Atlantic Offshore Wind Transmission Study

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U.S. Wind Energy

Key Challenges Remain

- Unsubsidized costs are still too high for some applications
- Many technical challenges remain especially for floating offshore
- Environmental and siting constraints
- Integration of large-scale power into the grid presents complexities

U.S. Wind Resource is Vast

U.S. Land-Based and Offshore Wind Resources
Annual Average Wind Speed at 100 Meters Above the Ground

U.S. Wind Energy Spurs Economic Growth

Wind Energy Deployment by State & Related Economic Centers and Manufacturing Facilities of the Domestic Supply Chain

DOE Wind Energy R&D, by Sub-Program

- Land-Based (Utility-Scale) Wind
- Distributed Wind
- Offshore Wind
- Grid Systems Integration & Analysis
Background for the DOE study

- Offshore wind deployment goals

- DOE’s Offshore Wind Transmission Integration R&D RFI

- Atlantic Offshore Wind Transmission Literature Review and Gaps Analysis (energy.gov)

What is the DOE study?

- 2 year’s study
- Alignment with state and federal offshore wind goals: near term (2030) and long term (2050)
- Integrated onshore and offshore planning
- Economic, reliability, and resilience analysis
- Considering environmental and community impacts
- Inter-states, inter-regional, from Maine to South Carolina
**Project Objective**

- Identification of **scenarios, and pathways** of OSW deployment with **transmission topologies** (such as radial lines, shared backbones or a meshed network), sequencing, and build-out in the Atlantic for 2030 till 2050 that meet or exceed reliability and resilience criteria while considering **ocean co-use**.

- Quantification of impacts such as **economic, reliability, and resilience** of multiple OSW and transmission scenarios and pathways, including during periods of system stress under typical and extreme weather conditions.

- Characterization and comparison of **transmission technologies** for the different scenarios, including onshore and offshore substations and cabling, and tradeoffs and costs for high voltage alternating current (HVAC) and high voltage direct current (HVDC) scenarios.

- Identification of **a critical point** (either in time or in GW of OSW deployed) at which the benefits of a coordinated transmission framework will outweigh the benefits of radial generator lead lines (GLL).

- Collection of **data and models** that are readily useable by industry for accelerating their own planning studies.
Extensive iteration and feedback among tasks
Task 1: Data, model, and TRC

• Forming of technical review committee (TRC)

• TRC will likely have three focus areas:
  1. Environmental, community, and Siting
  2. Technology
  3. Generation and Transmission Planning

• TRC meetings:
  – Kickoff meeting Dec. 8, 2021.
  – Plenary meetings on quarterly or bi-annual basis
  – Topic-specific meetings in between
Task 2: Transmission Expansion Planning

• Use NREL Regional Energy Deployment System (ReEDS) model to explore the scenario space of a variety of transmission options through 2050, likely including but not limited to:
  – Business as usual, radial approach with generator lead lines, with and without corridor consolidation
  – Collector systems to consolidated OSW clusters
  – Regional backbones Inter-regional mesh grid
  – Larger land-based HVDC overlay

• At what critical point do the coordinated transmission builds become more important? Are there risks to overbuilding?
Task 2: Transmission Expansion Planning

• Detailed transmission scenarios will be assembled using information from a variety of sources:
  - ReEDS model build trajectories
  - Stakeholder input: TRCs, project pipeline and queues
  - Data analysis
  - Initial results from production cost and resource adequacy
  - Initial results from technology characterization

• 2030 scenarios may focus more on stakeholder input, with 2050 considering models more
Task 3: Production Cost and Resource Adequacy

• Perform production cost modeling to simulate the operation of the 2030 and 2050 grids to inform:
  – How does the transmission expansion impact the operation of the grid? How is it utilized, and how does that impact curtailment?
  – What time periods would be interesting to study in the reliability work (tasks 5 and 6)?

• Perform resource adequacy modeling using NREL PRAS model to calculate reliability metrics and inform:
  – What is the resource adequacy impact of offshore wind?
  – How does transmission topology affect that?
Task 4: Technology Characterization

- Technology characterization of final transmission scenarios

- The following three OSW subsystems will be included along with environmental and regulatory considerations:
  - Delivery from platform to onshore substation,
  - Undersea cabling and installation, and
  - Marine substation design and hardware.

- We will screen for cable route areas and landing points that avoid sensitive areas, such as critical habitat, military sensitive areas, fisheries, and mitigate impacts to communities and key ocean users.

- Estimate capital costs for final transmission scenarios
Task 5: Reliability and Offshore Grid

Objectives:

– Perform comprehensive reliability studies for several stressed transmission scenarios identified in Task 2 and 3 between years 2030 and 2050

– Evaluate different planned and meshed offshore transmission approaches from the reliability standpoint
Task 5: Reliability and Offshore Grid

Evaluate system reliability for contingencies identified in coordination with TRC

5.1: Steady-state contingency analysis

5.2: Dynamic contingency analysis

5.3: Stability and Fault Behavior

5.4: Regional HVDC and Backbone
Task 6: Extreme Event Analysis

Objectives:

- Identify extreme weather events for further evaluation using PNNL’s EGRASS tool
- Conduct analysis of system steady-state and dynamic behavior during extreme weather events using PNNL’s DCAT tool.
Task 6: Extreme Event Analysis

Task 6.1
Generate Monte Carlo outage sequences

Task 6.2
Dynamic cascading grid simulations using Dynamic contingency Analysis Tool (DCAT)

- Thousands of realistic dynamic cascading simulations
- Analytics in DCAT and EGRASS to derive recommendations for:
  - Transmission hardening; Protection coordination; Preventive operational actions; Voltage support; Asset management and investment prioritization
Task 7: Review and Final Report

- Additional runs if needed
- Review and approve final report
Project Schedule

• **In Year 1 (November 1, 2021 – October 31, 2022)**
  • Create a technical review committee (TRC) with a wide range of stakeholders and expertise
  • Establish plausible onshore and offshore transmission expansion scenarios for 2030 and 2050, that consider the impacts of cable routing, points of interconnection, landing points, and environmental and community impacts.
  • Identify any critical point at which the benefits of a coordinated transmission framework will outweigh the benefits of generation lead line approach and assess how transmission will evolve over the time.
  • Begin to evaluate system operations, cost, and reliability of the established, plausible scenarios

• **In Year 2 (November 1, 2022 – October 31, 2023)**
  • Complete production cost modeling, capital investment estimation, and reliability studies
  • Perform stability analysis, transient fault behavior analysis, and resilience studies for the onshore and offshore grid
  • Deliver the final report
Questions?

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