

An Era of Transformations

As more and more manmade devices connect to the Internet, enabling them to communicate and respond to us and to each other, the consequences will be nothing less than transformative.

BY 2020, SOME 50 BILLION “things” will be connected to the Internet. These myriad connections are transforming our buildings, the grid, infrastructure and cities. In the best-case vision, transportation will run flawlessly, and the grid will evolve from a one-way delivery system to a nimble exchange of energy. Cities will be safe, clean and accessible to all. Homes will be automated, yet firmly in the hands of homeowners, as they endlessly customize appliances and devices to reduce energy use and increase comfort and convenience.

Necessity is driving some of this. Take Singapore, which may well represent the urban future. It’s one of the most connected cities in the world; it’s also one of the densest. The nation-city’s leaders needed to create solutions for transportation, housing, security and energy use before the city became hopelessly congested or dangerously polluted—or just plain dangerous. Information and communication technology is playing a vital role.

The features in this issue will introduce you to all aspects of the Internet of Things, as we explore the promises, pitfalls, obstacles and innovations along the way to an über-connected world. **GB**

Connected City. Singapore’s Intelligent Transport System uses big data to provide real-time traffic information to residents. Despite its density, Singapore is one of the least congested large cities in the world.

PHOTO CREDIT: EUSTAQUIO SANTIMANO



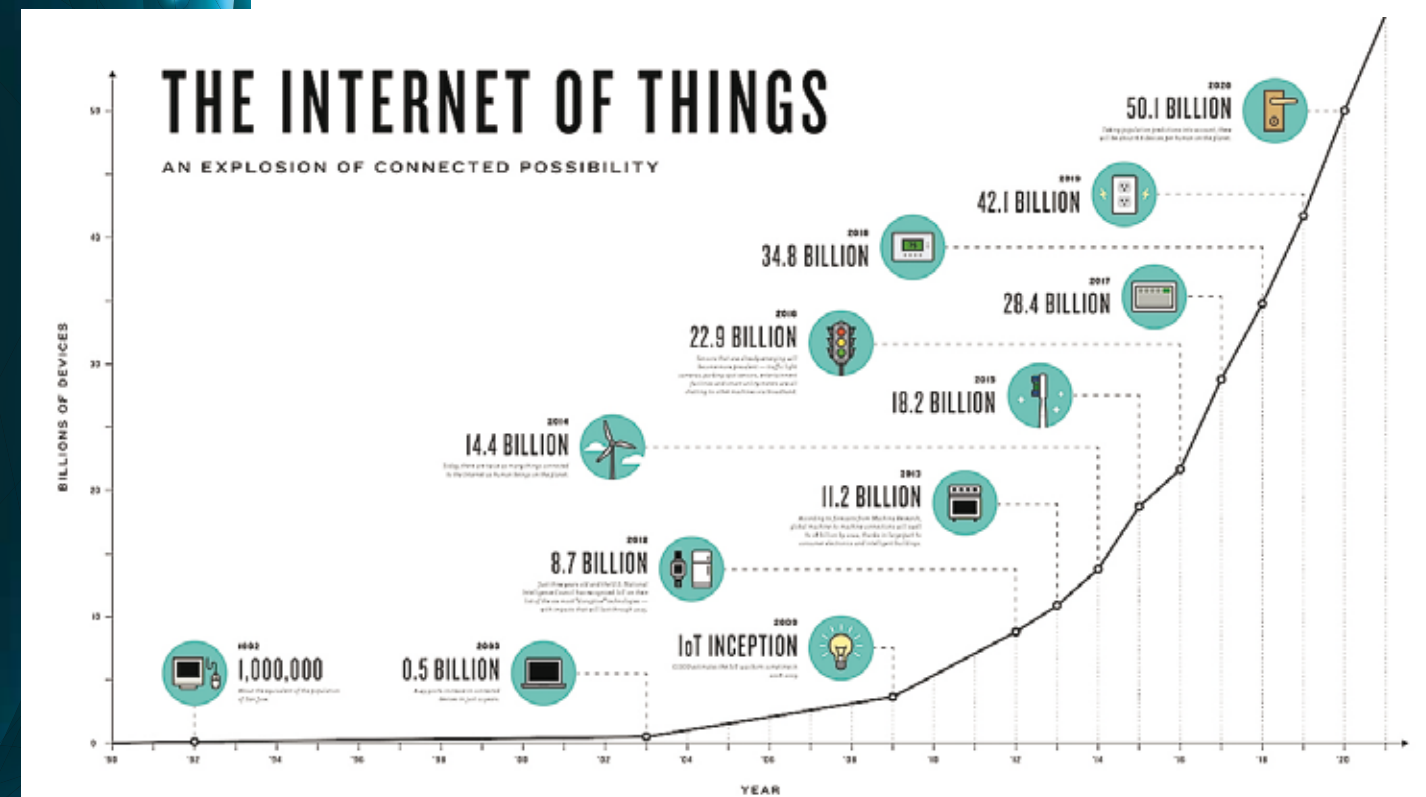
BY SUCHI RUDRA

FROM CARTOON IMAGES of robot maids and flying cars to Ray Bradbury's ironic story of an automated house operating without a family, smart homes are nothing new to the modern human imagination. Only now, companies are racing to release the next generation of connected devices that will make a reality out of this phenomenon dubbed "The Internet of Things" (IoT). In the not-so-distant future, household appliances will be communicating with your driverless car, with the smart grid and with the buildings of the smart city that you live in—and your life will be absolutely hassle free. Homes, cars and cities will be safer and more efficient.

But at what cost? Thanks in part to sci-fi books and films, there's a prevailing wariness in our society, a belief that people will eventually be forced to relinquish control to the machines that do their bidding. If by 2030 over one trillion sensors are connected to the Internet, as predicted, then there's still some time left to figure out how the IoT can and will reshape your life.

