From the basic to the complex

Optimizing an aging infrastructure in the modern grid

ROGER ESPERT, GARY FOUBERT – Hurricanes, tornadoes, blizzards, extreme temperatures – all occur on a regular basis. An obvious consequence of any natural disaster is the disruption of electrical networks. The monetary costs of these disruptions run into the billions of dollars annually.[1] In addition, vendors of medium-voltage overhead distribution networks are under increasing pressure to supply products with shortened delivery times so that their customers can deliver a reliable power flow. An aging infrastructure can make meeting these tasks challenging, to say the least. To meet the challenge, ABB is providing a range of solutions incorporating network applications and schemes through its vast portfolio of overhead installations. Providing a reliable and economic industry standard such as a basic fuse cutout with improved insulation, or providing the most advanced technology in switching and environmentally friendly applications in the form of an automatic recloser with IEC 61850 communication capabilities, are just two examples.

One of the most popular switching devices, the automatic recloser, has gained a significant role in the development of the smart grid.

To avoid the economic ramifications when outages occur, utilities must invest in maintaining their existing overhead lines and assets, both in terms of the quality of the cable conductors as well as the operating devices. This can become especially challenging for overhead networks suffering with assets that should be replaced or upgraded in order to avoid undesired outages and endure harsh climate conditions more resiliently.

But how can utilities overcome this situation while facing capital expenditure limitations, minimal operational costs and higher safety and reliability standards for power supply? Utilities can optimize the grid for a better, safer and more reliable energy supply to consumers by using either a proven ABB solution, an innovative technology developed by ABB or a combination of the two.

Different approaches and schemes can be deployed by the utility to merge proven technologies with innovative intelligent devices.

Advanced switching devices

Switching devices have been on the market for many years as a way for utilities to safely and quickly restore energy to their consumers. However the ability to automate those devices in order to take advantage of the existing technologies for telecommunication and monitoring to create a smarter and optimized network are still a great task for many utility companies.

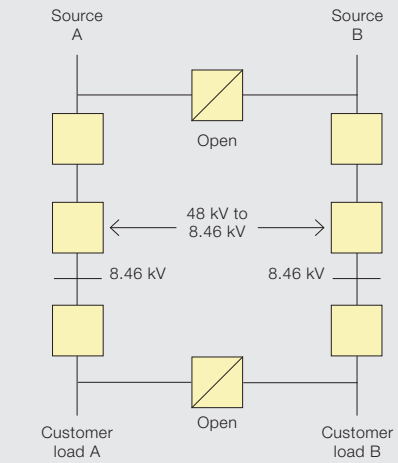
One of the most popular switching devices, the automatic recloser, has gained a significant role in the development of the smart grid. First introduced in the 1950s, this technology has gone through an astonishing development in the past five years, specifically in terms of the improvement of power electronics and the different communication capabilities. Today, it is normal to have meshed networks, GPRS/GSM communications from devices to a centralized SCADA (supervisory control and data acquisition)

Title picture
ABB is providing innovative solutions allowing utilities to optimize the grid for a better, safer, and more reliable energy supply.

Footnote
1 According to an August 2013 report from the US White House, "Economic benefits of increasing electric grid resilience to weather outage," between 2003 and 2012 roughly 679 power outages, each affecting at least 50,000 customers, occurred due to weather events. Monetary costs of these outages account for up to between $18 billion and $33 billion annually.

1 An ABB GridShield® recloser with RER620 in a substation

2 Redundant 8.46 kV lines power an industrial customer's facility



The ABB polymer concrete insulator cutout is unique in the industry, but growing in popularity among utilities.

system, and significantly faster situation awareness of a specific line on a period of time provided by the status of the automatic recloser.

Today's most advanced automatic recloser, the GridShield® recloser developed by ABB, has the proven technology of environmentally resilient solutions with components such as HCEP (hydrophobic cycloaliphatic epoxy), magnetic actuation and stainless steel, and incorporates the latest features in relay and communications → 1. The GridShield recloser is a resilient device and operates with the Relion® RER620, which has native IEC 61850, the global compatibility standard used from the substation to the point of delivery of the energy loads, while keeping the already well-known DNP 3 or IEC 104 as standard protocols. This innovative recloser takes advantage of the real-time monitoring status of a switching point that provides the SCADA operator, either by man-operated decision or automatic fault detection isolation restoration (FDIR). In the event of a fault, it can identify where the fault is and if it can be automatically cleared, and then restore power in a certain portion of the line.

Different approaches and schemes can be deployed by the utility to merge proven technologies with innovative intelligent devices. For example, even with substation automation using existing infrastructure, introducing an advanced relay at the substation circuit breaker, along with a communication system to interact with the downstream overhead reclosers, the substation can maximize transfer performance and provide a reliable continuous power supply.

An example of this scheme has been proven in a US municipal utility where the results of the implemented transfer scheme test verify that it is possible to detect and transfer in less than four cycles → 2–4. The system fault detection, isolation, restoration and transfer scheme was based on the ABB Relion family of relays' native IEC 61850 capabilities with GOOSE, combined with R-MAG® distribution outdoor breakers and GridShield reclosers.

