commercial-scale wind energy deployment. The proposed Project innovations would deliver significant cost reductions that could be attributed to four major areas: increased annual energy production (AEP); decreased WTG capital costs; decreased balance of plant and foundation costs; and decreased operations and maintenance (O&M) costs. The Haliade™ 150 rotor, robust drive train, and high capacity factors contribute to the increase in AEP. The proposed use of the IBGS foundation also represents a cost savings, as this type of foundation system has a reduction in steel utilization leading to lower cost than current WTG foundation technologies. Furthermore, the application of the Haliade™ PMDD and the enhanced SCADA system reduce the need for visits to the WTGs, thereby reducing O&M costs. In addition, by using two WTGs, the Project would allow research on wind turbine wake effects and wind farm control strategies to optimize the power output of the entire system. Overall, the innovations proposed for the VOWTAP were originally estimated to lower the levelized cost of energy (LCOE) for a commercial scale project by an estimated 25 percent from Dominion's baseline conditions.
- **Removal of Market Barriers** – The VOWTAP was intended to provide a platform for removing many of the first-of-a-kind risks that currently constitute barriers to development of a U.S. offshore wind industry. Some of these risks include navigating the permitting process for an offshore wind project in federal waters; installing larger WTGs that are new to the offshore wind market, and gaining a better understanding of domestic supply chain requirements.
- **Identify Potential Improvements to the Permitting Process** – Of the demonstration projects selected by the DOE in 2013 and 2014, the VOWTAP was the only fixed-bottom project subject to the Department of Interior, Bureau of Ocean Energy Management's (BOEM) permitting process, and was one of the first offshore wind projects to use BOEM's Smart-from-the-Start Initiative. The VOWTAP Team documented the permitting approval processes and identified areas where the process could be improved in order to reduce deployment timelines and decrease risks.
- **Progressing Environmental Research and Understanding** – The VOWTAP Team collected data that will help to further the understanding of effects to the environment and from environmental conditions on future offshore wind projects, most notably the commercial development of the Virginia WEA. This data included the environmental baseline evaluations conducted in support of the siting and development of the VOWTAP and proposed post-construction and operational monitoring.

The VOWTAP was a 12 MW offshore wind technology testing facility located approximately 27 mi (24 nm, 43 km) east of the City of Virginia Beach, Virginia (Figure 1). While Dominion proposed to construct, own, and operate the Project, VOWTAP is a collaborative research and development effort comprised of the DMME, as the offshore lease holder; Alstom, as the turbine manufacture; Keystone Engineering Inc. (Keystone), as the foundation design firm; KBR as the marine engineering contractor; Tetra Tech as the environmental contractor; the NREL and the VCERC, represented by Virginia Tech, as renewable energy

research partners; and Newport News Shipbuilding, for their logistical knowledge of local ports and harbors. This group of partners, collectively referred to as the VOWTAP Team, exemplifies the essential roles necessary to deliver a state-of-the-art offshore wind technology advancement and demonstration project.

The VOWTAP would consist of two 6 MW WTGs, a 34.5-kilovolt (kV) alternating current (AC) submarine cable interconnecting the WTGs (inter-array cable), a 34.5 kV AC submarine transmission cable (export cable), and a 34.5 kV underground cable (onshore interconnection cable) that would connect the Project with existing Dominion infrastructure located in Virginia Beach, Virginia (Figure 1). Interconnection with the existing Dominion infrastructure would also require an onshore switch cabinet, a fiber optic cable, and new interconnection station to be located entirely within the boundaries of the Camp Pendleton State Military Reservation (Camp Pendleton).

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2.0 PROJECT EXECUTION

The primary goals listed in Section 1.1 above were met through a series of tasks and sub-tasks as defined in the SOPO. The sub-tasks were grouped according to the four Project objectives which include:

Design

- Design an integrated innovative turbine-substructure system to maximize the potential for lowering the cost of energy and reducing risk to increase industry confidence associated with these innovations.
- Perform a coupled loads analysis of the turbine-substructure system, including an investigation of new/refined load cases for hurricanes, to provide assurance on the suitability of the solution for the VOWTAP site, as well as provide design guidance for future projects placed in hurricane-prone regions.
- Continue to engage Det Norske Veritas (DNV), the Project CVA, throughout the design process to facilitate certification of the demonstration project and gain experience that would expedite the development of future commercial-scale projects located on the OCS.
- Establish a database of environmental and structural measurements that would serve to characterize environmental and structural loading conditions at the site to validate modeling and design tools and inform certification rules and design standards.

Installation, Operations, and Maintenance

- Install two large-scale 6 MW turbines and substructures using a Jones Act–compliant strategy in an exposed offshore site located 24 nm from the coast of Virginia Beach.
- Consult with the global supply chain to establish vendor capabilities and obtain firm pricing prior to applying for regulatory recovery of costs.
- Maximize local and domestic content to support the establishment of a robust U.S. offshore wind industry.
- Collect and disseminate operational performance data and maintenance records to provide evidence that the innovations and project design provide a cost-effective and reliable solution over the long term.

Environmental

- Receive requisite lease and environmental permits and approvals (with acceptable terms) for a first-of-its-kind demonstration project in Federal waters within the Project schedule.
- Identify opportunities for streamlining the permitting process for future projects sited on the OCS, including leveraging studies through VOWTAP to better characterize the Virginia WEA.
- Incorporate innovative environmental monitoring strategies to reduce risk during construction.
- Actively engage key stakeholders throughout the Project planning process.

Interconnection and Regulatory Approvals

- Receive required approvals for interconnection (PJM Interconnection and state processes).
- Receive approval from the Virginia State Corporation Commission (SCC) to recover reasonable and prudently incurred costs from our customers.

The sections below summarize the tasks, subtasks, objectives and significant activities undertaken to meet the goals of each budget period.

2.1 Significant Activities – Budget Period 1

The vast experience of the Team led to a comprehensive development approach, with all aspects of the Project advancing in BP 1. The key BP 1 accomplishments associated with each SOPO task are summarized in Table 1 below.

Table 1: Significant Activities within BP 1

Task/Criteria	Objectives	Activities
Budget Period 1		
Task 1.0 – Design	• Design an integrated innovative turbine-substructure system to maximize the potential for lowering the cost of energy and reducing risk to increase industry confidence associated with these innovations. • Perform a coupled loads analysis of the turbine-substructure system, including an investigation of new/refined load cases for hurricanes, to provide assurance on the suitability of the solution for the VOWTAP site, as well as provide design guidance for future projects placed in hurricane-prone regions. • Continue to engage Det Norske Veritas (DNV), the project Certified Verification Agent (CVA), throughout the design process to facilitate certification of the demonstration project and gain experience that would expedite the development of future commercial-scale projects located on the Outer Continental Shelf (OCS). • Establish a database of environmental and structural measurements that would serve to characterize environmental and structural loading conditions at the site to validate modeling and design tools and inform certification rules and design standards.	✓ Initial Basis of Design (BoD) documents drafted and reviewed by DNV; ✓ Site selected and optimized turbine spacing identified; ✓ Substructure/foundation alternatives evaluated, IBGS solution selected; ✓ Design evaluations completed, coupled loads process demonstrated; ✓ Preliminary Data Measurement and Testing Plan completed, additional data requirements for the 100% front-end engineering and design (FEED) defined and planned; ✓ Total installed cost (TIC) estimate compiled from vendor quotes; ✓ Continued engagement with DNV; ✓ Continued collection of environmental and structural measurements to be included in a database that will characterize environmental and structural loading conditions to inform certification rules and design standards; and ✓ Completed the 50% FEED.
Task 2.0 – Installation, Operations, and Maintenance	• Install two large-scale 6 megawatt (MW) turbines and substructures using a Jones Act–compliant strategy in an exposed offshore site located 24 nautical miles (nm) from the coast of Virginia Beach. • Consult with the global supply chain to establish vendor capabilities and obtain firm pricing prior to applying for regulatory recovery of costs. • Maximize local and domestic content to support the establishment of a robust U.S. offshore wind industry. • Collect and disseminate operational performance data and maintenance records to provide evidence that the innovations and project design provide a cost-effective and reliable solution over the long term.	✓ Turbine and substructure transportation requirements identified; ✓ Baseline Jones Act–compliant vessel strategy selected and construction plan drafted; and ✓ Preliminary operation and maintenance (O&M) plans completed.

Task/Criteria	Objectives	Activities
Task 3.0 – Environmental and Permitting Process	• Receive requisite lease and environmental permits and approvals (with acceptable terms) for a first-of-its-kind demonstration project in Federal waters within the Project schedule. • Identify opportunities for streamlining the permitting process for future projects sited on the OCS, including leveraging studies through VOWTAP to better characterize the Virginia Wind Energy Area. • Incorporate innovative environmental monitoring strategies to reduce risk during construction. • Actively engage key stakeholders throughout the project planning process.	✓ Unsolicited research lease application submitted and a Determination of No Competitive Interest (DONCI) was issued by BOEM; ✓ Marine geophysical and geotechnical (G&G) and other environmental surveys and assessments completed; ✓ Research Activities Plan (RAP) submitted to BOEM, NEPA review underway; ✓ Site Assessment Plan (SAP) submitted to BOEM for metocean equipment and under review; ✓ Coastal Zone Consistency Review Application submitted and under review; ✓ Joint Permit Application (JPA) submitted and under review; ✓ Notice of Intent (NOI) to file a Preconstruction Permit for OCS Air Emissions submitted to DEQ and under review.
Task 4 – Grid Interconnection	• Receive required approvals for interconnection (PJM Interconnection and state processes). • Receive approval from the State Corporation Commission to recover reasonable and prudently incurred costs from our customers.	✓ PJM queue request submitted and easement applications filed with Camp Pendleton and the Department of the Navy.
Task 5 – Economic Analysis	• Refine levelized cost of energy (LCOE) estimates by conducting trade-off studies of innovations. • Evaluate risk mitigation plan and associated impacts on LCOE.	✓ LCOE analysis updated to reflect refined cost data on the project-specific baseline and proposed innovations; and ✓ Held a series of risk workshops to identify potential risks and mitigation measures.
Task 6 – Project Management and Budget Period 1 Down-Select	• Demonstrate technical performance and progress towards stated objectives • Innovations and their potential reductions on LCOE. • Likelihood of Project success, advancement of the national knowledge base, and commercial impact in the U.S.	✓ Completed Down-Select Reports and submitted to DOE; ✓ Developed slide presentation and attended the DOE Down-Select interview; and ✓ DOE selected the VOWTAP to proceed to BP 2.

