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Nov 3, 2009, n.p.

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HowStuffWorks.com (MCT)

Electricity is as important as oxygen to a modern society. You can feel that importance as soon as there is a blackout. Our TVs, computers, gaming consoles, refrigerators, microwave ovens, reading lamps and traffic lights all depend on electricity, and without it our world grinds to a halt.

The electric power grid used in the United States to deliver all that electricity has not changed much in more than a century. And because of that, the grid has a number of problems in our modern world. Blackouts and brownouts are one obvious side effect. The old grid is also making it difficult to bring on new sources of energy from renewable sources like wind and solar. And it is making it difficult to create new billing models that would, potentially, save consumers money.

For example, it is expensive for a power company to provide power during peak demand. On the afternoon of a sweltering summer day when everyone has their air conditioners running full blast, power plants and the grid are working at the limits of their capacity. But then at 3 a.m. all of that infrastructure is largely idle. If there were a way, through pricing, to even out the load, electricity would be cheaper and cleaner.

The smart grid promises to solve many of these problems. It should make blackouts less common by making the grid more reliable. It should make it easier for new renewable power plants and home power generation to come on line. And it should help consumers manage their power consumption to lower their peak demand and therefore their bills. Right now the federal government is adding billions of stimulus dollars to the smart grid effort in order to turn the theory into reality.

Let's start by looking at the power grid we use today. It is designed around the idea of a one-way local model, where a few large power plants provide electricity to a city or region. A power plant pumps its electricity onto transmission lines. These lines carry the power to substations. From these substations the power is distributed to homes and businesses.

In this model, if a transmission line goes down, the whole region may experience a blackout. If a neighborhood loses power, there is no way for the power company to know unless people call and complain. There is no concept of time, so electricity costs the same whenever you use it. There is no designed way for homes and businesses to generate power and put it back into the grid. And there are problems bringing power in from other regions--for example, it is hard for a city in California to take advantage of inexpensive wind power generated in South Dakota.

With the smart grid, two things will change. First, the grid will be designed with a national model in mind rather than a regional model. Second, every part of the system will gain intelligence and bi-directionality. That intelligence will extend all the way down to the individual appliances in your home. For example, your electric car will be able to know how much electricity costs during the day, and may only recharge itself when power is the cheapest. It would also be theoretically possible for your electric car to act like a tiny power plant during peak hours. For example, say you go on vacation and leave your car sitting in the garage. Your electric car (because it has such a large battery), could buy power at 3 a.m. for a nickel per kilowatt hour. It could them discharge itself onto the grid during peak hours when the power company is buying power for 30 cents per kilowatt hour. You could make $10 a day from a transaction like that, and the overall cost of electricity for everyone would go down.

In the same way, major appliances in your home like your refrigerator or dryer would know when power is expensive and inexpensive and tell you about it so you could save money. Your air conditioner could decide to turn itself off in the afternoon when power is too expensive. And if your subdivision or even your individual home became disconnected from the grid, the smart grid would know it immediately. Blackouts would become less frequent, and should be much shorter.

The Department of Energy offers this amazing statistic: "If the grid were just 5 percent more efficient, the energy savings would equate to permanently eliminating the fuel and greenhouse gas emissions from 53 million cars." The smart grid should help provide that efficiency boost.

The big question right now is the cost of all of this new **technology**. The hope is that a push by the federal government, combined with national thinking for transmission lines, can help kick start the process. With luck, we will all be taking advantage of the smart grid within a decade or so.

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