

Adapting renewable energy to the data center



Context: Do renewables have a place in the data center environment?

Interest in renewables is driven by two key requirements: environmental sustainability and energy savings. Power consumption within a data center environment is substantial, accounting for almost half of total operating expenses. When one factors in escalating and unpredictable energy costs, along with fees associated with pending carbon emission legislation, it is understandable that operators are increasingly focused on the role renewables can play in reducing and/or stabilizing energy costs.

Hyper-scale data centers like Google's have stood at the forefront in renewable energy initiatives, as pioneers exploring their inherent business, environmental and social value. Google sites its data centers based on a number of factors

related to reliable service delivery, in locations that may not offer the best potential for renewable power. As a result, it is using renewable energy in the form of wind and solar by engaging in power purchase agreements (PPAs) to power over 35 percent of its operations, an approach that encourages the development of renewables on the part of utility providers. Facebook is building facilities in Iowa that will be 100 percent powered by a local wind project the social network helped to develop as well as a data center in the cool Swedish climate to take advantage of local hydro power. Microsoft, for its part, has built in Quincy, Washington, using 100 percent hydropower, and is experimenting with powering a 200kW data center in Wyoming with biogas from a local Cheyenne wastewater treatment facility. A third approach is demonstrated by companies like Apple, which has built into its Maiden, NC facility a 100 acre, 20 megawatt solar plant that enables total reliance on renewables, or Verizon Communications, which announced

plans in 2013 to invest \$100 million in the installation of solar panels and fuel cells at more than a dozen facilities that will use and generate the clean resource.

Renewables of choice for data centers include rooftop solar, wind, geothermal and waste heat reclamation. Solar has limitations in light of the high cost of photovoltaic solar arrays, climatic requirements and space restrictions. However, it has become one of the more widely used approaches in the data center environments since roof top real estate, when available, is virtually free, reducing the cost of implementation. Wind turbines are less widely used, largely because of real estate needs and cost, although interest in this resource is growing. Projects are also underway for geothermal (particularly in the US mid-west) and in waste heat recovery.

Battery storage is also top of mind in renewable management discussions as storage can mitigate issues with intermittency. While the technology is viable, large scale implementation is out of reach for many enterprises from financial and space perspectives. Once pricing comes down, battery storage promises to play an important role in overcoming some of the reliability concerns that are inherent in renewable power.

Business issues: The convergence of consumption and business value

When considering a renewables strategy, facilities operators should take into account two points of convergence: the need to better manage energy consumption on-site and the potential to generate loads that can build value through the creation of RECs (renewable energy credits) or the sale of surplus energy back to the main utility grid.

A key driver behind the adoption of renewables is the implementation of time-of-use rates by energy providers. Data center operators are continuously exploring alternatives to manage demand and/or mitigate reliance on the grid during peak rate times (i.e. periods of highest electricity demand on utilities when additional fees are charged); use of on-site renewables (or sale into the grid) during peak rate times could help manage costs.

While renewables have presented challenges from a capital cost perspective, the landscape is changing. Cost for renewables such as solar have recently come closer to achieving parity with the cost of energy from utility grid, due in part to incentive programs introduced by governments in many jurisdictions to offset the higher implementation costs associated with renewable generation. In addition, once in place, solar, wind and geothermal provide a free and limitless energy source, ultimately translating into lower cost of ownership for the facility.

“The question is, will the data center at least be ‘whole’ in terms of cost to implement renewables?” said Gary Rackliffe, vice president, Smart Grids North America for ABB. “Social conscience is often dependent on not so much saving, but on something not costing more.”

Technology capabilities: Connecting and controlling renewable technologies

In decision-making around renewables, there are a number of dynamics that come into play. The first question to ask is how the data center consumes electricity and to what extent consumption is controllable. In other words, can renewables play a role in delivering controllable, interruptible load and can they be integrated in a way that enables them to provide added value to the data center? And can control systems be installed that would allow interface with the utility for sale back of excess energy?

Recognizing the existing limitations of renewables, data center operators can still realize their benefits by introducing micro-grid platforms that integrate energy from multiple resources, including power from the grid, diesel generation and renewables. This approach is proving especially useful in regions where grid-delivered power is costly or unreliable.

