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How energy data will impact the smart grid

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a cleantech report

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The deployment of smart meters combined with the growth of cloud computing infrastructure has created opportunities to build business models around the volume of emerging energy data. Estimates indicate that when smart meters are fully deployed, they will generate 1,000 petabytes of data a year, about five times the amount of data on AT&T's network.

That said, challenges remain in terms of dealing with utilities as business customers, getting consumers interested in their own energy behavior, standardizing protocols for effective device-to-device communication, and providing a compelling ROI case beyond just energy efficiency. Energy efficiency plays that use data to solve customer problems and leverage decades of software development and advances in big data will attract investment dollars.

Key highlights of this report:

- The bias toward software development over hardware development in cleantech investing creates a positive environment for a value-oriented energy data startup.
- Emerging business models in home energy management are taking advantage of cloud infrastructure and channel partners to sell products and services in the home market.
- The future of building management systems (BMS) is effectively integrating systems with the smart grid to participate in revenue-generating programs like demand response.
- Utilities are facing key pain points and also have primary concerns when deciding which big data software tools to pilot.

Introduction: Data meets the smart grid

In 2010, leading cleantech investor Vinod Khosla titled a 34-slide presentation "Smart Grid or Smart Hype?" One of his core points was that just connecting a device to the grid, be it a smart meter or a refrigerator, did not result in energy savings, nor was it a sustainable business model for a startup in search of venture capital funding. Having data is not enough. Wringing economic value from that data by creating a product that, for example, reduces outages and increases billing accuracy for a utility is where the potential for a real business and a growing market can materialize.

It's not just venture investors who have expressed skepticism about the smart grid. Public utility commissions in multiple states are pressuring utilities to "show them the beef" after many government agencies have pushed for smart meter deployment. Billions in stimulus money went into smart meter deployment. There is mounting pressure on utilities to not only use smart meters as a way to avoid the high costs of manual meter reading and billing but also as a tool to save energy, increase grid reliability, improve demand response programs, better respond to outages, and upgrade distribution automation.

According to the U.S. Energy Information Administration, as of August 2012, 37 million U.S. customers had smart meters with enhanced communication capabilities. Penetration rates are uneven, with Texas, California, Maine and Georgia leading the way with at least 40-percent penetration. Meanwhile, some states, including Illinois, still have a penetration rate close to zero. Most predictions, like that of Berg Insight, see 100-percent U.S. penetration by 2020 with accelerated growth expected over the next three to four years in Europe and China, where the State Grid Corporation has said it will install 300 million smart meters by the end of 2015.

Projections indicate that a fully operational smart grid will generate 1,000 petabytes of data a year, which is more data than is trafficked on many cellular networks. All of this comes at a time when "big data" is the buzzword in general venture capital and when "smart grid analytics" was the key theme coming out of January's DistribuTECH Conference, the major meeting for smart grid players.

We're at a convergence point at which many algorithm-based technologies are coming online and hardware costs are declining to the point where it's getting cheaper to run analytics on larger volumes of data. Add to this trend ubiquitous broadband and cheaper chipsets (Wi-Fi, 3G/4G, ZigBee, Z-Wave) to make connectivity much easier, and it gets more enticing to build a business around energy efficiency and saving businesses money.

In general cleantech venture investing, the bias right now is away from hardware development and toward software-based solutions, which are primarily geared toward energy efficiency. One of the reasons for this is that software solutions are easy to scale. They also lend themselves very well to Software-as-a-Service (SaaS) models of customer engagement. On the smart grid, you're often selling to utilities; SaaS models are essential here because utilities are slow-moving and require pilots before purchasing. Being able to roll out a software product on a small scale and then scaling up to hundreds of thousands or even millions of customers is critical. The time has come for software development to tackle the smart grid. So

with that in mind, let’s examine the risks and opportunities across different sectors: home energy management (HEM), building energy management, and utilities.

Data and home energy management

The HEM market is slowly opening up as consumers get accustomed to the idea that their home appliances can run more efficiently and that their energy use is something they should care about and can do something about. It's a cultural shift as much as a business shift. It's starting slowly in energy-progressive markets like Texas and California and driven by retail utilities and improving consumer awareness, but it will take decades for home energy consumption to be a major consideration for all Americans.

In terms of getting consumers to care and invest in technology that will change their home energy footprint, startups targeting home energy use will be getting help from utilities and telcos. Many of these startups, including Nest, EcoFactor, Opower, and Tendril, have high hopes that their technology will gain adoption via channel partners and not just direct-to-consumer.

