Smart energy metering will transform the way we consume energy – in the home, on the go, and in industrial environments

Saving energy is high on the agenda for consumers and businesses, but with most electrical devices today, it's difficult to know how much energy you are actually using at any given point in time. Smart devices measuring and communicating how much energy is being used are potentially a powerful tool for managing energy consumption. Just as social networking has connected hundreds of millions of people, engineers who are designing smart utility grids, smart meters, and smart plugs want to network billions of *devices*.

Among the goals: Reduce overall energy consumption, balance supply and demand of energy over time (e.g. peak-load reduction) and enable green but intermittent energy from wind and solar to be used more effectively.

All three goals require detailed information about what is really going on deep inside power distribution grids whose basic architectures have not changed in 100 years. Information along with electric power will flow across the smart grids of the future. To leverage this information, engineers are already developing applications that will, for instance:

- Flatten the peaks of energy use that presently require far more power generation capacity to be installed than is necessary. Charging electric cars, to cite a simple but potent example, need not add an extra kilowatt of power generation capacity if it is done during off-peak.
- Control power usage right down to the electric teapot or toaster by utilizing smart meters and smart plugs. This level of control would be used for load leveling initially. But in the long term, through contractual agreements with customers, it could reduce overall power consumption by temporarily putting to sleep unused appliances in the home, machinery in factories, and lighting in offices.
- Discern patterns of electricity use in corporate enterprises, neighborhoods, and even individual homes. This would allow predictive algorithms developed by utilities to ensure that the right amount of lower cost power is available at all times and the percentage of power produced by fossil fuel plants in optimized.

By leveraging its 50-year technology heritage in consumer electronics, networking, and microcontrollers, NXP Semiconductors is introducing innovative solutions into homes, offices, and commercial spaces – wherever electricity is overused. ICs that are the heart of smart meters, smart plugs, and ultra-low-power wireless communications are all part of NXP's rapidly expanding product portfolio that will enable revolutionary reductions in energy use with minimal lifestyle changes.

Although the environmental and economic benefits of smarter energy utilization are impressive, reinventing the power grid has all the earmarks of a very expensive undertaking. The good news is that the grid doesn't have to be reconstructed. It just has to be overlaid with an IT network, part of it wireless, and enhanced with smart meters and plugs that don't cost much individually and recoup their cost of investment quickly.

That's where information technology, communications technology, and NXP come in. Thermostats become smart thermostats; area lighting control gets connected across buildings; and ultimately, lighting and climate control merge – to cite one example.

NXP is a leader in exactly the kind of low-power, wireless and narrowband communication, the smart grid requires. It offers total solutions for M-bus, a European remote communication standard for electric, gas, water, and heat meters based on 868 MHz band, including a protocol stack, transceivers, receivers and transmitters. It also offers industry-leading, low-power consumption solutions for 802.15.4 wireless communications including ZigBee.

HANs, NANs and WANs

Information exchange between dissimilar domains such as houses and power grids is best effectuated by networks. In a comprehensive smart energy strategy, a wide-area-network (WAN) transfers information over the smart grid to utility data centers to and from home-area networks (HANs) that use neighborhood -area networks (NANs) for data aggregation.

Actionable information (such as turn off/on or dim a light, transfer load from high-cost or high carbon production to green) also flows back and forth across the networks. Figure 1 illustrates how this might work in a residential scenario.

Greening the grid

The smart grid is a prime target for cyber attacks and NXP's years of experience in smart cards and e-Passports has made it a leader in the technology to help deal effectively with these threats.

Smart grid applications need low-power, wireless, narrowband communication. NXP delivers the solution with technologies such as M-Bus and 802.15.4-based wireless networking.

NXP's EM773 energy metering IC has all the right stuff to handle the smart plug's packaging, functionality, and cost restraints. It is the most integrated and cost-effective solution on the market and its metering accuracy of better than 1% exceeds market requirements.

