BY John C. Tysseling, Ph.D., Audrey Zibelman, Esq., and Allen Freifeld, Esq.

Facilities managers are adapting to reduced budgets and increased expectations as university finances continue to be stressed. Several university facilities managers have found innovative approaches to enhance their facilities' economic performance and earn new revenues for their schools.

HIGHER EDUCATION FACILITIES:

THE SMARTGRID EARNS A DOCTORATE IN ECONOMICS

DATA COMPLEXITY AND FACILITY MANAGEMENT

Most higher education facilities have already accomplished some measure of a "microgrid" investment with building control systems (BCS), energy management systems (EMS), and advanced metering infrastructure (AMI) installations. Available energy production facilities may include boilers, chillers, cogeneration, thermal storage, electrical substations — possibly new renewable resources (wind/solar/biofuel/geothermal) — and actively managed district energy (DES) and building management systems (BMS).

Missing, until recently, has been a decision tool tying these resources together in a coherent, optimal control regime that allows facility managers to operate these resources in the most economical fashion, while meeting all organization comfort and operational constraints. The addition of deci sion logic and control regimes can transform a "microgrid" into a "SmartGrid" resource.

Several vendors now offer microgrid "dashboards" as a tool to monitor and squeeze additional economic benefits from facilities. However, most of these tools fall short of optimizing facilities operations or realizing all the economic value inherent to the facilities operations.

For facilities managers the world has changed. The world is virtual and digital. Information access is greater than it has ever been. Transactions and collaboration with peers is no longer the exception, but the norm. But perish the false platitudes that facilities managers are organized and confident planners — the majority of their time is spent quickly responding to crises more than anything else.

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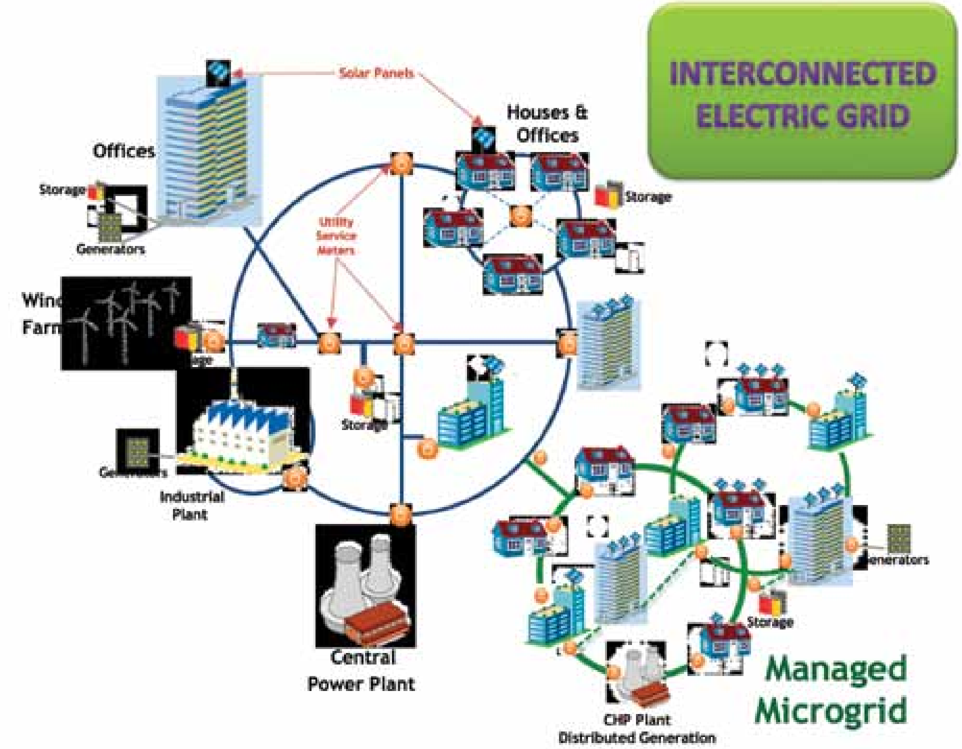

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DISCOVER THE INTERDEPENDENCIES

A microgrid "dashboard" — a system reporting real-time data on the operational and economic status of buildings, HVAC equipment, thermal production, distribution, and loads — is an information reporting system that *tells you what is now occurring, or has* already *occurred, in your facilities operations.*

Elegant, informative, real-time, flexible, and available to Web-enabled connections — a dashboard can reveal how you are spending your energy dollars — providing the tools for future savings.

It is a tool to observe the interdependencies in your facilities operations, identifying strategies that may be implemented by the deliberate operator actions. That is, *when* a specific strategy *is identified.*

Then economics creep into the discussion. Your "dashboard" details expenditures on energy in the past 15 minutes, an hour ago, last month, and allows you to allocate costs to individual facilities. Facility comfort and operation metrics are monitored and recorded. It may even predict, based on historic data, your future expenditures on energy.