2.2 Detailed Discussion of Budget Period 1 Accomplishments

The following sections provide a more detailed discussion of the accomplishments of the VOWTAP Team throughout BP 1, how these accomplishments fulfilled the DOE criterion used to assess the VOWTAP's progress towards meeting the objectives of the SOPO at the completion of the budget period, and how these accomplishments enabled the VOWTAP to achieve the project goals and advance the U.S. offshore wind industry.

2.2.1 Criterion 1: Budget Period 1 Accomplishments

All aspects of the VOWTAP advanced during BP 1. The following sections break down BP 1 Project accomplishments based on the Project objectives that each accomplishment satisfied. Project objectives include:

- Design;

- Installation, Operations, and Maintenance;
- Environmental; and
- Interconnection and Regulatory Approvals.

Design

During BP 1, the VOWTAP Team completed the 50% front-end engineering and design (FEED). The technical design accomplishments of the 50% FEED effectively addressed the following components of the Design objective (Appendix 1[2]).

Relevant Site Conditions: The Team collected information on relevant site conditions to inform the Project design, including information on metocean and geophysical and geotechnical (G&G) conditions. All BP 1 site assessment and characterization activities and scopes of work planned in BP 2 were reviewed by DNV.

Site Planning and Demonstration Layout: The VOWTAP Team chose the Research Lease site through consultation with numerous stakeholders. Preliminary turbine locations were selected based on results from the VOWTAP G&G surveys and a preliminary layout study performed by NREL.

Applicable Design Codes and Standards Requirements: The VOWTAP completed the wind turbine and substructure Basis of Design (BoD) outlining the external conditions, load cases, and standards that will be used for design evaluation.

Wind Turbine Design Evaluation: The wind turbine design evaluation process consisted of the wind turbine BoD and the coupled loads analysis to evaluate the suitability of Haliade™ 150 6 MW WTG for the VOWTAP site.

Substructure and Foundation Design Evaluation: The Keystone IBGS solution that was selected in September 2013 after an extensive substructure evaluation process.

Coupled Loads Analysis: Keystone and Alstom carried out a coupled load analysis accounting for aeroelastic and hydrodynamic loads for the entire turbine system.

Data Measurement and Testing Plan: The VOWTAP Data Measurement and Testing Plan builds on NREL's and Alstom's experience in testing of offshore and land-based wind turbines. The Plan includes state of the art instrumentation for measuring metocean conditions and provides dual redundancy in measuring the responses of the turbine, tower, substructure, and foundation to these conditions by proposing hundreds of signals on both turbines.

Electrical: The electrical design process included selecting the cable voltage, carrying out preliminary load flow studies, developing the offshore and onshore power system designs, selecting and specifying the cable sizes, preparing a single line diagram for the VOWTAP power system, and recommending preliminary dimensions for the onshore Interconnection.

Installation, Operations, and Maintenance

The 50% FEED also addressed the following components of the Installation, Operations, and Maintenance objectives.

Transportation, Installation, and Commissioning Requirements: The Team consulted with the U.S. and global supply chain including installation contractors, vessel owners and key material supply vendors to inform the process of developing a preliminary transportation and installation plan. The VOWTAP Team

[2] Appendix 1 only includes the table of contents for the BP 1 Downselect reports. Full versions of the reports were provided to DOE at the close of BP 1.

also performed an in-depth evaluation of the requirements of the Jones Act and utilized this information to develop the installation plan.

Preliminary Construction Plan: The VOWTAP Team finalized its preliminary construction plans for the offshore and onshore project facilities, including the turbines, substructure, and electrical components. The detailed plan was submitted to BOEM as part of the Research Activities Plan (RAP) filing in December 2013.

Operations and Maintenance: Dominion developed an O&M plan for VOWTAP that incorporates their prior onshore wind experience with Alstom as well as KBR's knowledge of offshore wind O&M practices.

Environmental

The VOWTAP Team made significant progress on successfully navigating the regulatory processes during BP 1 to support the construction and operation of the VOWTAP. These achievements included issuance of a research lease, delivery of NEPA-compliant documentation, and the preparation of permit applications required by other federal, state, and local jurisdictional agencies which address the BP 1 Environmental objectives listed in the SOPO. Please see Section 3.0 for a discussion of the regulatory process and the current status of required permits, consultations, and plan submittals, as well as information on the stakeholder outreach program.

The VOWTAP Team also completed G&G and other environmental surveys and assessments to support the site evaluation process during BP 1. Based on the results of surveys and assessments, as well as the detailed alternatives analysis, the VOWTAP Team identified a Project site that minimized potential environmental and socioeconomic conflicts and risks, while mirroring conditions of potential future commercial projects on the OCS within the Virginia WEA. Dominion and DMME submitted an Unsolicited Research Lease Application for the identified site in February, 2013, and BOEM subsequently issued a DONCI in December 2013. Please see Sections 2.3 and 2.4 for further information on the progress of the leasing process in BP 2.

Interconnection

Dominion submitted the PJM queue request and filed easement applications with Camp Pendleton and the Department of the Navy.

2.2.2 Criterion 2: Innovations and LCOE Reductions

Table 2 summarizes the benefits of the proposed VOWTAP technology innovations compared to technology installed in large offshore wind plants today.

VOWTAP used the methodology and assumptions outlined in DOE's guidance document (DOE 2013) to calculate the LCOE for the Project-specific baseline and commercial project with innovations scenarios. Estimates of the performance and cost savings benefits associated with VOWTAP's innovations were derived through a comparison with a site-specific baseline project, which consisted of the NREL 5 MW offshore wind turbine installed on a four-legged jacket substructure by a self-propelled jack-up and heavy lift vessel.

The VOWTAP Project-specific baseline was developed to capture site-specific attributes of the commercial-scale project placed in the Virginia WEA. The estimated LCOE for the Project-specific baseline is $0.2241 per kilowatt-hour, which represents a 44 percent increase in LCOE from the DOE recommended baseline. BP 1 calculations indicated that VOWTAP innovations had the potential to reduce LCOE to an estimated $0.1814 per kilowatt-hour, thereby achieving a 19 percent reduction in LCOE from

the Project-specific baseline cost estimate. The VOWTAP innovations that had the highest impact on reducing LCOE from the Project-specific baseline include:

- 15.8 percent increase in annual energy production due to the 150m rotor diameter and increased drivetrain efficiency of the Alstom 6 MW turbine, advanced turbine controls, and advanced wind farm controls.
- 10.9 percent reduction in overall balance of system costs due to the fabrication and installation strategy of the innovative IBGS substructure and foundation.
- 8.4 percent reduction in O&M costs due to the Alstom PMDD generator and PureTorque™ system, as well as innovations associated with SCADA and condition-based maintenance (CBM).

Table 2: Summary of the Benefits of VOWTAP Innovations

	Innovation	Baseline	Primary Benefits
Hurricane Resilient Design	Advanced Design Approach	Does not address Hurricane Design	• Demonstrates a tested design methodology for hurricane regions
	Uninterruptable Yaw System Power	No backup power to permit yawing of turbines	• Allows yawing under hurricane conditions through backup power and robust controls • Minimizes extreme turbine loading which has the potential to reduce substructure weight and cost
	Hurricane Ride-Through Controls		
Alstom Turbine	Alstom Haliade™ 6-MW, 150-m Rotor	NREL Offshore Reference Turbine 5-MW, 126-m Rotor	• Exceeds the rotor diameter of current commercial projects in Europe by 20% • New capacity factor at the VOWTAP site is estimated to exceed 40%
	PMDD Generator	Multi-Stage Gearbox	• Increases turbine availability, increases drivetrain efficiency, and reduces O&M costs due to elimination of gearbox
	PureTorque™ Drivetrain	Bedplate Architecture	• Bending loads are passed directly to tower, decreasing fatigue loading on critical drivetrain components
	Advanced Turbine Controls	Standard Turbine Controls	• Uses nacelle mounted light detection and ranging (LiDAR) and innovative controls to reduce structural loads and increase energy capture
Support Structure and Installation Methods	IBGS Design and Fabrication	Four-Legged Jacket Design and Fabrication	• One design for +/-5-meter depth increments allows a standardized design to be used for a range of sites • Composite design converts mass from the jacket to the piles reducing high cost jacket steel • Efficient framing and lower material usage allows for easier fabrication
	IBGS Installation Strategy	Four-Legged Jacket Installation Strategy	• Reduced weight of IBGS design uses smaller cranes for installation, reducing vessel costs • Compact design allows for more IBGS jackets to be transported per vessel reducing installation costs
Wind Plant	Wind Turbine Wake Effects and Wind Farm Control	No Wind Farm Control	• Incorporates advanced turbine and wind plant controls to reduce wake losses and increase annual energy production • This capability decreases fatigue loading, thereby reducing maintenance costs within offshore wind plants
O&M Strategy	Innovative SCADA and CBM	Standard SCADA	• Detect changes or issues before failure or damage occurs, reducing unscheduled maintenance costs
	Remote Blade Inspection	Standard Blade Inspection	• Elimination of personnel offshore safety risk • Reduction in O&M costs

2.2.3 Criterion 3: Likelihood of Project Success

Dominion has highlighted several indicators of Project success for the VOWTAP that point to successful completion of the Project, on-schedule and within budget. The indicators have been categorized based on the following, and are discussed below:

- Installation, Operation, and Site Evaluation;
- Environmental and Permitting Process;
- Grid Interconnection;
- Schedule/Work Plan;
- Project Management; and,
- Financing and Commercial Development.