Brave, New Connected World

The phenomenon of interconnected devices known as the Internet of Things promises to make every aspect of our lives more efficient and convenient. Are we there yet?



Prepare for the Ride. Just 15 years after the official birth of the Internet of Things, we're poised for exponential growth of connected devices.

SOURCE: CISCO

Public Awareness

Americans are just learning about the Internet of Things: what it means, how it works, and whether or not it will improve their lives. It's not that homeowners are uninterested in smart home gadgets—they undoubtedly want to save time and money and avoid the drudgery of certain household tasks. But the idea of applications that don't yet exist may intrigue consumers even more than what current connected devices are capable of, and that, according to Forrester Research, is the next and likely more successful phase of the IoT.

"Look at instant messaging—that went from zero to success overnight because it was useful, but this home automation stuff isn't useful. When the personal computer first came out, it was sold for kitchen recipes! Uses will show up, like the spreadsheet for the PC—or they won't show up. Our smart homes have been in the works for decades, and we have seen many items come and go. But no one can find the sweet spot yet, and even Nest hasn't made its way through the rest of home automation," Michalski points out.

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Or, as Allen Gilliland, owner of design build firm One Sky Homes, puts it, smart home devices are still a “solution in search of a problem.”

Many homeowners are still largely ignorant when it comes to connected products (see chart below). They’re not the only ones. According to Green Builder’s recent survey of building professionals, only a small fraction (7.8 percent) were “very familiar” with the concept of the Internet of Things, and only a small percentage regularly spec smart devices in their projects.

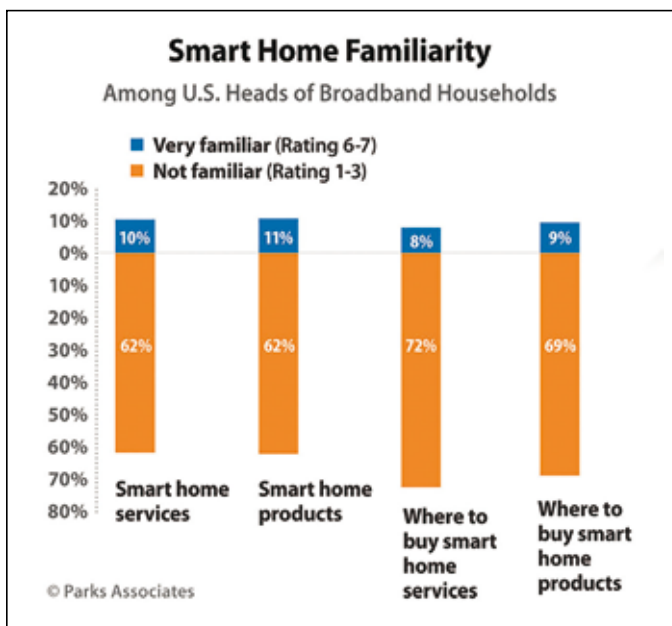
Although most homeowners don’t yet budget for smart home devices, that will change very soon. A recent study by Harvard’s Joint Center for Housing Studies found that home automation will be one of the top trends in remodeling in the next five to 10 years. And by 2018, the North American market for smart home systems will be worth \$9.4 billion (or about 31 million connected homes), up from \$1.6 billion in 2012, according to research firm Berg Insight.

