INDUSTRY SPOTLIGHT
January 2009

Power provision – electrical networks get smarter

By Julia King

It's late afternoon on a hot summer's day. The power goes down and a whole metropolis is blacked out for hours. Commuters can't get home because there are no trains, no lights. Automobile traffic is chaotic. It's 30 °C but, of course, there's no air conditioning. People mill everywhere not knowing what to do. Power companies and governments struggle to respond.

No, this is not the start of a horror movie but what really happened on the East Coast of the United States of America in August 2003. Some 50 million people were said to have been affected by the power losses, which caused much economic damage besides.

Winter or summer, when the power goes down there's turmoil. People can't get home and there's no heating or air conditioning

Steady grid improvement

"Since the wake-up call of the 2003 blackout in the north eastern US and Canada, there's been a steady push to improve the North American power grid," says Paul Karr Vice President of Marketing at Trilliant Inc., a US company that provides intelligent network solutions and software to utilities for advanced metering, demand response and smart grid management.

"Legislation in both the United States and Canada has encouraged investments in technologies intended to make the grid intelligent and to solve critical energy issues." Of course, the United States and Canada are not the only countries looking to modernize their power grids. Most countries are facing a fundamental shift in the way power is used, as well as in the demands placed on networks whose designs may well be rooted in the earlier half of the 20th century. "Smart grid means different things to different people," says Richard Schomberg Vice President Research at EDF (Electricité de France) in the United States. Schomberg is also chairman of TC (Technical Committee) 8: Systems aspects for electrical energy supply. "It is simply the concept of modernizing the grid."

Different drivers

There are different drivers at work in different countries, says Schomberg. The idea is simple: to optimize the delivery of electricity. Adding sensors, actuators and some intelligence allows as much energy as possible to be packed into the existing 'pipes'.

"There's been a lot of effort since 2001, starting in California," he says.

In the United States, the problem has been reliability of the electrical system due to under-investment in the infrastructure combined with growing demand. On top of that, environmental concerns make it increasingly difficult to build new generations of transmission lines even as the country makes considerable effort to integrate massive quantities of renewable energy to make itself less dependent on foreign sources of energy. The Electric Power Research Institute (EPRI) has pioneered detailed reference studies since 2001.

"There is a huge need for interoperability standards. They allow you to buy pieces of equipment from any vendor

In Europe, on the other hand, there has been more concern from the outset on "the integration of renewable generation, which is distributed by nature and highly intermittent," says Schomberg . The challenge has been to connect these renewable sources to a distribution network that has not been designed for this purpose. In some instances this may involve new generation partners (who may be very small) contributing energy to the grid. A couple of incidents have also shown

that blackouts are not impossible in Europe.

In Korea, a lot of new infrastructure is being built. The amount of intelligence in the electrical infrastructure is also being increased, but the emphasis there is on growth in construction.

The picture is different yet again in Japan. This is a country full of large industrial groups, each of which contains many companies. Projects tend to be more integrated and therefore the infrastructure can be less fragmented. A number of strategy studies show that the Smart Grid is the number one priority, given that it enables advanced generation technologies to be employed in reducing the emission of greenhouse gases.

As these varying demands indicate, there is no single solution to network formulation or structure. However all approaches share a number of common features. In all cases, intelligence needs to be added to various parts of the network – hence the terms smart grid and intelligent grid, which are in common parlance in different parts of the globe.

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Vice President Research at EDF,
Chairman IEC TC 8 and SMB Smart Grid Strategic Group Convenor

New challenges

Whatever the driver, in each case the network ends up with a high number of very distributed intelligent nodes that are tightly coupled and operating in real time. This means that new methods and approaches to formulating smart grids need to be devised.

A further technical challenge is to work out how and where the intelligence should be added to the network. There is also the question of how to procure a number of different interchangeable parts from a variety of different providers worldwide and put them all together simply.

System engineering may be a mature industrial area, but its level of complexity is unprecedented. In the first place, the electrical system is in continuous operation. At the same time, it is evolving constantly while incorporating a huge legacy. Second, different stakeholders are responsible for different parts of the system. Independently, each may make different choices about evolution and use. This is where standards can make a major enabling difference.