Installation, Operations, and Evaluation: The VOWTAP Team identified and received pricing for several suitable construction service port facilities in Hampton Roads that would be capable of providing ancillary services during the installation phase. Precon Marine in Virginia Beach was identified as the preferred option based on its size and distance to the Project site. Four O&M base ports were identified. Rudee Inlet was selected as the preferred option because operating out of this location would require approximately 1 hour of travel time, which is 15 minutes less travel time to the site than the next closest base port under consideration.

Timing of offshore installation activities will be constrained by several factors, including the North Atlantic right whale migration period and the onset of hurricane season. The VOWTAP Team has developed a schedule that takes these constraints, as well as others, into account while ensuring construction can be completed on time. Commissioning would occur in two phases so that initial commissioning and controls testing would be complete in mid-August and final commissioning would be completed by late August.

In addition to the offshore constraints, there are nearshore and onshore constraints to Project construction. Endangered sea turtles represent a constraint for the horizontal directional drilling (HDD) methodology that would be utilized to avoid the sensitive dune habitat. As such, HDD activity was scheduled to avoid the months of May through August in order to minimize impacts during the sea turtle nesting season. Please see Table 3 for the proposed timeframes and durations of construction activities.

The VOWTAP preliminary dissemination plan provides a detailed strategy that will be used to deliver Project-specific data to target audiences.

Table 3: Construction Schedule

Activity	Anticipated Timeframe	Duration (Weeks)
Interconnection Station Installation	April through June	8
Onshore Interconnection Cable and Switch Cabinet installation	March through April	6
Export Cable Landfall Construction (including Offshore HDD)	March through April	5
IBGS Installation and Pile Driving	May	3
Export Cable Installation	May through June	4
Inter-Array Cable Installation	June	2
WTG Installation	June through July	3
Commissioning	July through August	5

Environmental and Permitting Process: Significant progress has been made during BP 1 on the BOEM leasing process, the NEPA review process, and on other required permits and approvals. To date, the VOWTAP has submitted to BOEM all of the documentation necessary and required to successfully acquire

an OCS Research Lease and associated Right-of-Way Grant for the VOWTAP, and to conduct the Project's review under NEPA. Please see Section 3.0 for a more detailed discussion of the regulatory process and the current status of required permits, consultations, and plan submittals, as well as information on the stakeholder outreach program.

Extensive agency consultations and stakeholder outreach activities were conducted in support of VOWTAP. As a result of these agency consultations and stakeholder outreach, VOWTAP finalized the Research Lease site and submitted its Unsolicited Research Lease application to BOEM in February 2013. BOEM issued a DONCI for the Research Lease in December 2013 after receiving no other indications of interest or adverse public comments, clearing the way for VOWTAP and the state to obtain lease rights to the area. VOWTAP also submitted its RAP to BOEM in December 2013 detailing its construction and operations plan while providing results of the site-specific environmental surveys and assessments, alternatives analyses, and outreach activities. The submittal of the RAP initiated the Project's review under NEPA and other relevant laws. The VOWTAP remained on target to submit all required permit applications by the end of Q2 2014.

The VOWTAP Team took great care to work closely and directly with stakeholders and the public to identify and mitigate issues early on in the Project planning process. The stakeholder engagement process has included interactions with multiple key interest groups. In August 2013, the VOWTAP Team hosted a public open house in Virginia Beach to provide the public with the opportunity to interact directly with key members of the Team. Public feedback on VOWTAP has been very positive.

The VOWTAP worked proactively with BOEM to develop a NEPA review schedule that aligned with the Project's BP 1 schedule to begin operation in 2017. BOEM provided a schedule in November 2013 that was based on a very conservative review timeline. The BOEM timelines were incorporated into the Project schedule. Even under these conservative assumptions, the VOWTAP was expected to meet the 2017 in-service deadline.

In BP 1, Dominion conducted comprehensive site characterization studies on the proposed Research Lease Area, export cable route, and the locations of the proposed onshore facilities. The 1-year avian and bat studies initiated in BP 2 were scheduled to be completed during BP 2. Data from these surveys and studies would be used to support final environmental permitting and engineering design of the Project.

Grid Interconnection: To interconnect to Dominion's electric distribution system, the VOWTAP needed to gain approval at both the state and federal levels. To do so, the VOWTAP would submit interconnection requests in both jurisdictions and enter the queue process. Various studies would need to be conducted to determine the feasibility of the interconnection, the interconnection's impact on the system, and any potential grid infrastructure upgrades that may be required. The VOWTAP submitted applications into these concurrent processes in October 2013 and anticipated both queue processes to be complete by mid-2014. Based on preliminary findings, only minor upgrades would be needed to the distribution system. The onshore interconnection cable will traverse both state and naval property, and right-of-way easement approvals must be obtained from both entities. The onshore interconnection cable route survey was finalized in BP 1 and requests for obtaining the necessary easement approvals were initiated. With respect to negotiating a Power Purchase Agreement (PPA), the VOWTAP will be part of Dominion's regulated generation fleet. As such, no PPA would be necessary because the energy generated would directly serve Dominion's customers.

Schedule/Work Plan: At the completion of BP 1, the VOWTAP Team had developed a detailed Project schedule through a comprehensive review of Project activities and their interdependencies, providing a clear pathway to project operations by the end of 2017. This assessment, combined with Dominion's

considerable experience in project development and construction, produced a schedule that was fully integrated with reasonable activities lengths for all 250 tasks

Dominion mitigated schedule risk in the Project by ensuring adequate contingencies are applied. Furthermore, by taking actions such as issuing a limited notice to proceed (LNTP) prior to SCC approval on certain long lead items, Dominion accepted a degree of risk associated with reservation costs so that it would meet the 2017 timeline.

Project Management: The Team's collective experience prepared it to achieve the Project's goals on schedule and on budget. As the Project Sponsor, Dominion contributed to the VOWTAP Team's extensive experience with managing all aspects of Project development necessary to successfully complete large-scale, long-term capital projects on time and on budget. Prior to BP 1, Dominion evaluated the marketplace to choose the most qualified organizations to accomplish the project goals. The VOWTAP Team consisted of all the key players needed to successfully design, develop, permit, finance, execute, and operate an offshore wind facility. During BP 1, the addition of Keystone and Tetra Tech further strengthened the VOWTAP Team. Dominion also selected DNV to fulfill the CVA role for the Project.

Vendor quotes were received for the primary material and service components of the Project in BP 1. Dominion and Alstom initiated turbine supply agreement negotiations; the turbine supply agreement was anticipated to be finalized in BP 2.

A Commercial Risk Assessment (CRA) was conducted to take into account cost and schedule variances and discrete risk events that could have an impact to the Project. As part of the CRA, a series of workshops was held to develop a risk register which focused on identifying risks associated with tactical deployment, assessing the probability of occurrence, and estimating potential impacts on Project cost and schedule. This assessment enabled the Team to create mitigation plans for those risks that have the greatest potential impact.

In addition to the CRA, a Health and Safety Risk Register was developed to identify the severity of potential health and safety hazards. High impact hazards identified were associated with the construction and maintenance of the VOWTAP, including vessel transfers and heavy lifting.

Throughout the Project, the Team continued to update the risk registers and associated mitigation plans semiannually.

Financing and Commercial Development: The VOWTAP Team had a sound, well thought-out financial plan. The objective of the proposed financial plan was that the VOWTAP Team's cost share component of the Project would be readily available when needed for the duration of the Project until commissioning by year-end 2017.

The total estimated capital cost of the VOWTAP was approximately $230 million. During the 50% FEED, Dominion and KBR revised the total Project cost based on a structured methodology. The Project budget consisted of the total installed cost (TIC) estimate and Dominion's owner's cost estimate. KBR updated the TIC estimate based on the preliminary designs for the substructure, electrical, cable routing, and onshore connection, as well as the installation and transportation vessel strategy. Vendor quotes were received for the major material and service components of the Project, representing 90 percent of the total TIC. Dominion updated the owner's portion of the budget based on revised cost information in a number of areas, including estimates for geotechnical and metocean data needs.

As with any complex, innovative and technologically advanced project, VOWTAP had inherent risks that had the potential to lead to cost overruns and schedule delays. The financial viability of the Project participants and their demonstrated performance of successful project execution lowered potential risks

associated with the Project. In addition, VOWTAP planned risk mitigation strategies that included, but were not limited to, a comprehensive CRA, budgeted cost contingencies and schedule conservatism, a supportive state regulatory framework for timely cost recovery, Engineering, Procurement, Construction (EPC) or multi-prime contract protections, and insurance coverage.

As the Project Sponsor, Dominion proposed a viable path to secure financing for the VOWTAP Team's cost share component of the Project. Funding for Dominion's cost share component for all expenditures related to the Project would primarily be provided by income from Dominion's ongoing operations. It was anticipated that any additional project capital needs would be financed by its access to the debt capital markets and equity contributions from the parent company, DRI. VOWTAP could confidently state that no equity would be raised from unidentified parties or was contingent upon revenues generated from earlier phases of the Project or upon future placements of equity or debt securities which only added an additional dimension of strength.