Steve Gee, manager of software development for Nexia Home Intelligence, recalls that when Nexia began manufacturing connected devices five years ago, “it was a new market without much recognition, especially during the economic downturn. But then builders were looking for ways to stand out, and home automation was a hot topic. So we got a number of builders excited, and the market has continued to grow. My expectation is that home automation will become like having AC or power windows in the car—everyone expects it. The remotely controlled door locks and programmable thermostats just give you a taste of what is possible.”

Growing Pains

Certainly, one concern hovering over the evolution of the IoT is a loss of jobs as everything becomes automated. Taryn Rehn of Seattle-based Johnston Architects believes that with any tech

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Early Adopters. About 10 percent of householders say they are “very familiar” with smart home technology.

The Connected Home

Devices inside and outside of the home talk to users, each other and the grid to optimize energy use and comfort.

Solar Tracking. Homeowners can monitor the energy production of their solar PV arrays and compare output to consumption.

Peace of Mind. A smoke and carbon monoxide detector not only sounds an alarm, but will send a text or email alert if something’s amiss.

Smart Appliances. The washer and dryer delay the start of loads until after periods of peak energy demand.

Climate Control. A smart thermostat detects occupancy and adjusts the temperature accordingly.

Managed EV Charging. A connected electric vehicle charger suspends charging when electricity demand on the grid is high.

Wise Watering. The Wi-Fi-connected irrigation system adjusts the watering schedule based on season and soil moisture, but can be controlled via smartphone or tablet when needed.

Programmed Security. Homeowners provide unique access codes for different people, set to work on specific days/times.

Illuminating Technology. Lighting controls sense when the room is occupied; lights also automatically adjust to available daylight, saving energy.

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revolution, this could occur—but that there will also be gains in other areas.

“We’re seeing this occur in relation to the sustainable building industry, which is parallel to smart building and automation. There is already a demand for installers and facility managers with this specialized knowledge. Jobs are created as small businesses form to offer high-end custom home automation. It also creates niches for architects and lighting and acoustic designers, not to mention the jobs created as tech companies design and manufacture new products. This tech revolution will likely spur the economy as it encourages spending on electronics, apps, training and services,” Rehn notes.

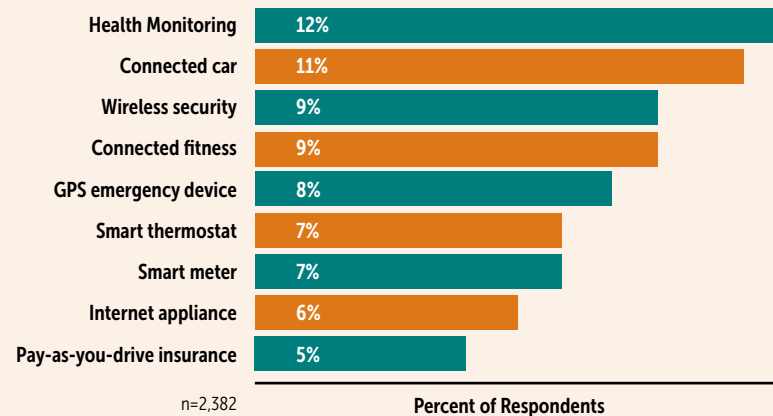
Another important issue is the loss of privacy, and on this subject there seems to be a general consensus among experts and consumers alike.

Jerry Michalski, founder of San Francisco think tank REX, admits he is a skeptic when it comes to the IoT, and privacy is no exception. If there are going to be sensors on everything, “it’s going to be a privacy mess and a hacker’s delight, and we’ll find some unexpected consequences to what we are doing,” he says.

But maybe that won’t seem so bad if, as Rehn puts it, the concept of privacy as we know it is transformed.

