



Prysmian cable-laying ship Giulio Verne.



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Long Island Power Authority links to the PJM Interconnection with an undersea/underground HVDC link.



Connection

LOWER-COST POWER, ENHANCED MERCHANT MARKET, ENERGY DIVERSITY AND OFF-ISLAND INTERCONNECTION CAPABILITY FOR RELIABILITY were the established goals. Through a competitive solicitation in May 2004, the Long Island Power Authority (LIPA; Uniondale, New York, U.S.) selected the Neptune Regional Transmission System (Neptune; Fairfield, Connecticut, U.S.) high-voltage direct current (HVDC) transmission project to be what LIPA termed "the centerpiece" of a comprehensive plan to meet its customers' growing energy needs.

The Neptune project, a 65-mile (106-km) undersea and underground cable, will allow LIPA to access as much as 660

MW of power from diverse resources within the neighboring PJM Interconnection, a regional transmission organization that taps into generation resources in the Pennsylvania, New Jersey and Maryland markets and beyond. The Neptune project also adds off-island transmission interconnection capability and helps to mitigate the risk of significant increases in the price of oil and natural gas as a result of national or international events.

OVERVIEW

The project involves the installation of a 500-kV, 660-MW HVDC cable that will extend from a First Energy Inc. (Akron,



Duffy Avenue HVDC valve hall and cable terminations.

Ohio, U.S.) substation in Sayreville, New Jersey to the LIPA Newbridge Road substation in Levittown. It is the longest undersea/underground transmission project on the East Coast.

The Sayreville converter station will transform ac power into dc power for transmission to Long Island, while the Long Island converter station will transform dc back into ac power for distribution to customers. The majority of the route — more than 50 miles (80 km) — is underwater in the New York-New Jersey Harbor and the Atlantic Ocean, and 14 miles (22.5 km) is buried in the eastern shoulder of the Wantagh State Parkway that connects Jones Beach on Long Island's southern shore to the Northern State Parkway, a major eastwest thoroughfare.

Construction of the US\$600 million project began in October 2005, with commercial operation commencing in July 2007. This project will result in more than \$1 billion in net benefits over 20 years to LIPA and its customers. Meeting this schedule required overcoming significant and complex siting, permitting and engineering challenges.

SITING AND PERMITTING

Environmental studies and siting began in September 2001, as scientists, engineers and regulatory specialists considered several alternative transmission technologies and routes to connect mainland energy resources in PJM to the relatively isolated Long Island electricity market.

Siting a new transmission facility in the New York-New Jersey metropolitan area, the most populated coastal region of the United States with approximately 20 million people, was no small task. With highly congested urban and residential areas separating Long Island from New Jersey, an underground and undersea transmission system, using HVDC technology, clearly was the least-impact alternative for connecting Long Island to the wider selection of mainland power supplies.

HVDC technology was selected over more conventional ac transmission systems for its superior ability to move large blocks of power over long distances without requiring the high-charging current of ac systems. Buried and submarine cable technology allowed the project to avoid or minimize common impacts associated with land-based high-voltage ac



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transmission, including acquisition and construction of new rights-of-way, electromagnetic fields and visual impacts associated with transmission-line towers.

While siting the transmission system in the water eliminated many land-side issues — including the need to cut across Staten Island or through Manhattan's tangled utility infrastructure — it required in-depth knowledge of existing commercial and natural resources in the New York-New Jersey Harbor.

The New York-New Jersey Harbor is the largest port complex on the East Coast of North America, handling more than 2.8 million containers every year, or on average about 7700 containers every day. Siting the submarine cable to avoid or minimize potential disruption and impacts to navigation channels and shipping lanes was critical to gaining project acceptance from local pilot associations and approvals from the U.S. Army Corps of Engineers and U.S. Coast Guard. Siting the submarine cable adjacent to existing utility easements whenever possible was also important in minimizing potential cumulative impacts of an additional utility crossing.

Key approvals were also necessary from local and state

MOTIVATIONS

In 2004, the Long Island Power Authority (LIPA) contracted with Neptune Regional Transmission System, LLC to build and operate the power line in response to steadily mounting energy demands. LIPA's service area, which includes Suffolk and Nassau counties, as well as Rockaway Peninsula in New York City's Borough of Queens, is home to a growing population of more than 3 million people.

Faced with the need to act quickly and avoid potentially lengthy permitting and siting issues required for new generating facilities on Long Island, LIPA determined that improving transmission and connecting to a diversity of energy resources were among the best options in terms of cost and schedule. An underground and undersea transmission line cutting across Lower New York Bay between New Jersey and Long Island proved to be a viable solution to Long Island's energy needs.

agencies, including the New York State Public Service Commission, the New Jersey Department of Environmental Protection, the New York State Department of Environmental Protection, the New York State Department of Transportation and the New York State Office of Parks, Recreation and Historic Preservation. While modern submarine cable technology has been repeatedly proven as environmentally friendly, resource agencies in both states had concerns about the concept of installing a submarine transmission cable through the highly valued shellfish resources of Raritan Bay and the south shore of Long Island. The agencies required extensive assessment of potential impacts to these valued resources, as well as of the potential release of contaminated sediments from other areas of New York Harbor along the proposed cable route.

To address agency concerns, a 3-D hydrodynamic and water-quality model of the New York-New Jersey Harbor, New York Bay and New York Bight was developed to predict potential sediment-suspension and water-quality impacts of burying the power cable in the seabed. The results of the model formed the basis for key permit conditions to be negotiated and the approval process to move forward.

