National Conference on Recent Research in Engineering and Technology (NCRRET-2015)
International Journal of Advance Engineering and Research Development (IJAERD)
e-ISSN: 2348 - 4470 , print-ISSN:2348-6406

Smart Grid and its Development Prospects In the Asia-Pacific Region

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***Abstract*— the purpose of this paper is to explain the importance of Smart Grid Deployment in Asia-Pacific region. The paper throws the light on various problems and challenges related to electricity grids that are faced in Asia-Pacific region and the solution to manage those problems by adopting the vision of a "Smart Grid." The smart grid holds promise of transforming our current electricity delivery system into a more efficient and secure system that is able to better integrate variable supply resources while giving the end-user – the customer – greater autonomy in his/her energy consumption. Without a doubt, many of the technologies and management tools the smart grid may depend on have lead regulators, policy-makers, customers, companies, and stakeholders to consider many questions – what it is, what its benefits are, what value it brings to society as a whole as well as individual consumers, what its potential challenges are, and what kind of mistakes can be avoided when moving forward. The purpose of this literature review is to explore these questions and more in a fair and balanced, comprehensive overview of the smart Grid. The resources contained in this review are primarily derived from the internet and as such, many are available simply via the web links. For organizational purposes, the sources have been divided into five sections respectively: (1) The Basics; (2) Supply Resources; (3) Transmission & Distribution Technologies; (4) End-Use Technologies & Rates; (5) Cyber security.**

Index Terms— Smart Grid, energy consumption, Cyber security.

I. INTRODUCTION

DEFINITION

The smart grid represents an array of visions to an array of stakeholders. Due to this variance, as well ascomplexity of the technologies involved, it is not surprising that the smart grid has given rise to a number of definitions and explanations. Here are three examples of descriptions recently published by trusted authorities: A smart grid is a modern electricity system .It uses sensors, monitoring, communications, automation and computers to improve the exibility, security, reliability, efficiency, and safety of the electricity system.The smart grid takes the existing electricity delivery system and makes it 'smart' by linking and applying seamless communications systems that can: gather and store data and convert the data to intelligence; communicate intelligence omni directionally among components in the 'smart' electricity system; and allow automated control that is responsive to that intelligence. "An automated, widely distributed energy delivery network, the Smart Grid will be characterized by a two-way ow of electricity and information and will be capable of monitoring everything from power plants to customer preferences to individual appliances. It incorporates into the grid the benets of distributed computing and communications to deliver real-time information and enable he near-instantaneous balance of supply and demand at the device level.[1][2]

Automated Meter Reading	Remote Customer Disconnect
Outage Management	Call Center Integration

Theft Detection Distribution Automation The internal factors are "pushing" the utilities to change the way they operate in order to improve current services. The factors include: Grid Performance - Reliability - System Efficiency - Safety - Security Supply and Demand - Pending rate increases The external demand drivers are "pulling" the utilities to offer new services. The drivers include: Evolving customer experience - Demand-side Management - Value-Added Services - Customer Service Quality Environmental Pressure - EE and RPS mandates - Carbon abatement New forms of Generation - Distributed Generation and Storage - Intermittent and renewable Generation For example, smart grid monitoring helps utilities asses their line proximity issues as it relates to trees and tree growth, because dense growth results in a significant increase in the number of short voltage blips that occur. Early detection of these short line contacts by trees will assist utilities in their "just in time" tree programs, effectively focussing crews on the correct "problem areas". In addition, network enhancements, and in particular improved visualization and monitoring, will enable "operators to observe the voltage and current waveforms of the bulk power system at very high levels of detail."[3] This capability will in turn "provide deeper insight into the real-time stability of the will in turn "provide deeper insight into the real-time stability of the power system, and the effects of generator dispatch and operation;" and thereby enable operators to "optimize individual generators, and groups of generators, to improve grid stability during conditions of high system stress.[4]

II. MOVING BEYOND AMI TO ADOPT A SMART GRID VISION (SMART METERS / ADVANCED METERINGINFRASTRUCTURE (AMI))

Smart meters and the information backhaul systems required to support them are probably the best known, and also likely the most expensive, building block supporting a smart grid. As of September 30, 2009, electricity distributors in Ontario had installed approximately 2,883,000 residential and 171,000 general service (<50 kW) meters[5]. In the Ontario Energy Board's March 2010 audit of electricity distributors' smart meter regulatory accounting, they found capital expenditures for all meters to be about $633 million, and OM&A expenditures to be $63 million. Fully enabled smart meters can communicate in real-time between users and energy suppliers about energy use and prices, coordinate household consumption based on these signals and customer preferences, and facilitate measurement and custom-ized pricing. AMI can also enable net-metering which allows for the of electricity onto the grid from residential or commercial distributed power generation. The process of determining electricity usage and then billing accordingly has high transaction costs on a manual meter reading system, especially in regions that involve considerable driving distance from the utility to the meters, as in parts of Canada. A number of reports identify avoided meter reading costs as a major benet of AMI[6]. The Brattle Group, for instance, provides an illustrative theoretical example of a smart power region with one million residential customers, 100,000 small and medium commercial and industrial customers, and 5,000 large commercial and industrial customers. With annual meter O&M costs assumed to be $18 million per year, the present value of avoided meter reading costs, over a 20 year forecast horizon.

