Oregon Department of Energy
Marine Transmission in Oregon

Report to the Oregon Legislature

Reducing the long-term costs of energy for Oregonians including environmental and public health

OREGON DEPARTMENT OF ENERGY

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Cover photo credit: An Oregon fishing vessel patrols near an undersea cable ship, warning nearby vessels and watching for fishing gear. Courtesy Oregon Fishermen's Cable Committee, www.ofcc.com.

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STUDY BACKGROUND

In 2013, the Oregon Legislature passed Senate Bill 606. This law largely deals with financial assurance for marine energy devices. Section 4 of the bill directs the Oregon Department of Energy to study marine transmission:[1]

> SECTION 4. (1) The State Department of Energy shall study issues related to the transmission of electricity from wave energy facilities and devices.
>
> (2) The scope of issues to be studied may include, but is not limited to:
> (a) Opportunities for the ownership and financing of structures for the transmission of electricity from wave energy facilities or devices;
> (b) Barriers to the development of structures for the transmission of electricity from wave energy facilities and devices;
> (c) Construction and maintenance of structures for the transmission of electricity from wave energy facilities and devices;
> (d) The costs and benefits of establishing consolidated transmission capacity for multiple wave energy projects; and
> (e) Risk management and decommissioning issues related to wave energy facilities and devices and to transmission capacity.
>
> (3) The department shall seek public input regarding the scope of issues to be studied.
>
> (4) The department shall report the results of the study required by this section to the interim committees of the Legislative Assembly related to environment and natural resources on or before November 1, 2014.

The Department sought feedback on the content of the study from experts and entities directly involved in siting transmission in the ocean. In January 2014, in compliance with the requirement to seek public review of the scope of issues, the Department published a draft outline of the study.

An attachment to this report contains a list of comments filed on the draft outline, the substance of their comments and how those comments are incorporated into the final study.

In particular, the Department appreciates the assistance of John Schaad, Bonneville Power Administration; Chris Castelli and Jim Grimes, Oregon Department of State Lands; Jack Holland, formerly of Alaska Communications; Jason Busch, Oregon Wave Energy Trust; Jean Thurston, Bureau of Ocean Energy Management; Dan Hellin, Oregon State University; and Scott McMullen, of the Oregon Fishermen's Cable Committee.

[1] While the bill specifies wave energy transmission, it also expressly does not limit the report from addressing transmission appropriate for offshore wind. Therefore this report does not distinguish between types of marine renewable energy generating projects and includes potential transmission for off-shore wind.

EXECUTIVE SUMMARY

For purposes of this report, marine transmission means the primary electric power cable delivering power from a marine renewable energy project to shore.

While onshore transmission networks form an international web, offshore transmission in the Pacific will look like spokes jutting from the coast, with developers charting the most direct feasible route from the project to the onshore system. This report responds to the legislature's inquiry into what these offshore lines mean for Oregon, and whether financing or planning platforms can make offshore transmission networks operate more efficiently, with fewer lines, costs and impacts.[2]

Oregon has highly energetic marine waters and winds, plus available onshore transmission to receive power. The National Renewable Energy Laboratory estimates that the total technical potential of offshore wind in Oregon is nearly 220,000 megawatts (MW) with most of the resource located more than 12 miles offshore.[3] The Electric Power Research Institute estimates the total technical potential of wave energy on the inner shelf of the Oregon coast as 143 terawatt-hours per year (TWh/yr), or 143 billion kilowatt-hours per year (KWh/yr).[4] Modeled estimates show the coastal grid could absorb at least 430 distributed megawatts of new energy generation without requiring infrastructure upgrades to cross-coast range transmission.[5] Coastal electricity loads vary from roughly 500 megawatts in the summer to 900 megawatts in the winter.[6]

In addition to Oregon's strong resource availability, marine energy does not contribute to greenhouse gases and can take advantage of the renewable power of the ocean, providing a generating resource to Oregon's coast to strengthen coastal electricity systems. Given the opportunity for future marine energy development, and the state's interest in reducing environmental and economic impacts through efficient transmission development, the Department makes the following findings and recommendations:

1. Start a dialogue with potential marine transmission owner/operators and project developers. This would give the state, transmission planners and project developers a better understanding of building blocks to marine transmission development.
2. Consider investments in currently planned lines. This would support either oversizing lines for future projects or substation development offshore to condense the number of routes in the nearshore

[2] The Department does not, in this report, attempt to outline environmental impacts associated with transmission lines, although we do point to emerging science that is studying the most commonly identified impacts. The Department does not have expertise in environmental impacts.

[3] National Renewable Energy Laboratory, *Assessment of Offshore Wind Energy Resources for the United States*. June 2010. http://apps2.eere.energy.gov/wind/windexchange/pdfs/offshore/offshore_wind_resource_assessment.pdf.

[4] Electric Power Research Institute, *Mapping and Assessment of the United States Ocean Wave Energy Resource*. December 2011.

[5] J. Khan, D. Leon, A. Moshref, G. Bhuyan. "A Scenario Analysis of the Northwest Electrical System toward Determining the Level of Wave Power that can be Integrated by 2019 in Oregon." Powertech Labs, December 2009. http://www.oregonwave.org/wp-content/uploads/Task-4.2-Integrated-Systems-Analysis.pdf.

[6] Oregon Coastal Loading - Cross-Coast-Range Transmission Lines to Oregon Coast Area, BPA Powerflow Model, Calendar Year 2009, Load Forecast Year 2012.

environment. Fewer lines and established routes would help manage sensitive ecology, higher user density, and on-shore electrical capacity.

3. Investigate expansion of state programs and financial incentives. Incentives could be strategically targeted based on input from project developers and transmission entities.

4. Commission the next study. This report is intended to inform the Legislature about the fundamentals associated with marine transmission and offer a vision for development. A more expansive study could examine potential routes, analyze coincidence of coastal electrical capacity and development areas, provide more data analysis relevant for wave energy, conduct scenario planning, or review other Oregon-specific circumstances. For example, the Massachusetts Clean Energy Center commissioned a report to provide a technical road map for transmission development.[7]

[7] ESS Group, *Offshore Wind Transmission Study*, September 2014. http://images.masscec.com/uploads/attachments/2014/10/MassCEC-OSW-Transmission-Study-2014.pdf.

MARINE TRANSMISSION: AN OVERVIEW

Why investigate marine transmission?

In 2012, there were two proposals for marine renewable energy development off the coast of Reedsport, Oregon. One proposal, Ocean Power Technologies' Reedsport project, was a private development; the other was Oregon State University's Pacific Marine Energy Center siting proposal, a public project. With two marine energy projects in proximate development, there was an opportunity to investigate shared transmission infrastructure and the appropriate role of the state in the development process.

Since that time, Ocean Power Technologies surrendered its Reedsport project license and the Pacific Marine Energy Center proposal moved to Newport. All proposed developments at the time of this report's publication are spread between the north, central, and south coasts offshore from Warrenton, Newport, and Coos Bay respectively.[8] While the immediate opportunity for shared infrastructure is no longer present, the issue remains significant as these projects are developed: are there barriers to development of transmission? Are there efforts we can implement today to create opportunities for future projects, sharing corridors and lines to reduce costs and impacts?

