



# Smart Grid Data Centers Distributed & ICTs Sustainability on Generation Energy-Efficiency

A.Anuradha<sup>1</sup> | R Varaprasad Rao

<sup>1</sup>PG Scholar, Department of ECE, Geethanjali College of Engineering & Technology, Kurnool, AP, India.

<sup>2</sup>Associate Professor, Department of ECE, Geethanjali College of Engineering & Technology, Kurnool, AP, India.

## ABSTRACT

Smart grid has modernized the way electricity is generated, transported, distributed, and consumed by integrating advanced sensing, communications, and control in the day-to-day operation of the grid. Electricity is a core utility for the functioning of society and for the services provided by information and communication technologies (ICTs). Several concepts of the smart grid, such as dynamic pricing, distributed generation, and demand management, have significantly impacted the operation of ICT services, in particular, communication networks and data centers. Ongoing energy-efficiency and operational expenditures reduction efforts in communication networks and data center have gained another dimension with those smart grid concepts. In this paper, we provide a comprehensive survey on the smart grid-driven approaches in energy-efficient communications and data centers, and the interaction between smart grid and information and communication infrastructures. Although the studies on smart grid, energy-efficient communications, and green data centers have been separately surveyed in previous studies, to this end, research that falls in the intersection of those fields has not been properly classified and surveyed yet. We start our survey by providing background information on the smart grid and continue with surveying smart grid-driven approaches in energy-efficient communication systems, followed by energy, cost and emission minimizing approaches in datacenters, and the corresponding cloud network infrastructure. Through a communication infrastructure, a smart grid can improve power reliability and quality to eliminate electricity blackout.

**KEYWORDS:** Smart grid, Data centers, distributed generation, energy-efficiency, ICTs, sustainability.

Copyright © 2016 International Journal for Modern Trends in Science and Technology  
All rights reserved.

## I. INTRODUCTION

Current energy distribution grid has been in use for almost a century. The aging of equipment's and increasing consumer demands necessitate a revolution in the grid. By 2020, it is foreseen that the energy demand will almost be double the present demand. Increases in recent times in electricity costs and in associated emissions of greenhouse gases are having an impact on societies to adopt business and lifestyle strategies based on sustainability practices. The existing electricity grid has remained unchanged for about 100 years. It lacks the capability of providing information and communication. To realize these capabilities, a new concept has emerged the smart grid. Wireless Sensor Networks (WSNs) are becoming a fundamental tool of the smart grid.

Advanced information and communication technologies, monitoring and control and innovative metering technologies via intelligent devices, will

Become increasingly important. The benefits of the smart grid are not limited to the power distributors but reach both industrial and residential customers as well. By deploying the proper control mechanisms, the power distributor can save money by avoided investments for additional capacity. The industrial and residential customers benefit from green, locally produced power and lower energy bills by automated shifting off flexible loads towards cheaper time windows. To enjoy these benefits, an integrated network for controlling (distributed) energy sources is required. The initial concept of SG started with the idea of advanced metering infrastructure (AMI) with the

aim of improving demand-side management and energy efficiency, and constructing self-healing reliable grid protection against malicious sabotage and natural disasters [204]. However, new requirements and demands drove the electricity industries, research organizations, and governments to on advanced electricity generation, advanced delivery, advanced information metering, advanced monitoring, advanced management and advanced communication technologies. The smart management system is the subsystem in SG that provides advanced management and control services. The smart protection system is the subsystem in SG that provides advanced grid reliability analysis, failure protection, and security and privacy protection services.. Hence, in this paper, first the smart demand responsive energy management system under new comprehensive field tests with mesh network design based on AODV for wireless communication is proposed. We present a real-time distributed multi-agent algorithm for coordinating supply and demand in there identical power network in an optimal way. An important goal of the algorithm is to improve the local consumption of the energy produced by solar panels.