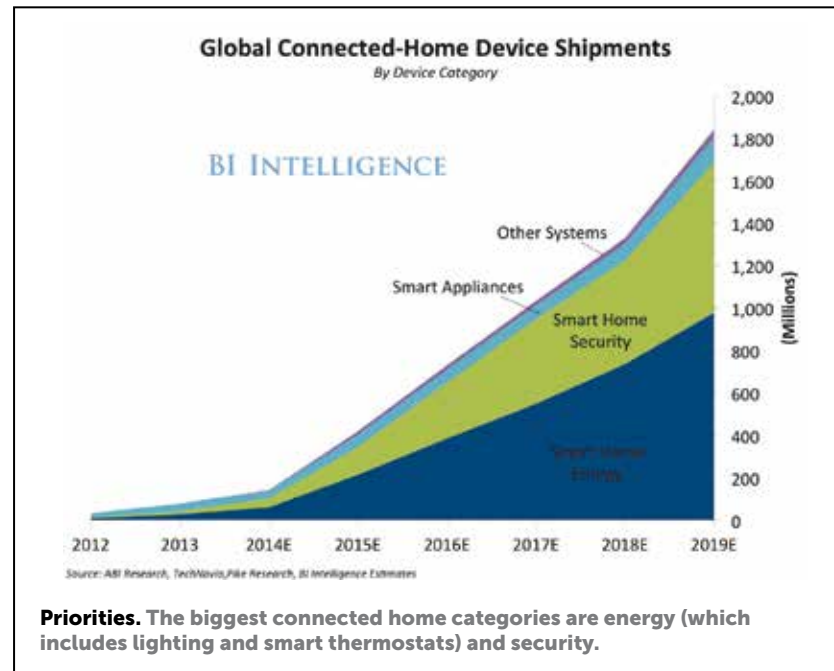
“Google Street View (and now many public interior spaces) blurs faces in an effort to keep identities hidden,” Rehn says. “But if each home, yard and vehicle is equipped with cameras, sensors and tracking devices, every moment of our lives will be documented and quantified. It is unlikely that private surveillance will blur faces for privacy, and this data will be vulnerable to security breaches. On this trajectory, we have to come to terms with the possibility of a complete loss of privacy in every aspect of our lives. The idea of privacy is already becoming obsolete voluntarily through social media, so perhaps this won’t be a concern for future generations.”

Health, Car and Home Connected Devices Top Consumers’ M2M Products



Welcome to the Machine. People are embracing machine-to-machine (M2M) communication in many aspects of their lives, from health and fitness monitoring to smart navigation technology.

SOURCE: YANKEE GROUP'S 2012 US CONSUMER SURVEY, DECEMBER



Wanted: Standardization

While the IoT drama rapidly unfolds, early adopters are entangled in the various networks that connect smart home devices, most commonly Wi-Fi, ZigBee, Z-Wave, INSTEON and Bluetooth. But there’s a race by some of the largest corporations to set industry standards and tame the highly fragmented market.

Intel announced its Open Interconnect Consortium right before Google-owned Nest and six other large companies joined forces in July to establish a new IP-based networking protocol known as Thread. Thread plans to offer manufacturer certification from June. At the end of last year, the ZigBee Alliance launched the ZigBee 3.0 standard, a mesh network which includes over 1,000 devices from manufacturers like Philips, Samsung, LG, Bosch and GE.

Quirky’s general manager Mike Sullivan points out that Wi-Fi—which is a power drain and is prone to interference and bandwidth issues—isn’t the ideal network for connected devices, and the firm is working on a Bluetooth mesh network for its smart home products.

While developers are hacking it out on the standardization battlefield, consumers really just want simple control (one master app) and seamless integration of their connected gadgets that utilize various networks. Achieving this is the aim of companies that have created platforms to serve as a one-stop smart home shop. Hubs are being offered by companies like Samsung-owned SmartThings, Staples Connect, Lowe’s Iris, and Quirky’s low-cost Wink. The free *Yonomi* app also lets normally incompatible devices get along. Apple plans to release the smart device-unifying *HomeKit* system very soon, possibly centering around an updated *Apple TV* as a hub or even controlled via *Siri*. Still, the system is initially meant for developers rather than consumers.



Start with the Big Three

Current consumer data reflects that those who are either flirting with the idea of a smart home or are already enamored have prioritized the areas of security, lighting and entertainment.

Security. Instead of paying a monthly or annual fee to a security company for home monitoring, homeowners are buying up connected security devices and systems that send text alerts directly to a smartphone, signal LED smart bulbs to flash red and even dial 911. Popular products include Schlage’s touchscreen deadbolt with alarm or the *DropCam Pro* security camera.

