APPLICATION OF SMART GRID SYSTEM IN BANGLADESH POWER SYSTEM

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Declaration

I hereby declare that this thesis is based on the results found by myself. Materials of work found by other researchers are mentioned by reference. This thesis, neither in whole nor in part, has been previously submitted for any degree.

December 7, 2010
Signature of the Supervisor

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Abstract

The smart grid is a simple upgrade of 20th century power grids which generally broadcast power from a few central power generators to a large number of users, to instead be capable of routing power in more optimal ways to respond to a very wide range of conditions, and to charge a premium to those that use energy during peak hours. It delivers electricity from suppliers to consumers using digital technology with two-way communications to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency. To use smart grid system if we can use the unused power from the private power generation companies then our nation will be largely benefited.

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Chapter 1

INTRODUCTION

Due to decreasing resources as well as massive greenhouse gas emissions, the need for a more efficient energy grid is obvious. This resulted in the Smart Grid, a more efficient grid, being introduced. Most notably, this novel grid incorporates communication flows.

The electric grid delivers electricity from generation points to consumers. Electricity delivery network consists of two primary systems. First, the transmission system which delivers electricity from power plants to distribution substations. Second, the distribution system delivers electricity from distribution substations to consumers. Traditionally, the electrical "grid" only refers to the interconnected transmission system. On the other hand, the term "Smart Grid" is used to refer to the entire electrical system, including generation, transmission, and distribution as well as into the home or building.

The smart grid system and smart meter are not used in Bangladesh. The purpose of the thesis is to combine the private power generation company with national grid through smart metering system. My objective is to visit those power generation companies in Dhaka, who have their own power generation system and show the statistics of what amount of power they can contribute to the entire national grid by using smart meter.

Chapter 2

SMART GRID

2.1 Introduction to Smart Grid

Smart grid is an electrical grid which is a network of technologies that delivers electricity from power plants to consumers in their homes and offices. A smarter grid is different in a few important ways. First, it uses information technologies to improve how electricity travels from power plants to consumers. Second, it allows those consumers to interact with the grid. Third, it integrates new and improved technologies into the operation of the grid. A smarter grid will enable many benefits, including improved response to power demand, more intelligent management of outages, better integration of renewable forms of energy, and the storage of electricity.
It refers to the modernization of the current electrical grid so that there is bi-directional
flow of information and electricity in order to achieve the following goals: provide consumers with more choices on how, when, and how much electricity they use, self-heal in case of disturbances, physical and cyber attacks, and natural disasters, link with a wide array of energy sources, in addition to energy produced by power plants, such as renewable energy producers, provide better power quality, and more efficient delivery of electricity. Communications technology and infrastructure is at the heart of improvements to the electrical grid, which will collect data provided by smart meters, sensors, computer systems, and many other devices into understandable and actionable information for consumers and utilities.

2.2 What Smart Grid Does?

The transition to a fully implemented smart grid brings a host of benefits to a wide range of constituencies. Smart grid will do the following things:

1. Optimize asset utilization and operating efficiency.
2. Accommodate all generation and storage options.
3. Provide power quality for the range of needs in a digital economy.
4. Anticipate and respond to system disturbances in a self-healing manner.
5. Operate resiliently against physical and cyber attacks and natural disasters.
6. Enable active participation by consumers.
7. Enable new products, services, and markets.

2.3 Technologies

There are different technologies that play a vital role at the distribution level. A Smart Grid should utilize these technologies in order to move the distribution system forward. This includes: Smart meter, Distribution automation, Low-cost communication systems, Distributed energy resources, Broadband communications for distribution applications, Closed loop systems using advanced protection, Distributed storage and generation, Real-time angle and voltage stability and collapse detection, Reactive power control based on intelligent coordination controls, and Fault analysis and reconfiguration schemes based on intelligent switching operations.

From these one of the most important applications is smart meter.

2.4 Benefits

If smart grid system used in power system many benefits can be harvested such as: Improved system performance meters, better customer satisfaction, improved ability to supply information for rate cases; visibility of utility operation / asset management, availability of data for strategic planning, as well as better support for digital summary, more reliable and economic delivery of power enhanced by information flow and secure communication, life cycle management, cost containment, and end-to-end power delivery, and impact access to historical data for strategic planning.

2.5 Vision

The overall vision for the Smart Grid is that it will have the following qualities:

- Intelligent – capable of sensing system overloads and rerouting power to prevent or minimize a potential outage, of working autonomously when conditions require resolution faster than humans can respond and cooperatively in aligning the goals of utilities, consumers and regulators.
- Efficient – capable of meeting increased consumer demand without adding infrastructure.
- Accommodating – accepting energy from virtually any fuel source including solar and wind as easily and transparently as coal and natural gas, capable of integrating any and all better ideas and technologies – energy storage technologies, for example – as they are market-proven and ready to come online.
- Motivating – enabling real-time communication between the consumer and utility so consumers can tailor their energy consumption based on individual preferences, like price and/or environmental concerns.
- Opportunistic – creating new opportunities and markets by means of its ability to capitalize on plug-and-play innovation wherever and whenever appropriate.

