“Distribution intelligence” refers to the part of the Smart Grid that applies to the utility distribution system, that is, the wires, switches, and transformers that connect the utility substation to you, the customers. The power lines that run through people's back yards are one part of the power distribution system.

A key component of distribution intelligence is outage detection and response. Today, many utilities rely on customer phone calls to know which areas of their distribution system are being affected by a power outage. Along with smart meters, distribution intelligence will help to quickly pinpoint the source of a power outage so that repair crews can be immediately dispatched to the problem area.

A utility's outage response can also improve. Most utilities count on complex power distribution schemes and manual switching to keep power flowing to most of their customers, even when power lines are damaged and destroyed. However, this approach has its limitations, and in many cases an automated system could respond more quickly and could keep the power flowing to more customers.

By having sensors that can indicate when parts of the distribution system have lost power, and by combining automated switching with an intelligent system that determines how best to respond to an outage, power can be rerouted to most customers in a matter of seconds, or perhaps even milliseconds.

It may even be possible to react quickly enough to power disturbances so that only those in the immediate neighborhood are affected, while other customers' power source are rerouted fast enough to avoid any interruption in power. This capability could be the first example of the highly touted "self-healing" aspect of the Smart Grid in action.
The "Self-Healing" Power Distribution System

Outage response is one aspect of distribution intelligence that is commonly referred to as distribution automation (DA). DA may actually be the oldest segment of the Smart Grid, because utilities have been automating their distribution systems since the 1960s. But while DA initially focused just on remote control of switches, the Electric Power Research Institute now considers distribution intelligence to mean a fully controllable and flexible distribution system.

Combining DA components with a set of intelligent sensors, processors, and communication technologies will lead to distribution intelligence. When fully deployed, distribution intelligence will enable an electric utility to remotely monitor and coordinate its distribution assets, operating them in an optimal matter using either manual or automatic controls.

Helping the Grid Run More Efficiently and Reliably

Along with outage detection and response, another potential application of distribution intelligence is the ability to optimize the balance between real and reactive power. Devices that store and release energy, such as capacitors, or that use coils of wire to induce magnetic fields, such as electrical motors, have the ability to cause increased electrical currents without consuming real power; this is known as reactive power.

A certain amount of reactive power is desirable within a power system, but too much reactive power can lead to large current flows that serve no purpose, causing efficiency losses as they heat up the distribution system wires. An intelligent distribution system can use power electronics to maintain the proper level of reactive power in the system.

Distribution intelligence can also help to protect and control the feeder lines, the power lines that make up the distribution system. Most feeder lines are now protected by breakers or relays that trip when high currents flow through the line, a situation normally caused by a fault somewhere in the system. These relays sometimes incorporate time delays to allow for momentary flows of high current, which may be caused by industrial equipment powering up, rather than a fault. Protection systems are often a combination of instantaneous breakers with high current settings and time-delayed breakers or relays with lower settings.

These systems of automated breakers and relays end up being a balancing act: they must allow the system to operate with high currents when needed but protect the system and the people around it from high current flows when a fault exists. Distribution intelligence can provide a more elegant approach to protecting the feeder lines, using sophisticated monitoring and controls to detect and correct for faults while maintaining the highest level of system reliability during non-fault conditions.

An intelligent system could even detect and isolate faults in specific pieces of equipment and route power through a backup system instead, maintaining power reliability. Distribution intelligence can also incorporate more sophisticated ground-fault detectors to minimize the possibility that people can be shocked or electrocuted when encountering downed power lines.

Most utilities are only starting on the road to true distribution intelligence, but the market is expected to boom in the coming years.