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What the internet of things means for cleantech

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a cleantech report

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Declining chipset costs, improving data analytics, and ubiquitous broadband are driving the onslaught of connected devices. Taken together we're entering the brave new world of the internet of things (IoT), where significant venture capital will flow toward business models that figure out a way to connect a device, mine its data, and provide valuable services to businesses and consumers.

What does this trend mean for cleantech? The ability to connect "things" will result in the possibility of automating decision making in a broad endeavor to drive efficiencies in areas ranging from lighting to home appliances to the smart grid. Almost all of these business models will be broad efficiency plays and carry the advantage of having much less technology risk than other cleantech sectors like next-generation batteries or solar.

Key findings from the report include:

- No single company dominates home energy management, and many players, from utilities to broadband providers, are becoming increasingly important partners in the ecosystem. There is tension in the market among those companies offering a single point solution like Nest and those attempting to fully connect the home under one automation system.
- Efficient and connected lighting is coming, particularly in the commercial and industrial space. LEDs are expensive, but lighting-as-a-service models could make them more attractive to customers.
- The smart grid epitomizes the data services theme, connecting energy users' data to the network with smart metering. Look for two-way communication, decentralized power generation, and a much more controllable and flexible demand side of the grid to change how energy is distributed and consumed.
- Environmental sensors will become increasingly widespread as they are made more compact and function on less power. Startups with simple, elegant, and creative solutions to producing value from that sensor data will find customers.

Introduction

The internet of things appears to be the new buzzword in tech and venture investing circles these past 12 months, perhaps where big data was a few years ago. And it's inevitable that entrepreneurs would jump on the promise of never-ending possibilities stemming from connecting devices to the network as a trend. For cleantech investors, the internet of things holds promise that it can be leveraged to drive energy savings and sustainability projects, just as big data technologies have been used to drive efficiency projects like smart grid data analytics.

The definition of the internet of things is itself hard to pin down, precisely because it's evolving even as analysts attempt to draw boundaries around it. (For a broad look at the trends in the internet of things landscape as well as conceptual definitions of the market, see "The internet of things: a market landscape.") As a broad concept, the physical world, including objects ranging from cell phones to thermostats to glucose monitors, is becoming a reservoir of data to be mined, because it can now be easily connected to a network. More importantly, we've reached a point in technology evolution when it's becoming feasible to mine that data for useful and actionable data.

Projections are overall optimistic in terms of growth of what can broadly be termed the internet of things. Cisco estimates we'll hit 50 billion connected devices worldwide by 2020 versus about 15 billion today. And market projection specialist MarketsandMarkets sees the IoT and machine-to-machine (M2M) communications markets growing to 290 billion by 2017 at a annual growth rate of 30 percent. The analysis looks broadly at sectors that will be impacted, ranging from retail to energy.

So what are the macro trends enabling the internet of things? The ubiquity of broadband at millions of access points along with the ease with which wireless connectivity and sensors can be placed in physical objects has been one giant leap. At the heart of this leap has been declining chipset prices across multiple protocols including Wi-Fi, cellular chipsets, and ZigBee.

Texas Instruments is so keen on the internet of things that it's releasing low-cost Wi-Fi chip modules at the cost of $10 per set so that startups can experiment with connecting lots of different things. Wi-Fi chipsets hover around $5 for mass production while 3G cellular chipsets are under $30.

Cheap, compact, and available chipsets combined with broadband networks are feeding tremendous growth in data accumulation. All of this data has to flow somewhere. It's being warehoused in data centers, the backbone of the cloud.

The stability of cloud providers ranging from behemoths like Amazon Web Services and Rackspace all the way to simple private cloud buildouts has made storage and access to data secure and accessible. There's also growing interoperability to the point where it's getting easier to amass pools of data and make it accessible to third parties, which leads to the final critical issue with the internet of things: what to do with all of that data.

Collecting data from devices isn't a solution. Rather, it's what can be done with that data in terms of analytics and business intelligence. At a San Francisco meetup earlier this year hosted by GigaOM in which speakers attempted to hash out a concept of the internet of things, the following key point was made: The connected device isn't the product; the service is. It's what you can do with the data emerging from the device. And in the world of cleantech, those services invariably come down to reducing energy consumption and driving efficiency.