II. RELATED WORK & IMPLEMENTATION

Implementation of wireless communications and data centers in connection with the smart grid is illustrated in Fig. 1, including the power flow in the grid. Electricity is transported to the consumers over the transmission and distribution system similar to the legacy grid, while in addition, consumers can become power generators and sell power the grid according to the novel distributed generation practices of the smart grid [1]. In the smart grid, all of the entities are connected through communications. In the figure only wireless technologies are presented but as will be discussed later on in this paper, using optical and wire line communications is also possible. In the figure, data collected from sensors and meters are fed into the utility headquarters and stored in cloud data centers.

2.1 Energy-Efficient Communications and The Smart Grid

Energy-efficiency has been an integral part of networks that consist of battery-run nodes such as sensor nodes or mobile phones while energy-efficiency of network equipment powered from mains such as base stations, switches, routers has not been under the spotlight until

recently. In parallel to the increasing number of subscribers and their diverse demands, electricity bills of network operators have been skyrocketing. As a result, a significant amount of academic and industry efforts have been put into reducing the energy consumption of core and access network equipment. Along with the traditional electricity costs, large amount of GHG emissions of communication networks is foreseen to add more costs to the operators with the forthcoming carbon taxes and caps. Price-following demand management of smart grid can be employed by the communications infrastructure to reduce electricity bills where this can be also extended to emission-following load management of the equipment. On one side smart grid-driven approaches impact the way energy-efficient communication technologies are implemented, on the other side smart grid involves dense communications and it is impacted from energy-efficiency techniques. This section summarizes the works that study the mutual impacts of smart grid and energy-efficient communications. We have grouped these studies under wireless, wire line and optical networks and for each type of network, we focus on the appropriate smart grid domain.

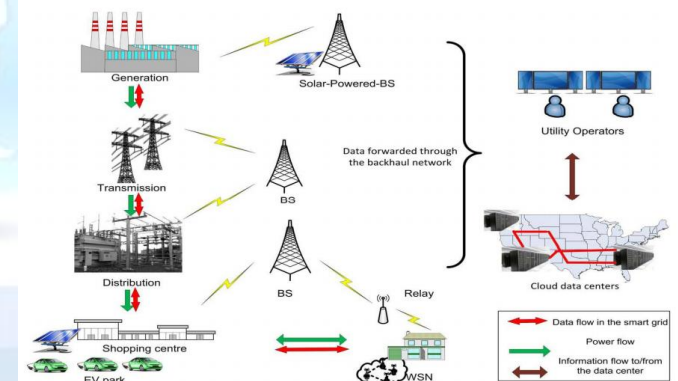


Fig. 1. Smart grid, wireless wide area solutions and Internet data centers.

Energy-efficiency of battery-run, hand-held devices and Wireless Sensor Networks (WSNs) are beyond the scope of this survey since their energy-efficiency aims at increasing the lifetime of the network or the device considering their limited battery power. The smart grid can be roughly divided into three domains in terms of communication coverage and functionality; Smart Grid Home Area Network (SG-HAN), Smart Grid Neighborhood Area Network (SG-NAN) and Smart Grid Wide Area Network (SG-WAN). SG-HAN is a single residential unit with smart appliances, an energy display, power consumption control tools, storage, solar panels, small-scale wind turbines,

electric vehicles and a smart meter. A SG-NAN corresponds to a group of houses possibly fed by the same transformer. Advanced Metering Infrastructure (AMI) collects smart grid data from the premises in a SG-NAN and aggregates the meter data before they are sent to SG-WAN which connects SG-NANs to the utility operator. From the utility perspective, besides metering, equipment in the field needs to be monitored and controlled. Hence the equipment in the field are managed by a separate network which is called as Smart Grid Field Area Network (SG-FAN). The geographical scale of a SG-FAN is similar to SG-NAN therefore similar communication technologies are applicable for both. These network domains can be implemented using a variety of communication technologies.

