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NEMA The Association of Electrical and Medical Imaging Equipment Manufacturers ■ www.nema.org ■ April 2011 ■ Vol. 16 No. 4

The Greening of Building Performance

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The National Renewable Energy Laboratory (NREL) is in the forefront of getting renewable energy onto the nation's electrical grid. Photo courtesy of NREL

NEMA and ASHRAE Team up to Develop Facility Smart Grid Information Model Standard

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The national electric grid has been called the supreme engineering achievement of the twentieth century by the National Academy of Engineering[1].

In spite of its success and the tremendous impact it has had on our lives, the electric grid is under strain from increasing demand and aging infrastructure, and is in need of modernization. The *Energy Independence and Security Act (EISA) of 2007* established a national policy to modernize the nation's electricity transmission and distribution system to maintain a reliable and secure infrastructure that can meet future demand growth and a range of other specific objectives. The legislation calls this modernization a "Smart Grid."

The current electric grid can be characterized as a top down system with one-way flow of electricity from central generating plants through regional transmission systems to local distribution networks and end loads. Market operations centers and the generation and transmission systems make control actions with limited situational awareness and information about customer interactions. There is limited automation and in many cases the utility is unable to detect a service outage unless a customer reports it.

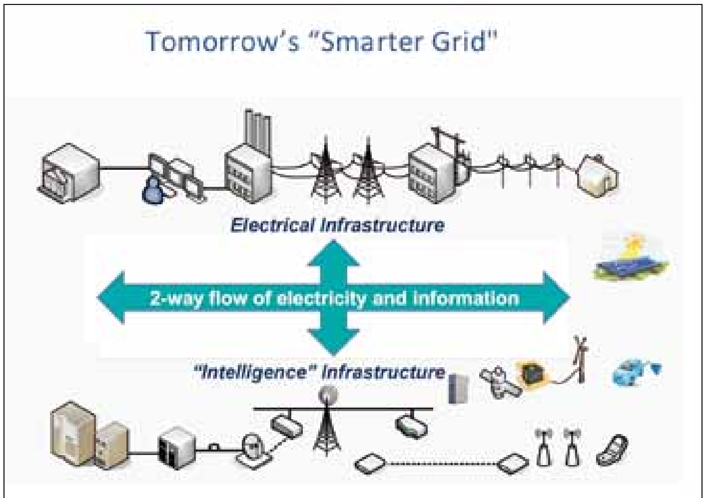

Figure 1. *A Smart Grid will combine two-way communication infrastructure and local generation with the traditional electrical distribution system.*

Part of the idea behind a future Smart Grid is to improve measurement and control technology used to manage electricity generation and distribution, but the most important concept is to transform the fundamental structure of the grid by combining an intelligence infrastructure with the grid that will enable two-way flow of both information and electricity (see Figure 1).

Smart Grid Requires Smart Buildings

Residential and commercial buildings together consume 75.1 percent of our electricity and another 24.7 percent is consumed in industrial applications (transportation consumes only 0.2 percent)[2]. Figure 2 shows a daily load curve from a regional transmission operator in the northeast U.S.[3] This figure illustrates that one of the significant challenges for the electric grid is the wide fluctuation in load throughout the day.

About 20 percent of today's electrical generation capacity is needed only 5 percent of the time to meet peak loads[4]. Figure 2 also shows the availability of electrical power from utility-owned wind generation in the same region. This illustrates two challenges with increased use of renewable generation systems: a mismatch between the availability of the energy supply and the load, and the short-term variability in the output from renewable energy generation.

Efforts to promote the widespread use of electric vehicles could make matters worse for the grid if people charge them at a time that contributes to the afternoon peak. Electric vehicles will be plugged in for charging at people's homes, typically when they return home from work. There is a need for incentives and controls to shift vehicle charging time away from peak periods.

The drive toward net-zero energy buildings (those that produce as much energy as they use on an annual basis) also has implications for the grid. Achieving net-zero energy requires significant improvements in energy efficiency combined with the use of renewable energy. Net-zero energy homes and buildings can help reduce the demand on the electric grid and therefore the need for additional generation capacity. They will also increase the variability of loads because of increased renewable generation. Homes and buildings will sometimes be generators contributing to the grid and sometimes loads consuming from the grid.