Why IoT matters in cleantech

If there has been a significant trend over the past few years in cleantech investing, it's been the shift away from debt-capital-intensive renewable-energy and next-generation battery startups and toward easy-to-scale energy-efficiency technologies, sometimes referred to as "digital green" or the "cleanweb." There are a number of reasons for this, but most boil down to the fact that efficiency plays invariably build on decades of software-based innovations and technologies to reduce resource consumption. This approach has little technology risk, avoids significant scaling costs, and is increasingly being understood as a new form of power generation. (The failures of multiple solar and battery startups haven't helped either.) Software that makes resource demand more flexible and reduces waste is the new black.

We're seeing these investments in a range of different areas. Data center infrastructure management (DCIM) providers like Power Assure that are building visualization and rules-based analytical systems to reduce power costs in the modern data center, have picked up investment capital. In the commercial building space, startup Building IQ, which has a predictive-analytics engine that crunches real-time data to make building management systems more efficient, opened the year by picking up $9 million in strategic investment from industry heavyweights including Schneider Electric and Siemens.

These are analytics- and data-driven approaches to resource efficiency. The questions are, How far can startups take this trend, and what value can be generated from connecting more products? The benefit of the efficiency startup is that it if its power savings are significant, it can be an easier sell, not just to investors but also to end customers, be they end consumers in the case of a connected thermostat or a utility in the case of an automated demand-response platform.

And if we return to the original message at the heart of the internet of things — that it's about building services from data, not just connecting objects — then we can begin to take a look at where there might be opportunities for building startups that can deliver a service that transforms a user's experience and saves energy.

The internet of things in cleantech: key sectors

Home energy management

If there's a familiar location in which to begin connecting devices to the internet with an energy-savings proposition, it's definitely in the home. Sometimes referred to as home energy management (HEM), this market is summed up by the installation of systems to control various home appliances, from washing machines to thermostats. Pike Research has forecast the market for HEM to rise to 63 million users by 2020. As more homeowners control their devices from a web interface or, more likely, a mobile device, the potential to maximize energy savings increases. GigaOM Research and NextMarket Insights forecast shipments of home automation systems — a category that adds entertainment and security to home energy management under the smart home banner — to increase from almost 1.7 million units in 2012 to 12.2 million units by 2017. Over the same time frame, revenues from the sale of these systems will increase from $1.9 billion to $3.8 billion.

At present the competitive focus in the home centers around the thermostat. It's the most active area where connected hardware as well as analytics-based software services are being rolled out. This is because the thermostat is the low-hanging fruit, with the HVAC system representing the largest energy demand in the home. By energy expense, heating and cooling account for 56 percent of power use in a home.

Smart learning thermostat Nest has grabbed most of the headlines in this sector, owing to its design and first-of-its-kind buzz. The company was founded by Tony Fadell, the former chief architect at Apple, who has managed to sell the thermostat directly to consumers despite the fact that installation is more complicated than just registering an iPhone. Equipped with sensors that take readings for light, activity, temperature, and humidity, the thermostat crunches all the data to program itself, reducing power use.

The company, though, has its eye on other revenue streams, primarily from utilities in deregulated markets that want to use the Nest thermostat to lure energy customers into long-term contracts. Recently Nest is going a step further by trialing its two-way communication-capable thermostats in demand-response programs that would give utilities the ability to remotely adjust thermostat setpoints during peak load. In terms of an internet of things model, this could prove one of the most advanced applications where a device is providing lots of data and the network can automate decisions for that device in service of creating a more stable grid.

Nest is not alone, and multiple models are emerging here. Competitor EcoFactor is building out software that provides similar energy savings and can work with multiple connected thermostats. CEO Rory Johnson noted to me recently that chipset pricing for a ZigBee-enabled thermostat is now down to about $55. The company wants to allow others to build the hardware while its team of data scientists figures out ways to improve algorithms and allows channel partners in broadband, HVAC servicing, and home security to do the sales.

And the channel partners, particularly in home security, are taking notice of the trend toward selling broader packages to customers. Alarm.com recently acquired EnergyHub, which will enable the company to offer a connected-thermostat product to customers already opting for a home security system. Control4 recently filed to go public, with its business model built around connecting home devices including door locks, video cameras, and lighting.

This is all going toward broad home automation systems where everything from lighting to security to entertainment to thermostats can coexist on one platform, all connected on a single network. Many of those service providers are looking to offer a connected thermostat offering because of the energy savings. We're at the beginning of consumer adoption here, but the increased competition is encouraging. And while the thermostat is being rapidly connected, other areas of the home are still in a nascent stage.