Gee explains that with Nexia’s products, many controls and lock codes are stored locally in the home.

“We take explicit steps to make sure cloud-based services don’t have that information. We identify locations of customers, and that’s stored in a completely different system independent of the Nexia management system. But schedules or alternate/default



All in One. The Roku Hisense smart TV combines streaming player, gaming console and sharing center and boasts a simple, intuitive interface.



settings are stored in the cloud, providing additional information so you can find out what’s going in your house, if you want to access the history of events,” he says.

Protecting the home is already a major concern for most homeowners using connected devices, but monitoring and remote care of dependents inside the home is a rapidly growing area.

“Services and support for seniors will extend the time period when they can live independently at home. I also foresee increased monitoring of care, snacks, homework and after-school safety and activities for children [...] due to increasing cost of care and busy schedules with a desire for constant connection and the need for security. And we shouldn’t underestimate the value of convenience and fun. Taking a work break to interact with your pet online by giving her a snack is far more exciting than watching random animal videos on YouTube,” Rehn explains.

Smart lighting. Michalski believes that the lighting arena is going to change dramatically, “but that’s aesthetic, not economic. It’s not a game changer.” Lutron and Philips Hue are probably two of the most well-known players on the market for smart LED bulbs and occupancy sensors. But especially in the lighting arena, there’s a constant influx of new products from smaller startups to stir up the competition—and lower costs. The *Alba* smart LED bulb from Stack adjusts itself according to the amount of sunlight streaming in from your window—and learns your light behavior. One of many Kickstarter projects (the popular crowdfunding website has become an exciting breeding ground for smart home products), BeOn Home’s burglar deterrent Bluetooth-connected LED bulbs (which include a microphone to listen for the doorbell) communicate with each other to learn the household’s lighting patterns that are replayed when the house is empty. The bulbs are due to ship in April of this year.

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The Connected Kitchen

Smart devices will help one of the home's most energy-intensive rooms become more efficient.

Remote Chef. Smart oven allows a user to turn it on and off or adjust the temperature remotely, using a smartphone, or to download recipes and cooking tips.

Coordinated Convenience. Customized programs can coordinate several actions to begin, such as making coffee, switching on lights and turning on a selection of "morning music."

Learning Lights. Dimmable LED lighting adjusts to ambient light conditions, but also learns users' behavior and adjusts accordingly; for instance, it learns that the home chef likes bright task lighting while she preps.

Nimble Appliances. The refrigerator connects to the home's smart meter, ramping down energy usage during times of higher demand.

Water Monitors. Sensors under the sink (and in other areas vulnerable to leaky plumbing) can detect the presence of water and automatically send an alert.

The Internet of Things



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Audio/visual equipment. After Sonos implemented an update allowing all of its speakers to connect to the home's Wi-Fi network, the company released its *BOOST* product, which sets up a 50 percent more powerful independent Wi-Fi network solely for its speakers. Roku, a well-known streaming player, recently joined up with Hisense to produce the *Roku TV*, an edgy competitor to smart



Fast Learner. Over time, the Nest *Learning Thermostat* learns what temperatures occupants like. The company claims it can lower heating and cooling bills by 20 percent.

TVs from VIZIO or Samsung, whose recent models also include a built-in mic and camera for voice and facial recognition—features that have stirred up controversy and fear over loss of privacy.

Heating, cooling—and learning. Nest has scored big with its *Learning Thermostat*, which even critics admire for its sleek and sexy design. Unlike the Google-owned Nest thermostat, Honeywell's *Lyric* is iOS compatible and uses geo-fencing to adjust the temperature, although the company's *Wi-Fi Smart Thermostat* offers up a Nest-like learning algorithm. Apple's *ecobee3* adds a touchscreen interface and allows placement of up to 32 temperature sensors around the house. Quirky's *Norm* is similar (but about \$200 cheaper); it creates and adjusts to a network with other connected home devices equipped with temperature sensors. Quirky also offers *Aros*, a low-cost Wi-Fi window unit AC.

While the EPA has said that an automatic thermostat could cut energy bills by \$180 a year, Gilliland doesn't buy the hype.

