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COLUMNS

DEPARTMENTS

Smart Grid Impact on Intelligent Buildings

By Ken Wacks

CABA members have the opportunity to participate in leading-edge research by joining a CABA project steering committee, proposing topics, and sharing costs. The organization that performs the research and the program manager are selected and contracted by CABA. This process makes collaborative research cost-effective for CABA members. Furthermore, participants get exclusive use of the findings during an embargo period of about four months.

The most recent CABA research is "Smart Grid Impact on Intelligent Buildings," for which I was the project manager. The research was conducted by BSRIA with assistance from CoR Advisors. This article summarizes the project objectives and findings. The complete report will be available when the embargo ends in late spring 2012.

Energy consumed by commercial buildings

In the United States, the electricity market is valued at $120 billion annually. Commercial buildings consume 37 percent while industrial buildings use 26 percent of this total. Electricity typically accounts for 15 to 22 percent of building operating costs. Industrial buildings are at the lower end of this range, while office and healthcare buildings use more electricity. For many it is the second or third biggest expense after labor costs and property taxes.

As I reported in my summer 2011 article for *iHomes & Buildings*, upgrading the electricity grid to a smart grid is a national priority in the United States and in many other countries. The broad objectives are to increase the reliability of electricity while integrating local generation from sources such as solar and wind, and supporting the proliferation of electric vehicles.

Environmental concerns are constraining electricity supply expansion. Therefore, there is now a focus on energy management to flatten the demand for power over time so expensive peak generators can be avoided. Smart grids are not intended to lower overall electricity costs because most fuel prices such as coal, which supplies more than half of the U.S. electricity, are increasing. Smart grids will deliver customer benefits with an assured supply of power at predictable costs that customers can manage.

Since buildings account for almost two-thirds of national electricity consumption, smart grid programs should have a significant impact on buildings, but not yet, as CABA discovered. For now, building managers are focusing on energy conservation measures and just starting to learn about smart grids.

Energy conservation in buildings

Making buildings more energy efficient has been identified as one of the fastest, easiest, and cheapest ways to create jobs (one report found it could create up to 114,000 jobs), save money, boost manufacturing of energy-efficient materials, and reduce harmful pollution. Recently, President Obama directed all federal agencies to:

- Make at least $2 billion worth of energy efficiency improvements.
- Plan to achieve by 2020 greenhouse gas emission reductions of 28 percent from direct sources such as building energy use and fuel consumption, and

reductions of 13 percent from indirect sources such as employee business travel and commuting.

Sixty private companies, hospitals, cities, states, colleges, and universities, among others, have collectively committed a further $2 billion in energy efficiency retrofits to 1.6 billion square feet of property.

There are now a variety of programs for companies to make their buildings more energy efficient, such as:

- The ENERGY STAR rating program.
- The U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) certification.
- The Building Owners and Managers Association (BOMA) program.
- The President Clinton Initiative for improving building efficiency.

Many international companies have issued strategy statements addressing environmental and corporate social responsibility. Most have appointed chief sustainability officers within the past five years. Together with company energy managers, these champions will drive change in the industry. A range of *clean-tech* and energy efficiency technologies and services will be integrated into intelligent buildings. Legislation is encouraging and "incentivizing" this transformation.

Specific conservation projects undertaken by building management include (starting with the most popular):

1. Lighting (25-40 percent of building energy consumption)
2. Occupancy sensors (for lighting, heating, and cooling control)
3. Retro-commissioning of air-conditioning systems
4. Demand Response initiatives

The smart grid market

The goal of this study was to estimate the potential market for smart grid products and services in non-residential buildings. The methodology involved a combination of an online survey and interviews (most were face-to-face) with building managers. These data were combined with knowledge of the industry to produce the report estimates.

These estimates are based on possible investments by medium and large buildings in methods to save electricity (energy conservation plus smart grid program participation). Total expenditures on electricity for these buildings in 2003 were $33.5 billion according to the U.S. Energy Information Administration. An assumption was made that these building managers would like to achieve a 20 percent reduction in electricity costs with a 2.5-year payback. This implies an expenditure of up to 0.20 × $33.5 billion × 2.5 = $16.75 billion. This figure was increased by 15-20 percent to include industrial and federal buildings and another 10 percent to include buildings in Canada. This makes the total potential market for electricity saving in non-residential buildings about $22 billion.

How much of this $22 billion might be spent on smart grid projects? The CABA study estimates the total smart grid market for non-residential buildings is worth about $6.6 billion this year and will grow to $10.2 billion by 2015. As illustrated in Figure 1, this market comprises:

- Grid applications
- Non-residential smart meters and advanced metering infrastructures (AMI)
- Building energy management systems (BEMS) designed for smart grid programs
- Demand response

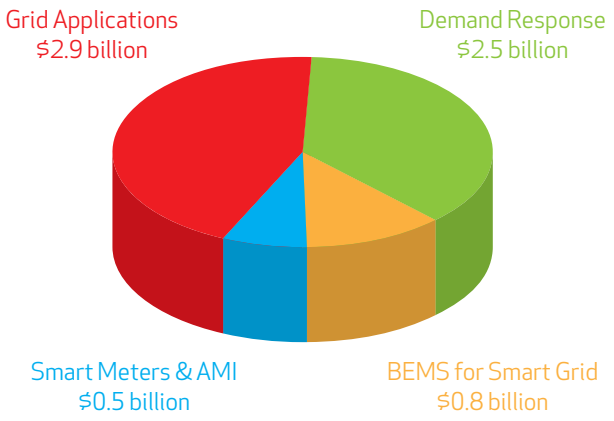

Figure 1 - $6.6 billion smart grid market for non-residential buildings

The prime market consists of the 1.3 million buildings in North America that already include building management systems (BMS). The BMS penetration level is 20 percent overall. Table 1 lists BMS adoption among commercial (offices, education, health, retail, and transportation), federal, and industrial buildings.