Because of the energy demands of pool heaters and pumps, many analysts have long opined about the need for a connected pool pump. On warmer days are there potential energy savings in automatically turning down a pool heater? And the connected appliance issue remains uncracked. Do consumers want a connected fridge that alerts you if you've left the door open or if temperatures are above an optimal range for raw meat?

Samsung has rolled out connected washing machines that users can control from their phones. There are potential benefits here in terms of scheduling loads to coincide with either discriminatory energy pricing or in a future of rooftop solar, when solar power is most available. The issue with all of these connected appliance endeavors remains the payoff for consumers. But I believe that as consumers come to expect a connected home, the value will be partially energy savings and partially user experience.

Connected lighting

When we talk about connected lighting and efficiency, it's important to discuss the adoption of LED lighting, which uses 75 percent less energy than traditional incandescent bulbs and lasts 35 to 50 times longer than incandescent and 2 to 5 times longer than fluorescent. There's also a slowly growing awareness surrounding light pollution and wasted lighting, largely due to its impact on human sleep patterns and environmental impacts on wildlife. (For a full GigaOM Research report on the LED market, see "The growth and promise of the LED market.") LED is interesting in that it has energy-efficiency benefits as well as the fact that it's a light bulb technology that almost across the board is being introduced with connected capabilities.

If we want to use less light, we'll need environmental sensors and smart lighting systems. LEDs are themselves constructed from semiconductor material and are typically based on silicon or gallium-nitride wafers, and many companies are looking at using this construction as a way into easily networking LED bulbs so that they can be remotely controlled on a network.

Startups like GreenWave Realty are building LED lights with IP addresses built in that will make them

programmable as well as allow for basic functionality like automatically turning off when no activity is detected. Philips has waded into the connected-lighting space with its consumer-directed Hue light bulb and has actually opened a software development kit (SDK) so that developers can take their stab at developing apps that dim, turn off, or sync the bulbs.

In terms of market traction, there's much more movement on the commercial and industrial side, because the energy savings of replacing incandescent with a networked, LED system are far more quantifiable at a larger scale. Companies like Digital Lumens are rolling out wirelessly networked LED lighting systems that can be remotely dimmed to optimize lighting in large commercial spaces. Digital Lumens is also creating lighting-as-a-service offerings whereby companies can just pay a monthly service charge rather than the expensive up-front capital costs of putting in a whole LED system.

LEDs remain expensive and are much easier to sell to commercial customers, who have a sense of the total cost of ownership. While LEDs can be 15 to 20 times more costly in terms of up-front cost versus an incandescent bulb, the total cost of ownership is typically 4 to 5 times lower, due to the enormously long lifespan of an LED. It's early days in the connected lighting market, both in the home and at commercial locations, but regulatory incentives along with energy savings should push the evolution forward.

The smart grid

The requirements of today's modern electrical grid invariably involve connecting renewable energy sources like solar and wind power that have intermittency challenges. This means there are times when the sun isn't shining and the wind isn't blowing, as well as times of excess renewable-power generation when the grid can't use all the energy being generated. On a broad scale, what will be required is a flexible demand side to the energy equation.

In order to make the demand side flexible, sources of power consumption, be they the thermostat in your home or a major wastewater treatment plant, need to be able to respond to the availability of power. On a deployment level, what has been occurring is the phasing out of analog energy meters in favor of smart meters, which wirelessly transmit energy-usage data to utility back offices, often every 15 minutes. This digitization of the grid gives utilities granular data on energy consumption, improving outage response, billing accuracy, and reliability.

But the next evolution of the grid will include two-way communication between generation and demand in order to create a more flexible and stable grid. One of the macro factors driving this necessary trend is that while the grid has historically been conceived of as a centralized hierarchy where power comes from one place and is transmitted, the grid is evolving to have a more decentralized architecture. Customers can generate their own power and are doing so with rooftop solar. In some cases, they're selling that power back to the grid.

The ability to shed and move load, particularly in a decentralized generation setting, requires improved demand-response abilities. On a consumer level, companies like Nest have begun to work with utilities to

give them control over residential thermostats to be able to shed load during peak power usage. Larger opportunities exist on the commercial and industrial scale. ENBALA Power Networks has developed a software platform to help large power customers like manufacturing plants connect with utilities. The platform incorporates utility data as well as the needs of the power user, crunching data in order to create situations where the power user can offer flexibility in its power use and get compensated by ISOs. (For a longer look at energy data and the smart grid, see "How energy data will impact the smart grid.")