As power failures occur relatively in this region especially India, Nepal, China as compared to other regions, there's been an urgent need to renovate the country's power network and since 2005 the research projects and government policies focusing on smart grid and next generation electric networks have been carried out[7]. The above challenges can only be met if we move towards the future vision of electricity system and making our electricity network "Smart". The user specified quality, security and reliability of supply for the digital age can be achieved. Harmonized legal frameworks facilitating cross-border trading of power and grid services, extensive small and distributed generation connected close to end customers etc…all can be achieved. But all this is very far until and unless we move our approach towards Smart Grid. "A Smart Grid is an electricity network that can intelligently integrate the actions of all users connected to it –generators, consumers and those that do both in order to efficiently deliver sustainable, economic and secure electricity supplies[8]." Smart Grid refers to next generation Electric power network that makes use of IT and other high technologies so as to operate intelligently. Compared to telecom industry the power sector has not developed remarkably in terms of innovative technologies. But if we see the scenario of telecom industry, earlier say 8-10 years back the telecom industry was not developed as it is today. The mobile phones were just used as a means of wireless communication i.e. just for outgoing and incoming calls. But now the remarkable revolution has been observed in this industry from past 5-8 years wherein now this industry with the use of latest IT and other innovative technologies offer thousands of services to its end customers[9][10]. Now it's the turn of power sector, as, smart grid by revolutionizing the electric power networks and being almost as powerful as the Internet, is attracting many attentions among various industries[11].

When power prices are volatile or supplies are short, reducing peak loads becomes a top priority for utilities. Billing customers for energy based on the time of day has proved to be a viable means for reducing peak loads. This case study examines one of the first field trialsof time-of-use [TOU] tariffs and automated meter reading technologies, how they worked, the results, and why the program ended abruptly."[12]

One of the objectives of our Smart Grid City initiative is to demonstrate the possibilities that smart grid technologies have for the enhancement of the grid of the future as well as its impact on the environment. We are also anticipating significant involvement in the effort from regulators and legislators as well to help educate them on those possibilities. The goal will not be to request specific recovery on the dollars we invest in the Smart Grid City effort but rather set the stage and work with the regulators on how recovery should be sought in the future. Because of the potential for rate return degradation and uncompensated demand destruction that the smart grid will result in, we believe that regulatory structures will need to be significantly different in the future than they are today[13]. Our hope is to use Smart Grid City to help bring awareness to these issues and enable regulators an opportunity to see the value of smart grid and be open tomaking changes; perhaps even provide that test ground to experiment with different regulatory scenarios[14].

III. ONGOING PROJECTS IN ASIA- PACIFIC REGION

China has embarked on a 10-year project to build a "Smart Grid" that will catapult its power transmission into the digital age, securing electricity supplies and boosting energy conservation[16]. The Government of India has devised a scheme which is called the Restructured Accelerated Power Development and Reforms Program to address the strengthening & upgrading of the Indian transmission and distribution network. The program calls for an investment of US $ 10 billion over a five year span[16].

The Japanese trade ministry has estimated the shift to renewable power will require a grid upgrade at a cost of between US$ 51 Billion and US$74 Billion by 2030. Korea aims to create a nationwide Smart Grid by 2030 for an electricity market worth US$ 60 Billion[17].

IV. CONCLUSIONS AND SUGGESTIONS FOR REGIONAL APPROACH TO SMART GRID DEVELOPMENT

Even An additional consideration for states is the need to coordinate their activities with one another. Many of the

interoperability and functional specification issues are common throughout the region and are probably best dealt with regionally rather than on an individual state basis. It is suggested therefore that the states in this region work together in a collaborative fashion to come forward for developing the AMI systems that will support a Smart Grid vision. The key issues that need to be dealt with this regard includes: - resolving interoperability issues, defining the minimum technical requirements for the system and establishing the appropriate technical standards. Further, because of growing environmental concerns, it is suggested that Asian grids need to become far more flexible than they are today, accommodating distributed power generation from renewable sources and use several energy-efficiency techniques. Within Asia, the demand for Smart Grid capability is quite diverse in nature ranging from reflecting the sophisticated nature of electricity demand in developed nations such as Japan and South Korea, to the need for first deployment of grids and massive grid upgrades in the developing economies of India and China. Yet, there is also general consensus that existing electricity grids in Asia are not sufficient in terms of capacity, efficiency, reliability, security, and environmental impact to supply the electrical power needs of modern societies. Therefore the need of the hour and for modern revolutionizing societies of Asia-Pacific region is to adopt Smart Grid Vision.

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