• Quality-focused – capable of delivering the power quality necessary – free of sags, spikes, disturbances and interruptions – to power our increasingly digital economy and the data centers, computers and electronics necessary to make it run.
• Resilient – increasingly resistant to attack and natural disasters as it becomes more decentralized and reinforced with Smart Grid security protocols.

Chapter 3
COMPARISON BETWEEN EXISTING GRID AND SMART GRID

There are lots of difference between current grid and smart grid. Some of those are distinguish below:

	Current Grid	Smart Grid
1.Communication	None or one-way; typically not real-time.	Two-way, real-time.
2.Customer interaction	Limited.	Extensive.
3.Operation	Manual equipment checks, maintenance.	Remote monitoring, predictive
4.Generation	Centralized	Centralized and distributed
5.Power flow control	Limited.	Comprehensive, automated
6.Restoration disturbance	Manual.	Self-healing.
7.System topology	Radial; generally one-way power flow.	Multiple power flow pathways.
8.Metering	Electromechanical.	Digital.

Chapter 4

SMART METER

4.1 Introduction to smart meter

A smart meter is an advanced meter that records consumption in intervals of an hour or less and communicates that information at least daily via some communications network back to the utility for monitoring and billing purposes. Smart meters enable two-way communication between the meter and the central system. Unlike home energy monitors, smart meters can gather data for remote reporting. Smart meters measure and record the amount of electricity used in a home or business, just like the mechanical meters that have been working on homes and businesses for years. Instead of the gears and dials in older meters, smart meters use digital technology and have no moving parts. Smart meters may be part of a smart grid, but alone do not constitute a smart grid.

4.2 Electromechanical meter.

The electromechanical induction meter operates by counting the revolutions of an aluminium disc which is made to rotate at a speed proportional to the power. The number of revolutions is thus proportional to the energy usage. It consumes a small amount of power, typically around 2 watts.

The aluminum disc is supported by a spindle which has a worm gear which drives the register. The register is a series of dials which record the amount of energy used. The dials may be of the cyclometer type, an odometer-like display that is easy to read where for each dial a single digit is shown through a window in the face of the meter, or of the pointer type where a pointer indicates each digit. With the dial pointer type, adjacent pointers generally rotate in opposite directions due to the gearing mechanism.

The amount of energy represented by one revolution of the disc is denoted by the symbol *Kh* which is given in units of watt-hours per revolution. The value 7.2 is commonly seen. Using the value of *Kh*, one can determine their power consumption at any given time by timing the disc with a stopwatch. If the time in seconds taken by the disc to complete one revolution is *t*, then the power in watts is $P = \frac{3600 \cdot Kh}{t}$. For example, if *Kh* = 7.2, as above, and one revolution took place in 14.4 seconds, the power is 1800 watts. This method can be used to determine the power consumption of household devices by switching them on one by one.

4.3 How do the smart meter works?

As digital technologies are increasingly used in electrical equipment and appliances around the house, the time has come to use these same technologies to manage overall electricity consumption.

Electronic meters display the energy used on an LCD or LED display, and can also transmit readings to remote places. In addition to measuring energy used, electronic meters can also record other parameters of the load and supply such as maximum demand, power factor and reactive power used etc. They can also support time-of-day billing, for example, recording the amount of energy used during on-peak and off-peak hours. One of the easiest ways to understand how a smart meter works is to compare it to the traditional electromechanical meter that is likely on your home or business now. Electromechanical meters have mechanical parts that spin as electricity is consumed in the premise; they show usage readout on small dials that a utility meter reader reads while on the property of your home or business. This reading then translates into your bill. Compare this to an advanced digital or "smart" meter. Smart meters track consumption digitally – with no moving parts. It tracks the energy use in home on an hourly basis and sends this information automatically to local distribution company. Then use a secure radio frequency band to communicate directly with the distribution company through intelligent devices installed on the electrical grid.

