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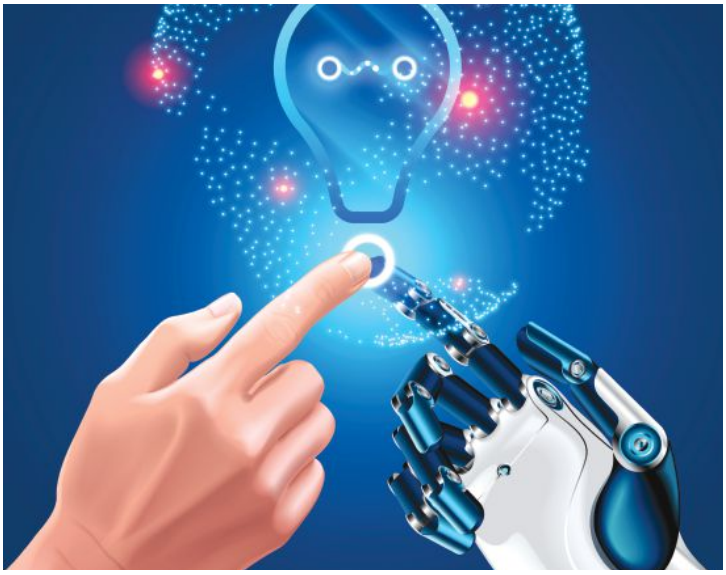

The reinvention of electricity

'Smart Grid' is more than a conservation effort

BY BF NAGY

Early in this century, North American governments realized much of our electricity infrastructure needed a significant amount of investment, and more effort needed to go into job creation. Meanwhile, within the electricity industry and elsewhere, the term 'smart grid' began to appear more frequently. Many people at the time, and even today don't know much about what it means.

The US Congress and George W. Bush brought in the Energy Independence and Security Act of 2007 (EISA-2007). The act's stated purpose was "to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth..." It described smart grid using languages such as digital control, reliability, security, distributed resources, renewable resources, demand response, consumer devices, smart appliances, metering, grid status, distribution automation, electricity storage, thermal storage and electric vehicles.

Clean energy

The passage of the act may not have created many news headlines in 2007, but among environmentalists, it was celebrated because the power industry had estimated that smarter electricity infrastructure and management could result in efficiencies of about 20 percent. It would also help in the development of cleaner electricity technologies.

A dozen years later, smart grid remains a complex topic with limited presence in public discourse but is an umbrella for some of the most exciting developments in modern society. We now know that we are likely moving toward a complete transformation of our global energy system. It appears that smart grid innovations are key elements in this process; and they now go far beyond smart meters, sensors on the power lines and demand response program development.

Electric car charging

"Our electricity system was built in a very centralized way and designed around a single hour on the hottest day in August, that represented the peak demand level for the year," says Jessie Ma, a former PhD hydro engineer and a senior research fellow for the Centre for Urban Energy (CUE) at Ryerson University. "For the other 364 days, we still use and pay for this system, that no longer reflects the needs of the modern electrical grid."

"A typical North American home has traditionally used about two kilowatts at peak load, but an electric vehicle charger might require eight or 10 kilowatts. That isn't really a problem for the system if one person has one, but when everyone comes home and plugs in their cars at the same time, we're going to need new ways to manage that." The CUE, the Province, and a private sector Ontario power storage company called eCamion are developing solutions in this area.

Grid impact testing

"Today there are numerous solar, wind, storage and microgrid entities requiring access to the electricity grid, and distributed generation plant owners do not usually have in-house impact assessment expertise," says Garreth Coelho, business

area director, distribution and asset management for Kinectrics Inc. Kinectrics runs grid-related computer scenarios.

"Depending on the size of the plant it might require confirmation of grid interoperability…We're testing and certifying inversion and other technologies against required UL (Underwriters Laboratories Canada Inc.) and IEEE (The Institute of Electrical and Electronic Engineers) standards that help confirm that the introduction of the solar generation plant, or whatever it is, does not cause unintended consequences on the local grid."

With 1100 employees in Canada, the USA and Europe, Kinectrics is the only lab of its kind in our country and one of few in North America, and indeed, the world. Among its ranks are many OACETT members including Rajneesh Goyal, C.E.T., Lipi Patel and Nicolas Sek, C.E.T.

The Kinectrics UL and IEEE standards testing lab in Toronto.

Cyber security

"A couple of years ago grid security was a factor in a war between two nations," says Mihir Kapadia, vice-president, engineering at N-Dimension Solutions in Richmond Hill, Ontario. "Russians hacked into a utility's system in the Ukraine, manipulated the grid and turned off the power. Digital security is very serious. That's why about 120 utilities are now using our cybersecurity software."

"Many startups create new products and want their systems connected to the Internet as soon as possible. They often overlook security, making them very susceptible to enormous risks. Cyber criminals can freeze a company's systems with ransomware and then demand bitcoin to unfreeze it. They can hack smart meters and manipulate customer data and walk off with large sums of money. We sometimes don't hear about these episodes, because companies and utilities are hesitant to admit vulnerability in public."

DC microgrids

The 1893 electrification of the World's Fair and the 1896 Niagara Falls/City of Buffalo lighting contracts were both won by Nikola Tesla and AC power. Thomas Edison's DC power was deemed to have lost "the war of the currents." Tesla's transformer meant that AC power could travel further.

Unfortunately, it had become a polarized, binary choice, when it might instead have been a productive collaboration between two great minds and two kinds of power that have since proven to each have important strengths. The DC power used by cell phones, electric cars, solar panels and LED lights may soon lead to design changes in some of our key electrical systems.

"Interconnection on the DC side makes hardware designs and construction simpler and less expensive," says Peter Lewis, vice-president of business at ARDA Power. "We specialize in power electronics focusing on microgrids, often DC microgrids. We create the software and hardware, eliminate unnecessary AC/DC inversions, and provide complete plug and play solutions."

Usually, when you connect solar arrays, storage or electric vehicle chargers, the grid needs to know about complex

A DC battery at an ARDA microgrid project in Burlington.

interconnections. With the ARDA system, various elements can be connected on a DC network and then tied into the grid via the inverter. All the grid sees is the inverter, making approvals from the utility simpler and less expensive, and sometimes unnecessary.

"We developed this kind of microgrid in Burlington, Ontario. It included a solar array, battery, generator, LED lighting and a small refrigeration unit, all on a DC network." The model was created under a government research program as a demonstration site. It succeeded. "Now we're going back to expand the solar and add an electric vehicle charger, and we won't need significant engineering or utility approval."

Future opportunities

"There are great future opportunities for smart homes, smart buildings and electrified vehicles," says Young Ngo, chief technology officer for Survalent Technology Corporation in Brampton, Ontario, which provides advanced electricity analytics tools for 600 utilities around the world.

"Rather than being owned by utilities, power generation will become part of the commercial space, owned by consumers and corporations. OACETT members need to become more aware of many new devices and systems because there will be more power generation at the grid edge. Technologists are creating the adaptive innovations, and they are all part of the management of a completely new grid, the grid of the future."