Development of Smart Grid Technology

Abstract

Smart Grid technology has become more and more imminent as a part of Obama’s energy initiative. Also, much of the nation’s grid is incapable of handling much of the power usage that an average American sustains. Therefore, it is necessary to update the grid in order to handle the usage today. My paper will be demonstrating why the grid needs to be updated to an intelligent one and analyze one group’s experiment that tried to model a smart grid network on a small scale.

Introduction

Smart grids are based on communication between the provider and consumer. One of the main issues with today’s outdated grid deal with efficiency. The grid now may be prone to overloading during peak times or seasons. It is also possible to hack the system, and basically, take free electricity. “Examples of common failures that occur in the power grid are power outages, low power quality, overloads that could lead to cascading failures, and service disruptions.” [1] Many industrial and commercial buildings require that they be constantly powered at all times from the grid. For example, some hospitals require machines that pump oxygen to be working at all times. Often times, their backup generators may be insufficient. In order for this to not happen anymore, it is necessary to implement a smart grid. Smart grids are grids that are constantly in flux to make sure that one section of the grid is not overused.
What Defines A Smart Grid

According to the Office of Electricity of the Department of Energy, there are several objectives that must be met in order for the electrical transmission system we have today to be considered a smart grid. First, technology should be used to increase reliability, efficiency, and security. Second is optimization of the grid, as well as cyber security. We must also incorporate renewable sources of energy into the grid. One of the key parts that make it a smart grid is real-time communications between appliances and the grid. These devices would have to be “smart” devices. The easiest way to do this is to assign each of them an IP address and connect them to the network that exists in the house. [2] Energy providers insist that customers are the number one priority when it comes to implementing the smart grid, and that is true. It is necessary for the consumer to make sure his appliances and network are connected to the smart grid. Networking and communication is essential to the smart grid.

Potentials of the Smart Grid

Smart Grids are essential to the lifestyle that we live in today. During the hottest summer months, we depend on electricity to run our air conditioning systems, and during the coldest, the heater. We power our lights at all hours of the day, and run our appliances. It is very common that black- or brown- outs occur during these times. Smart grids would be able to determine when these peak times and be able to deliver electricity to areas that need it most, or obtain more straight from the producer. This connection between supply and demand is also crucial to the Smart grid. Increased power consumption by the consumer should be monitored at all times in order to determine when more power is needed to be put on the grid.
On “SmartGridLab: A Laboratory-Based Smart Grid Test Bed”

Researchers at Washington State University developed a test bed to better understand how a smart grid works, rather than running just simulation tests. After all, simulations are only accurate to a degree and even then, without testing it out first, you still have no idea how it will work. The researchers created a test bed with: “Intelligent Power Switch, power supply, energy demander, and Power Meter.” [3] All of these are basic components of any smart grid. The Intelligent Power Switch would be what determines how much electricity routes where. The power supply would be the electricity coming from the grid as well as electricity generated from alternative energy sources that directly power the building. The energy demander would be any appliance that needs the electricity. The power meter measures how much electricity is consumed and sends that information back into the grid and ultimately to the provider to show how much electricity a consumer is using. There are two networks within the test bed, the power network which supplies the electricity, and the information network, which controls the data flow and also manages the power network.

An important part of this power network is the Intelligent Power Switch. This, in and of itself, is the smart grid. This part is what makes the smart grid different from any other normal grid. The IPS will control how the flow of electricity goes to the different nodes. Below is a diagram of the test bed:
The power meter in the test bed system is also an important aspect. The power meter This is the diagram of the parts of the power meter:

Then the researchers are able to hook up a power supply of their choice, as well as the appliance that they are trying to power. The researchers decide to test several aspects of the test
bed. They needed to test real-time response to supply and demand, and they were able to simulate this through the pathways taken through the network.

One of the Experiments Done: Price Driven Demand Response with Multiple Flow

This experiment had to deal with flux from supply and demand. There is a difference in energy quality and energy quantity, i.e. price. Consumers may want better energy, or cheaper energy. Therefore, multiple flows would be needed, as demonstrated in the above figure. Some consumers would need more wattage. “Our experiment is to show multiple power flow can co-exist by using IPS. In Figure 9, A3 is a 40 watt lamp which gets energy from Supply P1 through path P1→S1→M1→S2→M6→S6→A3, while A1 is a 100 watt lamp which gets energy from Supply P2 with path P2→S4→M7→S6→M8→S5→A1. The two paths can co-exist in this network according to the reading of power meter. Even they have an intersection in S6, they will not affect each other.” [3] The fact that they will never interfere even if there is an intersection is
important in the grid. It allows different amounts of energy to be sent at the same time without worrying about overloading or under-loading the grid.

Why This Technology Is Viable

Smart grids are different than sources of alternative energy that we want to implement in that very little must be done in order to completely revamp the grid. Only software must be integrated in order to update the grid. It costs very little to do this even on a national scale. It costs nothing to maintain; if software malfunctions, it only needs to be repaired. There are many benefits, for both the consumer and producer if the nation switches to a smart grid. “The smart grid is expected to provide benefits to society in the following areas: reduced losses to society from power outages and power quality issues, improved operating efficiencies of delivery companies and electricity suppliers will reduce their O&M and capital costs, keeping downward pressure on electricity prices for all consumers, improved National Security, improved Environmental Conditions, and improved Economic Growth.” [4] Most of all, smart grids allow for the growth of alternative energy as a power source. Many consumers are afraid to use solar panels on their homes, for instance, because there are circumstances in which they will not be using all the electricity that they generate, and batteries are not economical enough to keep in the home setting. There would be nowhere for that electricity to go, and it would be wasted. The homeowners would not be able to profit from the electricity they generate and spent money toward getting a system. However, with a smart grid implemented, it would be possible to send electricity back into the grid, which means the consumer could sell extra electricity back to the provider, which allows them to regenerate money lost when they bought the system quicker than they would have just waiting for the electricity bill to go down.
Conclusion

In conclusion, smart grids are a totally viable way of transporting power. There are many positive sides to implementing the smart grid. Since this technology is still new, there are still many parts that need to be researched. The researchers at WSU have a start on it, but after all it is only a test bed and it has yet to be tested on a larger scale, i.e. the national level. Also, much of the other research is not even with tangible parts, rather just simulations. Simulations are not guaranteed to work in the real world. Smart grids are an essential part of our future, in addition with all other alternative energies.
References


http://www.oe.energy.gov/DocumentsandMedia/EISA_Title_XIII_Smart_Grid.pdf