

## The Elements of the Perfect Power System

In a Perfect Power System, consumers will have control over their own energy destiny, rather than having it imposed upon them by a sole supplier. Each customer will decide — and get — the system and services that are perfect for them. In the beginning, Perfect Power will be accessed via smart microgrids — small, self-contained systems connected to and augmenting the larger electricity grid. As consumer demand grows and the regulated monopoly system of utilities evolves, Perfect Power will increasingly become available through the grid, with individual microgrids designed to augment the grid to meet particular needs.

Although the requirements of Perfect Power will vary by consumer, the key components of a Perfect Power System have become clear. To achieve Perfect Power, the elements listed below must be present and working together as an integrated whole whose performance and value is greater than its parts.

### “Smart” Technology

In today’s electric power system, the only thing that gets carried over power lines is power. In tomorrow’s system, the lines will carry both power and information, in real time, to be used exactly when and how each is needed.

**Digital communication:** The grid will be equipped with instantaneous sensors that will gather information from every inch of the grid, collecting data about how much power is flowing where and how reliable it is, at the exact time it is flowing. These data will be communicated wherever they are needed, including to household appliances, which will respond by using only the precise amount of power needed while taking into account the price of energy at any given time.

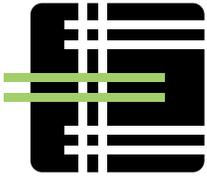
**Digital control:** In today’s electromechanical system, the switches that act as traffic controllers on the grid operate at a speed that is equivalent of being 10 days late, relative to the speed of light. Based on the continuous flow of information from the sensors, smart digital controls will be able to anticipate and respond intelligently to whatever is happening anywhere in the grid. For example, if a sensor finds that one power line is on the verge of being congested, the controller will, in real time, reroute power to lines that have available capacity.

### Why is it better?

Today’s electric power system is dangerously vulnerable and inefficient because it lacks these smart technologies and the other 21st century innovations described below.

**Reliability:** Working in real time, these sensors and controllers can prevent most power disturbances caused by supply interruptions or congestion before they happen. Should a portion of the utility grid go out, these controllers can proactively move power around the damaged portion and use locally distributed clean power generation to avoid any interruption in service.





**Efficiency:** This system will also reduce the need for new power lines and generating plants because it will ensure every line and power plant is used most efficiently at all times. What's more, providing customers and their electric appliances with the ability to automatically respond to power demand and price signals will fundamentally increase the efficiency of electricity use while significantly cutting power costs.

**Security:** These smart systems will be able to instantaneously wall off or "island" problem areas on the grid so that they do not affect other parts. This will minimize the damage and disruption in case of a terrorist attack or natural disaster.

## **Distributed Generation and Storage**

Today, power flows to customers over hundreds and even thousands of miles of transmission lines from very large, centralized generating plants far away. In the Perfect Power System, an optimal portion of that power will be generated at or near where it is used.

### **Why is it better?**

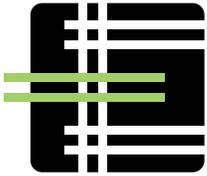
**Reliability:** In connection with the existing grid, distributed generation and storage can ensure perfect reliability. The distributed system can augment the grid with back-up power when the grid is unavailable or damaged, or at strategic times to reduce demand and costs, benefiting consumers and suppliers alike. The smart power system will also be able to use renewable energy as a reliability asset, rather than as liability, as is the case in today's power grid. This will dramatically expand the market opportunities for clean energy.

**Security:** Distributed systems will protect consumers from being vulnerable to weak links in the grid system resulting, for example, from squirrels, trees and thunderstorms. Widespread availability of power from distributed sources also would further limit the possible damage of a terrorist attack — either physical or through cyberspace — that shuts down the utility grid.

**Efficiency:** Distributed generation typically operates at a higher level of energy efficiency than the old, centralized, fossil-based power plants that now dominate electricity production. Also, the ability to incorporate much higher quantities of renewable energy will further reduce the demand for fossil fuels.

## **Cogeneration or Combined Heat and Power**

Heat is created as a byproduct of turning a fuel source into electricity. Many distributed generation technology applications can recapture this heat as useable energy for water heating, cooling and other purposes. The distributed generation technologies in the Perfect Power System will, whenever practical, incorporate cogeneration.



### **Why is it better?**

**Efficiency:** Widespread adoption of cogeneration could have a major positive impact on our environment. For example, these technologies can produce fuel efficiencies of up to 70 percent compared to current centralized power plants, which are only about 33 percent efficient.

### **Smart Meters**

In a Perfect Power System, every electricity consumer would be equipped with a smart meter that receives real-time information about the price of power and conveys that information to the consumer and his or her smart appliances and end-use devices.

#### **Why is it better?**

**Reliability:** Smart meters conveying price information received from the utility grid could automatically prompt consumers and their end-use appliances to use less energy at a specific time, thereby relieving stress on the utility grid.

**Efficiency:** Smart meters enable smart appliances and end-use devices to obtain and automatically respond to real-time price signals in order to best serve the needs of each consumer.

**Cost:** Numerous studies show that when consumers know exactly how much they are paying for energy, they not only pay less but also use less, particularly during high power demand and high-cost periods.

### **Smart Appliances/End-Use Devices**

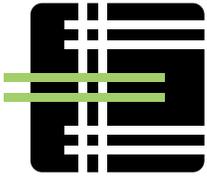
In the Perfect Power System, appliances will be smart about how they use electricity, using information relayed in real time from the grid through the smart meter.

#### **Why is it better?**

**Efficiency:** Appliances will be able to sense how much energy they need and not consume more than that. For example, refrigerators will keep themselves calibrated to the temperature necessary, while lights will brighten and dim themselves in response to the available sunlight in the room.

**Reliability:** Appliances will get real-time information from the grid about congestion and price and be able to respond accordingly.

**Cost:** The ability of these smart appliances to respond automatically to real-time price signals can substantially reduce the cost of electricity service for every consumer.



## **Consumer Control/A New Marketplace for Power**

In the Perfect Power System, electricity consumers will be able to choose the quantity and quality of power that best meets their needs. For example, industrial consumers may opt to pay for the highest quality and most reliable service, while those concerned about the environment might choose to pay a premium for electricity generated by a renewable fuel. Consumers will be kept informed, in real time, of the fluctuations in the cost of power, and will have the ability to manage their energy and pay for it accordingly. Consumers will no longer pay for kilowatt hours of bulk electricity, but for carefully designed service tailored to best meet their needs.

### **Why is it better?**

**Reliability:** Consumers will be able to choose whether they want to pay for the highest level of reliability — as commercial users most likely will — or some lesser degree, as may be sufficient for most residences. Reduction in demand at peak times because of demand response will also help ease congestion and the potential for outages.

**Efficiency:** Everyone will pay for only the electric services they want and use: No more and no less. Less infrastructure will have to be constructed because consumers will use less power at peak time, eliminating the need for expensive power generating facilities that are only necessary a few times a year.

**Cost:** Today, the lack of a smart power system costs the U.S. economy about \$150 billion per year through unreliable service alone. This is the equivalent of at least a dollar additional “tax” on every dollar of electricity that retail consumers purchase. The nation’s outmoded power system is also a significant drain on productivity and competitiveness in today’s global economy. At least a trillion dollars in gross domestic product is already being lost each year as a result and that cost is growing rapidly as the digital economy expands. Individual consumers cannot and must not tolerate this drain on personal and national economies.