### III. EXPERIMENTAL WORK

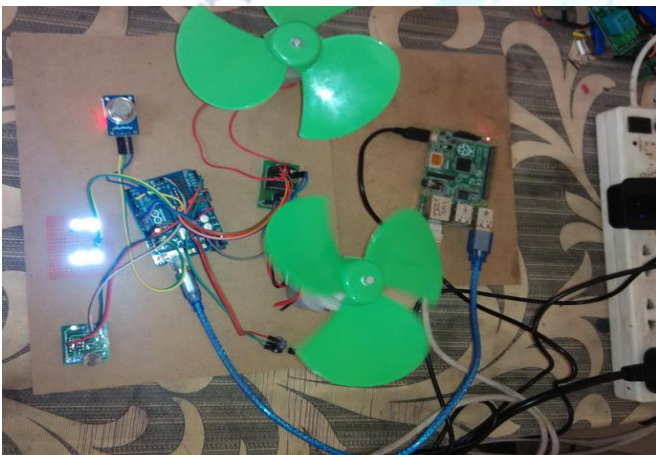


Fig 2: Project with Kit1

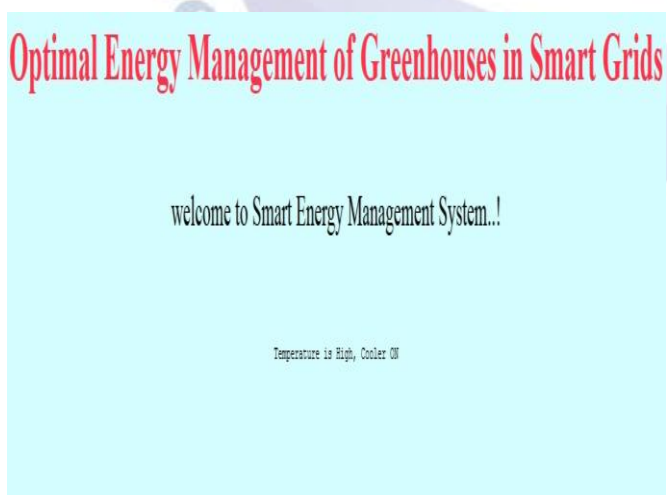


Fig 3: System in web page welcome screen.

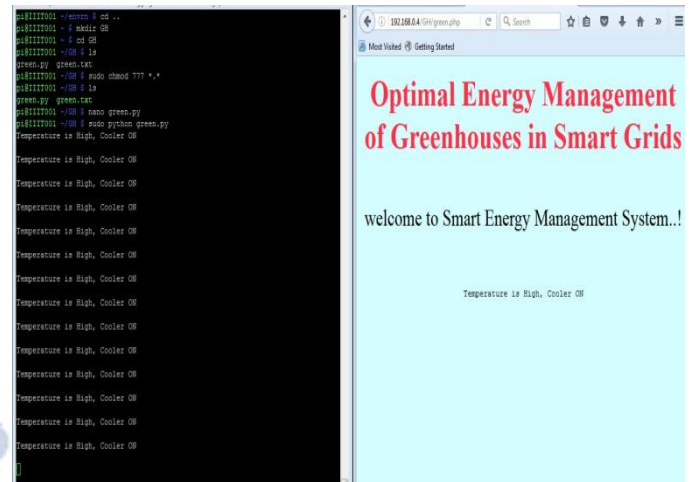


Fig 4: Web Screen with monitoring values.

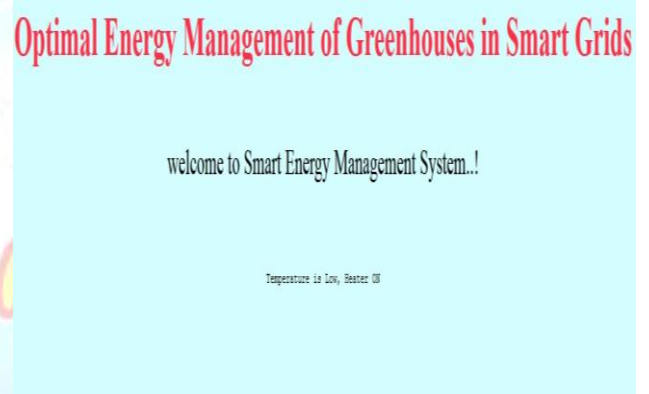


Fig 5: Web Screen 2.

