Abstract
The development and integration of smart grid technology in current scenario is very crucial and useful. Involving the Smart Grid computing into electricity supply, yields a huge amount of monetary benefits which includes less emissions, better storage and high efficiency. Such grid based system is proving to be highly lucrative for customers using it. The Governments are highly investing in such technology to achieve independence especially into power sector. Deploying Smart Grid technology has been a priority for governments all around the world. It is having a revolutionising effects on existing conventional power grid systems. Smart Grid lies at the confluence or intersection where Computers and Electronics intersect. Both these things have been in their prime and have had far-reaching effects on the innovations off late. Smart Grid is the very new innovation possible with the contribution of former and latter and is proving to be boon not only for developing but developed countries too.

Introduction
The smart grid is an electricity supply system which functions under two-way communication channel. In this channel customer receives the electricity and also returns a feedback. This feedback is vital in cutting down the wastage of power and extra expenditure. It has also been breakthrough technology in reducing the effect of global warming. Consumers, using the smart grid devices, transmit information that is used to customise the supply according to the needs as seen in this information[1]. The presence of internet connection is very much needed to make the presence of smart grid technology possible.

Blackouts and brownouts were a severe headache for any country in its electrical grid system [2]. Normal grid systems are not equipped to handle additional load given the demand is high. It seriously affected the industrial and services sectors. These factors alone account for the need of a system that can handle all the failures effectively. In came the Smart Grid.

Smart grid technology became known in 1990s after drawbacks of its predecessors became prevalent. What makes smart grid smart, is its ability to track the power usage. It can very well identify the amount of power required over a varying time period of a given day. This was not possible in previous available arrangements. Smart grid can also efficiently detect the location and cause of fault. This detection was not possible previously. Smart Grid technology has achieved path breaking results in area of fraud detection. This drawback of previous systems is very well covered by the Smart Grid. The most advantageous and vital aspect of Smart Grid is that it is dominantly customer-driven. This feature helps the beneficiary to manage their consumption and expenditure.

What makes a smartphone smart? It is the in-built computer which makes the phone smart. Similarly, it is the computer which smartens our existing grids to make it Smart Grid. Some very obvious computer technologies involved in implementation of Smart Grid involves Database Management, Cloud Computing, Distributed Computing etc. Since customer preferences are constantly tracked, they are stored in database which are further very much useful to make prediction and track the behaviour. This database is very useful for the distributing company to cater to the needs their customers. Techniques of distributed computing is used at the distribution centre. This helps in switching between different sources of energy available. Smart Grid is equipped with a lot of sensors which are inter-connected in a network. Computer scientists invest huge fraction of their time setting up the sensors in a network.

Basic Elements of Smart Grid
Architecture is very important to manage the complexity and easily manages to achieve goals[4]. Architecture helps visualising the challenges which lie in implementation. Taking precautions prior to implementation helps reducing risks. Building infrastructure of Smart grid is pretty much sophisticated and complex. This also is very costly as compared to conventional electricity distribution systems available. The architecture of Smart Grid as depicted Figure 1 is majorly composed of following: -

- **Transmission Stations**: Transmission stations is where electric power is generated by different means. The power generated is sent to the distribution centres for further supply. They too make use of smart devices that make supply automatic and need-based.

- **Distribution Centres**: This is the pace where majority of work takes place. Distribution centres receive power from transmission stations and redirect them to the consumers. Important tasks like fraud detection, load balancing and
distribution according to the need and switching between various transmitting stations of thermal, tidal, hydro-electric power plants.

- **IoT Devices**: Smart Grid, simply put, is not possible without IoT devices. These devices are installed at each and every step and part possible in the complete setup. Devices like sensors, actuators, smart meters etc. These devices are used in process of transmission, metering and distribution. It is these devices through which the needs and behaviour of consumption is reflected. The data collected in the devices is precious for future pattern predictions and customisation of supply.

**Why do we need Smart Grid?**

Smart grid is the utmost need of the currently existing out-of-date and obsolete electrical supply system which vulnerable to frauds and wastage of power. Building Smart Grid is the need of the hour not only because is almost fraud-proof but also cost efficient and eco-friendly. Bringing customer into the picture is what is the most prominent feature of Smart Grid. This technology also deploys renewable sources of energy like wind, tidal, solar etc. and blends it in with other non-renewable sources of energy like thermal. The system is smart enough to switch according to the demand and automatically lowers the load, hence saving money. Smart Grids have been found to save 30% more energy than conventional grids.