The combination of all of these factors makes it clear why a communications infrastructure is critical to a Smart Grid and that smart buildings will be a necessary and critical component. Instead of being a dumb load at the end of a wire, homes, buildings, and factories will become full partners in managing a Smart Grid. Utility suppliers will need reliable information about forecast demand from buildings. Buildings will need to be able to respond to signals that reduce peaks by shifting loads to non-peak times. Buildings will need to be able to help maintain stability in the grid by moderating loads in response to fluctuations in renewable energy generation.

Enabling this collaborative arrangement between buildings and utility providers will require the development of industry standards. This need has been recognized in national efforts to develop a smart grid standards infrastructure[5].

Facility Smart Grid Information Model Standard

NEMA and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) have joined forces to develop one of the needed industry standards, a Facility Smart Grid Information Model. The purpose of the standard is to create a common information model to enable appliances and control systems in homes, buildings, and industrial facilities to manage electrical loads and generation sources in response to communication with a smart electrical grid and to communicate information about those electrical loads to electrical service providers.

The kinds of functionality that will be enabled by the model include:

- on-site generation
- demand response
- electrical storage
- peak demand management
- forward power usage estimation
- load shedding capability estimation
- end load monitoring (submetering)
- power quality of service monitoring
- utilization of historical energy consumption data
- direct load control

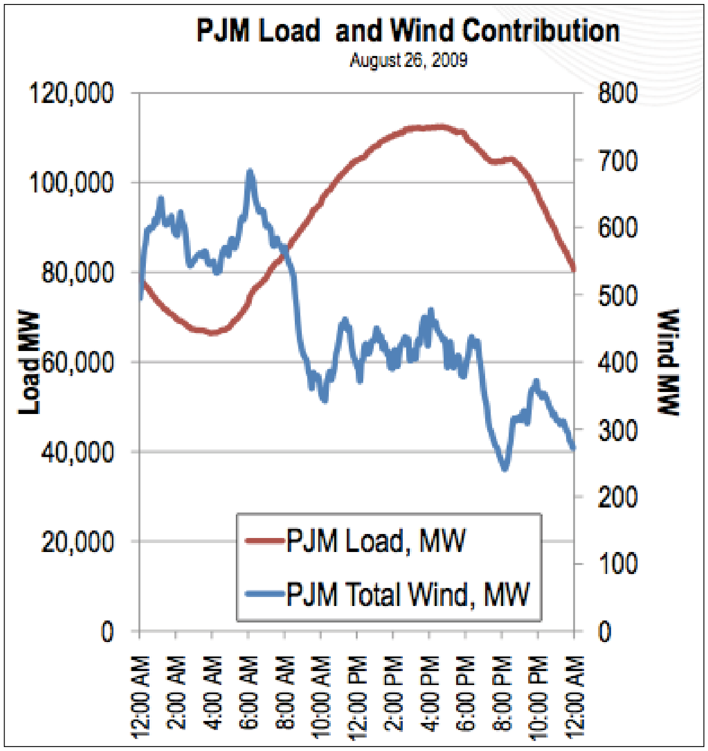

Figure 2. *An example daily load and wind generation profile for a portion of the U.S. Diagram courtesy of Sean McNamara[3]*

The standard is being developed by ASHRAE Standard Project Committee 201P (SPC 201P) and will be published as an ANSI/ASHRAE/NEMA standard. Both ASHRAE and NEMA are providing staff support to enable the rapid development of this standard. NEMA member Robert Hick is one of three vice-chairs of the committee. The others are Stephen Kennedy of Georgia Power and Sharon Dinges of Trane Company.

By combining their resources, NEMA and ASHRAE can take advantage of the expertise of their members in electric meters, electrical and electronic devices, heating and air conditioning systems, and building automation and control systems. Also involved in the process are key stakeholders with backgrounds in home appliances, industrial control, manufacturing systems, electrical utilities, and end users.

One of the key concepts behind the standard is the idea of a "facility." Facility is broadly defined to be anything from a single-family house, to a commercial building, an institutional building, or an industrial or manufacturing facility.