Transmission is an important issue for marine energy development. With the completion of the Territorial Sea Plan for marine renewable energy siting, transmission is a logical next step. Organized financing for ocean power cables could reduce costs for developers and cause fewer environmental and fishing impacts. Currently there is no platform for sharing marine-related transmission access; each developer plans, permits, and controls its own lines to shore for interconnection as a primary facility transmission line.[9] While the environmental effects of marine electric cables are being studied, there is a need to analyze offshore utility-scale power cable development in Oregon to support the marine renewable energy sector.

Terrestrial transmission: a primer

Before investigating the new space of Pacific marine transmission, a basic understanding of the existing transmission system is useful.

On shore, transmission networks are responsible for carrying electrical energy from generation projects to distribution networks. In the West, the regional transmission network spans north and south from Canada to Baja California.

The electric grid consists of a network of electrical pathways with wide variation in voltage level, power capacity and length. Generally, large amounts of power that need to be transmitted over long distances utilize high voltage transmission lines.[10] To reach customers, the high voltage power is transformed to medium

[8] This is in reference to M3's deployment at Camp Rilea, September 2014, and proposed similar short-term deployments in the next year; the Pacific Marine Energy Center proposal, Federal Energy Regulatory Commission Project No. 14616; and Principle Power's proposal to deploy six floating wind devices under Bureau of Ocean Management docket BOEM-2014-0050.

[9] For some, this may be a practical matter – they may need to "smooth" or "clean" the power shoreside before transmitting the energy to the offtaker.

[10] Practically speaking, high voltage transmission in the Northwest is 69-kV and above. Medium voltage distribution lines utilized in the Northwest span the range of 34.5-kV down to 1.2-kV.

voltage at substations and the power flows across distribution lines that make up the network at a local level. The last step in getting power from generator to customer is transforming medium voltage power to a primary voltage level which is connected to the customer at the meter.

Transmission lines can be owned by a variety of types of organizations: investor-owned utilities, consumer-owned utilities, Federal entities such as the Bonneville Power Administration, and for-profit companies known as transmission merchants. In all cases, the operations of the transmission system must comply with reliability criteria set by regional organizations such as the Western Electricity Coordinating Council and the national regulatory body known as the North American Electric Reliability Corporation.

In Oregon, the transmission network is operated by investor-owned utilities and Bonneville Power Administration. There are many distribution utilities operating their own medium-voltage networks. Some of the utilities are vertically integrated and operate both distribution and transmission assets.

The interconnected electric grid has been described as the most complex machine every devised. The electric grid in North America operates at a system frequency of 60 Hz, and this frequency must be maintained within tight tolerances to avoid instability and possible blackouts. Loads on the grid are always changing, and the loads must always be in balance with the generation. In practice this is achieved by monitoring grid operations within regions (balancing areas) every four seconds and using automatic generator control to adjust generators up or down as needed.

Transmission planning and operations is an extremely complicated area of work. The transmission lines are costly to build and have long, complex planning, siting, and permitting processes. The transmission system has to meet regulatory requirements for very high reliability, and the system is interconnected among many different operators which necessitates coordinated, long term planning. The construction of a new transmission line is in some cases undertaken by a single owner/operator, however the high level of investment encourages cost-sharing and coordination on siting.

In the West, the transmission network consists of longer single lines and more radial configurations than in other parts of the country. The addition of significant amounts of renewable energy generation has been a driver to upgrade older transmission lines to increase power-carrying capacity and to build new lines.

Marine transmission: a primer

The term transmission is usually distinguished from the distribution system, which are the smaller lines, poles, and transformers that make up the power distribution system that we see in our communities. By contrast, transmission refers to lines with voltage levels at 69 kilovolts (kV) and above.

This report uses the term marine transmission broadly and does not distinguish between the voltage levels of the line, as the regulatory structure and financing considerations are identical. Instead, marine transmission means any power cable connecting an offshore project or projects to the shoreside electric system.

Offshore power cabling for electric generation projects such as offshore wind can be divided into two categories: *inter-array* cabling, or the power cables connecting devices to one another or to a single substation; and *export* cables, the cable connecting the offshore substation to the onshore station. For wave energy and offshore floating wind devices, inter-array cabling is an important part of project design and is authorized as part of the generation project. This report focuses on the export power cables that link the project to shore.

Standard export cables for offshore renewable energy projects are alternating current rather than direct current. High-voltage direct current lines convey bulk power over long distances more efficiently, but at a tremendous cost. The rule of thumb is that a high voltage line must be at least 50 miles long before it makes economic sense to switch from HVAC to HVDC.


Photo, left: HVAC cable. Right, HVDC cable. Credit: ABB (http://www.abb.com/).

For decades, power cables have been deployed in water environments to connect islands or cross river mouths and bays, such as San Francisco Bay and Puget Sound.

Today, more than 100 offshore wind projects are deployed in the world, totaling more than 7 gigawatts (GW) of installed capacity.[11] Many more facilities are proposed for the U.S. Atlantic coast and in Europe. For these wind farms, inter-array cables are commonly at voltage levels of 20 to 33 kV. An offshore substation is then used to transform the power up to an export voltage, such as 132 or 150 kV. According to the European Wind Energy Association, there are 11 offshore grids currently operating in Europe and 21 more grids under consideration in the Baltic and North Seas.

[11] *Offshore Wind Market and Economic Analysis, 2014 Annual Market Assessment*, Navigant Consulting for the US Department of Energy. August 2014. http://energy.gov/sites/prod/files/2014/08/f18/2014%20Navigant%20Offshore%20Wind%20Market%20%26%20Economic%20Analysis.pdf

Deployment of submarine power cables, deployed for Fire Island Wind Farm in Alaska, 2012. Credit: Bill Roth / Alaska Dispatch News.

Differences between telecommunications cables and electric transmission

Modern cable treaties and laws offer the same protections to all cables, whether used by the telecommunications, energy, or other industries. Still, there are key physical differences between power cables and telecommunications cables, which result in different deployment, operations and maintenance, and repair equipment and techniques. A comparison table is provided below. [12]

	Power Export Cables	Telecommunications Cables
Weight	176-200 pounds/meter of cable	10 pounds/meter of cable
Diameter	8-9 inches	0.7-2 inches
Flexibility	Stiffer, stouter lines	Thin, more flexible lines

Deploying cables in the ocean

Cable deployment generally follows this process path:

1. Draft route using known bathymetry, landing points and routes.
2. Survey draft route to determine official route.

[12] The International Cable Protection Committee (ICPC) maintains a library of accessible public education materials on both power cables and telecommunications cables. http://www.iscpc.org/

3. Seek authorizations.[13]
4. Design cable system to meet conditions of selected route.
5. Lay and bury cable.
6. Notify and communicate location of cable.

Surveying the Route

An initial study reviews possible routes using available information such as bathymetry data, known avoidance areas (sensitive ecology, coral, wrecks), and eligible landing points. The next step in survey work is to study the area directly.[14] In order to determine whether the seafloor characteristics are appropriate for cable burial, a survey unit may use multi-beam echo-sounding, sonographs, and seismic sub-bottom profiling to narrow down eligible routes along a 1-kilometer swath.[15] Sediment coring and other geotechnical testing can verify location suitability for burial (e.g. depth of sediment to rock, type of substrate) and help finalize the official cable route.