But this dashboard is only a discovery tool, it does not implement strategies — that task is the daily operational work of the BCS, EMS, DES, BMS, and the physical plant staff that controls the facilities' operations. Stated differently, it is a real-time *monitor* that *informs* the (largely) manually implemented responses.

THE MORE RELATIONSHIPS, THE MORE COMPLEXITY

The array of energy marketplace transactions between buyers and sellers — including the relationship between consumer-owned energy production facilities, competitive suppliers, regulated utilities, and the pricing of the energy commodity — continues to grow increasingly complex.

What if . . .

- Task-oriented work can be *passively directed* by the control systems.
- The control systems facilitate creation, definition, and transaction of a *new energy commodity* that actually produces revenue, in addition to saving costs.
- The control systems set hourly and day-ahead cost minimization operational strategies while maintaining defined comfort, operational and safety parameters.
- Systems operations could react to dynamic real-time market opportunities, and adjust energy use strategies (within defined operational parameters) *in response to an opportunity to sell latent distributed energy resources (DERs)* and capitalize on unique

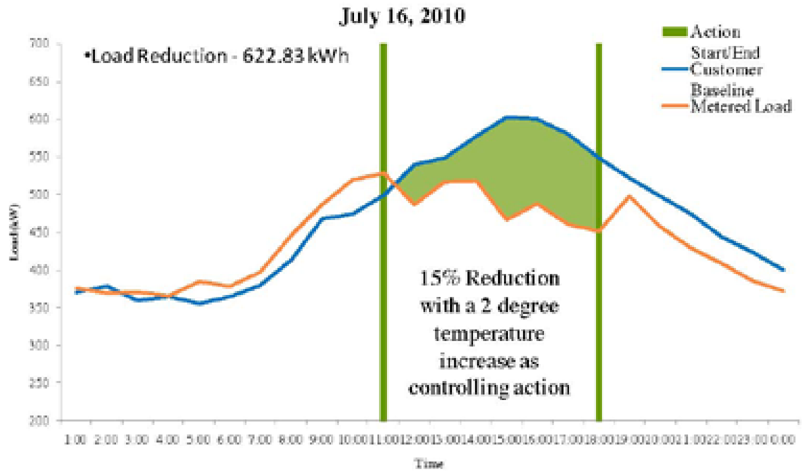
energy market conditions.

Can the complexity of the energy marketplace be managed to your advantage by IT systems?

Can an advanced control system facilitate actual sale of these new commodities?

Can the sales occur while simultaneously optimizing both the costs of facilities operations *and* actively directing both the dispatch of energy systems and facilities management protocols throughout your microgrid network?

Indeed, such "SmartGrid" opportunities are emerging — as *optimally controlled microgrids.* Drexel University, University of Massachusetts-Amherst, the University of California at San Diego, and other institutions are doing all these things with their advanced SmartGrid systems today.



These campuses, working with Viridity Energy, Inc., are using an automated, advanced decision making tool that enables them to sell energy, and load curtailments, to the grid. Viewed as *virtual power plants* by the grid, these resources are compensated for both generation and load curtailments.[1] They have become active market participants selling to the grid, rather than simply passive buyers of electricity.

OPTIMIZED FACILITIES IMPLEMENTATION: CASE STUDIES

Drexel University is monetizing the value of its distributed energy resource portfolio. Drexel, located in the heart of Philadelphia, is a community of 22,000 students and faculty. The Drexel main campus is host to a diverse portfolio of buildings, energy infrastructure and special-use facilities.

Drexel's own campus facilities contain latent, distributed energy resources that could be harnessed to produce revenue for the university, reduce energy expenditures, and improve the reliability and efficiency of the local power distribution grid. Drexel's DERs include controllable loads, back-up generation plants, thermal storage systems, electricity supply contracts, and the prospect of installing onsite renewable generation and electricity storage systems.

Drexel is a major account customer of PECO, Philadelphia' regulated electric utility. With an annual electricity bill exceeding $4.2 million and a peak demand of 10.5 MW, Drexel views energy supplies in a *new context* including its valuable portfolio of DERs. Drexel's project implemented a DER optimization platform for three campus buildings during 2010.

As a result, Drexel has more than doubled the economic value of the DERs optimized in just three campus buildings, as compared to the monetized value offered by conventional "demand response" programs. Drexel has generated new revenue and cost savings, demonstrating a campus-wide, potential economic value (conservatively) estimated at more than $360,000.