![Figure 1: Different Elements of Smart Grid Architecture](image)

Fault detection still remains one the grave area for conventional energy grids because, to detect the place and kind of fault is a very tedious task which is made pretty easy by Smart Grid. Smart Grid automatically detects the fault and itself tries to handle it with pre-defined measures. Other advantages of Smart grid are as follows [5]:

- **Reduced Costs and Expenditure**: Managing and providing the load and power according to the demands lowers the cost and cuts expenditures.
- **Eco-Friendly**: Since Smart Grid makes use of both renewable and non-renewable sources, it lowers the harmful emissions and reduces the risk of global warming.
- **Robustness**: Smart Grids being more robust means that they are less prone to attacks and can manage themselves. It is also blackout and brownout proof.
- **Smart Storage**: If in case, somehow, the power generated is more than what was demanded; it also provides smart facilities, which can be utilised as and when required.
- **Interoperability**: The fact that Smart Grid utilises various smart devices and other technologies proves this technology is interoperable [6].
- **Load Balancing**: Balancing the load [5] with techniques like switch-configuration [7] and tie-line addition helps save power by storing it when not needed.

The technological revolution, started almost a century ago, has been a bang and is still has great momentum. The number of innovations coming up would never have been possible without electricity. These inventions when combined with the Smart Grid technology would completely revolutionise the way we see the world. As the large cities are growing larger, the challenges which lie ahead are too are becoming much bigger. Integrating the infrastructure according to the digital age is
where the major benefits of Smart Grid lie. This technology can be used to lay foundation of Smart City [8], whose other layers contain remote light monitoring, public safety, water and gas supply, traffic control. Nothing is possible until and unless the electricity distribution system is efficient and robust.

**Deploying Smart Grid: From the perspective of Developing Nations**

Developing countries like India, Iran, Brazil, Ukraine etc. find satisfaction in the fact that using technologies like Smart Grid would lead them to a path of development and rightly so. Developed countries like United States of America, China, South Korea, Japan and some European giants have proved that Smart Grid is the way to development. What all developing countries have in common is their productive expenditure. Their expenditure in the right direction is paying off. Smart grid is one such area where they must invest to bore fruits in future. Here are some of the techniques employed by some countries to integrate Smart Grid:

- **Smart Grid in China:** It is estimated that China may have 233% growth in electricity demands by 2050 [9]. Since its introduction in 2006, the Chinese have very much focused on this technology so much so that, they are investing around RMB 17 billion. They have also laid down separate ministry for power grid technology in Twelfth Five Year Plan. This will help create around 15 million jobs. Induction and realisation of the power of this technology has completely boosted the growth rate of China.

- **Smart Grid in India:** Smart Grid is a must inclusion in the Indian electricity system because India tops the list in terms of percentage of production lost to theft, around 26% [10]. India is bereft of poverty and this again is good reason to introduce Smart Grid Technology in India. Indian markets would benefit with this technology, because present distribution systems are weak and fragile. The energy planning and investment would definitely boost the Indian economy [11].

- **Smart Grid in Brazil:** Seeing the potential of growing economy, Siemens has invested around $1 billion USD [12]. Brazil is big hydro-electricity producer and making use of it through Smart Grid technology would produce fruitful results. Brazil makes great use of pilot projects to induce this technology in their existing distribution system.

**Conclusion**

This article provides the broad view towards benefits of smart grid technology which is investing heavily in power enhancement for any country’s development. It has been initiated with the efforts related to change in implementing the concept of smart grid computing and would have splendid results for the coming future generations.