Experience gained from the application of system engineering in industry demonstrates the importance of separating out requirements from any kind of solution. "Very often there's not enough separation between the two and the picture becomes blurred," Schomberg says.

Requirements versus Specifications

Increasingly, there is a need for standards that provide building blocks on two different fronts. On the one hand, standards need to address requirements. This allows utilities and distribution and transmission operators to document their needs. On the other hand, standards that apply to technical design and specification allow system architects and integrators to implement devices that not only speak the same language but also behave synergistically and could be interchangeable.

Requirements can be considered as building blocks, Schomberg believes. "There are generic requirements – in metering, for example, utilities could reuse 80 % of the same requirements", he thinks. "It helps utilities not to reinvent the wheel. Vendors can recognize standard 'bricks' and manufacturers can see where the market goes. It's cheaper for the user and it also allows competition."

Writing standards for requirements is a new concept. Producing these standards successfully demands that utilities, regulators and distribution and transmission system operators discuss what they use today, how they process the information and to whom they send it, says Schomberg.

Technical specification standards are necessary for the development of standardized devices. Today, if anything, there are too many specification standards, resulting in a somewhat piecemeal approach.

The technical challenge is much more than the simple addition of a computer infrastructure to an electrotechnical infrastructure. In fact, each device that is connected to a smart grid is at the same time an electrotechnical device and an intelligent node. Today's interconnection standard needs to address both aspects concurrently. In the IEC, separate TCs are already dealing with each approach.

"There is a huge need for interoperability standards", says Schomberg, explaining that they allow you to buy

Optimizing the delivery of electricity by adding sensors enables as much energy as possible to be packed into existing 'pipes'

"There is now an urgent need to demonstrate how the electrical industry will

be able to rely on the IEC as a 'beacon' in terms of smart grids, and to start providing a one-stop shop for the large number of smart grid projects that are being launched around the world.”

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pieces of equipment from any vendor and know that they will work in the same way. "It's more than interface standards," he says, "because they have to interact at a deep level in the same way." The efforts of the US Department of Energy Gridwise Architecture Council (GWAC) to promote interoperability approaches, and of the National Institute of Standards and Technology (NIST) to start developing a framework for Smart Grid projects, are good examples of what is feasible.

A need for change

The need for this 'new' brand of standards is born out of the change that is occurring in and transforming the world of power provision. The 'old' market was one filled with vertically integrated monopoly providers; the 'new' market is one filled with more and different players as re-regulation takes place. Relationships between them are increasing in complexity.

"Developments are happening quickly but separately in many technology areas, including communications, computing and sensing," says Giovanni Valtorta from Enel in Italy, secretary of TC 8. "Many types of equipment are becoming standardized. Putting them together needs specific system approaches, so that the entire 'chain' provides the expected services." He adds that both electrical and intelligence aspects of power provision need to be dealt with at the same time.

For the IEC, this means the involvement of a number of TCs. While TC 8 has an overall view across the system, others also have key roles to play, including TC 57: Power systems management and associated information exchange, TC 13: Electrical energy measurement, tariff and load control, TC 34: Lamps and related equipment, TC 82: Solar photovoltaic energy systems, TC 88: Wind turbines, and TC 105: Fuel cell technologies. (A detailed inventory will also show the need for the involvement of other TCs.)

As Schomberg says, the IEC is the most trusted international electrical Standards Development Organization, providing a large catalogue of extremely well focused standards. However there is now an urgent need to demonstrate how the electrical industry will be able to rely on the IEC as a 'beacon' in terms of smart grids, and to start providing a one-stop shop for the large number of smart grid projects that are being launched around the world.

During its meeting held in São Paulo on 16 November 2008 under the chairmanship of IEC Vice-President Frank Kitzantides, the SMB (Standardization Management Board) approved the setting up of a Strategic Group to help the IEC develop Standards for 'Smart Grids'. The group will develop a framework for IEC Standardization that includes protocols and model standards to achieve interoperability of smart grid devices and systems. Richard Schomberg has been proposed to convene this Strategic Group.

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