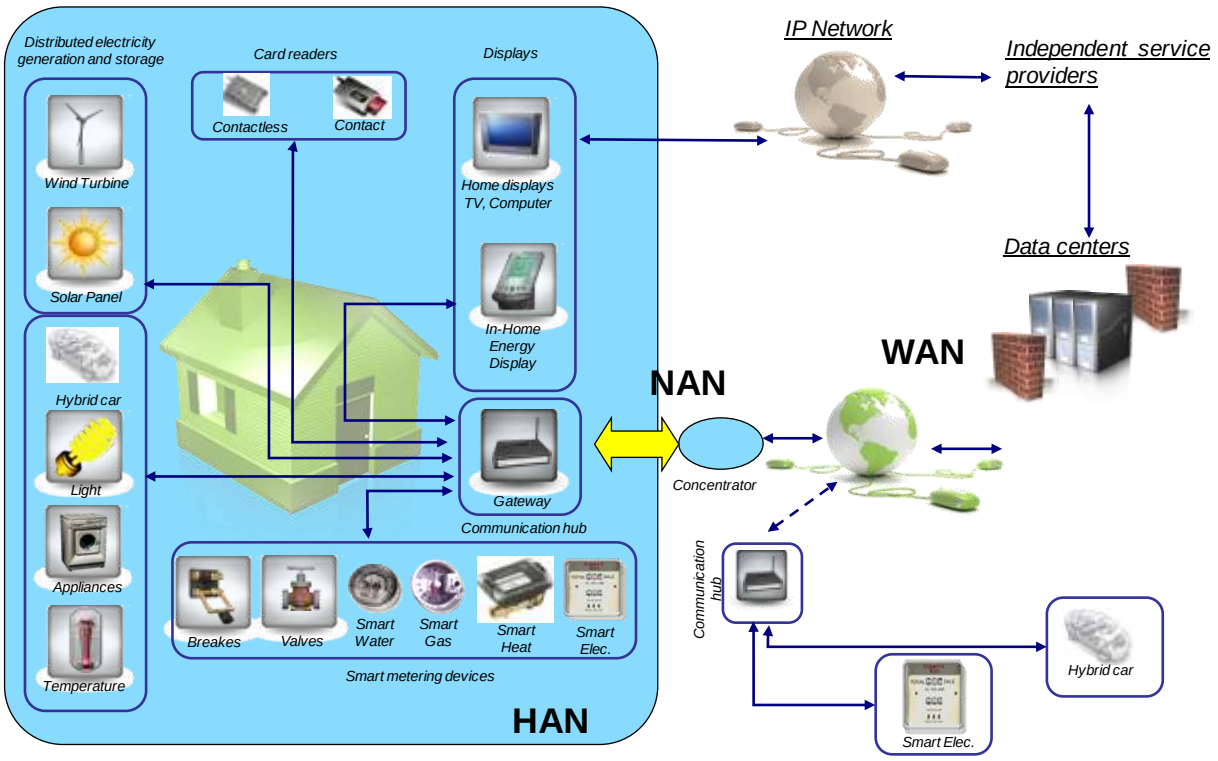

Figure 1: Technologies now exist to overlay the old grid with networks that transform it into a smart grid.

Smart meters

Even a virtual journey aimed at saving billions of kilowatt-hours per year starts with a single step. For electric utilities, that first step is the smart meter.

Controlling things inevitably means *measuring things* and energy measurement is the primary mission of smart meters and their downsized cousins, smart plugs. To optimize energy use, apart from measuring energy, other factors such as humidity, heat, light, and air quality should also be measured by the sensors to ensure lifestyle choices are minimally affected. No one wants an ice cream to melt, a hallway to fall into utter darkness, or an indoor plant to die while achieving energy efficiency.

When a utility starts fiddling with someone's energy use, the first order of business is to install meters designed with high-precision semiconductor devices that deliver exceptional accuracy even in the presence of non-linear loads. Smart meters also give the utility a jump-start on load balancing by integrating basic power-quality measurements such as total harmonic distortion, power factor and sensing voltage drop.

NXP's smart-meter product portfolio includes microcontrollers, networking chips, real-time clocks, LCD display drivers, and power supplies, all fine-tuned to deliver the right performance in the right location at the right price.

A smart meter really begins to show its star quality when communications technology is added to it. Options include remote meter reading, load control, and a slew of operations that now require service

calls such automatic connect/disconnect and detection of power outages and intermittent ground faults.

With hundreds of millions of entry points, the smart grid is a prime target for cyber attacks, which can range in criminal intent from crashing the grid to pilfering electricity. NXP's experience in smart cards and e-Passports has endowed it with the technology to effectively deal with these threats. 80% of e-Passport projects around the world use NXP technology, for example, and the company has extensive experience in supplying secure microcontrollers for bank cards and NFC payment services. Its SmartMX microcontrollers are widely used in programmable, high security, multi-application smart cards.

Smart plugs

From the homeowner's or business owner's perspective, smart meters are the interface to the utility and its smart grid. In this view, the meters request actions inside the premises to save energy. In order to do this effectively, they require two things: Information from inside the home or business and a means to alter the states (on/off/dim/slow down) of lighting, appliances, motors, and climate conditioning systems *at a very granular level*.

Enter the smart plug, which in engineering speak is sometimes defined as *a metrology engine enabled appliance*. In other words, it's an inexpensive means of integrating intelligence and communications capability into every appliance. To build one: Take the smart meter, remove the components related to power conditioning and utility company billing, shrink the rest down to thumb size or less.

This is easier said than done. But it is very helpful to engineers who design appliances, lighting systems and HVAC systems because it becomes – no pun intended – a plug-in solution. Faster time to market, product differentiation with software and communication with standard protocols make it an attractive feature. The smart plug's functionality can either be in the plug or in the appliance, depending on the application.

The business or home owner can use the smart plugs and smart meters to control their energy use, as long as the cost of reconfiguring their wiring systems are reasonable. Smart plugs can also be used to monitor an entire room or building.

A standard application programming interface (API) is useful to design smart plugs or appliances. The reason is that the companies that build standard washing machines or HVAC equipment are not the same ones that build smart meters. So while the smart meter manufacturers may be loaded with engineers who know and understand metrology, white goods manufacturers would prefer a standards-compliant module that they can just "plug-in".

NXP's EM773 energy metering IC has all the right stuff to handle the smart plug's packaging, functionality, cost restraints and ease of use requirements. It is easy to use, cost-effective and highly integrated, and its metering accuracy of better than 1% exceeds market requirements.

The remaining question – retrofitting costs – is best addressed by ultra-low power wireless technology. Walls remain intact, maintenance costs are reduced, and subsequent room reconfigurations become

easier with smart plugs that communicate over standard protocols such ZigBee and consume very little power in the process. NXP's JN5148 low-power ZigBee chip addresses these issues successfully. NXP's ZigBee solutions consume so little power that it is possible to build wireless and batteryless light switches that can be placed anywhere and moved around at will. Power to run the communications is harvested from the mechanical energy generated by pushing the button and stored as electric energy in a small capacitor.

Smart choices

To achieve optimal results in reducing CO_2 emissions and cutting energy bills while having minimal effects on lifestyle choices, smart grids, smart meters and smart plugs must be viewed as a continuous ecosystem, not independent technologies. This is NXP's vision and its technology heritage in consumer, wireless communications and control put it in an excellent position to execute this vision.