"A Nest on your wall isn't going to save you energy if energy is still leaking out of your building. Show me the physics, because your building hasn't changed. If you're really looking for energy savings, you'll get more if you take an old home and use air sealing and add insulation than by using your smartphone," Gilliland says.

In building or retrofitting a passive home, Gilliland reduces energy bills to "pennies a day" by installing "very advanced split heat pumps or a new generation of smart heat pumps that turn themselves on and off, and modulate refrigerant and compressor. They have their own proprietary thermostats, like the Fujitsu mini-split. They have their own controller and sense indoor and outdoor temperature."

Appliances. When it comes to serious innovation and value, experts say that the future kitchen is where it's at. In South Korea, LG recently rolled out its *HomeChat* messaging service (coming soon to the U.S.) that allows consumers to communicate with its

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The Future of Home Cooking? The Dacor Discovery iQ wall oven will send you a text when your dish is done, then automatically reset to warming mode. It can also store recipes.

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LG *Smart ThinQ* smart appliances, including a refrigerator that can send you photos of what's left while you're at the grocery store and an oven that can boil and grill in 20 percent less time and recommend new recipes—somewhat similar to Dacor's Android-powered *iQ* wall oven. Whirlpool and Samsung also offer web-based washers and dryers, which allow the user to start, stop or pause loads from afar. But with a price tag of around \$1,600, homeowners aren't yet sold on the value of a texting appliance.

On a smaller scale—but not a smaller budget—is Scanomat's *TopBrewer*, a deceptively simple coffee-from-a-faucet connected device that goes for a cool \$12,000. But for just \$150, there's the coffee pot from Mr. Coffee and Belkin's *WeMo* platform. Another clever gadget that, for some, may be worth its \$8,000 expense: the Sleep Number *FlexFit 2*, a connected bed that, besides many other tricks, gently nudges your snoring partner.

But perhaps a more meaningful application of the term “smart appliance” refers to those that can interact with the grid, and throttle back on energy use at times of peak demand. A few leading brands, including Whirlpool and LG, have released smart grid-ready appliances already.

Shading. “Smart shades” are motorized interior or exterior blinds and shades that include sensors which automatically adjust them for privacy and respond to changing daylight conditions. As Rehn

explains, smart shades are more than just a weekend DIY project.

“It depends on whether you want sensors that control shades based on daylight levels or if you simply want to control shades from an app.” Next month, Jalousier is sending out the first shipment of its *Comfee* product that will turn old school blinds into smart ones. Connected via Wi-Fi or ZigBee, this DIY device reacts to temperature, light and weather conditions and time of day and can be controlled from an app.

In-home digital assistants. Although smart computers (like UCIC's *Ubi* and Amazon's *Echo*) haven't exactly taken the market by storm, it's important to note that in-home digital assistants could take the smart home to a whole new (although slightly creepy) level with the ease of voice control. Think of *Ubi* (short for ‘ubiquitous’) or *Echo* as the *Siri* for your home. The concern of privacy may be one issue that keeps consumers initially at bay, as smart computers like these store all conversations in the cloud; however, both companies state, as they always do, that no one has access (legally) to these logs besides the consumer and the company.

Another possibility lies in *Keeker* (another Kickstarter project)—a tiny, wireless robot with a projector that among other things, turns the walls of your home into a screen and can monitor the home. Currently priced at \$1,900, the number of helpful household functions performed by *Keeker* will be endless.

The Allure of Novelty

Home automation still isn't cheap, but the introduction of low cost, *Lego*-like DIY smart home products (from Home Depot, Target, Lowe's) might be one solution for consumers who don't want to pay for a custom installation or a fancy smart appliance.

In a partnership with GE, Quirky launched seven new smart home items in November, all under \$100, while a *Smart Home Kit* from littleBits (on their website or at RadioShack) goes for \$249, turning regular household items (a lamp, coffeemaker, fridge, pet food dispenser, blinds, etc.) into connected devices by attaching a sensor and using the included *CloudBit* hub (\$60 for each additional hub).

littleBits also works with IFTTT (If This Then That), a nifty little web service that allows users to program devices to follow simple routines based on triggers and conditions: if the coffeemaker turns on, then play my morning playlist on the kitchen speakers.

The functionality of devices like those from littleBits remains



Trigger Happy. The *Smart Home Kit* from littleBits allows users to coordinate the actions of common household devices.

basic—if your fridge door is left ajar, a temperature sensor will notice and send you a text. If you're not at home, well, there's nothing you can do about it.