Laying and Burying Cable

To lay a power cable, which is larger and heavier than a fiber-optic cable, specially outfitted vessels are required.

In Oregon, nearshore cables are likely to be routed through a directional drilled conduit underneath the nearshore and beach environments. Horizontal directional drill routes are strained in technical feasibility after 1,000 meters. Further offshore, power cables will be buried in a trench of substrate, usually at least one meter deep.

To bury a telecommunications cable, a plough cuts a trench, shifting the seafloor to allow the unspooling cable to be placed beneath a layer of sediment. According to the International Cable Protection Committee, a burial process for armored cable advances at 0.1 miles per hour. A cable may be buried until reaching 2,000 meters in water depth. This is the general limit of trawl fisheries and a best management practice outlined in Part 4 of the Territorial Sea Plan. A remotely operated vehicle may be used for reconnaissance.

Cable repair

Cable injury can occur for many reasons: siting near seafloor lines across existing cables or fishing gear entanglement. When an injury causes service failure, it is called a "fault." According to the ICPC, most faults are caused by human activities in less than 200 meter water depths.

As with deployment, special vessels and relatively scarce but crucial expertise is required to repair damaged cable. Timelines for repair are long, and highly dependent on accessibility and whether the right vessel can be obtained.

[13] See section below, *Regulating Marine Transmission in Oregon*.

[14] In Oregon, cooperation with the fishing community has resulted in communication to avoid crab pot placement during survey work and using local fishing boats to conduct some forms of survey work.

[15] United Nations Environment Programme, *Submarine Cables and the Oceans: Connecting the World.* 2009. http://www.iscpc.org/publications/ICPC-UNEP_Report.pdf.

Specialized vessels

There are currently two telecommunications cable repair ships based on the Pacific coast: one based at Swan Island in Portland, and the other based in Victoria, BC. Global Marine Services is the current supplier of the cable repair ship for the North America Zone Cable Maintenance Agreement. Its ship out of Victoria services the NAZ member telecommunications as well as the scientific cables installed along the Oregon coast.

Because power cables are much stiffer and heavier than telecommunications cables, vessels for deploying and repairing this type of cable must be specially outfitted. In Europe, these vessels are available but lead times for contracting their services are long and must be planned ahead. The Pacific Coast does not have any standing vessels designed for power cable deployment or repair. Instead, a vessel of opportunity that can work as a stand-in is a modified barge, as power cables are typically relatively short and installed within relatively shallow nearshore environments.

Power cable risks

The offshore renewable power industry has focused recently on power cable design and deployment, as it is perceived as an area of heightened risk for project developers.[16]

One report outlining the risks associated with subsea power cable points to the supply chain. The recent uptick in demand for power cable technologies can lead to high prices, short warranties, and long lead times.[17]

Unique Environmental Concerns for Power Cables

One of the most common questions regarding environmental impacts from electric transmission is the presence of electromagnetic fields. The Electric Power Research Institute [18] and the Bureau of Ocean Energy Management (BOEM)[19] are investigating the effects of EMF on marine ecology. It is standard practice to shield marine transmission lines with conductive sheathing to block direct electric fields. The Oregon Wave

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[16] See, e.g., DNV-GL's recommended practices for subsea power cables, released March 2014. The premise: "Problems with subsea cables have affected many offshore wind farms and damage to cables has been identified as a major insurance risk for the offshore wind industry." http://www.dnvgl.com/news-events/news/dnvgl-releases-subsea-power-cable-guideline-following-18-month-joint-industry-project.aspx.

[17] See for example this analysis by Lloyd's of London: *Subsea Cables and the Insurance Risks Involved.* http://www.lloyds.com/news-and-insight/lloyds-blog/our-experts/andrew-mackenzie/2013/07/subsea-cables-and-the-insurance-risks-involved

[18] http://www1.eere.energy.gov/water/pdfs/mhk_spa_enviro_project_selections.pdf
The Electric Power Research Institute will assess how electromagnetic fields generated by undersea electricity transmission may affect marine species. To simulate the conditions that would exist around a transmission cable connected to a hydrokinetic energy device, researchers will observe fish behavior around a high-voltage cable connecting the cities of San Francisco, California, and Pittsburg, California. The project will investigate whether the electromagnetic fields around the power cable alter the behavior or path of fish along a migratory corridor and find out whether the electromagnetic fields help guide migratory movements or create obstacle to migration.

[19] See *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species*, May 2011. http://www.data.boem.gov/PI/PDFImages/ESPIS/4/5115.pdf.

Energy Trust has funded a number of studies including one by the Science Applications International Corporation on electromagnetic field measurements.

For more information about environmental studies associated with marine energy deployment, BOEM's environmental studies program is one resource.[20] The Pacific Northwest National Lab also hosts a database of environmental studies, called Tethys, related to marine renewable energy.[21]

Atlantic Wind Connection and longitudinal transmission corridors

In Oregon, marine transmission will be generally latitudinal in the short-term: lines that extend from the shore to each project in a spoke-like fashion.

In contrast, the Atlantic coast is considering a longitudinal backbone transmission line, called the Atlantic Wind Connection.[22] Faced with enormous Eastern seaboard electric loads, highly constrained onshore transmission, and offshore wind proposals for thousands of megawatts of power, the Atlantic coast could support an offshore high-voltage direct current transmission line that connects Virginia to northern New Jersey.[23]

The Atlantic Wind Connection proposal would extend 820 miles and expects to support 7,000 MW of offshore wind,[24] connecting with PJM (Pennsylvania, Jersey, Maryland) Interconnection and possibly the New York Independent System Operator.

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[20] http://www.data.boem.gov

[21] http://tethys.pnnl.gov

[22] http://atlanticwindconnection.com.

[23] Atlantic Wind Holdings, "Unsolicited Right-of-Way Grant Application for the Atlantic Wind Connection Project," Aug. 10, 2011, http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/State_Activities/ROW%20Application_Restated_FINAL.pdf, Accessed Oct. 28, 2014

[24] BOEM, Docket 2011-0023, "Commercial Renewable Energy Transmission on the Outer Continental Shelf (OCS) Offshore Mid-Atlantic States, Notice of Proposed Grant Area and Request for Competitive Interest in the Area of the Atlantic Wind Connection Proposal," 2011.

The proposed phases of the Atlantic Wind Connection Project. Graphic Credit: Atlantic Wind Connection

The initial application for the project was filed with BOEM in 2011. The first phase of the project is planned for New Jersey, and if approved, construction is slated to begin in 2016 and complete in 2021.[25]

The Atlantic coast has conditions (coastal loads, physically constrained terrestrial transmission, and likelihood of significant power generation in the next five to ten years), for a *backbone* transmission line connection, which the Oregon coast does not appear to have.

