Advancing trends of Smartgrid Technology

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***Abstract*— Before we can begin to modernize today's grid, we first need a clear vision of the power system required for the future. Understanding that vision, we can create the alignment necessary to inspire passion, investment, and progress toward the Smart Grid. The Smart Grid is a necessary enabler for a prosperous society in the future. Energy supply has become one of the most challenging issues facing the world. Growing populations, more homes and businesses and a myriad of new appliances have caused energy demand to skyrocket in every part of the country. Utilities across the globe are trying to figure out how to bring their networks into the digital age. This effort to make the power grid more intelligent is generally referred to as creating a "smart grid". The industry sees this transformation to a smart grid improving the methods of delivery as well as consumption. In This Paper of Smart Grid along with vision, befits, challenges, building block, application of smart grid are introduced. This Paper also identifies drivers, future scope and problem for Smart Grid.**

I. Introduction

WHEN the advanced system is completely implemented, it will allow for communication features across the grids that are not currently available--hence the term "smart"[4]. A "smart grid" is simply an advanced electrical distribution system that has the capability to balance electrical loads from diverse, and often intermittent, alternative energy generation sources. One key component of the "smart grid" is the capacity to store electrical energy; this allows the demand from consumers to be met [5].

The Smart Grid is: Adaptive, with less reliance on operators, particularly in responding rapidly to changing conditions, Predictive, in terms of applying operational data to equipment maintenance practices and even identifying potential outages before they occur, Integrated, in terms of real-time communications and control functions, Interactive between customers and markets, Optimized to maximize reliability, availability, efficiency and economic performance Secure from attack and naturally occurring disruptions [1].

The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of today's most important business drivers environmental concerns and power delivery constraints and disturbances. The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software

Modernizing the electrical transmission and distribution network to create a smart grid, along with the incorporation of 'smart' meters and 'smart' appliances into consumers' homes and businesses, has become a major policy focus in recent years. The smart grid offers various potential benefits, including greater energy efficiency for end-users and in the grid. But while the potential for such operational benefits as grid reliability, smoothing peak loads, and eased meter reading seems clear and large, the impact on overall energy use seems much less certain..

II. Benefits and Challenges

Consumer-Level Benefits and Challenges

The energy-saving benefits for end-use consumers should be of particular interest in developing policies for implementing smart grid systems, especially in regards to smart meters, because these benefits may be readily apparent to consumers.
Benefits other than those directly reflected in energy bill savings may be very important to consumers, so it is important that these benefits be made visible, though this can be a challenge. Grid stability (reduced blackouts), improved renewable energy integration and reduced environmental impact all offer tangible benefits. And reduced operational costs, such as meter reading, and energy savings from grid efficiency may benefit consumers as well.

Data Display and Engagement

Smart meters create a valuable opportunity for home or business owners: access to near-real-time data on their energy use. Studies by the Brattle Group have projected 6.5% energy savings for consumers with energy use displays, on average;[2]other studies[3]have shown similar savings from data display systems with or without smart grid integration. Yet few current smart meter programs make these data available to consumers at intervals significantly more frequent than monthly meter readings of non-smart meters.

Large data streams may be of interest to a small number of technically savvy consumers who have the time, interest, and knowledge to interpret them and adjust their own behavior accordingly, but the typical consumer will likely find this overwhelming, difficult, or simply of little interest. Consumers must be able to make sense of the data and, indeed, actually want to see the data in the first place. The system for data display is critical. For the casual user, the system should be easy to use and the content should be useful and engaging to the consumer.
Also, those interested initially may not remain interested over time, as the novelty of the display system wears off and behavior returns to pre-display patterns; the information and its presentation must remain compelling for consumers.

Ongoing Commissioning, Energy Assessment, and Evaluation of Savings

Improved understanding of building energy use, such as could be offered by smart meter data collection, also holds a number of opportunities for improving building performance and understanding the results of retrofits through professional analysis of the data.
Combining real-time or near-real-time data on energy use with periodic or ongoing building commissioning could provide a comprehensive understanding of building performance metrics and effectively diagnose performance issues. Access to shorter-interval data than is currently offered by conventional energy meters would help identify building performance problems with much greater rapidity and could allow for more rapid trouble-shooting of building energy performance problems

Utility-Side Benefits and Challenges

A smart grid not only can promote end-user efficiency but also promises to be a more efficient grid, reducing losses on the utility side of the meter in generation, transmission, and distribution of power. Precise control of customer load is essential to achieve these benefits as well.

Smart grid capabilities across the transmission and distribution (T&D) network can allow T&D systems to operate more efficiently and responsively, reducing line losses and reducing excess generation needed to ensure grid stability. Smart grid systems would allow improved awareness of T&D system conditions in real time.