But at least consumers can choose for themselves what connected *continued on page 22*

FEEDING THE SMART GRID

ONE OF THE most promising aspects of the Internet of Things, from our perspective, is the promise of the smart grid, which transforms the relationship between energy users and energy producers, a.k.a. utility companies. In fact, utility customers become collaborative participants, feeding back to the grid via onsite renewable energy systems, such as PV arrays, and regulating their energy use to reduce peak demand. Much of this so-called “demand response” could happen automatically through smart, connected appliances and HVAC systems, which respond to hourly feedback from the grid and adjust energy consumption accordingly.

A key ingredient to making the smart grid work is the smart meter, which communicates energy consumption directly to the utility company, and which often comes with an in-home display, so the utility customer has access to that information as well. The Federal Energy Regulatory Commission (FERC)



reports that U.S. utilities have installed 50 million smart meters, as of July 2014; many manufactures are releasing smart appliances (or ones that smart grid-ready) in anticipation of the mainstreaming of the smart grid. Although much of this will happen automatically (and hopefully, painlessly), individual choice will still play a role. As Jenny Roehm, senior manager of Utility Residential Solutions for Schneider Electric, explains, smart meters definitely save energy, but just how much will depend on choices utility customers make; in particular, balancing comfort and energy savings.



New Line-Up. The partnership between Quirky and GE has spawned a family of devices, including a learning thermostat, smart plugs, water sensor, garage door controller and more, all controlled by the Wink app and hub.

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functions are actually useful for their home and reduce waste caused by throwing out old “dumb” appliances—although more connected products are being designed to allow remote updates, which can extend a product’s useful life.

Toward More Sustainable Infrastructure

Like chatty gadgets in the home, the smart grid is a two-way street, where connected appliances will help maximize energy efficiency and minimize costs by operating at the most opportune times, when demand is low and good weather boosts renewable energy production from photovoltaic panels and wind turbines.

Applying the IoT to the smart grid is not a new idea—the utilities sector has been remotely monitoring equipment in the field for years. Tax incentives and rebate programs from utility companies, on top of dropping costs, are enabling more homeowners to add solar panels and purchase electric vehicles (EVs)—two components that will build up the smart home/smart grid system.

It’s this very system that is creating a foundation for the automated infrastructure of the smart city—a concept that could be essential to the conservation of natural resources if two-thirds of the global population will be living in cities by 2050. Siemens and Cisco have already committed themselves to the construction of brand new smart cities around the world, and are working on ways to smooth out the challenges faced by existing cities worldwide with intelligent traffic management, city management and development systems, security management and, of course, smart grid technologies that will push the need for automated homes and buildings.

But one thing to note about those EVs: eventually, they’ll be *continued on page 25*

Connected Living Room

Energy management, privacy, lighting, comfort and entertainment are all coordinated in one of the most-used rooms in the house.



Smart Shades. Blinds raise and lower automatically to take advantage of or prevent solar gain, and coordinate with other features, such as lighting and entertainment.

Comprehensive Monitoring. An environmental monitor not only senses smoke or carbon monoxide, it also tracks particulate matter, humidity and temperature.

Responsive Lighting. Lights respond to changing occupancy and daylight conditions; they can be controlled as part of a “scene” that creates the perfect conditions for a specific event, such as watching a movie.



That’s Entertainment. Smart TV connects to the Internet to allow seamless streaming of movies and other content. It also connects wirelessly to other devices to allow sharing of photos, music and videos, all controllable by a single smartphone.



Coordinated Actions. Sensors detect when doors open and close and can trigger another action; for example, if the doors stay open for a certain period of time, the AC turns off.

SMART CITY: BARCELONA

CITIES ACROSS THE GLOBE are transforming themselves into "smart cities." These use connected technology and data to improve energy and transportation efficiency, city services and safety. Barcelona, Spain, is well on its way to becoming one. With over 450 access points, its Wi-Fi network is one of the largest free, public-access networks in Europe. Smart City Barcelona's comprehensive plan includes projects and initiatives in several areas. Here a seven of them:

Smart lighting. The city developed a master plan which includes projects to remotely control street level lighting and transition 50 streets and 1,155 lampposts to LED technology. The lights activate when they detect motion and also gather environmental data.

Smart energy. The city has installed more than 19,500 smart meters in the Olympic Villa district; various projects to increase energy efficiency include the creation of self-sufficient blocks.