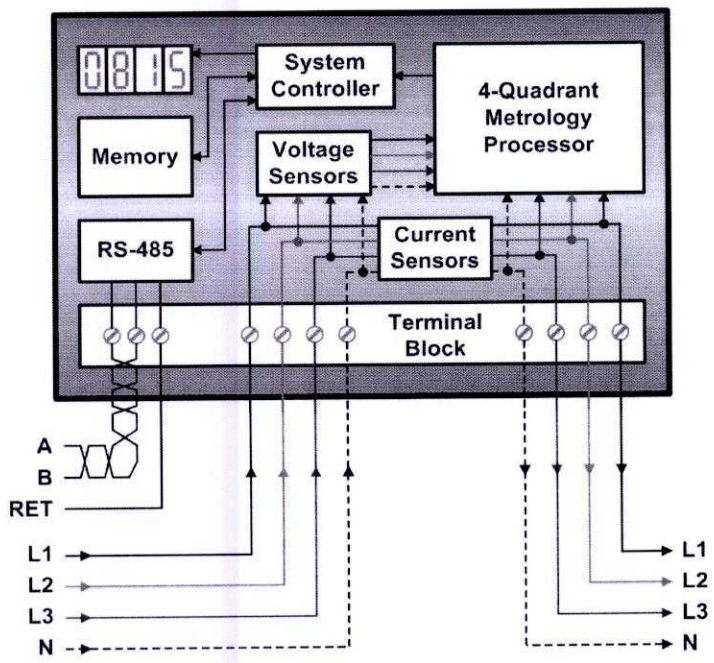

Fig-1: Basic block diagram of smart meter

4.4 Technologies

There are so many technologies which can helps to communicate smart meter with utility suppliers as well as with consumers and read consumption automatically in an hourly interval or less. These are radio frequency network, automatic meter reading, power line communication etc.

4.4.1 Radio frequency network (RF)

Radio frequency networks are mostly used technology for smart meter. The more common ones are handheld, mobile, and fixed network. There are both two-way RF systems and one-way RF systems in use that use both licensed and unlicensed RF bands. In a two-way system, a radio transceiver normally sends a signal to a particular transmitter serial number, telling it to wake up from a resting state and transmit its data. The meter attached transceiver and the reading transceiver both send and receive radio signals and data. In a one-way continuous broadcast type system, the transmitter broadcasts readings continuously every few seconds. This means the reading device can be a receiver only, and the meter AMR device a transmitter only. Data goes one way, from the meter AMR transmitter to the meter reading receiver. There are also hybrid systems that combine one-way and two-way technologies, using one-way communication for reading and two way communication for programming functions.

4.4.2 Power line communication (PLC)

PLC is a method where electronic data is transmitted over power lines back to the substation, then relayed to a central computer in the utility's main office. This would be considered a type of fixed network system—the network being the distribution network which the utility has built and maintains to deliver electric power. Such systems are primarily used for electric meter reading. Some providers have interfaced gas and water meters to feed into a PLC type system.

4.4.3 Automatic meter reading (AMR) hosting

AMR Hosting is a back-office solution which allows a user to track his/her electricity, consumption over the Internet. All data is collected in near real-time, and is stored in a centralized database by high-end data acquisition software. The user can view the data via a secure web application, and can analyze the data using various online analysis tools. The user can easily chart load profiles, analyze tariff components, and verify his/her utility bill.

4.5 Benefits

Now the concern is why smart meter should we use in spite of existing meters? The current grid system of Bangladesh is running by electromechanical meters. This meter has moving parts and it cannot communicate with the consumers itself like a smart meter can. Thus, many illegal operations are occurring in the national grid system of Bangladesh mostly because of illegal reconnection and power theft. If smart meter can be used in spite of electromechanical meter, these corruptions may decrease at a large extent. Moreover, many power generation companies who have their own power generation resources will also be interested to sell their unused power as smart meter can directly communicate with those private companies and it can read the hourly consumption. Resultantly, both those companies and our nation will be largely benefited as national power utility will be increased.

Chapter 5

PROGRESS

As this is my pre-thesis semester, I have gathered enough idea about smart grid as well as about smart meter. Moreover, from my current survey that I have done so far, I realized that the application of smart grid system using smart meter can largely benefit our nation as it will decrease illegal occupancy. So, my concern is to implement smart grid to consume unused power from the private companies through measuring the cost of the utility with the help of smart meter.

Chapter 6

FUTURE WORK

Now-a-days, in our country many multi-national companies as well as some public and private universities have their own power generation through which they are able to meet up their demand. Many of those are used in the day times only. If we can use those unused private power generation systems in the night-time for the use of national grid or to meet up the demand of any specific city then the load–shedding will be decreased. Now my first concern is to find out those unused power generation sources and the total utility of their production. Then I want to make such a plan where I can use smart meter successfully to calculate those unused power.

As the present billing system of our country using existing electromechanical meters are easy to cheat in many ways and we cannot measure the cost of power consumption per hour, thus the private company may not be interested in dealing their power generation sources, may be for their own safety. But if smart meter can be implemented successfully to calculate how much power is being used from those private power generation companies, then there will be easy availability of bill costing. Thus those companies will be interested in dealing with my idea. As through smart meter they can calculate the cost of power consumption in hourly basis, they can easily sell their utility to the government. As a result, the entire nation will be benefited.

Chapter 7

CONCLUSION

In conclusion it can be claimed that the application of smart grid using smart meter can bring revolutionary change in our national grid system in Bangladesh. As smart grid is not currently used in our country and if we want to use it in the whole grid system, it is not possible now. Therefore, my objective is to make such a plan where I can use smart grid system by using smart meter- the bi-directional meter which can directly communicate with both the consumer and the supplier, to calculate the unused power consumed by private owners, so that the private power generation companies can sell their unused or excess power utility to the government, as there is less possibility of electricity theft. Resultantly, the load-shedding problems will be reduced as the net power utility of our national grid will be increased and we, the common mass will be benefited too.

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