Incorporating Electric Vehicles and Renewable Energy into the Grid

Smart grid technologies in generation, transmission, and distribution systems, coupled with smart meters and appliances, can play an important part in managing potential problems that may arise from increased loads caused by electric vehicles and intermittent generation from renewable energy sources

III. BUILDING BLOCKS OF SMART GRID

The building blocks needed to implement the various capabilities. Implementation of a smart grid will require investments and changes in tangible infrastructure complemented by investments and changes in soft infrastructure. A detailed understanding of the benefits and challenges for both of these categories is required when assessing the business case for the various capabilities of the Smart grid.

A) *Hard Infrastructure*

Key investments and changes in tangible infrastructure to deliver smart grid capabilities are the following:

i) Smart meters /advanced metering infrastructure (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. 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 customized pricing

ii) Network devices and Increasing Importance of Communication and Network communication
Grid enhancements will be required to integrate additional renewable and distributed generation into the grid. These enhancements will include enhancement of
monitoring systems—more locations, with better visualizations and improved simulations, as well as improved data processing across the entire grid. They will also include advanced voltage control, increased fault detection, digitization, and (automatic) system protection practices. These improvements have the potential to limit losses, optimize integration of distributed resources and electric vehicles and enhance the resilience of the system.

iii) Household appliances
To get the full value from the smart grid, customers will require appliances to communicate with a home area network (HAN) that will optimize electricity use depending on market signals (and within limits set by the customers). The magnitude of the replacements is required—a change that will be dispersed across millions of households—poses some clear challenges at the interplay of technology, standardization among suppliers, and customer behavior.

B) *Soft Infrastructure*

Soft infrastructure required includes the following issues:

1. *Cyber Security*

Cyber security becomes a priority concern as additional technologies connect to grid systems and provide more real-time data as well as two-way communications.
A number of national forums are addressing security concerns. One is the National Institute of Standards and Technology that recently released NISTIR 7628, Guidelines for Smart Grid Cyber Security. This is a three-part document covering smart grid from a high-level functional requirements standpoint.

ii. Customer engagement
There is a general lack of public awareness of the smart grid and a lot of confusion in sorting through the various claims and definitions that are being advanced to explain it. It will be important for customers to have a much better understanding of the benefits of smart grids if they are to be introduced effectively and sustainable. Since the high cost of smart grid implementation will, directly or indirectly, be shared by customers, if they are not convinced by claims regarding current and future benefit, they are likely to resist and challenge those costs over time.

IV. MODERN HARDWARE AND CONTROL FOR SMART GRID

A smart information network the energy internet for the electric grid is seen as necessary to manage and automate this new world.

Modern Hardware For Smart Grids	***Modern Control Methods For Smart Grids***
1. Power Electronic Devices. • **Unified Power Flow Controller(UPFC)** • **DVAR or DSTATCOM** • **Static Voltage Regulator(SVR)** • **Static VAR Compensator(SVC)** • **Solid state Transfer Switch** • **Dynamic Brake** • **AC/DC inverter** **2. Superconductivity** • **First Generation wire** • **HTS cable** • **Second Generation** **3. Distributed Generation** • **Micro turbine** • **Fuel cell** • **PV** • **Wind Turbine** **4. Distributed Storage** • **Nas battery** • **Vanadium Redox Battery** • **Ultra capacitors** • **Superconducting magnetic energy storage(SMES)** **5. Composite conductor** • **Aluminium conductor composite core cable(ACCC cable)** • **Aluminium conductor composite reinforced cable (ACCR cable)** • **Annealed aluminium steel supported(ACSS)**	1. Distributed intelligent Agents • Digital relay • Intelligent tap changer • Energy management system • Grid friendly appliance controller • Dynamic distribution power control 2. Analytic tools • System performance monitoring and control • Phasor measurement analysis • Weather prediction • Fast load flow analysis • Market system simulation • Distribution fault location • High speed commutating 3. Operation application • SCADA • Substation automation • Transmission automation • Distribution automation • Demand response • Outage management • Asset optimization

Table: Modern Hardware and Control of Smart Grid [6]

In the application technologies for SG, an Intelligent Universal Transformer (IUT) has been introduced. It is a power electronic base transformer introducing for Advanced Distribution Automation (ADA) in future. ADA is the state of art employing the new architecture based on both the flexible electrical network and open communication construction comprise the Future Distribution System. IUT is a basic resource enrolling a key point in ADA conceptual construction which is fundamental part in smart grid network.