**References**


Siemens acquiring smart grid company in Brazil, (http://www.metering.com/node/212192012).
About the authors

Sanjeevikumar Padmanaban (M’12–SM’15, IEEE), received the bachelor’s degree in electrical engineering from the University of Madras, India, in 2002, the master’s degree (Hons.) in electrical engineering from Pondicherry University, India, in 2006, the Ph.D. degree in electrical engineering from the University of Bologna, Italy, in 2012, and the Ph.D. degree. He was an Associate Professor with VIT University from 2012 to 2013. In 2013, he joined as the Faculty with the National Institute of Technology, Pondicherry. He is an Associate Professor with the Department of Electrical and Electronics Engineering, University of Johannesburg, South Africa, from October 2016 to February 2018. From March 2018, he is with the Department of Energy Technology, Aalborg University, Esbjerg, Denmark as faculty. He has authored 300 plus scientific papers and has been the Best Paper cum Most Excellence Research Paper Award from IET-SEISCON’13, IET-CEAT’16 and five best paper award from ETAEERE’16 sponsored Lecture note in Electrical Engineering, Springer book series. He is a fellow Institution of Engineers (FIE’18, India) and fellow Institution of Telecommunication and Electronics Engineers (FIETE’18, India). He serves as an Editor/Associate Editor/Editorial Board of many-refereed journal in particular the IEEE Systems Journal, the IEEE Access Journal, the IET Power Electronics, and the subject editor of the subject editor of IET Renewable Power Generation, the subject Editor of IET Generation, Transmission and Distribution, the subject editor of FACTS journal, Canada and Journal of Power Electronics, Korea.

Bhadoria has worked on different fields like Data Mining, Frequent Pattern Mining, Cloud Computing Era including Service Oriented Architecture, Wireless Sensor Network. He completed his PhD from Indian Institute of Technology (IIT) Indore, Madhya Pradesh, India. He did his Bachelor and Master of Engineering in Computer Science & Engineering from Rajiv Gandhi Technological University, Bhopal (MP), India. He has published more than 60 articles into International & National conferences and journals of repute like IEEE, Elsevier and Springer that also includes book chapters. He has edited more than 05 books from the publishers like CRC Press, IGI Global Inc. (USA), and Springer. He is also serving as editorial board member for different journal around the globe. Presently, he is a professional member for different professional research bodies like IEEE (USA), IAENG (Hong-Kong), Internet Society, Virginia (USA), IACSIT (Singapore).

Frede Blaabjerg (S’86–M’88–SM’97–F’03) was with ABB-Scandia, Randers, Denmark, from 1987 to 1988. From 1988 to 1992, he was a Ph.D. Student with Aalborg University, Aalborg, Denmark. He became an Assistant Professor in 1992, an Associate Professor in 1996, and a Full Professor of power electronics and drives in 1998. From 2017 he became a Villum Investigator. His current research interests include power electronics and its applications such as in wind turbines, PV systems, reliability, harmonics and adjustable speed drives. He has published more than 450 journal papers in the fields of power electronics and its applications. He is the co-author of two monographs and editor of 6 books in power electronics and its applications. He has received 22 IEEE Prize Paper Awards, the IEEE PELS Distinguished Service Award in 2009, the EPE-PEMC Council Award in 2010, the IEEE William E. Newell Power Electronics Award 2014 and the Villum Kann Rasmussen Research Award 2014. He was the Editor-in-Chief of the IEEE TRANSACTIONS ON POWER ELECTRONICS from 2006 to 2012. He has been Distinguished Lecturer for the IEEE Power Electronics Society from 2005 to 2007 and for the IEEE Industry Applications Society from 2010 to 2011 as well as 2017 to 2018. He is nominated from 2014 to 2017 by Thomson Reuters to be between the most 250 cited researchers in Engineering in the world. In 2017 he became Honoris Causa at University Politehnica Timisoara (UPT), Romania.

Jens Bo Holm-Nielsen currently works at the Department of Energy Technology, Aalborg University and Head of the Esbjerg Energy Section. On this research, activities established the Center for Bioenergy and Green Engineering in 2009 and serve as the Head of the research group. He has vast experience in the field of Biorefinery concepts and Biogas production–Anaerobic Digestion. Implementation projects of Bio-energy systems in Denmark with provinces and European states. He served as the technical advisory for many industries in this field. He has executed many large scale European Union and United Nation projects in research aspects of Bioenergy, bio refinery processes, the full chain of biogas and Green Engineering. He has authored more than 300 scientific papers. He was a member on invitation with various capacities in the committee for over 500 various international conferences and Organizer of international conferences, workshops and training programmes in Europe, Central Asia and China. Focus areas Renewable Energy - Sustainability - Green jobs for all..

Sahil Nathani is an undergraduate student at Indian Institute of Information Technology, Bhopal, Inda. He is specialising in Computer Science and Engineering. He is keenly interested in Data Science, Machine Learning and Artificial Intelligence. He is working on projects related to the same.