Overview of Smart Home and Building Automation Systems using a Correlative Demand Response

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Abstract : Home and Building Automation (HBA) trends toward the Ambient Intelligence paradigm, which aims to autonomously coordinate and control appliances and subsystems in a given environment using Smart Technology. Backward-compatible enhancements to demotic standard allow supporting the semantic characterization of user profiles and device functionalities. Distributed Energy Storage Systems in combination with advanced power electronic devices used in HBA involve great technical role and will have a huge impact on future electrical supply systems leading to many financial benefits. Despite storage devices, standardized architectures and techniques used for distributed intelligence, smart power systems, planning tools and models to aid the integration of energy storage systems are still lagging behind. Reliability assessment used in HBA is an important program and is performed using deterministic or probabilistic techniques to meet demand response in a viable method to motivate users and showing the negative response to demand during the peak load periods and the system leads to a capacity reserve in excess of the actual load demand. This paper presents a general overview of HBA integrated Smart Technology with trawling Demand Response (DR).

Keyword: **Home and Building Automation (HBA), Building Automation System (BAS), Demand Response (DR), Smart Grid (SG).**

INTRODUCTION

As Smart Technologies gain traction on an ever larger scale, Home and Building Automation (HBA) designs take on a whole new dimension and it introduces both opportunities and risks especially in terms of security challenging to consider a growing list of requirements. Robustness and reliability remain key in all HBA solutions along with cost-effectiveness. The use of wireless technologies in HBA systems offer attractive benefits, but also introduces a number of technological challenges. As energy consumption is rapidly increasing worldwide and to fulfill this energy demand alternative energy sources along with new trends in research and development for the technological advancement of efficient energy utilization employ Smart Grid (SG) systems in HBA [1], [3], [4]. Research studies show that how renewable energy resources are becoming more prevalent as more electricity generation becomes necessary and could provide half of the total energy demands by 2050. To satisfy the future energy demand the SG ascertained with HBA can be used as an efficient system for energy security. The SG also delivers significant environmental benefits by conservation and renewable generation integration and along with Demand Response (DR).

COMPARISON BETWEEN CONVENTIONAL GRID AND SMART GRID

New concept of next generation electric power system the Smart Grid (SG) has emerged recently and is a modern electric power grid infrastructure for improved efficiency, reliability and safety, with smooth integration of renewable and alternative energy sources through automated control and modern communication technologies overcoming the present grid which is facing a multitude of challenges such as infrastructural problems leading to blackouts, more information and transparency required for customer satisfaction as to make optimal decisions relative to the market [2], [3]. SG detects and reacts to changes and reduces the consumption during the most expensive peak hours.

SG is an electricity network that can intelligently integrate the actions of all users connected to it whether generators, consumers, and those that do both in order to efficiently deliver sustainable, economic and secure electricity supplies, as Table I presents a preparation of comparison. Finally, SG will overcome the uncertainty of the current grid which can't support the development of renewable energies or other forms of technologies that would make it more sustainable.

Table 1 Comparison between Conventional Grid and Smart Grid (SG)

Conventional Grid	Smart Grid
Poor Power Quality	Improved Power Quality
Reliable	More Reliable
Hectic Load Profile	Efficient Load Profile
No Auto Sectionalization	Auto Sectionalization is Possible
No Auto-Restoration	Auto-Restoration is Possible
Lack of Feeder Automation	With Feeder Automation results in deferring capital investment
Normal Grid	Fully Digital Grid
Efficient as usual	It's Efficiency helps in reducing operating costs
Weak at Peak Demand	Stronger in Stabilizing Peak Demand

Cannot be directly connected to SCADA system	With the facility of IED's digital grid is directly interfaced with SCADA system

III. HOME AUTOMATION

Home Automation is a design involving the patterns of control and automation of Lighting, Heating, Ventilation and Air-Conditioning (HVAC) and security systems, as well as home appliances such as washers, dryers, ovens or refrigerators based on smart thermostats noted as smart home or smart house [10], [11]. For remote monitoring and control Wi-Fi is often used.

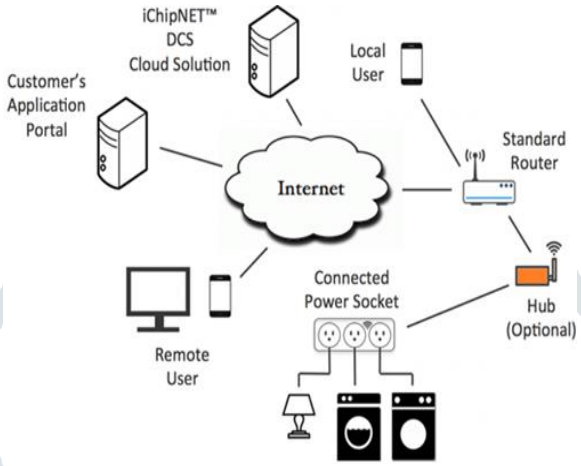

Fig. 1. Home Automation System

As Fig. 1 [9], [12] shows the basic diagram for Home Automation with proper functionalities. Home Automation system devices will employ switches and sensors connected via central hub from which the system is controlled with a user interface that is interacted either with a wall-mounted terminal, mobile phone software, tablet computer or a web interface and there are very few worldwide international accepted industrial standards among those the smart home space is heavily considered.

