INTEGRATION AND UTILIZATION OF THE SMART GRID

Jan Pithart
Doctoral Degree Programme (1), FEEC BUT
E-mail: xpitha01@stud.feec.vutbr.cz

Supervised by: Jiří Drápela
E-mail: drapela@feec.vutbr.cz

ABSTRACT

This paper is focused on the question how the distribution network should look in the future. There is described outline question about the Smart Grid, future distributed metering system, and others. The Smart Grid should be able to provide new abilities such as self-healing, high reliability, energy management, and real-time pricing. The new technology will be part of the Smart Grid, advanced metering, automation, communication component, distributed generation, and distributed storage.

1. INTRODUCTION

The new metering technology allowed communication with customers in two ways. Dispatcher has a feed back from the customers. The other part of the smart grid is the department of transmission and distribution instructions for automatic devices. It allowed as to operator industrial transmission and distribution with greater efficiently. It should be much a more efficient system. Modern computer software would allow total companies to manage and monitor energy use in every home in real time. It also gives consumers more energy control. Basically is about smart metering.

On the smart grid the customers will have the opportunity to read the time record of energy usage (how much and when). With theses records customers can optimise their energy usage. For example, they can shift some planned activities to another tariff zone.

2. A SYSTEMS VIEW OF THE SMART GRID

Because the Smart Grid concept is complex and contains many interdependent technologies and strategies, it is difficult to think of the Smart Grid as individual component technologies; rather, the Smart Grid should be viewed as an entire system with the whole greater than the sum of its parts. This complexity requires an analysis of the Smart Grid to be done using a systems view. The systems view takes a holistic and objective approach to a subject. This view recognizes the Smart Grid as a single system comprised of interdependent components. Such a model takes into account the full range of costs and benefits to society associated with the creation of a Smart Grid.

2.1. THE CONCEPT OF A SMART GRID

The debate over what constitutes a Smart Grid is still emerging. Utility and technology experts are now discussing the need for substantial changes in how we design, build, and operate the power generation and delivery system.

2.2. THE SMART GRID IMPLEMENATION

The Smart Grid is the integration of technologies that allow us to rethink electric grid design and operations. As a starting point for the study, the project team assumed that a Smart Grid would [2]:

- Detect and address emerging problems before they impact service.
- Make protective relaying will be the last line of defense, not the only defense as it often is today.
- Respond to local and system-wide inputs and know much more about broader system problems
- Incorporate extensive measurements, rapid communications, centralized advanced diagnostics, and feedback control that quickly return the system to a stable state after interruptions or disturbances.
- Automatically adapt protective systems to accommodate changing system conditions.
- Re-route power flows, change load patterns, improve voltage profiles, and take other corrective steps within seconds of detecting a problem.
- Enable loads and distributed resources to participate in operations.
- Be inherently designed and operated with reliability and security as key factors
- Provide system operators with advanced visualization tools to enable them to provide the essential human oversight.

A Smart Grid could provide the following benefits:

- Cost savings due to automated operation, predictive maintenance, self-healing, reduced outages, and increased asset utilization.
- Fewer blackouts and local power disruptions.
- Faster recovery when disruptions to occur.
- Greater security from self-healing technologies.
- Better real-time monitoring and response.
- New options for consumers to manage their electricity use and costs.
- The “plug and play” integration of control systems, power electronics, and distributed resources.

2.3. IMPRESSION OF SMART GRID TO DISTRIBUTION NETWORK

Implementation of the smart grid technology to current distribution network probably will impact their operation. Will the basic topology and layout of a Smart Grid be similar to what is seen today or will the basic topology and layout of a Smart Grid look different? The design implications associated with the major technological drivers will be examined.

2.4. SMART METER

A Smart Grid will utilize advanced digital meters at all customer service locations. These meters will have two-way communication, be able to remotely connect and disconnect services, record waveforms, monitor voltage and current, and support time-of-use and real-time rate structures [1].

There is shown in the figure 1 meter with old architecture only with one way communication. The smart metering offer more benefits than only automatized reading of consumed energy. Benefits can be explained by looking at the differences between the actual situation with the old meters and the future situation with the new meters. It is shown in the figure 1.