From the perspective of an electricity provider, all of these facilities are loads with responsive characteristics that need to be understood and forecast. They also all have some potential to be generators. From the perspective of a "facility manager," the

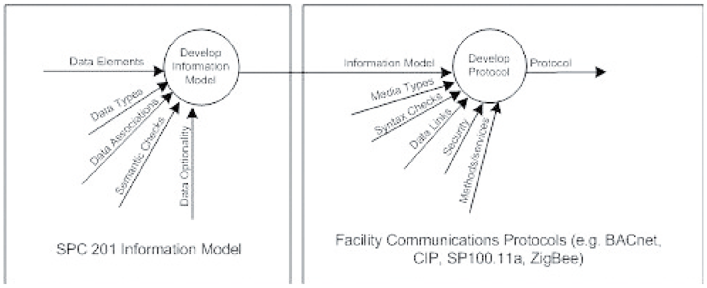

***Figure 3**. The Facility Smart Grid Information Model will be implemented through modifications to existing facility communication protocols.*

kind of information that is needed to make operating decisions and the kind of actions that can be taken are similar, regardless of the type of facility.

By developing a common information model for all of these kinds of facilities, utility providers benefit because they may be able to interact with all of their customers in the same way. A common model also benefits consumers because the dividing lines between these different kinds of facilities are not always clear cut. Using a common model will make it easier for a product designed primarily for one of these facility types to be used in others as well.

What will a Facility Smart Grid Information Model Look Like?

The key to an information model standard that meets these objectives is to define it in terms of building blocks that can be combined in multiple ways that provide flexibility and scalability. The ideas being deliberated by SPC 201P involve the definition of information objects that define load, generator, energy manager, and meter.

These building blocks can be combined. For example, storage has characteristics of both a generator and a load. The concepts can also be nested. A load may represent an individual device or a collection of devices that are aggregated together. With this kind of flexibility, it is expected that the information model components can provide all of the functionality identified in use cases that are guiding the development of the standard.

An information model is an abstraction, not an implementation. There already exist well established protocols used for automation and control in facilities although they vary with the type of facility. It is unrealistic to think that this installed base will just disappear. There are also practical reasons why protocols used in a manufacturing environment differ from those used in a commercial building or a home.

The vision is that this common information model will be adopted by making extensions to the various communication protocols already used within facility markets. Each protocol will use its own existing mechanisms to encode and communicate the information. This is illustrated in Figure 3. It is inevitable that the situation will arise where a product designed primarily for use in one of these environments will need to be used in another. This would require a protocol translation gateway but because the semantic meaning of the information is based on the same information model standard, this task becomes much easier and more reliable than it otherwise would be.

This collaboration between NEMA and ASHRAE will result in a Facility Smart Grid Information Model standard that represents the energy consuming, producing, and storage systems found in residential, commercial, and industrial facilities.

When industry standard protocols are enhanced to implement this model and the information it represents becomes available in equipment and energy management systems, a facility owner will be better able to understand what factors influence the facility's energy consumption; energy consultants can determine how to effectively reduce the energy profile of a facility; architects and engineers can design facilities that optimize the energy profile; controls manufacturers can create products that monitor and manage the facility energy profile; and energy providers can more accurately forecast energy consumption and demand as well as the reactions to energy supply constraints. ei

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1 Constable, George, Somerville, Bob, *A Century of Innovation: Twenty Engineering Achievements That Transformed Our Lives*, National Academy of Engineering, 2003.

2 Energy Information Administration (EIA), *Electric Power Monthly*, Table 5.1, August 11, 2010.

3 McNamara, Sean, *Electric Vehicles and the Power Grid*, A presentation made to the American Association of State Highway and Transportation Officials, October 29, 2010, *climatechange.transportation.org/pdf/sean percent20mcnamara_evsandpowergrid.pdf.*

4 PJM Regional Transmission Organization hourly load data, www.pjm.com/markets-and-operations/energy/real-time/loadhryr.aspx.

5 NIST Smart Grid Interoperability Panel Collaboration Site, Priority Action Plan 17, *collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP17FacilitySmartGridInformationStandard*