Fuse cutouts

For years, electric utilities have relied on cutouts in the power distribution grid in overhead distribution systems to provide overcurrent protection.

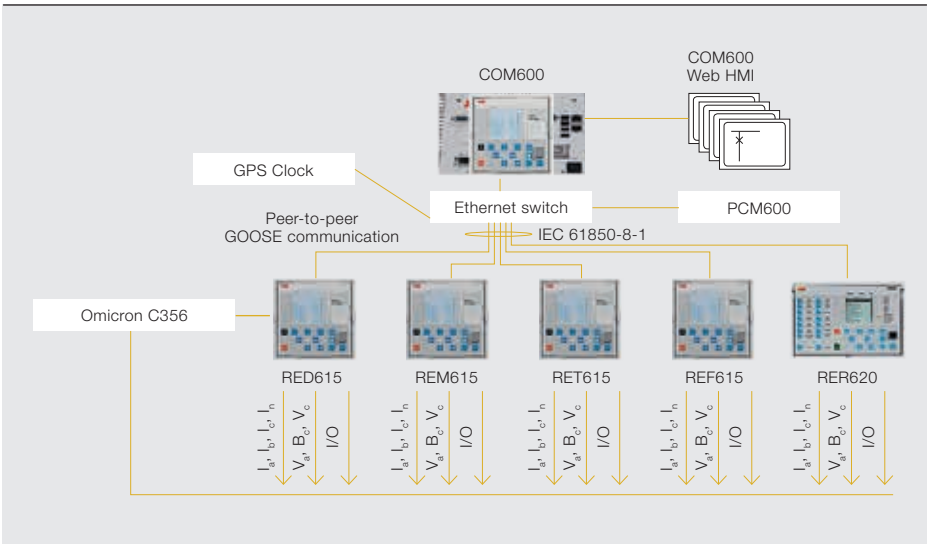
By the early 1970s distribution cutout insulators made from porcelain were a key component in most utilities' protection, security and operation of the distribution system. In the 1980s, however, PPL Electric Utilities, a US-based utility serving over 1.36 million electricity consumers in the state of Pennsylvania, noticed the porcelain cutouts it had used for many years were becoming increasingly damaged or affected by the cold-weather climate of the Northeast.[2]

The brittle nature of the porcelain insulator also made it susceptible to breakage from handling in transit and during installation. During extreme cold periods moisture ingress would freeze, expand

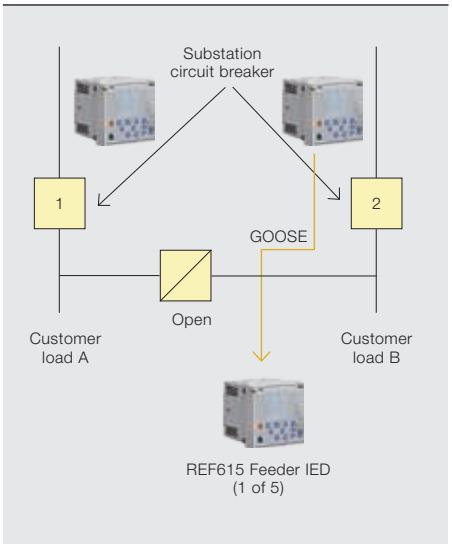
Footnote

2 See also: M. Berner and M. I. Abdelrahim, "Successfully Breaking the Mold with Polymer Concrete Cutouts," *Utility Products*, May 2011.

3 ABB's distribution automation verification lab configuration replicates a utility's field configuration.



4 An application example of feeder protection and control IEDs



5 ABB's polymer concrete insulator cutout

6 ABB Smart Grid Center of Excellence in Raleigh, North Carolina

and crack the insulator, which ultimately would lead to mechanical failure.

Polymer concrete search

Concerned about the degrading quality of its porcelain cutouts, PPL approached ABB in 1988 about creating a polymer cutout.

In 1990, PPL undertook a program to install all new cutouts using the ABB polymer concrete-designed cutout product. The ABB polymer concrete cutout came with all the common features but also provided additional benefits, including cold-weather reliability, durability, and excellent electrical properties and dielectric strengths.

To verify that the polymer concrete cutouts had performed without an insulator failure, PPL tested a small sample of the cutouts installed on its system. The company selected 30 units that were in service for 12 to 14 years on its distribution system. The sample units were tested by ABB, an independent testing lab and another utility's testing lab. The results from all tests verified that the units performed without failure while exposed to the typical harsh weather conditions for the northeastern United States.

PPL reports that, with more than 250,000 units installed over the last 20 years, there has not been a single known cracked polymer concrete cutout in its network.

The ABB polymer concrete insulator cutout is unique in the industry, but growing in popularity among utilities, as it provides excellent electrical properties and dielectric strengths, as well as superior mechanical toughness → 5. ABB's cutout and switch designs are available with a polymer concrete insulator.

What's next?

Without question, the use of field-proven devices, even as traditional as a cutout, will be an integral part of solutions for years to come. And yet the merging of simple solutions with complex intelligent devices providing communication and flexibility is what allows ABB to offer sustainable solutions for different global requirements → 6.

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