Founded by Apple's former chief architect Tony Fadell, smart thermostat-maker Nest is one of the few home energy management devices that has gone direct-to-consumer and had success. It's done so by creating buzz about its hardware, which looks beautiful and can adjust your HVAC system by learning residents' behaviors. But even now, the company is eagerly trying to partner with utilities to expand its reach and has struck a deal with Texas electricity retailer Reliant that stipulated that in exchange for signing a two-year electricity contract at fixed prices, customers received a free Nest thermostat. Going direct-to-consumer is costly and requires high-level design and marketing. Even for Nest, the chance to have utilities sell its product at volume is very attractive.

The early HEM victories have mostly been focused on the HVAC unit, which typically is responsible for 50 percent of the energy use in a home. And while you might assume you need thermostat hardware to attack that market, cloud-based SaaS models are emerging. EcoFactor runs its software atop a number of generic ZigBee or Wi-Fi enabled thermostats and partners with utilities, telcos, and HVAC servicers to sell its software solution. Its software accumulates data on setpoints and manual overrides. Then it crunches that data with weather data to optimize a thermostat's settings and reduce power use.

EcoFactor is built around four core data scientists with additional software engineers, and it is also an example of leveraging the telco channel to sell HEM gear. Its software is sold via Comcast, which offers HEM as part of its total home-automation package that also includes security and lighting control. The broadband providers remain a key entry point into the home since they have existing customer relationships and experience managing challenges like churn and customer maintenance.

Finally, Opower remains the big data energy player to beat. The company collects data from 75 utilities, including 96-billion meter reads, and then crunches that data to provide recommendations to customers in the form of mailed reports, text messages, and emails. Opower opted to come into the market first with the lowest tech solution, but it's been remarkably effective. On average, the company delivers savings of 1.5 to 3.5 percent in energy use per customer. It may sound like just a few percentage points, but after five years, more than 2 terawatts of energy have been conserved.

Opower remains an IPO possibility this year or next, and it has plans to move beyond the U.S. market, having partnered with First Utility in the UK in an early foray into the European market. Though it's unlikely to be a near-term problem for Opower, at some point there may be widespread adoption of HEM tools like those of Nest and EcoFactor, which produce far larger energy savings for consumers, hitting in the range of 15 to 30 percent. Once those percentages of energy savings are common, the appeal of the savings offered by Opower may wane. That said, by that time I'd expect Opower to have leveraged its years of analyzing utility data to offer its own deployable software analytics platforms that could compete in various markets.

Big data and building energy management

According to the U.S. Energy Information Administration, the building sector consumes almost half of all energy produced in the U.S. and is also responsible for almost half of the carbon-dioxide emissions. Seventy-six percent of all electricity produced domestically goes toward operating buildings. These are striking figures because when we think of energy demand, we tend to express concern about transportation, which accounts for roughly a quarter of energy consumption in the U.S. But it's actually buildings that are the biggest energy hogs. And with that amount of energy use, it's the one market in which energy savings can amount to real economic savings for any given medium- to large-sized customer.

There exists an established BMS market to address the needs of large commercial and industrial buildings, but the growth of the smart grid and the improving cost and capability of analyzing large swaths of data has opened the market up to startups with software approaches that can help these facilities integrate with the grid and communicate with utilities.

ENBALA Power Networks is an example of this type of approach. While it typically deals with independent system operators (ISOs) that are responsible for maintaining a balanced grid and moving electricity across states, the company also now targets large power users like hospitals and wastewater treatment plants.

ENBALA is focused on what's known as demand-side energy management, which is a way of asking big power customers like wastewater treatment plants to participate in the management of the demand side of the grid. ENBALA networks a group of large power users and then pays them to offer the grid flexibility in their power consumption. It's part of a larger trend in which startups want utilities to conceive of energy storage as the ability to work with energy demand, not just power up natural gas peaking plants or build expensive battery storage units.

ENBALA's pitch to customers is that they can generate revenue by working with utilities to shed load when necessary. Comprised of almost a quarter software developers, the service is powered by a platform that gathers data on customers and then uses real-time processing and protocols to determine how and when load can be shed. Essentially, a layer of software must exist between the power user and the utility (or ISO) so that second-by-second grid-balancing can occur.

ENBALA takes readings every few seconds and crunches that data against the power needs of the grid. This ability will become more important as more intermittent forms of energy supply, like wind and solar power, are integrated with the grid. In order for these energy sources to be adequately accessed, you have to either invest in expensive grid storage (batteries) or figure out a way for the demand side of the grid to become more flexible so that it can roll with the variability of supply.

Companies like ENBALA are betting that ultimately the latter solution will prove less expensive for

utilities. While not immediately dependent on the deployment of smart meters for their service, ENBALA, like most vendors in this space, welcomes the additional smart meter data because it further fine-tunes the performance of their grid-balancing software by bringing in more energy data to be crunched.