[25] New Jersey Energy Link, http://atlanticwindconnection.com/awc-projects/project-phases/New-jersey-energy-link

FINANCING AND OWNERSHIP STRUCTURES FOR MARINE TRANSMISSION

The rule of thumb for the cost to deploy marine cable is approximately $2 million per mile.[26] Based on a review of very large, 100+ MW offshore wind farms in Europe, a report prepared for the Crown Estate in the United Kingdom estimates that the balance of plant costs (those costs outside of the turbine units) are approximately 30% of the capital cost of the facility.[27]

Transmission Public Financing Opportunities

There are many public resources for funding marine transmission, but they are dependent on the ownership structure, discussed in greater detail below.

Most transmission is paid for through rates. Most small utilities do not own transmission; the larger utilities who do own transmission almost always finance this work directly through their rates. Investor-owned utilities in Oregon, Portland General Electric, PacifiCorp, and Idaho Power Company, are all shareholder-owned and earn a rate of return from their transmission investments.[28] In the case of Bonneville Power Administration, transmission construction and upgrades are financed through transmission rates and revenues.

Notable state funding instruments follow:

- *State Bonds*: General obligation bonds are the most secure bond; investors have absolute assurance that the bond will be repaid through the state's General Fund. The state typically invests bond proceeds in projects that can pay back the debt (for example, revenues from power sales from an energy generation project). In the event that this repayment does not cover a bond's debt, the state General Fund assumes full liability for the repayment of the bond.

  Lottery-backed revenue bonds are another alternative. Under lottery bond structures, the liability for payment on bond debt will come from those who play the Oregon Lottery, rather than the tax base

[26] Anecdotal information suggests that costs could be higher – a news report quoted a Rhode Island offshore wind farm as spending $60M on a 21-mile transmission line, 18 miles of which is undersea. http://www.providencejournal.com/business/content/20140320-national-grid-to-build-electric-cable-for-block-island-offshore-wind-farm.ece

[27] *A Guide to an Offshore Wind Farm: Published on Behalf of the Crown Estate*. BVG Associates, 2010. Other estimates for electrical system costs are as high as 40% of capital expenditure (RenewableUK: http://www.bwea.com/pdf/publications/Offshore_report.pdf) and low as 21%, where 5% is represented by the inter-array cabling (Risø DTU (Technical University of Denmark), in collaboration with the European Commission and the EWEA at : http://www.wind-energy-the-facts.org/development-and-investment-costs-of-offshore-wind-power.html).

[28] An investor-owned utility may earn a return on an authorized, prudent investment that is used and useful. A utility typically would not risk an investment that may not meet the test of being "used and useful."

and state General Fund. Lottery bonds are used to support economic development, education and natural resource programs.[29]

- *West Coast Infrastructure Exchange.* The West Coast Infrastructure Exchange[30] is a Pacific coast investment portal for private investment into public infrastructure. The Exchange is presently focused on water and wastewater infrastructure. The profile of an attractive investment is an enormous project scale (hundreds of millions of dollars), with extremely low risk and moderate long-term steady return. Marine transmission is not well-suited to an Exchange investment as it is a higher risk proposition and dependent on finding an appropriate transmission proponent.

- *State and Private Lending:* The Oregon Department of Energy operates the Small-scale Energy Loan Program, or SELP.[31] Marine transmission projects do not meet SELP lending criteria because they do not have a clearly identified and low-risk repayment source. Marine transmission has not been a good fit for traditional lending for the same reasons. Revenues from power sales are currently too low to support a proven repayment source; substantial grants and equity capital would need to be injected. In addition, collateral assets are not easily recoverable when installed at the bottom of the sea.

- *State Infrastructure Financing Authority:* Business Oregon's Infrastructure Financing Authority offers financing for energy projects through its Special Public Works Fund. This funding source is only available to municipalities, defined as "cities, counties, tribal councils, ports and special districts defined in ORS 198.010." Historically they have not funded transmission, although they have assisted with facilities planning for a municipal electric utility. However, the agency does operate a program specifically for another on- and off-shore utility: telecommunications. The program "facilitates the deployment and utilization of telecommunications infrastructure to support innovation, create economic opportunities, and build quality communities throughout Oregon," including cable landings.[32] Business Oregon supports the Oregon Broadband Advisory Council and the Oregon Broadband Outreach and Strategic Planning Project.

Transmission Ownership Models

The Oregon Department of Energy does not currently own or manage any part of the state's electrical system and lacks the infrastructure to operate a marine transmission line. This section outlines potential candidates for owning marine transmission other than a single marine renewable energy project developer.

Utility ownership

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[29] Energy projects are also eligible. See for example the Energy Efficiency and Sustainable Technology (EEAST) program, authorized in 2009. http://www.oregon.gov/energy/LOANS/EEAST/Pages/index.aspx.

[30] http://westcoastx.com

[31] http://www.oregon.gov/energy/LOANS/pages/index.aspx

[32] http://www.orinfrastructure.org/Infrastructure-Programs/Telecommunications/

The Bonneville Power Administration owns and operates 75% of the Pacific Northwest's high voltage electrical transmission system, which includes more than 15,000 miles of transmission line and 285 substations. The system spans 300,000 square miles in the West, enabling a peak loading of about 30,000 megawatts.

Bonneville is also the almost exclusive manager of transmission-level power lines on the Oregon coast. All transmission lines crossing the Oregon coastal range are Bonneville's (230-287 kV lines). With the exception of a few smaller lines owned by PacifiCorp and Avista, Bonneville manages most of the coastal transmission system. With its experience designing interconnection for the Reedsport project, Bonneville has experience interconnecting wave energy to the power grid.

If a marine energy facility of relatively large size (50 MW or larger) were developed, it would require an export cable operating at transmission system voltage. Bonneville could be a candidate for ownership of such a line. For a smaller facility, which would likely require an export cable operating at 34.5-kV or lower, Bonneville would most likely not be interested in owning the line as Bonneville has no other assets of this type.

PacifiCorp owns and operates one of the largest electrical transmission systems in the United States, spanning six states in the West. Along the Oregon Coast, PacifiCorp subsidiary Pacific Power is a distribution utility which operates *distribution* lines at 34.5-kV and below. As such, Pacific Power would be a more likely owner/operator if the export cable from a marine energy facility was at the medium voltage level of 34.5-kV. Approximately 40 MW of power could be accommodated at this voltage level, and a medium-voltage submarine cable is significantly less expensive than a high-voltage submarine cable.

Merchant transmission operator

Merchant transmission is where an independent company builds and operates a transmission line, charging user fees in order to recoup investments.

In the Northwest, there is no merchant transmission. All transmission is owned and operated by a utility, the Bonneville Power Administration, or a project developer interconnecting its project to the grid.

Collaborative ownership among project developers

The successful construction of shared renewable-energy transmission corridors in Texas could serve as a model to realize cost-effective, timely and well-sited marine transmission in Oregon.

In 2005, the Texas legislature passed SB 20 which established the concept of a Competitive Renewable Energy Zone. Consequently, five CREZ sites were identified as high-production wind areas in West Texas and the Texas Panhandle. (Total wind capacity in the CREZ is estimated at 18,500 MW.) The identification of the CREZ encouraged cooperation among wind energy developers as well as engagement of transmission planners and construction companies to analyze viable transmission corridors to deliver this rich renewable energy resource to the load centers in central and eastern Texas.