Survey findings

The key findings from 45 end-user and supplier interviews conduct in the fourth quarter of 2011 are:

- Early adopters of energy strategy implementations are government, followed by education, retail, and transportation.

North American Floor Space (square feet)		BMS Penetration	Buildings with BMS
More than 500,000	11%	95%	564,000
200,000 – 500,000	11%	55%	327,000
100,000 – 200,000	14%	25%	189,000
50,000 – 100,000	14%	10%	76,000
Less than 50,000	50%	1%	27,000
Total Commercial buildings	5.40 million	22%	1,182,000
Total Industrial buildings	0.53 million	5%	26,000
Total Federal buildings	0.61 million	20%	121,000
Total Non-Res. buildings	6.54 million	20%	1,329,000

Table 1 - Building Management System (BMS) Installations in North America

- Most energy investments are expected to be paid back within two to three years. The government and the educational sectors are prepared to accept a longer return-on-investment time span.
- Owners are more inclined than tenants are to undertake environmental investments.

The key findings from the online end-user survey are:

- 76% stated that they were familiar with the term "smart grid."
- 84% have implemented or are in the process of implementing a green/sustainable strategy to save energy.
- 44% have an arrangement with their electricity supplier for a special discount or payment for load shedding on agreed days (note: the sample is more representative of the larger end-users).
- 25% of BMS systems (in some or all buildings) were able to communicate automatically with the grid for the purpose of load shedding (56% said "No" and 19% didn't know).
- 24% were planning to upgrade their building/energy management systems for the purpose of integrating with a "smart grid" within the next 18 months (2011-2012).
- 13% generate or produce energy on-site for building use and/or to sell back to the grid.
- 18% plan to produce energy for building use and/or to sell back to the grid.

Here is a sampling of barriers and roadblocks:

- Cost to upgrade or install a BMS system and smart grid equipment including wiring, metering, and software.
- Relatively low-cost electricity.
- "Big brother watching" concerns.
- A lack of awareness.
- Too many providers.

Net Zero Energy Buildings

In addition to investigating investments in smart grids by non-residential building mangers, this study examined net-zero energy buildings (NZEB). The U.S. Department of Energy Building Technologies Program has adopted the goal of making zero-energy commercial buildings (ZEBs) marketable by 2025.

The National Renewable Energy Laboratory conducted an assessment of the entire commercial sector to evaluate the technical potential for meeting this goal with technology available in 2005 and projected forward to possible technology improvements for 2025. The results show that the ZEB goal is technically achievable for 22 percent of commercial buildings using 2005 technologies and practices, or 64 percent with projected 2025 technologies. If excess electricity production could be freely exported to the grid, then with the projected 2025 technology in every building, the commercial sector could generate as much as 37 percent more energy than it consumes.

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However, the CABA research respondents see limited opportunity for NZEB in the short term. Corporations find the cost prohibitive and the economy too weak to justify the "risk" at present. Most agree that on-site generation makes sense in the long term, but that different building types will require different strategies according to their location and footprint.

Facilities with a large footprint are seen as the best candidates. This can include campuses with multiple buildings, large roof spaces, such as those found on out-of-town malls, industrial sites, and buildings with generous space within the plots of land that they occupy. Building owners do not consider NZEB suitable for offices because the small footprint makes it prohibitive.

Increasing numbers of existing buildings are being equipped with solar photovoltaic and solar thermal energy sources that are helping to reduce energy bills. However, energy neutrality or a positive energy balance is not considered feasible.

NZEB will have greater penetration in new construction. In general, it is the out-of-town, large footprint buildings, rather than the central business district skyscrapers that will implement distributed energy resources and other measures towards achieving NZEB.

Impetus for net zero energy buildings

- Attractive feed-in tariffs (price at which excess locally generated power is purchased by the public utility).
- Dynamic pricing would help to drive the market, but present schemes are local and limited.
- A micro-grid of campus buildings or a small community that might offer NZEBs in the aggregate.
- Interconnections between micro-grids and public grids with low transmission losses.

Strategic implications from the CABA study

The introduction of a smart grid that enables a community to offer more reliable power with fairer pricing and optimum energy efficiency will make that community a more attractive investment location. In turn, the utility that invested in a smart grid will gain new businesses customers.

The "old guard" utilities have been slow to exploit the opportunities offered by smart grids. However, a generation change is underway since recent college graduates are very literate in information technology (IT) and can rapidly appreciate the benefits of applying IT to enhancing the grid infrastructure. At the same time, their engagement with ecological and "green" issues is high. Getting them involved now in grid planning will help transform the traditional power grid into a smart grid.

Dr. Kenneth Wacks has been a pioneer in establishing the home systems industry. He advises manufacturers and utilities worldwide on business opportunities, network alternatives, and product development in home and building systems. In 2008, the United States Department of Energy appointed him to the GridWise Architecture Council. For further information, please contact Dr. Wacks at 781.662.6211; kenn@alum.mit.edu; www.kenwacks.com.