The University of Massachusetts Amherst campus is implementing similar strategies for five building, with successful performance demonstration anticipated to lead to campus-wide deployment of the DER optimization systems. Annual savings of nearly $75,000 have been associated with just optimizing DERs in the first five buildings, with projection of potential campus-wide value greater than $550,000 (conservatively estimated). Significant additional opportunities are anticipated for the UMass campus to achieve its environmental and economic goals through active DER management, optimization of electrical load, generation, and storage capabilities, and by participation in the markets operated by ISO New England.

The University of California at San Diego has undertaken a three-year DER optimization project that will significantly improve economics of available systems' performance. Through optimization scheduling employing autonomous, real-time dispatch of DERs to integrate large volumes of distributed resources into the UCSD microgrid, this project seeks to enable wide-scale deployment of distributed solar generation.

The UCSD microgrid is an advanced, integrated system serving a daily population of 45,000. Facilities in its microgrid have a peak demand of 42 MW, and UCSD self-generates 82 percent of its annual load on campus.

Potential DERs integrated in this project include over 1.2 MW of PV at seven sites, a contracted 2.8 MW fuel cell utilizing "directed biogas" from Pt. Loma

Definitions:

"Distributed energy resources (DER)" are now defined as both supply (production) and demand (consumption) assets, generally collocated with (or proximate to) facilities with energy service requirements. In many regional markets, both "megawatts" of consumable energy and "nega-watts" of (actively) *avoided* energy consumption have economic value in organized energy markets.

"Demand response resources" may obtain compensable economic value for an active decision to *forego taking* electricity from the utility supply grid, in the same market clearing economic transaction that sets the compensation paid sellers of electricity supplies.

Wastewater Treatment Plant, 2.8 MW of electricity storage, 30 MW of combined heat and power (CHP) systems, 32 MW of emergency generators, numerous building EMS systems, and 10 Nissan Leaf™ PHEVs (Plug-in Hybrid Electric Vehicles).

UCSD is integrating controls and optimizing the use of these assets — producing an automated dispatch schedule optimizing economic use of all the DERs based upon rigorous load, weather, price, and generation forecasts, while simultaneously serving campus operations and safety energy requirements. A preliminary estimate of potential value earned by the optimized DER facilities (conservatively) suggests well more than $600,000 annual economic benefit from the strategies.

UCSD's utility providers, San Diego Gas and Electric (SDG&E) and the California Independent System Operator (CAISO), are participating to ensure that meaningful results are provided for utility and grid operators. A "virtual generator" platform will be provided, that is dispatchable by SDG&E into CAISOs regional transmission grid.

Specifically, the UCSD project is:

1. **Developing innovative business models employing autonomous, real-time dispatch of DER** to integrate high penetrations of PV.
2. **Developing innovative utility regulatory programs promoting integrated operation of DERs** to benefit the CAISO, the utility, and customers.
3. **Demonstrating comprehensive DER management strategies in a live, real-time environment**, with PV integration, building on microgrid controller and DER asset optimization software.

These universities are implementing tools needed to intelligently and automatically dispatch controllable DERs. These systems optimize building space conditioning loads to meet operating parameters, while generating revenue by selling dispatchable resources into power markets, capturing O&M savings by reducing wasteful energy consumption, and providing environmental benefits.

MICROGRID OPTIMIZATION

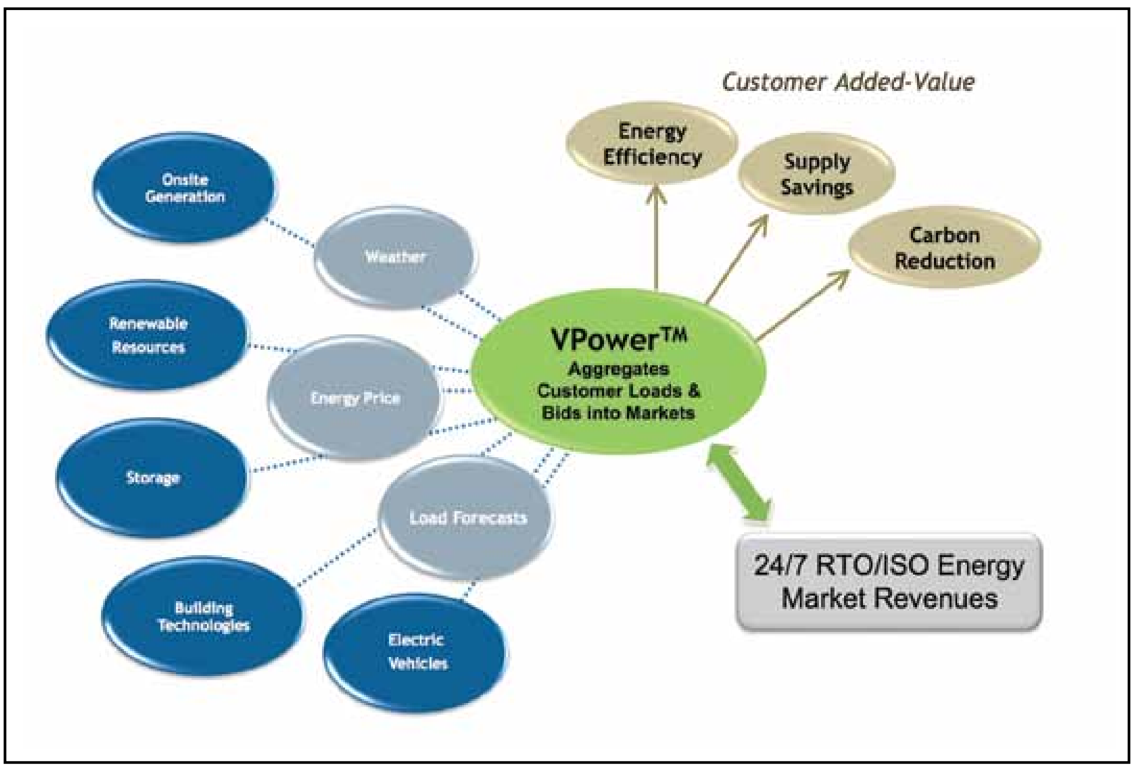
For Drexel, UMass, and UCSD, the software integrates with building automation systems and coordinates facility operations and distributed resource dispatch scheduling to maximize wholesale power market revenues for DERs and reduce facility energy costs.