The Public Utility Commission of Texas acted in 2009, on the direction of the Texas legislature, to select companies to build the new transmission lines. The companies have been told to identify alternate routes, communicate with public officials, communities and landowners including holding public meetings. Only after this study and outreach could a company apply to the PUCT for a Certificate of Convenience and Necessity. Issuance of the Certificate constitutes approval for the construction of the proposed transmission facilities. PUCT has responsibility for allocating the costs of the new transmission.

One successful example of this process is Wind Energy Transmission of Texas, LLC, which is a company formed to develop transmission for the CREZ.[33] Wind Energy Transmission of Texas is a transmission service provider in Texas, and is currently in the construction phase building approximately 300 miles of 345-kV transmission lines and six new substations.

Without the clear regulatory path laid out in Texas for collaboration among wind energy developers and selection of transmission line owner/operators, this level of transmission expansion would not have proceeded as quickly as it has, or perhaps not at all. A more-typical timeframe for high voltage transmission line planning, siting, approval and construction is 10-to-15 years.

Marine Transmission Interaction with Western Grid Management

The transmission project or projects to deliver power from marine power projects would be part of a balancing authority area (BAA) under the Western Electricity Coordinating Council. A balancing authority area is an area within which one system operator is responsible for balancing electric load and generation and interchanges to other balancing authority areas.

A marine transmission project could be either a new BAA or an extension of an existing BAA into the marine area. The two existing BAAs that serve the Oregon coast are PacifiCorp-West and the Bonneville Power Administration. PacifiCorp-West serves the areas around the City of Coos Bay, Lincoln City, and Astoria. Bonneville serves the rest of the coastal area.

[33] http://www.windenergyoftexas.com/project/process

MARINE TRANSMISSION OPPORTUNITY IN OREGON

The Oregon Wave Energy Trust (OWET) has supported at least two key studies considering energy integration and interconnection for marine energy. The Utility Market Initiative in 2009 outlined, among many other things, loading and capacity by substation along the Oregon coast.[34] In 2014, OWET commissioned a study that evaluated the potential generating profiles of marine devices in wave climates and variable water depths.[35]

These are areas of important study and keep Oregon at the forefront of understanding the electrical implications of developing marine energy, especially wave energy. By contrast, marine transmission raises largely physical and financial questions: how and where will the line be routed, and how can costs be managed?

A case study of developing marine transmission illustrates this point.

Camp Rilea desktop study

In August 2013, the Oregon Military Department commissioned a desktop study that evaluated the feasibility of placing a power cable offshore from Camp Rilea, south of Warrenton.[36] The study evaluated two routes, a north route and a south route, for installing power cables from an underground vault at Camp Rilea, through horizontal directional drilled (HDD) conduit below the seafloor, to an exit point two kilometers offshore and into an anchored junction box. Both routes are perpendicular to shore at the north and south boundaries of Camp Rilea. The purpose of the cables is to support deployment of multiple marine renewable energy devices off the coast and deliver power directly to Camp Rilea facilities. This desktop study considered interaction with other ocean users, bathymetry and water climate, and potential hazards along the routes.

Pacific Marine Energy Center cable route development

The Pacific Marine Energy Center's South Energy Test Site is a project of the Northwest National Marine Renewable Energy Center at Oregon State University. Proposed for a site six nautical miles off the coast of Newport, the project will host utility-scale wave energy conversion devices in testing berths with a connection to the onshore grid.[37] Oregon State plans to construct a utility connection and power monitoring facility on the shore where generated power can be monitored, conditioned, and ultimately delivered onto the grid through Central Lincoln People's Utility District's system.

Initially, Oregon State investigated three main routes with branches in the nearshore environment to accommodate variable routes through a wide swath of rocky reef and landing options.

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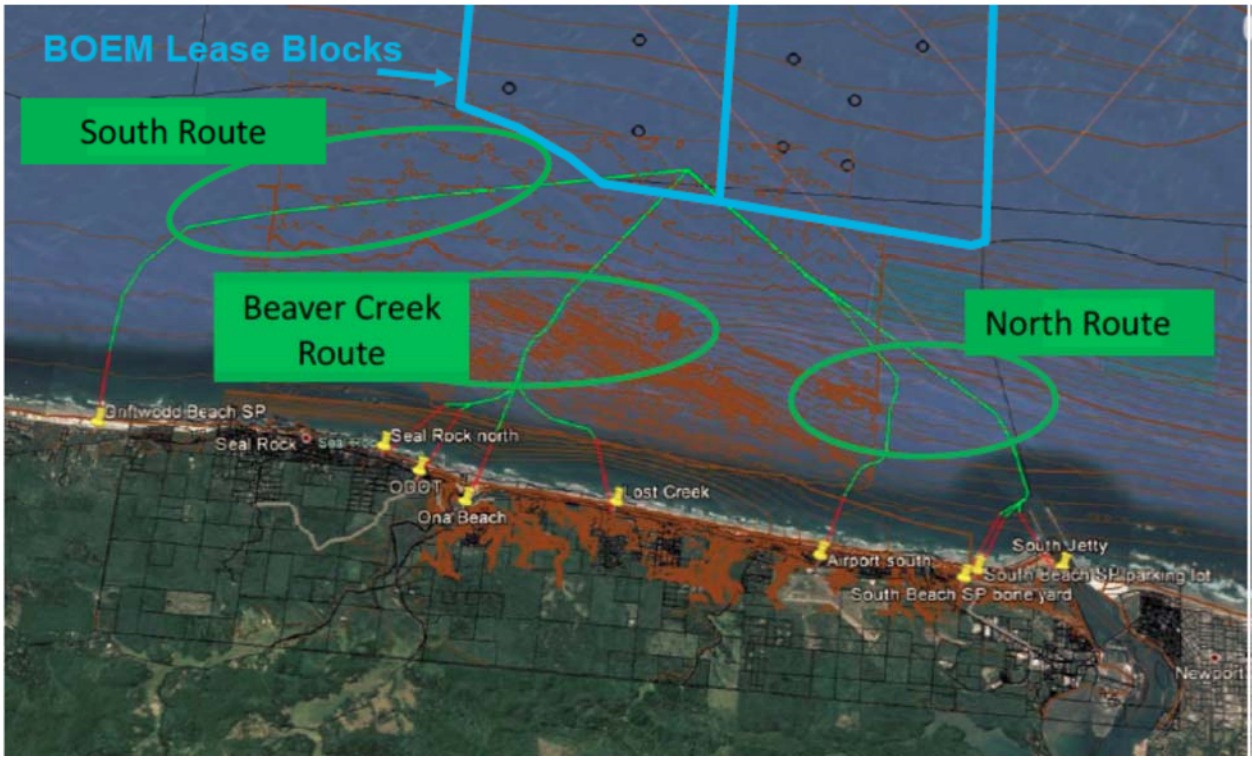
[34] Pacific Energy Ventures, *Utility Market Initiative,* December 2009. http://oregonwave.org/oceanic/wp-content/uploads/2013/05/Utility-Market-Initiative-December-2009.pdf