Power management technologies are key to the successful integration of renewables, and many generation solutions aimed initially at the plant or utility provider may be adapted to suit the data center environment. Leading suppliers like ABB provide (solar) inverters, low-voltage products, monitoring and control systems, grid connections, as well as stabilization and integration products.

ABB’s product line provides an example of the kinds of technologies needed to create a renewables platform for the data center. The ABB solar inverters enable data centers to convert direct current (DC) electricity generated by solar modules into alternating (AC) with 98%+ efficiency, and the company’s hybrid power plant will integrate one or several fuel-based generators and one renewable energy generator to enable combined generation. ABB adds engineered solutions for integrating renewables into an existing fuel-based generation grid (integrated wind or PV power plant) to increase stability and optimize energy flow. And to manage the erratic fluctuations in frequency and voltage characteristic of renewable energy, ABB offers a flywheel-based generator and software which controls power in and out of the flywheel, acting as what ABB calls a “high inertia shock absorber that can instantly smooth out power fluctuations.” For data center facilities interested in building their own plant and load, these power management technologies can help solve for issues with renewables.

Implementation challenges: Addressing renewable characteristics

The reality is that renewable options typically struggle to address 100 percent of the enterprise data center’s power needs. There are few scenarios in which on-site or even rooftop solar PV (photovoltaic) would fully supply a data center’s energy needs simply because there is not enough space available to house all the solar arrays that would be needed. In addition, weather conditions can have a dramatic impact on generation capacity: ultimately solar is not dispatchable power – i.e. capable of reliably delivering the required level of power when it is needed. Energy production can be

extremely variable, depending on time of day and weather conditions: a cloud passing over the sun could drop power generation from 5 MW to 100 kW in a matter of seconds. And while rooftop solar may have a natural “home” that does not add to operational costs, wind generation would require substantial real estate to generate energy at any meaningful levels. An underground source of energy, geothermal also comes with significant and costly logistics and infrastructure requirements.

The challenge for many data center facilities interested in on-site generation is that renewable technologies as they stand today are rarely a whole solution for the supply of energy 24/7 due to intermittency (in the case of wind and solar), real estate limitations and implementation costs or all of the above. But combining various resources such as rooftop solar, biofuel, battery and fuel cells and backing them up with diesel generation that is on-site for redundancy purposes can help to leverage and extend the role of renewables in the data center. The choice of resources depends on a number of variables, including climate, local utility provider fees and available access to renewable resources.

As Google and others have demonstrated, data centers can also sidestep the real estate and infrastructure cost challenges through partnerships with local power providers whose stock in trade is renewable energy production.

Benefits: A place for renewable

There is no technical reason why most data center facilities cannot consider renewable energy alternatives (though facilities located within high rise building complexes in highly congested urban environments may encounter special challenge). However, deployment decisions do not depend solely on questions of technology viability, rather the decision becomes one of basic economics: does a renewables strategy equate to real savings? Renewables, for example, would represent an interesting discussion point for a data center operation in New York City where space is limited but per kWh costs for grid energy, which is distributed by cable, are approximately double that in New Jersey, which uses an overhead distribution model.

When making the case for renewables, there are a number of questions that need to be addressed in planning, ranging from reliability and resiliency requirements to the role renewables can play as a primary, complementary or backup energy provider. The organization may also wish to weigh the importance of renewables in corporate social responsibility strategy, an intangible benefit that Facebook attempted to ignore to its peril.

The argument for renewables in data centers is increasingly compelling. Not only are renewables a central component in reducing an environmental footprint, they are also now viewed as a reliable backup source of power that can reduce reliance on what in some regions are overloaded utility grid systems.

While hyper-scale data centers account today for the lion's share of investment in renewable strategies, enterprise-level operations are showing increasing interest as the economic value proposition of alternative energy becomes clearer.

Some operations are already well entrenched in renewables strategies; others are still in the planning stages and exploring issues such as what aspects of energy use are controllable, what are the existing energy contracts, capacity needs, incentive program opportunities and their limitations (e.g. runtime, renewal qualification).

When these questions are answered, operators will be in a better position to make informed decisions around what percentage of supply can be sourced through renewables, and what enabling technologies make the most economic and environmental sense.

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