### IV. CONCLUSION

In the proposed system, we present the background and motivation for smart grid communication infrastructures. We are going to show that a smart grid built on the technologies of sensing, communications, and control technologies offer a very promising future for utilities and users. We review several industrial trials and summarized the basic requirements of communication infrastructures in smart grid paradigm. Efficiency, reliability and security of interconnected devices and systems are critical to enabling smart grid communication infrastructures. Interoperability must be achieved while avoiding being isolated into noncompetitive technical solutions and the need for wholesale replace of existing power communication systems. Alignment behind technical standards must be balanced with creating an environment that encourages innovation so that the overall communication infrastructure may continue to evolve. Based on the above survey, we can focus on those challenges to smart grid communication

infrastructures in both system design and operations to make it more efficient and secure.

#### REFERENCES

- [1] G. Zimon, "Integrating distributed generation into the smarter grid," IEEE Smart Grid, Dec. 2013. [Online]. Available: <http://smartgrid.ieee.org/december-2013/1013-integrating-distributed-generation-into-the-smarter-grid>
- [2] Anvari-Moghaddam, A., Monsef, H. and Rahimi-Kian, A. (2015) Optimal Smart Home Energy Management Considering Energy Saving and a Comfortable Lifestyle. IEEE Transactions on Smart Grid, 6, 324-332. <http://dx.doi.org/10.1109/TSG.2014.2349352>
- [3] Wu, Y., Lau, V.K.N., Tsang, D.H.K., Qian, L.P. and Meng, L. (2013) Optimal Energy Scheduling for Residential Smart Grid with Centralized Renewable Energy Source. IEEE Systems Journal, 8, 562-576.
- [4] Han, J., Choi, C., Park, W., Lee, I. and Kim, S. (2014) Smart Home Energy Management System Including Renewable Energy Based on ZigBee. IEEE International Conference on Consumer Electronics (ICCE), Las Vegas, 10-13 January 2014, 544-545. <http://dx.doi.org/10.1109/icce.2014.6776125>
- [5] Garner, G. (2010) Designing Last Mile Communications Infrastructures for Intelligent Utility Networks (Smart Grids). IBM Australia Limited.
- [6] Al-Omar, B., Al-Ali, A.R., Ahmed, R. and Landolsi, T. (2012) Role of Information and Communication Technologies in the Smart Grid. Journal of Emerging Trends in Computing and Information Sciences, 3, 707-716.
- [7] R. Yu, Y. Zhang, S. Gjessing, C. Yuen, S. Xie, M. Guizani, "Cognitive radio based hierarchical communications infrastructure for smart grid," IEEE Network, vol.25, no.5, pp.6-14, September-October 2011.
- [8] S. Massoud Amin and B. F. Wollenberg, "Toward a smart grid: power delivery for the 21st century," IEEE Power and Energy Mag., vol. 3, pp. 34-41, 2005.
- [9] F. Rahimi and A. Ipakchi, "Overview of Demand Response under the Smart Grid and Market paradigms," in Innovative Smart Grid Technologies (ISGT 2010), pp. 1-7, 2010.
- [10] R. Davies, "Hydro one's smart meter initiative paves way for defining the smart grid of the future," in Power & Energy Society General Meeting, 2009. (PES '09), pp. 1-2, 2009.
- [11] E. Santacana, et al., "Getting Smart," Power and Energy Magazine, IEEE, vol. 8, pp. 41-48, 2010
- [12] D. Sun, "The Utilization and Development Strategies of Smart Grid and New Energy," in Proceedings of Asia-Pacific Power and Energy Engineering Conference (APPEEC 2010), pp. 1-4, 2010.
- [13] C. Jaeseok, J. Park, M. Shahidehpour and R. Billinton, "Assessment of CO2 reduction by renewable energy generators," in Innovative Smart Grid Technologies (ISGT), pp.1-5, 2010.
- [14] F. A. Rahimi, "Challenges and opportunities associated with high penetration of distributed and renewable energy resources," in Innovative Smart Grid Technologies (ISGT), 2010, 2010, pp. 1-1.
- [15] G. Lorenz, "Regulatory framework to incentivise Smart Grids deployment - EURELECTRIC views," The 20th International Conference and Exhibition on Electricity Distribution - Part 2, 2009. (CIRED 2009), pp. 1-26, 2009