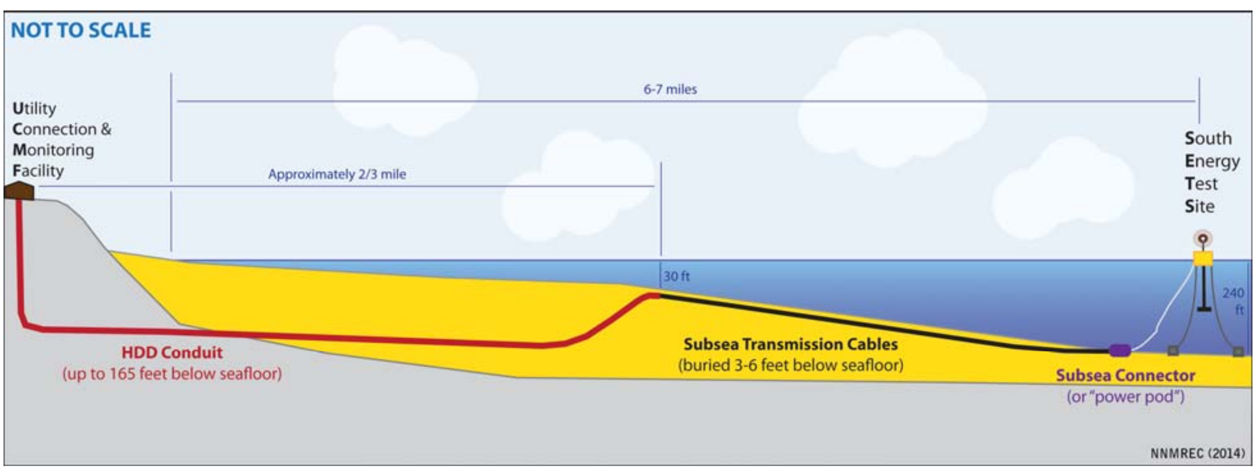
[35] Pacific Energy Ventures, *Wave Energy Utility Integration: Advanced Resource Characterization and Integration Costs and Issues*, June 2014. http://oregonwave.org/oceanic/wp-content/uploads/2014/06/Wave-Integration-Project_Final-Report.pdf

[36] Sound and Sea Technology, *Cable Route Desktop Study for the Camp Rilea Ocean Renewable Energy Project*, August 2013.

[37] At the time of this publication, Oregon State University was about to finalize its cable route study and release the results to stakeholders. The discussion of the Pacific Marine Energy Center's cable route investigation is informed by the draft study, completed in December 2013, and conversations with project personnel.



Draft cable routes from a point within the PMEC project area to shore. Credit: 3U Technologies, NNMREC.



Schematic of transmission from project to shore, showing trenched cable burial and transmission to horizontal directional drill (HDD). Credit: NNMREC.

After interconnecting with a station in the proposed leasing area, the transmission lines will be buried at 1-to-2 meter depths, then slotted through a horizontal directional drilled conduit beneath the nearshore environment to a manhole upland from the beach.

The most significant challenge with designing the route to date is navigating a rocky reef about 1 kilometer offshore, stretching from the mouth of the Yaquina River south to Waldport. Cable installation in rocky reef is technically difficult and to be avoided as an environmentally sensitive area. As a result, Oregon State is focused on the southernmost route, Driftwood Beach, although this route is significantly longer than the most direct path and as a result, increases costs substantially. Core sediment samples will be necessary to verify whether cable burial is possible along the entire southern route.

The PMEC-SETS project will have to secure easements from both BOEM and the Department of State Lands (see regulation discussion in this report), providing an opportunity to compare process and find opportunities for coordination. Once operational, there may be environmental monitoring for the cable, although the far greater unknowns around testing first-generation marine energy devices in open berths will be the main focus of environmental studies at the facility.

REGULATING MARINE TRANSMISSION IN OREGON

State and Federal Authorities, Requirements

Part 4 of the Territorial Sea Plan, *Uses of the Seafloor*, discusses the general requirements for siting telecommunications cables, pipelines, and other utilities in the Oregon territorial sea.[38] While the Territorial Sea Plan is housed at the Department of Land Conservation and Development, the primary agency implementing Part 4 is the Oregon Department of State Lands (DSL) through its authority to issue easements and authorize removal-fill activities within the Territorial Sea.[39] Cable easements require approval by the State Land Board, and need to be applied for at least 180 days prior to placement. The state Energy Facility Siting Council, staffed by the Oregon Department of Energy, is unlikely to play a role in authorizing marine transmission.[40]

In the Outer Continental Shelf, the federal Bureau of Ocean Energy Management is the lead agency granting leases, easements and rights-of-way for energy development activities. Transmission of energy generated from sources other than oil and gas on the OCS requires a right-of-way or a right-of-use and easement grant from BOEM.[41]

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[38] Adopted December 2000. Available at http://www.oregon.gov/LCD/OCMP/docs/ocean/otsp_4.pdf.

[39] Consistency with Part 4 of the Territorial Sea Plan is coordinated through DSL's proprietary and regulatory authorities (Section 3.d.). Applicable DSL rules for easements are OAR 141-083: *Rules for Granting Easements for Fiber Optic and Other Cables on State-Owned Submerged and Submersible Land within the Territorial Sea.* http://arcweb.sos.state.or.us/pages/rules/oars_100/oar_141/141_083.html ; and for removal-fill permits, OAR 141-085: *Administrative Rules Governing the Issuance and Enforcement of Removal-Fill Authorizations within Waters of Oregon including Wetlands.* http://arcweb.sos.state.or.us/pages/rules/oars_100/oar_141/141_085.html. DSL primarily coordinates consistency through the easement rules.

[40] The Council has jurisdiction over a transmission line if the line extends at least ten miles within Oregon and crosses over a jurisdictional boundary. The Department does not anticipate that a single line would select a route extending over ten miles within a three nautical mile band of the Oregon territorial sea. Moreover, if the project is a wave energy project and triggers FERC jurisdiction, then the federal authority over the primary transmission line would result in federal pre-emption.

[41] Applicable federal regulations are 30 CFR 585 Subpart C, http://www.ecfr.gov/cgi-bin/text-idx?SID=ad092a4a54725d8ae4a9c7cd5f4f4312&node=30:2.0.3.5.13.3&rgn=div6.

	Department of State Lands	Bureau of Ocean Energy Management
Jurisdiction	State Territorial Sea (3 nautical mi)	Outer Continental Shelf (federal waters, up to 200 nm)
Relevant Authority	All cables and pipelines, including telecommunications cables and transmission	Transmission of energy from non-oil and gas sources
Maximum easement / lease term	20, and by rule may be renewed at the holder's option for an additional 20-year term.	25
Width of easement	20 feet	200 feet
Fees	Cable easement application fee is $5,000. No rent but easement agreement will include a future imposition clause, which can be removed in exchange for one-time consideration fee (standard amount is $300,000).[42]	Initial rent of $70/nm and $5 per acre per year or $450, whichever is greater. Application fee for lease is $0.25 per acre. Right-of-use and easement: $2,742.