Dominion, as the only load-serving utility proposing a project for DOE funding, offered benefits that provided critical assurance of the means to finance the Project. The state regulatory framework in which Dominion conducts business (1) eliminates the need for a third party PPA by providing an existing customer base in an exclusive service territory that the company has an obligation to serve, and (2) provides the means for cost recovery of prudently incurred Project-related expenses.

Dominion advanced the VOWTAP while moving forward with the planned development of a commercial-scale project in the Virginia WEA in order to identify ways to lower the cost of bringing commercial-scale offshore wind to our customers in the future. During BP 1, Dominion was actively developing the commercial-scale project and planned to meet BOEM's timetable for commercial development, including the submittal of the SAP by May 1, 2014; submittal of a construction and operations survey plan by November 1, 2014; completion of high-resolution geophysical surveys by November 1, 2016; and submittal of a construction and operations plan by November 1, 2018.

DOE used the following three down-selection criteria to assess and select projects to advance to BP 2:

- Criterion #1. BP 1 technical performance and progress towards stated project objectives;
- Criterion #2. Innovations and their potential reductions on cost of energy (LCOE); and
- Criterion #3. Likelihood of project success, advancement of the national knowledge base, and commercial impact in the U.S.

Ninety days prior to the completion of BP 1, Dominion submitted a series of reports to DOE that were used to conduct a review of the Project against the BP 1 down-selection criteria. The reports submitted to DOE to support their project review included:

- Design Report;
- Installation, Operations and Maintenance Report;
- Environmental and Permitting Process Report;
- Grid Interconnection Report; and
- Summary Report.

Approximately 60 days prior to the completion of BP 1, Dominion gave a presentation to DOE to provide responses and clarifications to DOE's questions and perceived Project weaknesses.

2.3 Significant Activities – Budget Period 2

On May 7, 2014, Dominion was selected as one of three companies to advance to BP 2 and receive up to an additional $47 million in funding for the further development and deployment of the VOWTAP demonstration project. During BP 2, the VOWTAP Team anticipated finalizing progress in four key development areas: (1) 100% FEED; (2) update installation and O&M strategy; (3) receive all major environmental permits; and (4) complete grid interconnection process. The key BP 2 accomplishments associated with each SOPO task are summarized in Table 4 below.

Table 4: Significant Activities within BP 2

Task/Criteria	Objective	Activities
Budget Period 2		
Task 7.1 – Design	• Complete 100% FEED up to and including vendor quotes. • Perform geotechnical investigation of turbine sites, cable route, nearshore HDD area and onshore locations. • Finalize design basis for support structure (substructure and foundation). • Finalize design basis for electrical system. • Finalize onshore and HDD civil design basis. • Finalize design basis for wind turbine. • CVA review of Design Basis Documents.	✓ Completed 100% FEED; ✓ Completed verification of the suitability of the two turbine locations; ✓ Completed site characterization activities covering the geotechnical, metocean and sea bed conditions; ✓ Completed the basis of design for site conditions, substructure, foundations, turbine and tower, electrical systems, mechanical cable and onshore civils; ✓ Completed electrical system design; ✓ Completed offshore and onshore cable routing and burial assessment; ✓ Completed coupled loads analysis for the integrated turbine and substructure; ✓ Completed the SCADA integration functional design; ✓ Completed monitoring instrumentation plan; ✓ Completed the windfarm Operation and Control philosophy; and ✓ Submitted Design Basis documents to the CVA for review and comment.
Task 7.2 – Field Testing, Instrumentation, and Monitoring	• Data measurement, testing, and dissemination plans. • Update key innovation testing plan. • Update data acquisition and dissemination plan. • Metocean data gathering including procurement and deployment of LiDAR buoy and wave and current monitoring equipment.	✓ Procured LiDAR buoy; ✓ Developed monitoring installation plan; and ✓ Finalized the layout of the monitoring instrumentation on the piles and substructure.

Task/Criteria	Objective	Activities
Task 7.3 – Vendor Quotes	• Deliver final vendor quotes and total Project cost based on design work. • Develop and issue RFPs for: o Export cable manufacture o Export cable delivery & installation o WTG delivery and installation o Foundation/substructure manufacture o Foundation/substructure delivery and installation o Interconnection station equipment manufacture o Interconnection station construction and commissioning • Determine Engineering, Procurement, Construction (EPC) strategy including market survey. • Negotiate turbine supply and maintenance service agreements. • Update commercial risk assessment.	✓ Revised contract strategy from EPC to multiple contracts; ✓ Issued 4 major RFPs for: o Export cable supply installation & HDD; o Marine Transportation and installation of the IBGS and WTGs; o IBGS fabrication; and o Interconnection Station EPC. ✓ Received revised CAPEX forecast based on proposals; ✓ Undertook a Pre-Qualification Questionnaire (PQQ) process to identify suitable vendors; ✓ Developed an approved vendor list for the EPC RFP based on the output from the PQQ process; ✓ Conducted pre-bid review meetings and site walkovers; ✓ Dominion BoD authorized additional funding to execute new contract strategy; ✓ Vendor quotations received for the major elements of the project.
Task 7.4 – Installation, Operations, and Maintenance	• Update installation methods and identify operations and maintenance systems suitable to the site • Update Port logistics and manufacturing strategy • Update the U.S. Manufacturing Plan • Finalize substructure and foundation design installation methods. Finalize Installation Vessel strategy • Update installation schedule • Update O&M strategy • Update Project Health and safety file • Update decommissioning Plan • Finalize turbine and tower installation methods. • Evaluate innovation blade inspection methodologies.	✓ Developed an alternative installation vessel strategy based on feedback from EPC; ✓ Updated turbine installation methodologies; ✓ Undertook a survey of eight alternative construction services port locations; ✓ Developed alternative turbine transportation and storage strategy; and ✓ Updated project schedule to reflect commercial operation in 2018.

Task/Criteria	Objective	Activities
Task 7.5 – Environmental and Permitting	• Submittal of all permitting or approval studies and illustration of a clear and realistic path to regulatory compliance and project completion. • Gain issuance of Final NEPA Decision Document • Support review and approval of the RAP and SAP • Gain required federal approvals. • Gain required state approvals. • Obtain local zoning, building, and engineering approvals. • Develop construction and post-construction monitoring plans.	✓ BOEM approved the RAP; ✓ BOEM posted notice of the revised Environmental Assessment (EA) and Finding of no Significant Impact (FONSI); ✓ BOEM issued Wind Energy Research Lease to DMME; ✓ Final Endangered Species Act Section 7 consultation Biological Opinion issued by NOAA; ✓ BOEM issued a finding of "no adverse effect" under National Historic Preservation Act Section 106 consultation; ✓ Received notification of no Virginia Water Protection Permit required from VDEQ; ✓ VMRC permit approval received ✓ Norfolk District, U.S. Army Corps of Engineers permit approval issued; ✓ Received notification of no authorization or permits required from the Virginia Beach Wetlands Board; ✓ Received Federal Consistency Certification from VDEQ; and ✓ Prepared a draft bird and bat post-construction monitoring plan.
Task 7.6 – Grid Interconnection	• Satisfy all necessary grid interconnection requirements • Complete PJM combined Impact and Feasibility Study • Complete state feasibility study • Complete system impact study • Obtain State Interconnection Agreement • Obtain wholesale Market purchase agreement. • Finalize Camp Pendleton ROW.	✓ Submitted ROW documents to DOE; ✓ Obtained grid interconnection agreement ✓ PJM issued wholesale market participation agreement; ✓ System impact study issued; and ✓ Discussed potential revised project regulatory path submitting CPCN to SCC with DOE.
Task 7.7 – Economic Analysis	• Refine COE Estimates for VOWTAP and commercial scale project. • Update LCOE trade-off studies of innovations using Offshore System Engineering Model. • Update model using capital and O&M costs associated with hurricane resilient design. • Refine impact to COE for a 500 MW wind farm considering the impact of using local ports and vessels for manufacturing and construction support. • Perform a series of service life extension trade studies across the integrated wind turbine system to determine potential viability and cost effectiveness.	✓ Updated Economic Analysis based on costs received from the EPC bid and the Alstom Turbine O&M agreement offers;

Task/Criteria	Objective	Activities
Task 7.8 – Project Management	• Provide reports and other deliverables in accordance with the Federal Assistance Reporting Checklist.	✓ Received RFP proposals; and ✓ Interfaced with DOE, BOEM and other regulatory agencies.
Task 7.9 – DOE Go/No-Go Review	• Prepare and submit a Continuation Application to DOE. • Participate in DOE review meeting and present a summary of the continuation application.	✓ Discussed with DOE the potential revised Project regulatory path to submitting CPCN to SCC; ✓ DOE extended BP 2 to 5/31/16; ✓ BP 2 milestone presentation to DOE; and ✓ BP2 milestone assessment.

Between BP 2 and BP 3, DOE conducted a Go/No-Go review of the three projects that had been selected to advance to BP 2. The purpose of the Go/No-Go review was to provide guidance on how projects should proceed during the subsequent budget periods, and to obtain mutual concurrence on scope redirection or discontinuation of the award(s). DOE used the following four criteria to assess projects during the Go/No-Go review process:

Criterion #1. Completion of 100% FEED Documentation;

Criterion #2. Installation, Operating, and Maintenance Plans;

Criterion #3. Major Regulatory Processes; and

Criterion #4. Grid Interconnection Process.

To support DOE's assessment of the VOWTAP during the Go/No-Go review process, Dominion submitted a Design Report and a Summary Report to DOE. Following submission of the reports, Dominion gave a presentation to DOE to demonstrate the amount of work accomplished during BP 2. In the presentation, Dominion provided the background and basis for a decision to revise the regulatory filing process to include a separate CPCN filing. Dominion requested an extension to a Commercial Operation Date of 2020 so that a CPCN could be submitted to SCC. Ultimately, DOE decided to withdraw further project funding beyond BP2.