In terms of building management, startups are popping up to help facility managers not just visualize their power use on a more granular level but also power up and power down discrete operating units based on communication signals from the grid. The BMS space is already fairly staked out, so any incremental value from a startup has to come in the form of helping a business generate revenue by hooking customers into utility programs through which the customer makes money from demand response programs or even frequency regulation opportunities.

Companies like Powerit Solutions are founded on energy visualization technology, price response, energy efficiency, and the capability for demand management. In particular, Powerit's dynamic pricing technology incorporates energy pricing data, which can change hourly, into a building's energy use. Algorithms can then calculate the power needs of the building and figure out where load can be shifted.

As a simple example, a building could be pre-cooled over the summer to avoid peak pricing problems between 12 p.m. and 5 p.m. Responding to pricing manually is more difficult, with managers having to read price changes off a website, but OpenADR, which communicates dynamic pricing signals between a retail utility and an energy management system in a standard format, is allowing for greater automation.

The future of building management is grid integration, since utilities are incentivized not to bring on additional peaking power plants by either their own bottom line or by public utilities commissions. As renewable resources enter the grid and electricity use is digitized, the game will be about producing cost-effective software solutions that make the demand side of the grid equation increasingly malleable.

Energy data and the utilities

Utilities do not have IT cultures, yet as the smart grid evolves, they are saddled with enormous amounts of data and have little choice but to become IT-proficient. The first wave of companies to serve utilities was meter data management systems (MDMS) players like Ecologic Analytics and eMeter, which were acquired by Landis+Gyr and Siemens, respectively. In these cases, the parent companies felt they needed to offer utilities MDMS as part of their suite of offerings. MDMS do the basic management and warehousing of smart-meter data to ensure basic tasks like integrity of billing.

Historically the utilities have not been anyone's favorite customer, or as one startup founder described to me recently, "They're a nightmare." Utilities often have regulated profit margins, and thus any additional product purchased must be justified with cost savings. Utilities often aren't particularly IT-literate, and they prefer to deal with fewer vendors, making it tricky for small startups to access the market and one of the reasons that some startups have partnered with larger players. Finally, utilities typically don't buy a product outright but choose to run extensive trials first.

Software solutions firm SAS surveyed utility CIOs recently to discern their concerns, and the top three were:

- Network reliability
- Reporting requirements
- Renewable energy integration

In addition to the needs of CIOs, there are three key trends that are driving opportunities for grid analytics:

1) Penetration of enabling technology such as smart meters, two-way communication infrastructure, and grid sensors

2) Deregulation is accelerating, which creates greater incentive for retail utilities to improve offerings and services

3) Standardization is occurring, such as with OpenADR and Smart Energy Profile, which allows for easier communication of third-party hardware with utilities

The good news for those trying to enter the market is that utilities need help to address these concerns and the vendors with experience and knowledge will have an advantage because utilities have to look for outside help. That said, the pitch has to be about solving a pain point for the utility, which includes reducing costs, increasing reliability, meeting renewable energy mandates, and increasing customer

satisfaction.

For example, a good analytics tool could predict variables associated with outages, like a specific pattern of meter data from a subset of the grid. Data analytics are getting so granular that utilities can load forecasts for individual customers, which in turn improves short-term planning decisions and purchasing decisions in the day-ahead energy markets.

Additionally, some startups that entered the market with an algorithm technology could, for example, target the home energy market with an efficiency benefit. Khosla-backed Bidgely has developed disaggregation technology that can tell users the energy use of individual home appliances, like the refrigerator or the pool pump, based solely on the smart meter reading signatures. It is impressive technology that would allow utility retailers to offer customers a value-added service that would drive energy efficiency.

But Bidgely will have to go beyond the home energy efficiency value proposition and actually solve a utility problem. The company is going after the demand response market by offering utilities the ability to slice and dice their smart meter data, disaggregate it, and identify ideal customers who could participate in demand response. The software can see which are the biggest power users and which of those have the type of load use that is amenable to turning down power consumption. Utilities often incur expense just trying to identify and sign up demand response participants. If the Bidgely programs can be executed and proven, the algorithms will actually save utilities money.

Part of this new thinking centers on defining software as the central lever of energy efficiency. As Amit Narayan, the CEO of smart grid analytics provider AutoGrid, said to me recently, “I like to think of what we’re doing as the 21st-century power plant. By using the data and removing inefficiencies from the system, we essentially create new power. I’ve started using the term software-defined power plants.”

AutoGrid has received $9 million in funding in addition to an ARPA-E grant, and its first product offering is an analytics-based demand response optimization tool. Its analytics platform crunches a multitude of data to better manage customer enrollment to serve a variety of programs that include peak pricing, peak price rebates, and bidding programs. The software can forecast load and also show how much energy can be shed in real-time for various demand response programs.