Key provisions of cable regulation affecting electric transmission include:

- *Burial*. Cables within the Territorial Sea are required to be buried underneath the seafloor.[43] The state also considers a federal action to be consistent with state policy if the cable is buried to a water depth of 2000 meters in federal waters, unless deemed impractical. BOEM's Best Management Practices encourage cable burial, whenever practicable.[44]

- *Mandatory agreement with the fishing community*. Under Part 4, DSL must require a "written agreement" between the project developer and affected fishing community. The agreement must specify how the project developer and fishing community will "resolve disputes over lost fishing gear, damage to seafloor utilities, or liability for such actions."

Part 4 expressly advises cable developers that co-siting may be appropriate in the future in order to minimize impacts.

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[42] The future imposition clause is captured in rule, OAR 141-083-0850(7).

[43] The cable "shall be buried so as to ensure continuous burial unless the approving state agencies make findings that burial cannot be practically achieved and all affected parties agree that adverse effects of not burying the cable, pipeline, or fixture have been reduced, avoided, or mitigated to the extent practicable." Section 3.a.

[44] Best Management Practice 38, adopted by the Record of Decision for the Programmatic Environmental Impact Statement (PEIS), December 2007. http://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Regulatory_Information/OCS_PEIS_ROD.pdf

Telecommunications Cables in Oregon

Oregon is a premier Pacific coast site for broadband and fiber-optic network interconnection for trans-oceanic telecommunications cables. The Oregon coast hosts landing sites in Warrenton, Nedonna Beach, Pacific City, Florence, and Bandon.

The telecommunications industry first began seeking state authorization in the 1990s.

Easement Application Number	Project Applicant	Authorization Date	End of Authorization	Easement Term	Consideration Fee	Fishing Agreement?
14626	Alaska Northstar Communications	4/9/1999	4/8/2019	20	$20,000	Y
18506	AT&T Corp.	11/1/1994	10/30/2069	75	Unknown	Unknown
18865	AT&T Corp.	4/9/1999	4/8/2019	20	Unknown	Y
21833	MFS GlobeNet	2/8/2000	2/7/2020	20	$250,000	Y
23819	VSNL Telecommunications	6/12/2001	6/11/2021	20	$300,000	Unconfirmed
23823	VSNL Telecommunications	6/12/2001	6/11/2021	20	$300,000	Y
24987	VSNL Telecommunications	4/11/2002	4/10/2022	20	$300,000	Y
26130	GCI Communications Corp.	10/8/2003	10/7/2023	20	$300,000	Y
38010	MFS Globenet Inc.	8/22/2007	8/21/2027	20	$300,000	Y

List of approved telecommunications cable easements on file with the Department of State Lands.

In response to the increased interest in landing cables in Oregon, members of the fishing community organized into what became the Oregon Fishermen's Cable Committee. The fishing community was concerned about a range of issues: liability, siting, tangling trawler gear and compensation. In 1998, the community signed an agreement with a telecommunications company to work together to conduct surveys and site the route; offer simple solutions to gear entanglement and reimbursement; and allow the fishing community to continue to fish near cables. This agreement has become the template for all telecommunications cable development in Oregon.

Part 4 of the Territorial Sea Plan, most recently adopted in 2000, confirms this cooperation by requiring a written agreement with the fishing community in order to receive an easement to use the state seafloor. More about the Oregon Fishermen's Cable Committee is available on their website.[45]

The state of Oregon has a policy of recruiting undersea telecommunications cable companies to Oregon with assurances of timely permitting and partnership from state regulating agencies and Oregon's fishing fleet.[46]

A map of telecommunications cables in Oregon is provided on page 18 of the Territorial Sea Plan, Part 5, Appendix B.[47]

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[45] http://www.ofcc.com/

[46] See open letter to Pacific Ocean Undersea Cable Projects from Governor Kitzhaber, September 2011. http://www.orinfrastructure.org/assets/docs/govletter.pdf

[47] http://www.oregon.gov/LCD/docs/rulemaking/tspac/Part_5_FINAL_App_B_10082013.pdf

In practice, applying the telecommunications regulatory structure to transmission development for renewable energy may not work well. Trans-Pacific fiber-optic cable companies are private entities with significant capital resources, while the first developers of marine energy transmission may be small-scale technology companies or public entities. The mutually agreeable path to meet the requirement for written agreements may be different than the telecommunications template. Marine renewable energy devices are still in the research and development phase. Requiring burial of cables even for very short-term deployments of scaled-down units will limit Oregon's ability to support devices on a test basis.

Planning for Cables

Currently there are no spatial plans that pre-determine where cables for any purpose must be sited. Telecommunications companies will continue to plan cable routes that lead to the five known landing sites listed above, and transmission lines are linked to renewable energy project developments which are subject to the spatial plan within Part 5 of the Territorial Sea Plan.

Drivers for transmission lines will be different depending on the type and scale of development. European offshore wind facilities have already achieved a substantial scale of development and will site their project and route transmission where the onshore connection can access a major substation. By contrast, wave energy facilities are developing down-scaled models and technologies. For example, the licensed 10-buoy array at Reedsport had a nameplate capacity of 1.5 MW. This facility size was small enough to be interconnected almost anywhere on the coastal system.

Once a cable is in place, the cable owner's interest is in maximizing the distance between the cable and any potential interference,[48] despite Part 4 of the Territorial Sea Plan's reminder that co-siting may be appropriate: "New rights of way may be required to be located as close to existing rights of way as possible or with sufficient capacity to enable future expansion within the approved right of way." Some cable rights-of-way do cross paths.

Cable downtime has serious economic consequences, so it is critical that trans-Pacific fiber-optic cables remain online. There is broad recognition of the importance of cable owner communications. In 2012, the Crown Estate, an independent business which manages Sovereign property for the United Kingdom including seafloor out to the 12 nautical miles from shore, published proximity guidelines specifying that cable owner dialogue should take place if development siting will occur within one nautical mile, and that a presumptive starting point for buffer is 750 meters, although each interaction should take a site-specific risk-based approach.[49]

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[48] A dispute about the appropriate distance between a Puget Sound tidal energy project and a fiber-optic cable corridor was a significant factor in Snohomish PUD's decision not to proceed with the federally licensed Admiralty Inlet project, FERC Project No. 12690. Although FERC agreed with Snohomish PUD that its tidal turbines were unlikely to have any effect on the cable, the cable owner, PC Landing, continuously challenged the project on administrative as well as substantive merits. Once US DOE decided not to increase its federal grant contribution to cover these and other cost escalations, Snohomish PUD declined to pursue the project.

[49] The Crown Estate, *Proximity of Offshore Renewable Energy Installations and Submarine Cable Infrastructure*, 2012. http://www.thecrownestate.co.uk/media/5658/proximity-of-offshore-renewable-energy-installations-submarine-cable-infrastructure-in-uk-waters-guideline.pdf.

In planning for marine renewable energy projects, the state provided existing seafloor cables with a planning buffer of 1000 meters in the spatial plan associated with Part 5 of the state Territorial Sea Plan.