Smart water. Barcelona's parks and green spaces, including 77 fountains, are switching to remote control. Park staff can monitor plants via tablet; in addition, a network of sensors gathers data on the input and output of the system's water and integrates it with data on rainwater, evaporation, drainage and other variables, so that plants only received the water they need.

Bike service. Barcelona maintains 6,000 bicycles and 420 "Bicing" stations. Users simply swipe a card to unlock a bike, then return it to the station nearest their destination. Residents can locate the nearest bike for rent via the *Bicing* app.

Smart transportation. The city's new "orthogonal bus network"—based on a foundation of horizontal, vertical and diagonal routes—uses smart technology to improve speed



"Bicing" It. An annual subscription grants users access to Barcelona's extensive network of bikes for rent.

and efficiency. Other improvements include a system that manages traffic lights, setting those along the route to a fire or accident to green, just long enough for emergency vehicles to pass.

Zero-emissions mobility. Barcelona is electrifying public and private transportation by installing an extensive system of free, public charge points across the city. Its public transportation fleet includes electric buses and electric taxis; a new charging station for electric scooters and a car-sharing program using electric vehicles have also come on-line.

Open government. City government is striving to make its activities more transparent by deploying 44 "citizen's attention" kiosks. The city also launched an Open Data portal, which organizes data into several categories and enables services such as the *App&Town* app, which helps users plot routes using public transportation.

Learn more at <http://tinyurl.com/mwm66gu>
By Juliet Grable



Urban Apps. Barcelona residents can aim their smartphones at a street to get an instant overlay of bus lines, stops and the distances to them.

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driverless. Some experts predict that even a decade from now, only half the number of automobiles on the global market will feature an advanced driver assistance system or be completely driverless. And the results of a recent Pew Center survey showed respondents split between a future of mass unemployment due to driverless cars and robots and that of a world where jobs simply shifted. Michalski admits he is also unsure about the consequences.

"On the one hand [...] I think driverless will take a huge piece of the market faster than we imagine it will. I see a trifecta coming: driverless, electric, shared vehicles. Then the whole fleet turns over, all the ownership models change and our built landscape can be repurposed in huge ways: what would you do if all garages could be turned into living or working space? Street parking spots? On the commercial side, though I think an automated big rig is likely in the works, that's not an easy job to automate. I think that process is slow. But when it takes hold, those people have no work, because the needed repair people are already available repairing today's vehicles. I don't think we'll need more." **GB**



Getting Around. More cities are offering specific "metro apps," which allow residents to plan trips using public transportation.

THE EV-GRID CONNECTION

THE MAINSTREAMING OF electric vehicles (EVs) creates an ironic problem: uncoordinated electric vehicle charging can generate loads significant enough to cause voltage fluctuations, increased on-peak load and a higher probability of blackouts. But EVs aren't just a strain on the grid; they can also potentially feed it at critical times with the juice stored in their batteries. EVs may eventually play an important role in supporting microgrids—small grids that are connected to the larger, main grid—which are often capable of some energy generation. Such "vehicle-to-grid" (V2G) exchange can not only save money by mitigating the cost of charging EVs, but improve grid reliability and reduce carbon dioxide emissions.

For this to happen on a large scale, access to information about the status of both the grid and the electric vehicle fleets is critical. Bosch has created a cloud-based software and service that connects electric vehicles, drivers and energy providers. The U.S. Air Force is experimenting with a V2G pilot project at the Los Angeles Air Force Base using Bosch's *eMobility* software



and a fleet of 40-plus electric vehicles. The software keeps track of which vehicles are in service, which ones are parked, and which ones are charging (and charging status)—information managers can use to manage charging and discharging. The project is also using the Distributed Energy Resources Customer Adoption Model (DER-CAM), which monitors energy prices in real time, to help determine when EVs should be charging and when they should be feeding the grid. On the driver side of things, the *eMobility* app not only allows drivers to find charging stations, but learn whether they are occupied or in service, track charging status and review charging history. The next phases of the project will involve 500 trucks at six military bases, which will eventually expand to 1,500 vehicles.

For more info on the pilot V2G project visit <http://tinyurl.com/nf5mpdv>

Bosch offers its *eMobility Starter Package* for fleet managers and distribution system managers. For more info, visit <http://tinyurl.com/lchdw6y>