2.4 Detailed Discussion of BP2 Accomplishments

The following sections provide a more detailed discussion of the accomplishments of the VOWTAP Team throughout BP 2, how these accomplishments fulfilled the DOE criterion used to assess the VOWTAP's progress towards meeting the objectives of the SOPO at the completion of the budget period, and how these accomplishments enabled the VOWTAP to achieve the project goals and advance the U.S. offshore wind industry.

2.4.1 Criterion #1: Completion of 100% FEED Documentation

The key design and certification accomplishments achieved in BP 2 are listed below. Further detail is provided in the 100% FEED Design Report and appendices (Appendix 2[3]).

- Site Characterization Studies;
- Basis of Design:
  - Site Conditions and general Requirements Basis of Design
  - Substructure and Foundation Basis of Design
  - WTG Basis of Design

[3] Appendix 2 only includes the table of contents for the BP 2 Downselect reports. Full versions of the reports were provided to DOE at the close of BP 2.

  - Electrical Basis of Design
  - On-shore and Civil Basis of Design

- Load Analysis;
- Coupled Loads Analysis;
- Wind Turbine Evaluation;
- The preliminary Hurricane Resilience Operational Design;
- Electrical System Design;
- Operation and Control Philosophy;
- Calculated Risks; and
- CVA Deliverables.

During BP 2, the VOWTAP Team embarked on a procurement Pre-Qualification Questionnaire (PQQ) process to identify suitable vendors with the capability to supply and deliver the project. The PQQ enquiries comprised an expression of interest questionnaire, vendor capability and experience statements, Health, Safety and Quality performance, financial stability and an anti-corruption declaration.

The PQQ enquiries were compiled into the following work areas: (i) IBGS and foundation fabrication, (ii) Export and Inter-Array Cable, (iii) monitoring instrumentation, (iv) offshore HDD, (v) onshore supply and construction, (vi) installation vessel for the IBGS and foundations, (vii) installation vessels for the offshore Export and Inter-Array Cable, (viii) installation vessels for the turbines, towers, and blades, (ix) testing and commissioning, and (x) EPC services.

The output from the PQQ process was the development of approved vendor lists for the EPC RFP.

Vendor quotations were obtained for the major elements of the project covering:

- Capital expenditure (Capex) pricing for the TIC obtained from the EPC bidder based on a level of definition consistent with the 50% FEED study.
- Capex pricing for the design and supply of the wind turbine components including generators, towers, blades and associated equipment. This is to be formalized in a Dominion / Alstom Turbine Supply Agreement (TSA). The TSA was drafted and negotiated but was not finalized at the conclusion of BP 2.
- Pricing for the provision of O&M facilities at the Wind Farm Operational Control Center (WFOCC).
- Capex pricing for the external utilities including the 34.5 kV interconnection cable and the fiber optic cable from the Interconnection Station to the Prosperity Road junction.
- Operating expenditure (Opex) pricing for the O&M crew transfer vessel. Two pricing options were obtained, new build where the vessel is owned and operated by Dominion and Charter where the vessel is leased.
- Opex pricing for the operation and maintenance of the turbines over the 5-year monitoring period. This is to be formalized in a Dominion / Alstom Service Maintenance Agreement (SMA). The SMA was drafted and negotiated but was not finalized at the conclusion of BP2.

During BP 2, Dominion developed an updated Capex budget for the Project largely based on quotations from the EPC bidder and the turbine supplier. The total estimated Project cost in BP 2 was $386.6 million.

The Capex forecast had significantly increased from that developed for the 50% FEED mainly due to an increase in the EPC cost over the original estimate. Dominion investigated a value management and public

stakeholder review process with the objective to reduce costs and optimize the execution and installation plan.

During BP 2, a stakeholder review was undertaken prior to submitting a cost recovery application to the SCC. The stakeholder review process concluded in September 2015.

The VOWTAP Economic Analysis, which included the LCOE, was updated with the new costs received from the EPC bid and from the Alstom Turbine and O&M agreement offers. Although turbine costs increased, the analysis previously included a value which was still bounding. The weight for the IBGS substructures was reduced significantly but the overall costs for fabrication and installation increased per the EPC bid.

Preliminary Project estimates were performed by the Team based on preliminary design, vendor quotes and market data. A verification of these costs was completed via the EPC bid process which resulted in an increase in forecast. This updated forecast was compared to publicly available data for the Block Island Wind Farm project offshore of Block Island, Rhode Island as scaled for two turbines verses five turbines which indicated cost were in the same order of magnitude. Cost refinements and potential additional funding sources would be further evaluated in the public stakeholder process prior to commencement of BP 3.

During BP 2, the VOWTAP Team also maintained a 100% FEED Master Document Register for documents prepared by the Project Team.

2.4.2 Criterion #2: Installation, Operating, and Maintenance Plans

The following sections provide an overview of onshore and offshore installation, construction, operations and maintenance, commissioning, and decommissioning plans, and the U.S. manufacturing plan.

Installation Vessel strategy: The offshore installation base plan, as developed in BP 1, utilized two primary installation vessels: a U.S.-based Floating Crane Derrick Barge for installing the foundations and IBGS structure and a jack-up vessel for installing the WTGs, towers, and blades.

This strategy, to deploy two installation vessels, was considered the least risk approach due to:

- Utilization of a U.S.-based vessel for the IBGS, thereby reducing reliance on foreign offshore vessels;
- Mitigation of risk of construction schedule delays by decoupling the installation of the substructure from installation of the wind turbine and tower;
- Schedule flexibility should the turbine installation vessel, which will most likely be mobilized internationally, be unavailable at the scheduled time; and
- Enabling cable connection at the turbine, independent of the installation of the turbines and towers.

An alternative installation strategy was proposed by the EPC bidder to use a single installation jack-up vessel to install the IBGS and foundations and the WTGs, towers and blades. This strategy has the following advantages:

- Provides a stable platform for the IBGS and the turbines which is less weather dependent than a floating derrick barge;
- Avoids the requirement for transporting craft workers to and from shore as offshore accommodation will be available; and
- Reduces the overall vessel mobilization logistics.

Jack-up Vessel Availability: As part of the BP 2 PQQ process, the VOWTAP Team reached out to vessel vendors with regard to availability for installation in 2017, per the original installation schedule. Six vessels were identified as available but all vendors were unable to make any commitments to the VOWTAP due to the potential for more lucrative opportunities on larger wind farms in Europe.

The EPC bidder experienced more tightening of the vessel market during the bidding period (Q1 2015) and could only identify one jack-up vessel available to undertake installation during 2017, although the vendor was also unwilling to make commitments.

Dominion planned to determine the final vessel strategy during BP 3 largely centered on the availability of a suitable vessel for the revised construction date in 2018. In determining the strategy, consideration would be given to optimizing vessel costs against risk while maximizing flexibility in the schedule for equipment delivery and significant weather events.

***Substructure Transport and Installation*:** The substructures and foundation piles would be fabricated at a yard in the Gulf of Mexico. To minimize work offshore, the fabrications would be fitted with balance of plant equipment and monitoring instrumentation at the yard. The fabrications would be secured to transport barges in the vertical position and transported to the VOWTAP site starting at WTG No. 1 (southern WTG). The substructures and foundations would be installed by either a derrick crane barge as per the base strategy or a jack-up installation vessel.

The installation vessel would be equipped with pile hammer, grouting spread, pile welding equipment, swaging tools, and a crane with sufficient lift capacity and height to maneuver and install the 152-ton caisson, the 75-ton foundation piles, and the 750-ton IBGS substructure.

Turbine and Tower Installation: The turbines would be installed by a jack-up vessel to provide a stable platform with the capability and height to install the tower sections at a maximum weight of 203 tons, the 360-ton nacelle, and the 29-ton turbine blades.

Export and Inter-Array Cable Installation: The export and inter-array cables would be manufactured and supplied from outside the U.S., likely from a supplier in Europe. The cable would be loaded at the cable supplier's quay side onto a shipping vessel and transported across the Atlantic to a port in the U.S. Upon arrival in port, the cable would either be spooled directly from the transportation vessel to a cable installation barge or temporarily stored at a port for subsequent transfer. The method of cable transfer would be dependent upon the contractor selected.

Cable burial would be undertaken from a cable lay barge typically 250 feet in length and dynamically positioned. The barge would be fitted with a cable tank, cable-laying plow with navigation suite, cabling handling equipment, and a jetting capability.

The offshore cable installation would begin with pre-installation clearance to remove any debris or obstructions on the seabed along the cable route. Following clearance, the export cable installation vessel would be positioned close to the location of the nearshore conduit punch-out and the export cable spooled off and pulled through the conduit for termination at the beach manhole.

Once secured within the conduit, the export cable would then be laid and buried to the required minimum burial depth of 2 m in a single operation using a mechanically pulled plow. The cable would be installed from the end of the punch-out location to WTG No. 1 (southern WTG) where it would be pulled up through the central caisson of the installed IBGS and terminated at the turbine hang-off head. Any local cable burial work close to the turbine substructure would be performed using a jetting remotely operated vehicle (ROV).

The inter-array cable between turbines WTG No. 1 (southern WTG) and WTG No. 2 (northern WTG) would then be installed to the required minimum burial depth of 1 m using the same methodology by either the plow or the jetting ROV.

Construction Services Port: During BP 1 and BP 2, the VOWTAP team undertook a survey of eight alternative locations. Dominion planned to make the final selection of the construction services port during BP 3, in conjunction with the EPC contractor.