CONCLUSION: CHALLENGES AND VISION FOR DEVELOPMENT

State investment in creating organized platforms for marine transmission development makes sense from a policy perspective. Simplifying access to the grid, permitting hurdles, and cable installation, operation and maintenance will foster development of marine renewable energy projects and recruit project developers to Oregon. Siting fewer, larger lines in the ocean will reduce impacts to marine life and to ocean uses such as fishing. Protecting the environment, developing clean energy, and encouraging economic development are state goals.

Candidates for transmission ownership and financing structures do not neatly align. A case can be made for public investment where the risks and scale of traditional investment do not match the opportunity. But what is the project that public investment should support?

Development Scenarios that Meet Public Policy Goals

The outcome that best facilitates marine renewable energy development is a unified open-access form of available high-capacity off-shore transmission.

Oversize currently planned lines.

The state could fund current project developers to oversize their planned transmission lines. From north to south, these developers are the Oregon National Guard at Camp Rilea, Oregon State University's Pacific Marine Energy Center at Newport, and Principle Power's Windfloat project offshore from Coos Bay.

The first two examples make the most sense for oversizing as relatively short distances with identified marine renewable energy development opportunities. At Camp Rilea, power cable infrastructure would support short-term tests and future commercial development in a relatively shallow shelf identified as a development area in the state Territorial Sea Plan (inside the three nautical mile line). For Oregon State University, located further offshore at six nautical miles, an oversized line would extend to a substation on the Outer Continental Shelf. Oregon State's construction plans include a facility that operationally stands between the test devices and the power grid; some accommodation for additional developers to use or bypass that facility would need to be designed.

Build a line to an offshore hub substation.

For Principle Power, with a project located closer to 20 miles offshore, an oversized line from point-to-point would be a significant investment benefitting only one project site. Instead, an alternative might be to route a shorter line that navigates some of the highest potential conflicts and impacts directly offshore and interconnects to an offshore substation.

Under this "hub" scenario, the physical interconnection to the onshore grid is already managed; all that is required of a project developer is interconnection to an offshore hub. The hub would be connected to a coastal substation with available capacity and possibly designed to serve other on-shore needs for power system benefits where we currently have constraints and no power generation support.

An offshore substation would create predictability for developers, ocean users, and public interests, clustering deepwater commercial development in one area of the Outer Continental Shelf.

Alternate Ownership Scenarios: Plausible Candidates

Merchant transmission operator

While transmission merchant companies can develop transmission cost-effectively and manage for high risk investments, the cost to developers to access the line and the level of costs assigned to developers to insulate the merchant transmission company from risk would be high. Also, for merchant transmission companies to be interested in developing in the ocean, there should be both a reasonable expectation of near-term project development and a scale of development that would yield returns that make the effort worthwhile.

Bonneville Power Administration and PacifiCorp

Bonneville is a candidate for building, owning, and operating marine transmission. While development timelines may be longer and the costs of construction may be higher, there are tradeoffs in significant technical expertise and the line's inclusion in the existing balancing authority. As an organization, Bonneville is likely less risk-averse to owning this type of asset. It has long-term experience operating submarine cables in the Puget Sound region.

For Bonneville to consider developing a line, however, there would need to be a queue of probable and firm transmission customers requesting service – a long-term proposition for marine energy. Bonneville owns and operates transmission almost exclusively at the 115-kV level and above. If the collective size of connected marine energy facilities is less than 50 MW, the export cable would likely be a lower voltage. This could present a barrier to ownership.

PacifiCorp provides electric service to the coast and owns substantial transmission in the West. PacifiCorp has little to no experience operating submarine cables. The company has also not shown interest to date in developing marine renewable energy projects, a likely prerequisite to investing in marine transmission.

Key Considerations

Chicken and egg: transmission and energy projects, which comes first?

Building an oversized line or other system investment in anticipation of future development is an issue present in both terrestrial and marine transmission. Do you "build it and they will come," a common reference to building transmission before new generation projects are proposed? Oversizing works well when there is a chain of development and the follow-on projects are clearly known. A transmission line that is not fully utilized risks becoming a stranded asset and in particular for regulated utilities, a failure to meet the test that a line is "used and useful" and therefore not eligible for a rate of return.

Timing: funding infusion to oversize before lines are constructed

For project developers to build a larger line than they need, money is required. Despite the Territorial Sea Plan's (Part 4) warning to cable owners that their routes may need to be used by others in the future, economic considerations drive decisions in the opposite direction from this planning directive. Once a line is in place, a capacity upgrade to the entire line does not make sense from a cost and technical standpoint. Co-siting a new line next to another line creates physical hazards to the existing line. Oversizing and the associated funding incentive must take place during the design phase of a project.

Building a marine services supply chain

Oregon has a strong subsea telecommunications cable industry operating off its shores. This has resulted in a relatively known regulatory scheme and series of practices for cable deployment. Because power cables are heavier, thicker, and stiffer than fiber-optics, the marine services and associated equipment required to deploy power cables will be different. Cable deployment vessels will be workarounds, such as barges, or pulled from other coasts on long lead times until a larger marine renewable energy industry can be established on the Pacific coast.

Even for the sophisticated offshore European wind industry, power cables are still a key component that needs supply chain and deployment technique improvements. With our focus on wave energy, where devices themselves are still in the research phase, assisting with electrical system development will be a substantial boost to making marine energy a reality for Oregon.

ATTACHMENT: PUBLIC COMMENT OPPORTUNITY COMMENTS RECEIVED AND DEPARTMENT RESPONSES

Commenter	Comment	Response
Atmocean	Points out that wave energy development can operate at much smaller scales than offshore wind, and that some wave energy devices use pressurized water to create power onshore, rather than generate power at the device and transmit power to shore. Indicates belief that the cost of transmission paired with potential power production from individual projects makes transmission uneconomic for wave energy.	Points will be noted in commenter appendix.
Bureau of Ocean Energy Management	Provided description and references to BOEM authorities and rules for siting transmission on the Outer Continental Shelf. Provided references to studies on the environmental effects of transmission lines.	The Department appreciates these references and will incorporate them into the final draft.
Northwest National Marine Renewable Energy Center (NNMREC) at Oregon State University	Agrees that supply chain and marine operations are important factors for development. Suggests including discussion of non-electrical transmission, such as pressurized hydraulics. Recommends additional clarity in the final report on the discussion of financing tools.	Agree on the importance of supply chain discussion and will provide recommended clarity on financing options.
Oregon Department of Land Conservation Development	Scope and references appear appropriate. Recommends that description of Part 4 procedures broadly describe the intent and structure of the regulatory process rather than individual actors in past proceedings.	The Department appreciates these comments and includes limited discussion of past proceedings for telecommunications development as a reference presumption for how transmission lines will be permitted in the future.
Oregon Department of State Lands	Provided description and references to State Lands rules and administration procedures under Part 4 of the Territorial Sea Plan	The Department appreciates these references and will incorporate them into the final draft.
Oregon Wave Energy Trust	Supports the study purpose and outline. Recommends including the use of general obligation bonds as one of the financing alternatives evaluated. Recommends avoiding extensive discussion of environmental impacts from marine energy development.	Agree on limited scope and avoiding subjects outside of the Department's expertise. The Department will include a discussion of general obligation bonds among financing alternatives.