The State of New York Public Service Commission issued a Certificate of Environmental Compatibility and Public Need for the Neptune project in January 2004, following a coordinated review among several state agencies. Almost a year later, in December 2004, the New Jersey Department of Environ-



Neptune Regional Transmission System site map.

mental Protection followed suit and issued a Waterfront Development Permit authorizing installation of the Neptune project in New Jersey waters. Federal authorization from the U.S. Army Corps of Engineers was received in February 2005.

In less than four years, Neptune had secured the federal and state permits required for construction of a new bi-state 65-mile HVDC transmission line, a process that often takes more than 10 years to complete.

ENGINEERING AND CONSTRUCTION

With the environmental permits in hand, Neptune Regional Transmission System, LLC, the company responsible for developing and building the 65-mile project, turned its



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attention to obtaining final engineering, procurement and construction (EPC) services to build the first-of-its-kind stateof-the-art underground and undersea HVDC transmission system in North America.

Neptune secured the services of a consortium of two global companies, Siemens Power Transmission and Distribution Inc. (a wholly owned U.S. subsidiary of Siemens AG) and Prysmian Cables and Systems USA, LLC (formerly Pirelli Cavi y Systemi Energia SpA), for manufacturing and installation of the cable, construction of the converter stations and installation of station components. Siemens, which has designed and built more than 20 HVDC projects throughout the world, and supplied the HVDC conversion and control technology for this project. Prysmian supplied and installed mass-impregnated 500-kV HVDC submarine and underground cables as the main link for the converter stations.

While the 500-kV HVDC cable provides the main link between the converter stations, Prysmian will also provide two additional but equally important cable segments: a 230-kV ac 2500-mm² cross-linked polyethylene (XLPE)-insulated underground cable between the Sayreville converter station and the First Energy Inc. substation; and a 345-kV ac 1600-mm² XLPE-insulated underground cable between the Long Island converter station and the LIPA Newbridge Road substation in Levittown.

Construction began at each of the converter station sites in October 2005, along with the 14 miles of underground civil



Cable-reel delivery at Long Island's North Wantagh State Parkway.

work required for upland cable installation underneath Jones Beach State Park and alongside the Wantagh State Parkway on Long Island. But before construction could begin, final civil engineering design was needed for agency review and approval of the entire underground cable route and significant portions of the converter stations.

The underground cable minimized impacts to the aesthetic and visual resources of the area along the parkway and through Jones Beach State Park, one of the most popular parks in the New York State Park system, with well over 30 million visitors each year. Burying the cable, however, had its own set of technical and regulatory challenges.

CHALLENGES

Placement of the cable underground within a heavily used park system and within a transportation right-of-way required careful thought to future infrastructure improvement and safety projects. To ensure the cable installation would not interfere with future safety improvements (such as walkway, lighting or guide-rail replacement) to the park and parkway right-of-way, a complex matrix of burial-depth criteria and offsets was developed. In addition, while most of the burial would be performed by trenching, roadway interchanges and bridges had to be crossed via horizontal directional drilling (HDD) to avoid lane and ramp closures. More than 2300 ft (701 m) of the 14-mile land route was installed via HDD.



Cable-laying barge, cable tender and floated cable during submarine cable landfall ops

The civil-engineering design for the cable installation work was delivered in less than four months, but meeting this schedule required early coordination with local and state agencies, as well as considerable site survey and preliminary design work to be done prior to final permitting.

As the civil work along the underground cable route neared completion, the focus shifted to the coordination of cable delivery and installation. The need to develop an acceptable work plan and coordinating the delivery of 36 cable reels, some weighing more than 120,000 lb (54431 kg) and measur-



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ing more than 13 ft (4 m) in diameter over 14 miles of public roadway, became a critical priority.

Using an iterative and collaborative approach among the general contractor, the civil, electrical and traffic subcontractors, the heavy-haul subcontractor, and state and local authorities, an acceptable cable delivery and installation work plan was developed that called for the setting up of special construction access areas and coordinated roadway closures to facilitate over-sized cable deliveries at night, without interfering with Jones Beach State Park's summer concerts and activities. Carefully coordinated efforts with local municipalities and state and local police departments, as well as public information announcements, were needed to avoid impacting traffic during the height of the summer season. Through a joint effort by all parties involved, the work plan was completed well before the delivery of the first cable reel.

CABLE INSTALLATION

Cable installation at sea was accomplished via a purposebuilt cable-laying barge and Prysmian's cable-laying vessel Giulio Verne. Cable burial was accomplished by hydro plowing. U.S. Army Corps of Engineers' permit stipulated burial depths of 4 ft (1.2 m) outside of navigation channels and up to 17 ft (5 m) at channel crossings. Pre-dredging crossing areas to depths that would allow subsequent cable burial via hydro plow facilitated cable installation at channel crossings. Approximately 75,000 cubic yards (57341 m³) of sand, silt and clay were required to be removed and properly disposed of to meet burial-depth requirements.

PROJECT COMPLETION

Facility construction and cable installation were completed in early 2007. Following commissioning and testing, commercial operation began in July 2007. The Neptune transmission system — the first underground and undersea HVDC transmission line between New York and New Jersey — will carry enough power for approximately 660,000 homes, providing Long Island with a major component of LIPA's long-term energy solution for its growing customer base. TDW

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