Turbine Transportation & Storage: The base plan strategy developed in BP 1 was for the turbine components, towers, and blades to be loaded onto the turbine installation vessel at a European port and transported across the Atlantic directly to the installation site. This approach benefited from using the turbine installation vessel for transportation and avoided double handing of the turbine components in a U.S. port.

Should a suitable installation vessel not be available to transport the turbine components directly to the installation site, the alternative strategy would be for the turbine components to be transported by a commercial carrier from Europe and offloaded at a turbine staging yard in a U.S. port, such as the Portsmouth Marine Terminal in Portsmouth, Virginia. Dominion planned to determine the final transportation strategy during BP 3 on the basis of optimizing cost and risk in conjunction with the EPC contractor.

Onshore Construction Plan: To ensure protection of the environment, the offshore 34.5 kV and fiber optic cables would be pulled through a conduit installed using HDD methodology. The conduit would run from the switch cabinet in the beach parking lot, under the sand dunes and beach to a point approximately 800 meters out to sea. Drilling of the hole for installation of the conduit would take place from onshore to offshore.

The onshore cables would be installed by shallow point-to-point HDD techniques. The 34.5 kV interconnection power cable would be installed by direct burial and the separate onshore fiber optic unit would be installed in a conduit. The Interconnection Station and switch cabinet would be fabricated and tested off-site and installed on spread foundations as plug and play components. Construction techniques would minimize disturbance to the environment and the land owner, the Camp Pendleton State Military Reservation.

Commissioning and Decommissioning Plan: The commissioning plan integrated all components of the Project covering the 34.5 kV transmission cable from turbine to point of interconnection, the electrical equipment in the interconnection station, the overall electrical system including connection to the grid, the WTGs and associated equipment, the wind-turbine control system, the offshore balance of plant and the overall SCADA system. The commissioning also included overall integration with Dominion's Market Operation Center (MOC), Regional Operating Center (ROC), and the WFOCC.

The decommissioning plan described an indicative methodology as to how the assets could be decommissioned and dismantled once the facility life has been reached. The plan was based on current industry knowledge and experience; however, the final plan would reflect technologies and methods available at the time.

Operation & Maintenance Strategy**:** Dominion planned to establish an O&M team responsible over the 5-year monitoring period for all operation, maintenance, and inspection activities including:

- The two 6-MW WTGs, SCADA, and associated equipment;
- All other assets, 34.5 kV transmission cables, 90 kVA back-up power generator, and 34.5 kV onshore interconnection station;
- IBGS foundation coating, corrosion, and inspection of the seabed scour at the foundation mudline;
- The monitoring instrumentation and data acquisition system (DAS); and
- Post-construction environmental monitoring.

The O&M Team would be led by a Dominion Site O&M Manager who would be directly responsible for overseeing the daily operation of the VOWTAP and interface with Dominion's ROC and MOC on matters relating to the windfarm operation, outages, and power export to the grid.

Dominion also planned to engage Alstom through an SMA to operate the VOWTAP and perform maintenance of the wind turbines as well as providing a Global Organization O&M Manager for planning of the maintenance program. This would ensure that the assets are maintained in a safe and fully functional condition. The SMA was drafted and negotiated but was not finalized at the conclusion of BP2.

Specialist activities such as environmental monitoring, instrument calibration, code electrical inspections, and cable burial surveys would be undertaken by competent subcontractors.

Equipment owned by Dominion Virginia Power (DVP) located in the Interconnection Station, such as the recloser and the revenue meters, would be maintained by DVP.

The O&M team will be supported by safety and environmental professionals, engineers, commercial personnel, and administration from Alstom's Barcelona, Spain, office.

Dominion planned to engage the services of a vessel company to provide a crew transfer vessel for the transport of the tools, spares, and technicians to and from the turbines.

Maintenance and Inspection Plan: Dominion planned to develop a maintenance and inspection plan covering preventative and corrective maintenance for all equipment in the windfarm in accordance with the equipment supplier's requirements.

O&M Facilities: The strategy was for the O&M team to operate on a day-to-day basis out of a base port. The base port will include a base office and storage for daily spares with close access to a quay for the crew transfer vessel. A warehouse facility will also be provided, at the same or separate location, for the purpose of storage of long term spares and larger items of equipment and tooling.

During BP 2, the VOWTAP Team identified and assessed a range of facilities suitable for the base port and the warehouse. The Team primarily focused on the Rudee Inlet area where there are suitable real estate facilities with good access to a quay side. Dominion planned to make the final decision on the location of the O&M facility during BP 3 / BP 4.

O&M Service and Crew Transfer Vessel: During BP 2, the VOWTAP Team issued an enquiry to the vessel market for the supply of a service and crew transfer vessel with the capability to cruise at up to 24 knots with a carrying capacity of 12 passengers and 5 tons of cargo. Proposals for 18 m to 21 m mono- or twin-hull vessels were received. Procurement of the vessel would be by new build or charter, and Dominion planned to make this decision during BP 3

Operating Expenditure Budget Forecast: During BP 2, the VOWTAP Team updated the Opex for the O&M phase of the Project. Quotations were obtained from Alstom for the turbine components and from vessel suppliers for the crew transfer vessel.

The Opex is made up of three cost components: (i) windfarm O&M covering turbines and the electrical transmission system, (ii) the monitoring instrumentation and testing, and (iii) post-construction environmental monitoring. Opex costs were forecast to be a total of $17.4 million over the 5-year monitoring period.

Decommissioning Budget Estimate: A decommissioning fund of $2.5 million per year was provided over the Project life for dismantling and disposal of the facilities once the life has been reached.

U.S. Manufacturing Plan: During BP 2 the VOWTAP Team updated the U.S. Manufacturing Plan developed during BP 1. The Plan breaks up the Project elements into components, equipment and services.

Equipment and components manufactured in the U.S. would include (i) IBGS and foundation piles which would be sourced from a fabricator in the Gulf of Mexico; (ii) 34.5 kV onshore Interconnection Station electrical equipment including the transformer and shunt reactors, which are manufactured in Virginia, and onshore SCADA; (iii) onshore 34.5 kV interconnection power cable; (iv) onshore fiber optic communications cable; (v) offshore balance of plant equipment including 480-volt (v) back-up generator, 400/480-v transformer and associated equipment; (vi) offshore small power and lighting; and (vii) offshore monitoring instrumentation and metocean recording instrumentation.

Equipment and components manufactured outside the U.S. would include (i) Alstom wind-turbine generator, towers, blades, SCADA, and turbine control system; (ii) 34.5 kV export and inter-array cables including the in-built fiber optic; and (iii) swaging tool for the IBGS foundation piles.

Services to be provided by U.S.-based companies would include (i) equipment transportation barges and offshore installation support vessels, (ii) export and inter-array cable installation vessels and equipment, (iii) port facilities, (iv) onshore construction and commissioning works including the HDD, and (v) construction of the Interconnection Station and onshore cabling.

Services to be provided from outside the U.S. would include (i) turbine installation vessel, which will likely be an internationally flagged vessel based out of Europe; and (ii) supervisory labor for the turbine installation and commissioning.

2.4.3 Criterion #3: Major Regulatory Processes

***Permitting Milestones*:** Dominion and DMME made progress towards the completion of necessary major regulatory processes as designated by the metrics in the SOPO, including lease issuance, interagency consultations, and NEPA documentation, other federal and state permits and consultations and plan approval to ensure schedule viability, and development of construction and post-construction monitoring plans.

Dominion and the DMME provided the final updated RAP for the VOWTAP to BOEM in April 2015 that incorporated additional information and responded to agency comments. BOEM issued final RAP approval on March 23, 2016. The full version of the RAP, including all appendices, can be found at http://www.boem.gov/VOWTAP-RAP/. Dominion also submitted an updated SAP to BOEM in December 2014to support the deployment of meteorological buoys to measure conditions within the VOWTAP area in December 2014.

On March 23, 2015, BOEM issued to DMME the first Wind Energy Research Lease in Federal Waters, and DMME and Dominion signed an agreement so that Dominion could operate the VOWTAP under the Research Lease.

A finding of no adverse effect was received from the Virginia Department of Historic Resources in April 2015, which concluded the BOEM's Section 106 consultation process as required by the National Historic Preservation Act. The National Oceanic and Atmospheric Administration (NOAA) issued the Biological Opinion in March 2016, which concluded the required Endangered Species Act Section 7 consultation process.

Dominion and DMME completed the necessary state and local consultations and received all required, non-time sensitive state and local permits to support the construction and operation of the Project. Please see Section 3.0 for a discussion of the regulatory process and the current status of required permits, consultations, and plan submittals, as well as information on the stakeholder outreach program.

As part of Dominion's commitment to environmental due diligence for the Project, a Post-Construction Monitoring Plan (PCMP) for birds and bats was developed and provided to agencies for review and comment. Based on comments received from agency review, Dominion provided an updated PCMP to

BOEM in April 2015. Dominion planned to continue to work with the regulators and agencies during BP3 to develop comprehensive work plans.

In July 2015, the BOEM issued the Final Revised EA and FONSI for the VOWTAP. The Final EA can be viewed at http://www.boem.gov/VOWTAP_EA/.

2.4.4 Criterion #4: Grid Interconnection Process

Interconnection Agreement: The grid Interconnection Agreement (IA) was obtained through the Virginia State Interconnection process for small generators. A Wholesale Market Participation Agreement (WMPA) was obtained from Pennsylvania, New Jersey, Maryland (PJM), allowing the VOWTAP to participate in the PJM markets. PJM is the Regional Transmission Organization for the grid where the VOWTAP is interconnected.

In BP 2, DVP issued a System Impact Study, along with the IA. PJM issued the WMPA in BP 2.