AutoGrid employs a secure cloud, can integrate with other clouds, and is a reminder that cloud infrastructure and broadband communication are transforming the grid. The trick then for accessing this market is showing utilities how your product can increase network reliability and lower costs.

The future of energy data and the grid

So far we've discussed addressable problems that center on thermostats, demand-side energy management, and optimization of demand response programs for utilities. But what other problems are on the horizon?

We're likely at least a decade away from it being a real problem for utilities, but electric vehicle integration stands out as a future problem, particularly when it is compounded by the intermittency of renewable energy integration. Software services that communicate with vehicles, vehicle owners, and the utility to optimize charging schedules with built-in price signals will eventually become a reality. Automakers like Toyota are already beginning to work on these issues.

For utilities, distribution automation and distribution management are nearer-term addressable problems in which voltage levels must be managed to increase efficiency and reduce costs. Software that can access demand response programs in real-time to assist in distribution automation controls so that utilities have more integrated controls will have value for utilities.

There are limits on the ability of utilities to sell add-on products to customers, but many ambitious entrepreneurs in the market are already asking the question of whether, as consumers have more granular data about the energy footprint of individual appliances and the related energy costs, it would be possible to sell them energy-efficient appliances. At the very least, I wouldn't be surprised if some companies in this ecosystem might not be able to begin doing lead generation for retailers as they leverage their algorithms to identify the customers most likely to benefit from and purchase, for example, a new energy-efficient dishwasher.

Conclusions: The state of investment

Venture investors who were hurt by the first wave of consolidation in renewable energy generation are actually increasingly looking to energy-smart technologies for the electrical grid. In 2012, venture capital and private equity investments in these smart grid efficiency technologies amounted to $2.2 billion and 38 percent of the clean energy investment, up from just 15 percent of investment in 2008.

Investors are drawn to the low scaling costs of these companies. Everyone loves Software as a Service, and many of the founders of the emerging smart grid analytics companies have come from cloud computing. Additionally, all of these startups are relying on subtle shifts in consumer and corporate behavior regarding energy. Part of it is driven by greater awareness of energy footprints, and part of it is driven merely by the availability of the technology itself.

It's happening slowly, but consumers will use smart devices to pare away their energy use. Retail utilities will aid them in doing so by supporting smart appliances. Commercial building operators can reconsider their energy footprint when technology makes communicating with utilities and participating in demand response programs easier and more profitable. And utilities have to confront new challenges, like renewable energy integration, that will make analytics software more interesting to them. At the heart of these trends is the volume of data itself, the communication of the data, and the software tools to create value from that data.

At the end of the day, these are efficiency plays, which offer less excitement than actually replacing a fossil fuel source with a renewable source but which also have the potential to significantly reduce energy use. And after many of the investment failures of the solar industry over the past few years, many investors and founders want to leverage decades of software technology to produce products with immediate returns on investment for both startups and customers. All in all, that's not the worst thing for cleantech right now.

Key takeaways

As we approach 2020 and full smart meter deployment, the challenge now is for business models to leverage that data to provide value for consumers, utilities, and commercial buildings.

The home energy management (HEM) market is slowly emerging as both hardware and software business models vie to save consumers energy. There are low-hanging fruit approaches (Opower) that use basic reports to reduce energy use and more advanced analytics technology geared at automating home devices like thermostats (EcoFactor, Nest).

Commercial buildings have the ability to reduce power usage and generate revenue from smart-grid incentive programs. To do so, they'll require software platforms and two-way communication with utilities.

The utilities remain challenging customers for smart grid startups, but those companies that can leverage energy data to increase network reliability, aid in reporting and compliance, and ease renewable energy integration will prosper.

As the venture capital-investing community moves away from renewable energy generation and toward software plays, analytics-based energy efficiency startups will look more attractive.

About Adam Lesser

Adam Lesser is a reporter and analyst for Blueshift Research, a San Francisco–based investment research firm dedicated to public markets. He focuses on emerging trends in technology as well as the relationship between hardware development and energy usage. He began his career as an assignment editor for NBC News in New York, where he worked on both the foreign and domestic desks. In his time at NBC, he covered numerous stories, including the Columbia shuttle disaster, the D.C. sniper, and the 2004 Democratic Convention. He won the GE Recognition Award for his work on the night of Saddam Hussein's capture. Between his time at NBC News and Blueshift, Adam spent two years studying biochemistry and working for the Weiss Lab at UCLA, which studies protein folding and its implications for diseases like Alzheimer's and cystic fibrosis.

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