This area is under a broad umbrella referred to as "automated demand response," which encompasses the possibility of having customers automatically shift their power usage because of two-way communication with the utility. As communication gets more fine-tuned, the possibility of frequency regulation has entered the picture. Frequency regulation is the second-by-second matching of supply with demand on the grid in order to maintain good-quality electricity and balance the grid. It has typically been harder to use two-way communication here because of the constant adjusting required, but improved connectivity has opened up this possibility.

In essence, the smart grid is one giant internet of things architecture where the demand side of the grid is being reconceived as connected and flexible. To that end, multiple startups from data- and demand-focused AutoGrid to home-energy-focused Bidgely are finding financing because they hold the promise of offering utilities new options to address challenges related to intermittent energy generation. The challenge in this market will be to build business models that can show utilities and end consumers the value of further connecting the demand side of the grid.

The potential for environmental sensors

At places like Intel, there's a focused push right now to improve environmental sensors in such a way that makes them low power, compact, and capable of wirelessly communicating data. These sensors include motion, weather, air quality, and life cycle management. The question with all sensors is how to get them out of the research lab and into a viable business model that can produce a benefit.

How might putting sensors in an environment translate into a sustainability-focused business model? There's actually probably more low-hanging fruit here than might be realized. Helsinki-based Enevo has raised a couple million dollars for its technology, which puts a volume and temperature sensor inside a garbage bin. The company then uses that data to optimize collection routes and intervals for its customers. This is a classic efficiency play. Competitor BigBelly Solar says that its sensor system allows for shrinking garbage collection frequencies by 70 to 80 percent. Its CLEAN mapping console is cloud-based and links real-time sensor data to heatmapping of garbage in a city to improve efficiency.

The applications here are broad and revolve around the possibility that improved monitoring equals greater efficiency. Startups around improved tire pressure monitoring are getting going, since it has long been known that incorrect tire pressures on 18-wheelers will result in subpar fuel efficiency. And for 18-wheelers that are doing tens of thousands of miles a year, there can be real cost savings. The question with many of these emerging sensor models is, Who's the customer? Who gets the alert, the driver, the tire company, or the trucking company?

Putting sensors in garbage cans and tires isn't particularly sexy. But the potential for all of these efficiency-related internet of things business models is in their simplicity and in appealing to customers with large-enough scales of business where saving a few percent in energy use or resource conservation will make a difference to the bottom line.

Key takeaways

- The internet of things will drive services that can be built around connecting an object and the data that is mined from those services. A service should provide some or all of the following benefits: resource conservation, cost savings, improved user experience, and better operational efficiency.
- The macro drivers aiding the growth of the internet of things include less-expensive wireless chipsets, the maturation of backend cloud technology, smaller and lower power sensor technology, and ubiquitous broadband.
- IoT business models matter in cleantech because venture investing is shifting away from capital-intensive projects toward startups that can produce energy-efficiency benefits and resource conservation around IT-based businesses. Connecting things to the network opens the possibility of using software-based solutions to make those things, or the system those things control, more efficient.
- The most mature IoT market on the consumer end has been the home, with the thermostat being target No. 1. Still, no single company comes close to owning this market, and many players, from utilities to broadband providers, are becoming increasingly important partners in the ecosystem. There is tension in the market among those companies offering a single point solution like Nest and those attempting to fully connect the home under one automation system.
- Efficient and connected lighting is coming, particularly in the commercial and industrial space. LEDs are expensive, but lighting-as-a-service models could make them more attractive to customers.
- The smart grid is the prototype for the IoT precisely because its premise is connecting energy users' data to the network with smart metering. Look for two-way communication, decentralized power generation, and a much more controllable and flexible demand side of the grid to change how energy is distributed and consumed.
- Environmental sensors will become increasingly widespread as they are made more compact and function on less power. Startups with simple, elegant, and creative solutions to producing value from that sensor data will find customers.
- -The number of connected devices will show consistent growth, as will the market for equipment that enables sensors and connectivity. Similar to big data and the share economy, look for a deluge of IoT startups searching for capital that are attempting to exploit this growth.

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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