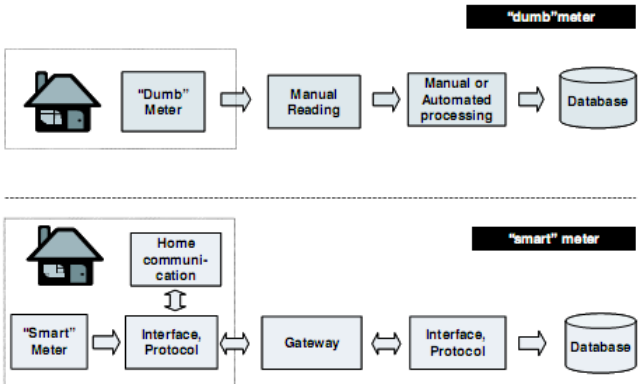

Figure 1: Different between convectional metering and smart metering. [6]

The smart meter can communicate with central database. All measured data are sent to this database. The data can be processed at the headquarters. On the basis of their results the headquarters can make some changes. Every smart meter can record quantity of energy usage and also power quality defined in the standard ČSN EN 50160 [3]. The disadvantage of this system is the large quantity of measured data and it is an exorbitant. It isn't necessary to archive the same data from adjoining meters which are situated in the same branch of the distribution network.

Figure 2a: Used in USA [4]

Figure 2b: Used in EU [5]

Figure 2: Smart meters.

Perhaps the biggest change that advanced meters will enable is in the area of real-time rates. True real time rates will tend to equalize distribution system loading patterns. In addition, these meters will enable automatic demand response by interfacing with smart appliances.

2.5. SMART METER WITH POWER LINE CARRIER (PLC) COMMUNICATION

There are some possibilities how to send measured data out from smart meter through power line to the central, or dispatching. One possibility is use a smart meter with power line carrier communication. All customers in one area may have smart meters with PLC. Every SM communicates with superior module. The module is connected with a central database.

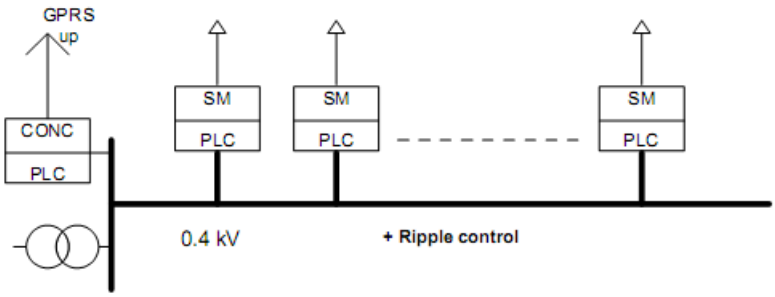

Figure 3: Smart meters with PLC communication. [7]

This concept has advantages.

- Easy to install
- The operation costs is low

And also some disadvantages.

- No 100% reliable
- Distribution of SM will take a decades

2.6. KEY SUCCESS FACTORS

The key success factors are the system "values" that everyone holds to be true, from operator to engineer to consumer to regulator. Such universal values establish a basis for desired performance and a compass for measuring progress and achieved benefits. The following are key success factors to assess the success of a Smart Grid.

- **Reliability** - A reliable grid operates as required by its users, tolerates disturbances without failing, and provides ample warning about growing problems such that corrective action can take place before damage and negative impacts are felt.
- **Security** - A secure grid tolerates physical and cyber attacks without massive blackouts or significant recovery investments.
- **Economics** - An economic grid operates under the basic laws of supply and demand, resulting in the fairest of prices in an open energy market.
- **Power Quality** - Power quality means the electric power will be delivered in a form that meets individual consumer needs.

- **Efficiency and Environmental Quality** - Efficiency means taking advantage of investments that control costs, reduce energy losses, and a lower total cost of ownership. Environmental quality means progressively fewer environmental impacts and reducing the cost of recovery from environmental consequences.
- **Safety** - A safe grid does no harm to the public or to grid workers during operations and maintenance.

3. CONCLUSION

Implementation of Smart Grid to the distribution systems from the beginning is a very complex process. But it is possible to manage it. Indeed, this problem isn't real, because the distributing infrastructure already exists. They are not designed for Smart Grid implementation and the final implementation will take decades.

It is impossible to remake the whole distribution system in the one moment to the Smart Grid. It's necessarily to make a study deal with the implementation of a Smart Grid. Then it is possible to begin with realization in parts. The development must go on, because sooner or later it may be possible to lose, for example, reliability of power supply

These systems will have advanced metering, robust communications capability, extensive automation, distributed generation, and distributed storage. Through the integrated use of these technologies, Smart Grids will be able to self heal, provide high reliability and power quality, operate with multi-directional power flow, increase equipment utilization, operate with lower cost, and offer customers a variety of service choices.

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