The process begins with analysis of the portfolio of DERs available in the buildings and models the economic benefits achievable. After validating the benefits, communications equipment is installed (as necessary) to allow real-time data transmissions between the buildings' automation systems and a network operations center.

The software engine models the energy requirements of the campus buildings based on multiple parameters, including:

- *Solar gain*
- *Business as usual temperature*
- *External temperature*
- *Building occupancy*
- *HVAC equipment*
- *Lighting*
- *Building temperature conductivity*

The network operations center enables the co-optimization and dispatch of any DER resident within the campus footprint, including controllable building loads, distributed generation, and battery storage configurations.



Unlike conventional "demand response" enabling participation in peak-period *capacity* markets only, the software platform enables continuous participation in *energy* markets. In short, providing significantly greater potential to garner new revenue and cost savings, without risking disruptions to campus operations or sacrificing the comfort of students and staff members.

Traditional "demand response" programs simply provide demand reductions when requested by the RTO/utility.

Instead, optimizing load using behind-the-meter DER resources provides dynamic and measurable demand reductions on a full-time and real-time basis — converting load curtailment into a controllable, fast responding resource to economic (price) signals.

As demonstrated by the Drexel, UMass, and UCSD examples, the system is scalable. Importantly, this advanced SmartGrid system is employed for enhanced economic benefits — not simply the reliability purposes of existing demand response programs.

ADVANCED SMARTGRID: EARNING ITS ECONOMIC CREDENTIALS

Automated SmartGrid systems have traditionally been installed where complex, billion dollar capital assets must be managed to serve increasingly complex loads. These IT systems capabilities are a necessity to optimizing operations of the utility grid, but are now also available to optimize microgrid operations such as found in many higher education facilities.

Moreover, these institutional facilities contain a host of DER "opportunities" that may produce new and enhanced economic value through sophisticated management and operations strategies.

Returning to the "*What if . . .* " questions.

What if the investment that your campus has made in SmartGrid capabilities can be enhanced to become virtual generation resources that are dispatchable to the utility; that is, during those periods when the economics and market prices justify such use of the latent energy resources of your campus.

The economic value of the managed DER grid resources do not simply inure to the owner of the facilities. Where these systems become reliable resources — just like an independent power producer selling generation into the wholesale markets — we have created *new economic value* from the more efficient use of an underutilized resource. This gain in efficiency — manifest (in part) as avoided utility capital investment in generation, transmission and distribution resources — has economic value to society as well.

And so, it is true that these advanced SmartGrid IT systems do have the ability to produce revenue from energy use data and the management of distributed energy resources.

REFERENCES

1. Economic value is derived from purchased supply cost savings (MWhs), and revenues from sales of load curtailments, capacity resources (MWs), a supplies (*avoided* MWhs) and ancillary services. The business model for (at least) these three universities shifts all financial costs and risks to the vendor, for a specified share of the realized value.

John Tysseling is president of E3c, Inc., Albuquerque, NM; he can be reached at *jct@e3c.com*. Audrey Zibelman (*azibelman@viridityenergy.com*) is president and CEO, and Allen Friefeld (*afreifeld@viridityenergy.com*) is senior vice president, external affairs, for Viridity Energy, Inc., Conshohocken, PA. This is Zibelman and Friefeld's first article for *Facilities Manager*.