IV. BUILDING AUTOMATION

Building Automation is the automatic centralized control of a building exploring a distributed control system with computer networking of electronic devices designed to monitor and control HVAC, lighting and other systems through Building Automation System (BAS) [5]. The main objectives of Building Automation include improved occupant comfort, efficient operation of building systems, reduction in energy consumption and operating costs, and improved life cycle of utilities, as Fig. 2 [13] shows the generalized block outline diagram for building automation [6], [8].

A Building Automation controlled by a BAS will provide the core functionality keeping building climate within a stipulated and specified range, provides light to rooms based on an occupancy schedule, monitors performance and will also detect device or module failures in all systems finally providing malfunction alarm alerts to building maintenance staff referred to as an intelligent building, "smart building".

Fig. 2. Building Automation System

IEEE standards notably IEEE 802.15.4, IEEE 1901 and IEEE 1905.1, IEEE 802.21, IEEE 802.11ac, IEEE 802.3at and consortia efforts like envoy or QIVICON have provided a standards-based foundation for heterogeneous networking of many devices on many physical networks for diverse purposes, and quality of service and failover guarantees appropriate to support human health and safety.

V. DEMAND RESPONSE

SG systems with the current state of development in Demand Response (DR) programs there have been great emblematic demands for automated energy scheduling for residential and industrial customers. Energy scheduling in SG's have focused on the minimization of electricity bills, the reduction of the peak demand, and the maximization of user convenience [1], [7].

The Federal Energy Regulatory Commission (FERC) currently defines demand response as:

Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized (FERC 2012).

The Automated Demand Response (ADR) program has been successful and easily expands to smaller businesses and residential customers. DR provides liberal opportunity for consumers by playing a significant role in the operation of the electric grid thereby reducing and shifting their unlimited electricity usage during peak periods in response to time-based rate profiles, financial incentives and these services range from ensuring high resource adequacy and providing ancillary services to reducing high energy prices through participation in energy markets. An overview of these capabilities is illustrated in Fig. 3 [14]

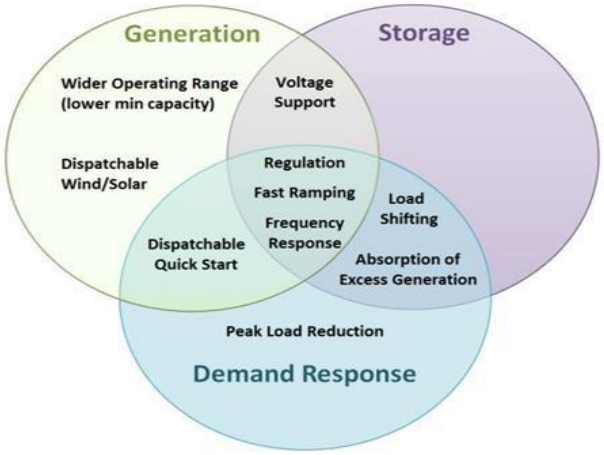

Fig. 3. Services Provided by Various Resources

DR programs when used by electric system planners and operators as resource options for balancing supply and demand will lower the cost of electricity in wholesale markets, and in turn, lead to lower retail rates. Methods of engaging customers in DR efforts in future will include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real-time pricing, and critical peak rebates. Furthermore, adoption of direct load control programs will provide the ability for power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive and lower electric bills.

More DR is not always a good thing instead it is situational, sometimes where it may not make economic or environmental sense to use. Whether a utility and its regulator encourages DR is an economic decision and will make relative to the local specific electricity supply mix and market conditions.

CONCLUSION

Electric Supply system is one of the most complex systems of the world. In the present scenario, there is a huge effusive gap in demand and supply. In this paper, we addressed how to reduce the gap between demand and supply with new Home and Building Automation (HBA) generation technologies when incorporated with Smart Grid system(s) which have less gestation period and less investment in terms of installation and commissioning. This will lead to ease of life through automated control of appliances and subsystems and by using correlative demand response will benefit both the users reducing their cost, and upgrades the utility company. Therefore, this paper has reviewed the automation generation technologies along with demand response their challenges, benefits and key issue(s) pertaining to their stability in the interconnected power system.

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