V. ELEMENTS OF TODAY'S SMART GRID

Offerings	Customer Benefits	Future Enablers
Grid-Friendly Renewables	•Controllability: Ramp, curtail... •Reduced uncertainty: forecast	•Stronger tie with utility EMS •Coordination with DER & loads
Grid Control Systems	•Operating efficiency •System reliability	•'Ever Green' Service •Modular applications
Substation	•Modular/standard	•IEC 61850

Digitization	•Less cost, time, risk	Compliant •Open architecture
Intelligent Electronic	•Performance monitoring •Control devices	•Standards based •IEC 61850 compliant
Monitoring & Diagnostics	•Asset protection •Life extension	•Progressive offering •Long term services
Communications Infrastructure	•Performance visibility •Remote control	•Seamless NMS, Security •Multi-applications
Smart Metering	•Customer billing •Demand management	•Software upgradeable

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VI. DRIVERS FOR SMART GRID IN INDIA

The drivers for smart grid for different stakeholders in India are:

Utilities:

1. Reduction of T&D losses in all utilities as well as improved collection efficiency.

2. Peak load management multiple options from direct load control to consumer pricing incentives.

3. Reduction in power purchase cost.

4. Better asset management

5. Increased grid visibility

6. Self-healing grid

7. Renewable integration

Customers:

1. Expand access to electricity – "Power for All"

2. Improve reliability of supply to all customers – no power cuts, no more DG sets and inverters

3. Improve quality of supply – no more voltage stabilizers

4. User friendly and transparent interface with utilities

5. Increased choices for consumers, including green power

6. "Prosumer" (producer and consumer) enablement

7. Options to save money by shifting loads from peak periods to off-peak periods

Government and Regulators:

1. Satisfied customers

2. Financially sound utilities

3. Tariff neutral system upgrade and modernization

4. Reduction in emission intensity

VII. SMART GRID APPLICATION

Smart grid concepts encompass a wide range of technologies and applications. We describe a few below that are currently in practice with the caveat that, at this early stage in the development of smart grids, the role of control, especially advanced control, is limited[6]:

1. Advanced metering infrastructure (AMI) is a vision for two-way meter/utility communication. Two fundamental elements of AMI have been implemented. First, automatic meter reading (AMR) systems provide an initial step toward lowering the costs of data gathering through use of real-time metering information. Second, meter data management (MDM) provides a single point of integration for the full range of meter data. It enables leveraging of that data to automate business processes in real time and sharing of the data with key business and operational applications to improve efficiency and support decision making across the enterprise.

2. Distribution management system (DMS) software mathematically models the electric distribution network and predicts the impact of outages, transmission, generation, voltage, frequency variation, and more. It helps reduce capital investment by showing how to better utilize existing assets, by enabling peak shaving via demand response (DR), and by improving network reliability.

3. Geographic information system (GIS) technology is specifically designed forth utility industry to model, design, and manage their critical infrastructure. By integrating utility data and geographical maps, GIS provides a graphical view of the infrastructure that supports cost reduction through simplified planning

VIII. SMART GRID PROBLEMS

Smart grid power systems use digital technology to deliver electricity. They are being rolled out as a means to create energy savings, some problems exist with this technology. Some of the problems inherent in smart grid power systems include custom privacy problems, security problems, grid volatility and inflexibility. Implementing a smart grid power system has considerable implications for personal privacy because the grid has the ability to control power access. Security experts believe that this technology may allow someone other than the customer to control the power supply. Some problems explained as [5]:

1. PRIVACY PROBLEMS:

Security experts believe that smart grid technology may enable some people to get control of the power supply. Communication between utilities and the meters at residential homes and businesses increases the chance of someone gaining control over the power supply of a single building or an entire neighborhood.

2. GRID VOLATILITY:

Smart Grid network has much intelligence at its edges; that is, at the entry point and at the end user's meter. But the grid has insufficient intelligence in the middle, governing the switching functions. This lack of integrated development makes the grid a volatile network. Engineering resources have been poured into power generation and consumer energy consumption, which are the edges of the network. However, if too many nodes are added to the network before developing the software intelligence to control it, the conditions will lead to a volatile smart grid

IX. FUTURE SCOPE

Future models for the electricity grids have to meet the changes in technology, in the values in society, in the environment and in commerce. Thus security, safety, environment, power quality and cost of supply are all being examined in new ways and energy efficiency in the system is taken ever more seriously for a variety of reasons. New technologies should also demonstrate reliability, sustainability and cost effectiveness in response to changing requirements in a liberalized market Environment.

Thus the future home can be like…

X. CONCLUSIONS

Positive consumer opinion is essential for smart grid's success. Without broadly positive consumer attitudes, public utility commissions are unlikely to be willing to approve utility investments in smart grid upgrades, and consumers will not allow control of their appliances or use energy information they receive. Consumers must recognize that smart grid systems and the advanced meters attached to their homes and businesses provide real value and are worth the costs they are required to pay on their utility bills. While grid reliability, operational savings, and reduced need for power plants are real benefits to all those connected to the grid, their relation to smart meters, time-based rates, and utility charges for smart grid may not be obvious. As such, it is important that consumers see useful information coming from the smart grid and realize real energy savings that bring down their energy bills

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