

Grid Frequency Reinforced by Wind Turbines

When the electricity generated by solar panels and wind turbines is fed into the power grid, one of the biggest technical challenges is to maintain a stable frequency of the electrical network — and thus prevent blackouts. Robert Nelson from Siemens Wind Power has developed techniques that help to control the frequency of the power in systems with wind turbines. This helps prevent sudden fluctuations in network frequency due to changing system conditions. These techniques are especially important for the operators of smaller power grids, such as those on islands.

A problem faced by all power systems is the sudden trip of a large generation source. Power system operators control frequency by balancing generation with load, so a sudden loss of generation can trigger a large frequency decline, which, in turn, can cause the operation of Automatic Under Frequency Load Shedding (AUFLS), causing customers to be disconnected suddenly and involuntarily. As power system operators like to joke, “AUFLS are awful!” In a large power system, the loss of a single generator may only cause a minor frequency decline, but in a small isolated “island” system, a single generator trip can cause customer load disconnection.

Robert Nelson of Siemens Wind Power in Orlando developed a control to allow wind turbines to respond to sudden grid frequency drops so that system operators can avoid under frequency load shedding, and “that is something that grid operators want to avoid,” Nelson explains. Nelson, an engineer, studied electrical engineering at the US Military Academy at West Point and received his Master of Engineering in Electric Power Engineering from Rensselaer Polytechnic Institute in New York. He has worked for Siemens for over 24 years, much of that time as a design, control and applications engineer for synchronous generators, excitation systems, and Flexible AC Transmission Systems (FACTS). Prior to coming to Siemens, he worked as a planning engineer for an electric utility, an operations engineer for a power pool, and a consulting engineer.

Nelson was working for Siemens Wind Power when he developed the method of controlling turbine output to alleviate frequency concerns. “The first power market that used my development to maintain network stability was on an island”, says Nelson. Although renewables account for only about 10 percent of the island’s power supply, they are very suitable to enhance frequency stability. “In a small network, the loss of a generator would have serious consequences,” he explains. “The grid frequency would fall sharply, and it would take some time before the reserve capacity from other power sources start producing power in adequate quantities.” To prevent the grid from automatic load shedding, wind turbines can rapidly increase their output for a short period of time to bolster the system frequency.

Now, thanks to his invention, the island power supply frequency is more stable. “The idea is simple,” explains Nelson. “Kinetic energy is available in the shaft and rotor of the wind turbine. It is possible to extract some of this energy and convert it to electric power in addition to what would normally be produced by the wind turbine. Although this slows the rotor down and results in a very short-term loss of energy production by the wind turbine following the contingency, it

helps prevent the system frequency from dropping to levels that may necessitate customer disconnection. It is only necessary to apply this additional power for a few seconds – 10 seconds is a typical number – in order to prevent unnecessary customer inconvenience and help make wind a ‘good neighbor’ in the power system.”

Although interest in this control was originally restricted to smaller island systems, it is now being required by increasingly larger “electrical islands,” like several of the Canadian provinces and Latin American systems that operate isolated grids. Nelson’s ability to anticipate that this control would become a widespread requirement helped Siemens Wind Power enter several new markets.

This valuable control is only one of Robert Nelson’s 50 inventions. Nelson, who works as a Senior Expert Engineer at Siemens Energy in Orlando (Florida), USA, has registered 44 individual patents in 18 IPR families for the Company.