Grid Code Parameters at Point of Interconnection: The VOWTAP team worked closely with the electrical grid distribution system which requires approval at state and federal level. The grid code parameters at the point of interconnection have been defined and captured in Section 3.7 of the Electrical BoD attached to the 100% FEED Design Report in Appendix 2. The grid code parameters are built into the VOWTAP electrical system design to ensure compliance under operating conditions.

The VOWTAP team discussed and finalized all interface points for communication and networking between interconnect station, wind turbine controls, ROC and MOC, including bringing third-party Internet services to the Interconnection Station. The Team also developed responsibility matrix for each party based on the functions they need to perform.

Power Offtake Agreements: A PPA for power offtake was not required because the regulatory framework in which Dominion operates provides exclusive service territories and customers that Dominion has an obligation to service.

During BP2, the project team completed key tasks in preparation to support an application for SCC approval for Project cost recovery and to support the detailed design and procurement stage in BP 3. These tasks included completion of the permitting process, completion of site characterization studies, and completion of the 100% FEED and obtaining updated vendor costs for the Project.

Dominion's strategy for Project execution included a Turbine Supply Agreement and an integrated EPC contractor. This strategy has been successfully employed on a number of large and complex projects managed by Dominion over recent years and provides for competitive pricing, appropriate risk allocation, and performance guarantees. Based on current market conditions and the nature of the project, Dominion evaluated a further breakdown of the project scope into multiple packages with appropriate risk sharing.

During BP 2, Dominion issued an RFP to the market for EPC services and received one indicative cost estimate for the Project which was significantly higher than the Project conceptual estimate. This bid was provided by a U.S.-based joint venture team with extensive EPC and marine experience. A number of European companies were contacted concerning the Project but declined to bid. In addition, the Project team significantly advanced the turbine supply negotiations completing key terms and conditions and scoping documents.

The original Project schedule contemplated commercial operation in September 2017. Due to the forecasted increase in Project cost (~70% increase over the BP 1 conceptual estimate), Dominion initiated a public stakeholder review process with the goal to reduce project cost or increase potential funding sources. Based on a successful outcome, commercial operations would now be targeted for 2018.

3.0 APPLICATION PREPARATION, BOEM REVIEW AND APPROVAL, AND STAKEHOLDER OUTREACH

The VOWTAP Team made significant progress towards the completion of necessary major regulatory processes as designated by the metrics in the BP 2 SOPO, including: issuance of a research lease; interagency consultations; NEPA documentation; and other federal and state permits, consultations, and plan approvals. The VOWTAP Team met with federal, state, and local officials throughout the duration of Project activities. At these meetings, the VOWTAP Team provided background information on the Project and solicited feedback from regulatory authorities on the Project scope, proposed environmental surveys and evaluations, and the anticipated timing and content of the required permit applications.

In 2013 Dominion undertook negotiations with BOEM regarding options for the most suitable type of Project plans and timing of plan submittal for the VOWTAP. BOEM ultimately directed Dominion to prepare a RAP for the technology demonstration portion of the Project (turbine and cable installation) in order to demonstrate compliance with federal regulations for renewable energy projects proposed under an OCS research lease (30 CFR §§ 585.626 and 585.627). Furthermore, BOEM directed Dominion to prepare a SAP for the installation of meteorological facilities that demonstrates compliance with the requirements of a SAP as defined at 30 CFR §§ 585.610 and 585.611. Dominion prepared a first-of-its-kind RAP which was approved by BOEM on March 23, 2016. The RAP was utilized to support acquisition of all other required permits, approvals and consultations. Table 5 provides a list of the approvals, consultations, and plans required for construction and operation of the VOWTAP, and the current status of each item. The Lease, RAP, RAP Approval, Revised EA and FONSI can be viewed at http://www.boem.gov/VOWTAP/. The Biological Opinion can be viewed at http://www.greateratlantic.fisheries.noaa.gov/protected/section7/bo/actbiops/vowtap_final__1_.pdf. Copies of permit applications and consultations listed in Table 5 that are not included in the links above are included in Appendix 3.

Table 5: Permits, Approvals, and Consultations

Permit, Approval, or Consultation	Regulatory Authority	Status
FEDERAL		
OCS Submerged Lands Lease pursuant to the OSCLA (43 US Code [USC] §§ 1331 et seq.) and BOEM implementing regulations (30 CFR Part 585)	BOEM	BOEM published request for competitive interest in Federal Register in December, 2012. In December 2013, BOEM issued DMME a DONCI for the proposed Research Lease. In March 2015, BOEM issued the Research Lease.
Individual Permit pursuant to Section 10 Rivers and Harbors Act (33 USC § 403) & Section 404 CWA (33 USC § 1344)	Norfolk District, USACE	Pre-application consultation was initiated in March 2013. Permit authorization was received in December 2014.
Review pursuant to NEPA (42 U.S.C. §§ 4321 et seq.) and BOEM regulations (30 CFR §§ 585.646, 585. 648(b))	BOEM, USACE, and DOE	Scoping with primary federal permitting agencies was initiated in March 2013. BOEM issued the draft EA in December 2014, and subsequently issued the final revised EA and FONSI in July, 2015.
Consultation and Incidental Take Authorization (IHA) pursuant to the Marine Mammal Protection Act (MMPA) (16 USC §§ 1361 et seq.)	National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries)	Pre-application consultation was initiated in March, 2013. Due to the time sensitive nature of the IHA (valid for only 1 year from issuance) Dominion planned to submit the IHA prior to construction of the VOWTAP.
Consultation pursuant to Section 7 of the ESA (16 USC §§ 1531 et seq.)	NOAA Fisheries, USFWS	Pre-application consultation was initiated in March 2013. The Biological Opinion was issued in March 2016.

Permit, Approval, or Consultation	Regulatory Authority	Status
Essential Fish Habitat (EFH) Consultation pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 USC §§ 1801 et seq.)	NOAA Fisheries	Pre-application consultation was initiated in March, 2013. The Biological Opinion was issued in March 2016.
Consultation pursuant to the Migratory Bird Treaty Act (MBTA) (16 USC §§ 703 et seq.)	USFWS	Pre-application consultation was initiated in March 2013. The Biological Opinion was issued in March 2016.
Consultation pursuant to Section 106 of the NHPA (16 USC §§ 470 et seq.)	Virginia Department of Historical Resources (VDHR)	Pre-application consultation was initiated in March 2013. BOEM issued a finding of no adverse effect in April 2015.
Approval for Private Aids to Navigation (PATON; 33 CFR 66)	USCG	Proposed lighting and marking was developed in consultation with the USCG. Dominion planned to submit the PATON and Local Notices to Mariners 4 months prior to construction.
Concurrence with Federal Consistency Certification pursuant to Section 307 of the Coastal Zone Management Act (16 USC § 1451 et seq.)	Virginia Department of Environmental Quality (VDEQ) , BOEM	Federal Consistency Certification was received in August 2014.
Submerged Land (VMRC) Permit (Code of Virginia § 28.2-1200 thru 28.2-1213; 4 VAC 20)	Virginia Marine Resources Commission (VMRC)	Pre-application consultation was initiated in March, 2013. The permit was unanimously approved by VMRC at the public hearing held in March, 2015.
Water Quality Certification under Section 401 of the CWA (33 USC § 1341); 9 VAC 25-660 et seq.	VDEQ	Pre-application consultation was initiated in March, 2013. VDEQ issued a waiver and no permit required letter for the Virginia Water Protection Permit in May 2015.
Conformity Determination Air pursuant to the Clean Air Act (CAA) (42 USC §§ 7401 et seq.; 9VAC5 CHAPTER 30; 40 CFR Parts 50 to 99)	VDEQ	Pre-application consultation was initiated in March 2013. VDEQ provided documentation that the VOWTAP would not require a formal general conformity determination since it was well below the conformity threshold level in December 2014.
OCS Air Permit (40 CFR Part 55; VDEQ 9 VAC 5-80 et seq.)	VDEQ	Pre-application consultation was initiated in October 2013. The application was submitted to VDEQ in October 2014. The application was deemed complete and sufficient in December 2014, but processing was put on hold due to the time sensitive nature of the permit (only valid for 18 months from issuance). Dominion planned to request that the application be processed prior to construction of the VOWTAP.
Construction Stormwater General Permit Authorization (VAR10; 9 VAC 25-880)	VDEQ	Dominion planned to submit the application prior to construction when construction details were finalized.

Dominion and the VOWTAP Team were committed to continued stakeholder communications and effective public outreach throughout the duration of Project activities. The public outreach program included the following:

- Identifying and meeting with local associations, citizen groups, and other non-governmental organizations to inform them about the Project and address any issues that were raised;

- Meeting with key federal, state, and local agencies, elected officials, and other potentially interested stakeholders to identify issues;
- Holding public open houses to provide information about the VOWTAP; and
- Maintaining a Project-specific web site with information on the status of the Project. Details that were available on the web site include:
  - A description of the Project, including photos and visual simulations;
  - News briefs;
  - Contacts for additional information; and
  - Other appropriate Project-related information.

Dominion also contacted Native American tribes to invite them to be a part of the VOWTAP process, to attend the inter-agency kick-off meeting, and to request information to be considered in the RAP. These early and frequent consultations with regulatory agencies and stakeholders facilitated a more streamlined and effective permitting process for the Project.

4.0 RFP PROCESS AND STAKEHOLDER REVIEW OF PROJECT COSTS AND METHODOLOGY

The total capital cost of the VOWTAP was initially estimated to be approximately $230 million. In addition to the estimated cost, which was significant for 11.1 MW of net generation, the regulatory process was quite involved and time consuming.

An RFP was issued for fully wrapped EPC Contractors in December 2014. Only one complete bid and one incomplete bid were received. Neither had a firm price, a provision typically required to proceed with an infrastructure project. The bids would have resulted in a project cost in the $375 million to $400 million range, which was considered unreasonable for 11.1 MW of intermittent generation. Subsequently, a new strategy was developed to take a step back in order to find a viable path forward.

