

Collector System Design and Installation for Canada's Largest Wind Farm

Background

To effectively harness wind energy, wind turbine generators must be strategically placed in areas with high average airflow velocities, with considerable separation between the generators. As a result, wind farms are often sited on gigantic parcels of land in coastal regions. The Prince Wind Farm—the largest wind generation facility in Canada—is no exception. Covering nearly 20,000 acres on the northeast shore of Lake Superior, in Sault Sainte Marie, Ontario, the facility can provide 189 megawatts of power from 126 wind turbine generators.

The wind farm has two collector substations that consolidate power from the 1500-kW wind turbine generators. Prince 1 substation receives power from four feeders, through the underground collector system connected to 66 of the generators. Prince 2 substation receives power from three feeders, through the predominantly overhead collector system connected to the remaining 60 generators. The two collector substations are connected to the interconnect substation via a 6.6-mile-long 230 kV transmission line. The interconnect substation at the other end of this line is the interface to the power transmission company.

The rugged terrain of the Prince Wind Farm made siting the wind turbine generators particularly



Pre-cast concrete vault for underground collector circuit isolation switch.

challenging. A great deal of rock blasting was necessary to construct the 30-miles of cable trenches and duct bank for the Prince 1 substation underground collector system. And hundreds of poles were needed for the Prince 2 substation overhead collector system. Further adding to the complexity of the project . . . the ground-resistance specification of the wind turbine generator manufacturer required the design and installation of a sophisticated counterpoise system to interconnect the turbine towers.



Prince 1 underground collector system.



Prince 2 overhead collector system.





Prince Wind Farm.

This last requirement was the most challenging. S&C prepared a needs assessment, which concluded that the electrical system had to be completely reconfigured. Automatic switching of the two incoming utility source lines would be necessary, with the two generators connected in parallel with the utility sources. A special control system would be required to synchronize the generators with utility circuit breakers. Extensive changes to protective relaying would be necessary too. More than 20 different automatic operating sequences had to be considered, to address possible equipment and utility source contingencies, and maintain electrical service in the plant.

Services provided

S&C Electric Company was the primary contractor for the two collector substations, the transmission line, and the interconnect substation. For the collector systems, S&C provided the following services:

- Project management
- Ampacity and voltage stability analyses
- Fault current, protective-device coordination, and grounding studies
- Civil, structural, and electrical engineering and design for the turbine tower grounding system,

counterpoise system, cable trenches, duct bank, overhead distribution system, and fiber-optic communication system; junction and switching details; and road and stream crossing details

- On-site construction management
- Equipment procurement
- Equipment installation
- Testing and commissioning, and
- Energization

Results

S&C received notice to proceed with the project in September 2005. The interconnect substation was to be on-line and connected to the transmission system by June 2006.

Engineering, design, and construction of the Prince 1 substation underground collector system began in September 2005. By October 2006, all 126 wind turbines were delivering power to Ontario's transmission grid. Now in commercial operation, the Prince Wind Farm produces enough energy for nearly 40,000 homes. It is an important contributor to the provincial government's goal to generate 5% of Ontario's energy requirement from renewable sources.