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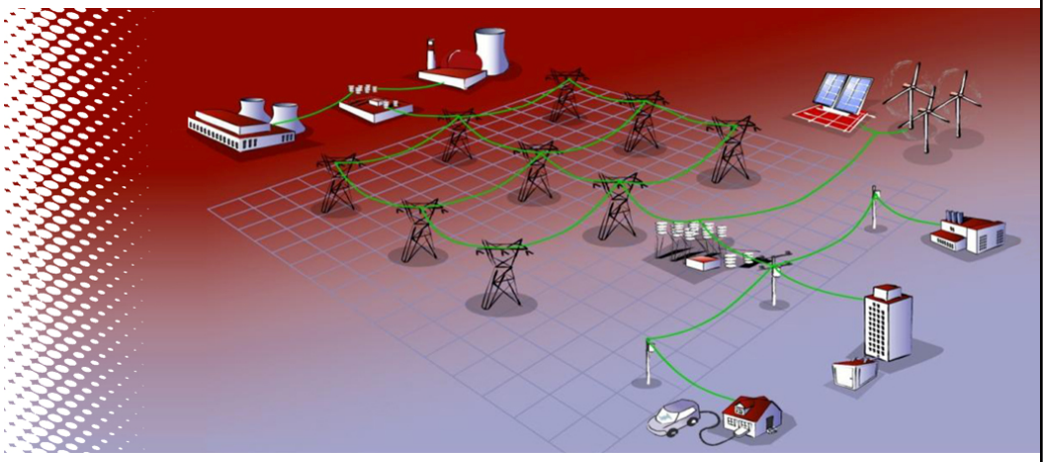

Broadband Over Power Lines Could Accelerate the Transmission Smart Grid

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Broadband Over Power Lines (BPL) Could Accelerate the Transmission Smart Grid

By Bruce Renz, NETL Smart Grid Implementation Strategy (SGIS) Team Member and President, Renz Consulting, LLC

The Transmission Smart Grid Challenge

Since the existing electrical grid's transmission system is "smarter" than the distribution system, the Smart Grid's focus has thus far been concentrated on the distribution system. Still, major functional changes will be required before distribution can support the Smart Grid's seven principal characteristics. Furthermore, at the distribution feeder level, unlike transmission, the required enabling digital technology has not made significant inroads.

By comparison, digital technology and high-power electronics are today employed to varying degrees throughout the transmission system, as reflected in a wide range of protection, monitoring, and control installations. Unfortunately, the communication channels supporting these transmission applications can be a limiting element that precludes even more advanced functionality, and they are frequently less secure than desired in the twenty-first century.

The transmission Smart Grid will require broadband, low-latency, secure connectivity between all transmission stations and from these stations to their control centers. With such a platform in place, faster and more reliable control, protection, and grid status information becomes possible. Synchrophasor measurements, combined with advanced digital protection (such as line differential relaying) will allow cycle-by-cycle system assessment and response. More powerful central computers will interact with these remote subsystems to create faster simulations and to convey grid conditions instantaneously to system operators in new, more easily understood ways. Power electronic-enabled devices, such as Flexible AC Transmission Systems (FACTS), high-voltage (HV) DC, and bulk storage, will respond in milliseconds to signals issued either centrally or locally. As the speed and penetration of grid technologies increases, transmission control will evolve from quasi-steady state to dynamic.

To accommodate confidently the full range of transmission Smart Grid applications available today would require installing optical communications between stations and to control centers. This is an excellent solution, but costly and time consuming to implement. The cost is estimated to be in the tens of billions of dollars, and the deployment time would be a decade or more.

The Broadband Over Power Line Solution

Since a reliable, high-speed, integrated communication system is the backbone of the Smart Grid, the NETL Smart Grid Implementation Strategy team identified broadband over power line (BPL) as a potential alternative. BPL is a technology that allows data to be transmitted over utility power lines. BPL has been implemented by the U.S. and other countries on medium-voltage distribution lines, but it had never been applied to HV lines.

HV transmission lines actually represent a far better medium for BPL because they are much more uniform and have none of the discontinuities inherent in the many devices installed on distribution lines. The net result is that BPL signals have less attenuation on HV lines, therefore increasing the distance they can travel. They are also more amenable to noise-mitigation techniques than distribution lines are.

Broadband Over Power Line Pilot Projects

Seeking ways to reliably couple the HV BPL signals onto the HV wire and to repeat the signal as it attenuates with distance, Amperion, a small company focused on smart grid applications, and American Electric Power (AEP) had previously conducted proof-of-concept testing on a short 46 KV line in West Virginia. The results indicated that digital relaying and supervisory control and data acquisition (SCADA) could likely be supported using BPL on HV lines.

Working together, the Department of Energy's National Energy Technology Laboratory (NETL), AEP, and Amperion have tested BPL over a 69 KV, 5-mile line connecting three AEP stations. Reliable communications at over 10 megabits/second, with typical latency of about 5 milliseconds, have been achieved. Distances achieved include approximately 4 miles without repeating and more than 5 miles with just one repeater—all while complying with FCC emission limits.

These results strongly indicate that high-speed, digital communications over HV transmission lines can be a viable alternative to traditional optical communication approaches, and at a small fraction of the cost. Additionally, circuit deployment times would be days rather than months.

HV BPL bandwidth, security, and latency are all expected to support the most demanding combination of Smart Grid applications. Hence, it is very likely that BPL could accelerate the Transmission Smart Grid.

Next Steps

NETL has served a valuable role in catalyzing this development. Amperion and AEP are now trying to advance it further, by raising the applicable voltage to 138 KV and extending the repeater-less distance. In addition, HV BPL's compatibility with today's most advanced commercial digital protection, monitoring, and control products will be tested. These results will be available in late 2010.