The concept of a stakeholder review process was presented to the VOWDA as a viable path forward for VOWTAP. A professional facilitator was retained to lead this process. The goal of the stakeholder process was to find a viable path forward for the VOWTAP and provide results and recommended next steps to the VOWDA. The process provided transparency on costs and the development/construction strategy to a wide range of stakeholders.

A total of 87 Stakeholders participated in the stakeholder review process. Participants included: local, state, and federal agencies; elected officials; DOE demonstration project participants; domestic and European contractors and suppliers; universities; environmental/conservation groups; media; technical and academic experts, representatives from key U.S. utilities, potential supply chain participants, and Dominion technical experts and leadership.

After introductory meetings, the stakeholders were divided into cohorts based on their experience and discipline. The three cohorts included Technology and Innovations, Policy, and Contract Process and Logistics.

The policy cohort considered long term issues such as possible legislation and state and federal funding options. No specific actions were initiated as a result of their review, nor was there any legislative updates in the 2016 general assembly..

The technology cohort reviewed the various aspects of the project that involved the technology innovations or new uses of technology proposed by the VOWTAP. Because the VOWTAP is a research and development project, the consensus of the cohort was that the new and innovative technologies that were to be used should not be compromised in an effort to make the project more affordable

The most beneficial discussion during the stakeholder review process involved the contracting process. The contract process and logistics cohort reached consensus that the contract should be rebid but should be broken up into 4 to 6 packages. While it was recognized that this approach created more risk around the interfaces between the different functions, this represented the best way to get lower bids on the project.

As recommended during the stakeholder review process, new bidders were identified and contacted prior to the issuance of the RFPs in order to optimize the bid process. In addition, an offshore wind advisor was contracted to provide lessons learned and to review the RFPs prior to issuance. The results were as follows:

- A Marine supply RFP was issued which included delivery and installation of the foundations and turbines. Six companies expressed interest and received RFPs. One conforming and one non-conforming bid were received in February 2016.

- A Cable Supply and Installation RFP was issued which included design, supply, and installation of export cable. Four companies expressed interest and received RFPs. One conforming bid was received in February 2016.

- A Substructure (Jacket) Fabrication RFP was issued which included fabrication and load out of the two IBGS structures. Six companies expressed interest and received RFPs. Four conforming bids were received in March 2016.

- An On-shore electrical RFP was issued which included all interconnection station related work. Six companies expressed interest and received RFPs. One conforming bid was received in March 2016.

There are a finite number of Contractors in the world who have ships capable of performing the work required to install the WTGs and export cable (~ 8 to 9 were identified). As such, this area represents the greatest cost risk to a project like VOWTAP and requires the longest lead-time for project planning. During the RFP process the majority of contractors with capable vessels, and a desire to participate in the bid process, were contacted. As a result, six companies received the RFP.

These ships have significant opportunity cost, typically hundreds of thousands of dollars per day. Based on this, it is typical for these ships to be "booked" several years in advance of a project and to require a significant cancellation fee. For VOWTAP, this would require reserving a vessel in 2015 for a summer 2018 installation. In order for them to support the VOWTAP project, they must travel to the US, support installation, then travel back which essentially causes them to miss the majority of an installation season in Europe.

The multi-prime contractor bid process, which was a result of recommendations provided through the stakeholder review process, did result in an overall lower forecast for VOWTAP. Even though total project bids varied by $80-$100 million, when using the low end of the multi-contract bids project costs went down to the $300 million range as compared to the bids received from original RFP with a range of $375-$400M,

In a strategy to improve the likelihood of SCC approval of the higher than expected project costs, Dominion made a decision to revise the regulatory filing process to include a separate CPCN filing ahead of the A6 Rider application. Although this could improve the potential success of project approval, the COD date would need to be extended. Dominion requested DOE to provide an extension to a Commercial Operation Date from 2018 to 2020 so that the two part filing strategy could be implemented for SCC review. Subsequent to this request, DOE did not select VOWTAP to proceed in the cost sharing program. Dominion continues to evaluate next steps and options to support deployment of the VOWTAP project.

5.0 COST SUMMARY

Table 6 below provides a summary of funds expended through BP 1 and BP 2 including DOE cost share.

Table 6: Summary of Funds Expended

Category	Budget Period 1 Costs	Budget Period 2 Costs	Total
Dominion Personnel	$1,317,675	$1,450,147	**$2,767,823**
Supplies/Misc.	$4,732	$2,481	**$7,214**
FFRDC/NREL	$955,000	$423,232	**$1,378,232**
Environmental Contracts	$1,489,671	$6,158,558	**$7,648,229**
Engineering Contracts	$2,371,721	$6,192,937	**$8,564,658**
LiDAR Buoy	–	$1,606,601	**$1,606,601**
Other Vendors/Services	$98,229	$822,169	**$920,397**
TOTAL	**$6,237,028**	**$16,656,125**	**$22,893,153**
DOE Share	$4,000,000	$6,666,667	**$10,666,667**
Recipient Share	$2,237,028	$9,989,458	**$12,226,486**

6.0 LESSONS LEARNED

The VOWTAP Team was able to identify lessons learned from previous commercial-scale offshore wind development to apply to VOWTAP, as well as during the course of developing the VOWTAP, to apply to future commercial offshore wind development. Table 7 below categorizes issues encountered and successful approaches utilized during the course of the Project, the resolution that was implemented or positive Project impacts, and recommendations for future projects.

Table 7: 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
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.

7.0 CONCLUSIONS AND INDUSTRY CONTRIBUTIONS

The VOWTAP has provided a critical first step for the U.S. offshore wind industry and making commercial scale offshore wind development a reality in the U.S. The VOWTAP has provided valuable information that can be transferred to other future large-scale projects by evaluating processes and innovations that will reduce risk and LCOE. The experience gained in permitting, design, installation, and O&M will be directly applicable to future commercial-scale development. By operating in the same far offshore environment as many of the Atlantic WEAs, VOWTAP will enable future commercial projects to reduce their first of a kind risk premiums. The following section summarizes the major accomplishments of the VOWTAP, how these activities met the project objectives outlined in the SOPO, and how the VOWTAP contributed to the advancement of the commercial offshore wind industry in the U.S.

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[4*]:
    - Hurricane Studies;
    - Breaking Waves Studies;
    - Seabed Mobility Studies,
    - Scour Assessment Study;
    - Metocean Conditions Studies;
    - Geotechnical Campaign Surveys; and
    - Laboratory Analysis.
- Information collected on metocean and G&G conditions were reviewed by DNV to facilitate certification of the VOWTAP and provided experience that will help expedite the development of future offshore wind development on the OCS.
- The coupled loads analysis for the integrated turbine and substructure allowed the IBGS arrangement to be optimized providing savings in total pile weight of 240 tons and a reduction in pile lengths by 15 percent.
- The suitability of the HALIADE™ 150 for the VOWTAP environmental and site conditions was evaluated and accepted by DNV which will provide design guidance for future projects sited in hurricane prone regions.
- VOWTAP would be the first integration of the Alstom 6MW offshore wind turbine and the Keystone IBGS substructure and foundation, which have been previously demonstrated separately in the marine environment.

Installation, Operations, and Maintenance

- The VOWTAP Team consulted with the U.S. and global supply chain to inform their development of the preliminary transportation and installation plans. Information gained during these consultations can be used to establish vendor capabilities and provide insight into pricing to inform future development of commercial scale offshore wind projects.

[4] The surveys and studies listed have been previously provided to DOE throughout different phases of the project.

- After an in-depth evaluation of the Jones Act, the VOWTAP Team pioneered a baseline Jones Act-compliant vessel strategy that: reduced reliance on foreign offshore vessels by utilizing a U.S. based vessel for IBGS installation; mitigated risk of construction delays by decoupling the substructure installation from the wind turbine and tower installation; provided schedule flexibility to account for the possibility that a turbine installation vessel may not be available at the scheduled time; and, enabled cable connection at the turbines independent of the installation of the turbines and towers.
- The VOWTAP Team conducted a PQQ to identify suitable vendors with the capability to supply and deliver the project. The final result of the PQQ was development of an approved vendor list for the EPC RFP. Information obtained during the PQQ process can be utilized to inform future development of commercial scale offshore wind projects.
- Due to the increase in forecasted project costs based on EPC bids received, Dominion revised the contract strategy from an EPC to multiple contracts. Bids received from both the EPC and multi contract RFPs will help to inform future commercial offshore wind developers on the best contract strategy for their given site.
- VOWTAP innovations have the potential to reduce LCOE by 19 percent from the project-specific baseline estimate which represents s significant cost savings when applied to commercial scale development.
- The VOWTAP Team identified several suitable locations for construction service port facilities, O&M facilities and base ports in the vicinity of the project. This information can be used to inform the selection of appropriate facilities to support commercial offshore wind developers along the Atlantic coast

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.
- The VOWTAP Team worked closely with several agencies to prepare draft post-construction monitoring plans to reduce the risk of environmental impacts during construction, operation and maintenance of the VOWTAP.
- The early and frequent communication of the VOWTAP team with regulatory authorities and outreach to stakeholders resulted in early issuance of many permits which would have enabled construction and completion of the project on schedule.

Interconnection and Regulatory Approvals

- The grid interconnection agreement was obtained through the Virginia State Interconnection process for small generators.
- A Wholesale Market Participation Agreement was obtained from Pennsylvania, New Jersey, and Maryland (PJM) allowing the VOWTAP to participate in the PJM markets.

8.0 REFERENCES

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APPENDIX 3 – PERMIT APPROVALS AND CONSULTATIONS