Designing of smart grid system in Indian Scenario

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Abstract

In terms of energy utilisation, the aim of this research is to build a smart small-scale electrical power system termed as a smart microgrid. One of the biggest trends in the electricity system right now is energy utilization. Energy is lost in enormous amounts due to the imbalance between energy production and consumption. Microgrids are crucial for generating energy from renewable sources like photovoltaic systems in response to demand. In a MATLAB and Simulink framework with standard distribution elements, the microgrid system has been modelled. Solar energy systems serve as the microgrid energy sources, while during normal operation, the main grid supplies electricity to residential areas. Another component of this microgrid is AC power generation. To accelerate simulation speed, the model employs the Phasor solution of Specialized Power Systems.

Keywords- Smart Grid, Micro grid, Renewable energy, solar energy, Wind energy.

1. Introduction

A microgrid is a local electrical grid with control features, allowing it to operate independently and cross over to the old grid. A grid connected to mid-generation sources enables the use of electrical appliances, heat, cooling systems, and electronics devices in homes, buildings, stores, and other facilities. Distributed generators, batteries, and renewable energy sources like solar panels, wind farms can be used as a dedicated power source for the Smart Microgrid . The world's population is requisite to increase by almost a billion every year, that bringing the total population to more than 30 billion by 2030. Two things will result from this population growth: an increase in energy demand and issues with power grids.

A microgrid can enhance the quality of the power network from the perspective of the consumer. Both the likelihood of depletion and overall energy expenses will be decreased. The microgrid can reduce the flow of energy through the transmission and distribution lines, as well as their losses and burden on the network. It can also make it easier to maintain the network in the event of a malfunctions. Microgrids can operate in island mode and while connected to the main grid. A strong loading / production network can be built using this program's assistance in resolving RES problems and uncertainties. The Microgrid program's adoption will benefit the environment by lowering our reliance on fossil fuels and, the threat of climate changes. The future of energy systems is definitely the implementation of this programme with RES as an additional energy resource.

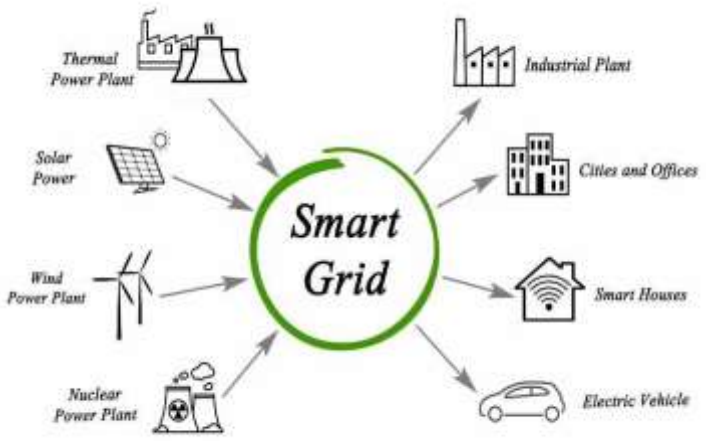

Fig 1: Smart grid scope and applications

2. Routes and challenges to using Smart grid in India.

As previously mentioned, the smart power grid is being transformed from a state-of-the-art technology to a functional level via smart grid technology. In order to provide relevant data to relevant Indian State stakeholders, the Department of Energy (Ministry of Power) engaged "The Climate Group" and "The Global e-Sustainability Initiative" at the System Modelling and Advancement in Research Trends. However, IT capabilities have totally improved and strengthened the simplification of the distribution side networks, which has improved the grid network by delivering personalised user service.

Table 1: Smart Grid Technologies, Challenges and Obligations.

Technology	Challenges	Obligations
Self – Healing Action	Security	Exploited from Internet Attacks (Spam, Worms, Virus etc.), National Question
	Reliability	Failure Loyalty during natural disasters, systemic exit and total darkness
Integration of Renewable Energy	Forecasting of Solar and Wind generation	Long term and unpredictable, random energy sources, unscheduled power flow and dispatch
	Power Flow Optimization	
Energy Storage Systems	Cost	Expensive energy saving systems such as Ultra capacitors, S.M.E.S, C.A.E.S etc
	Complexity	Complication of Complexities Complex design module and networks
	Non – Flexibility	Unique non-flexible designs for all individual networks do not make it easy to get used to
Consumers	Security	Malware, data capture, data corruption, illegal power management and Smuggling.
	Privacy	Sharing causes privacy attacks, copyright infringement, downside etc.
	Consumer awareness	Corruption and system threats like security and privacy issues.
	Disturbance	Grid Redesign Seeking balance and strength of the power system by grid weight.
	Harmonics Suppression	System instability during sag, dips or power fluctuations such as low voltage, volume power, electric lights etc.
Reliability	Grid Automation	The need for a strong data security system, with a secure and confidential network for reliable security, communication and control
	Grid Reconfiguration	System stability with grid complexity. And Generation demand equilibrium.

3. DESIGN AND SIMULATION OF MICROGRID

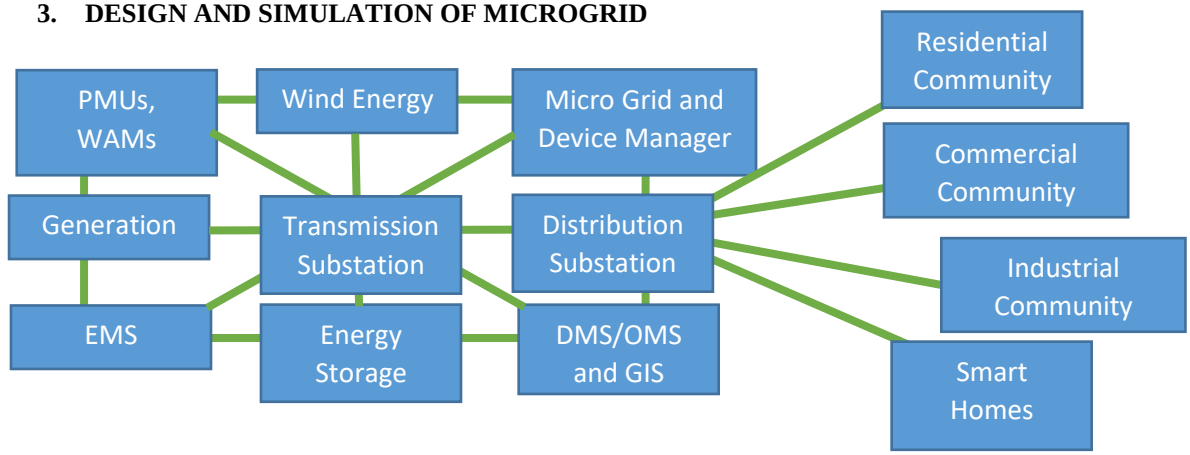

Fig 2: Block Diagram for smart grid hierarchy

Simulink Toolbox for MATLAB will be used to simulate the microgrid system. The simulation of AC power, a PV panel, a battery, and loads is represented in this image below.

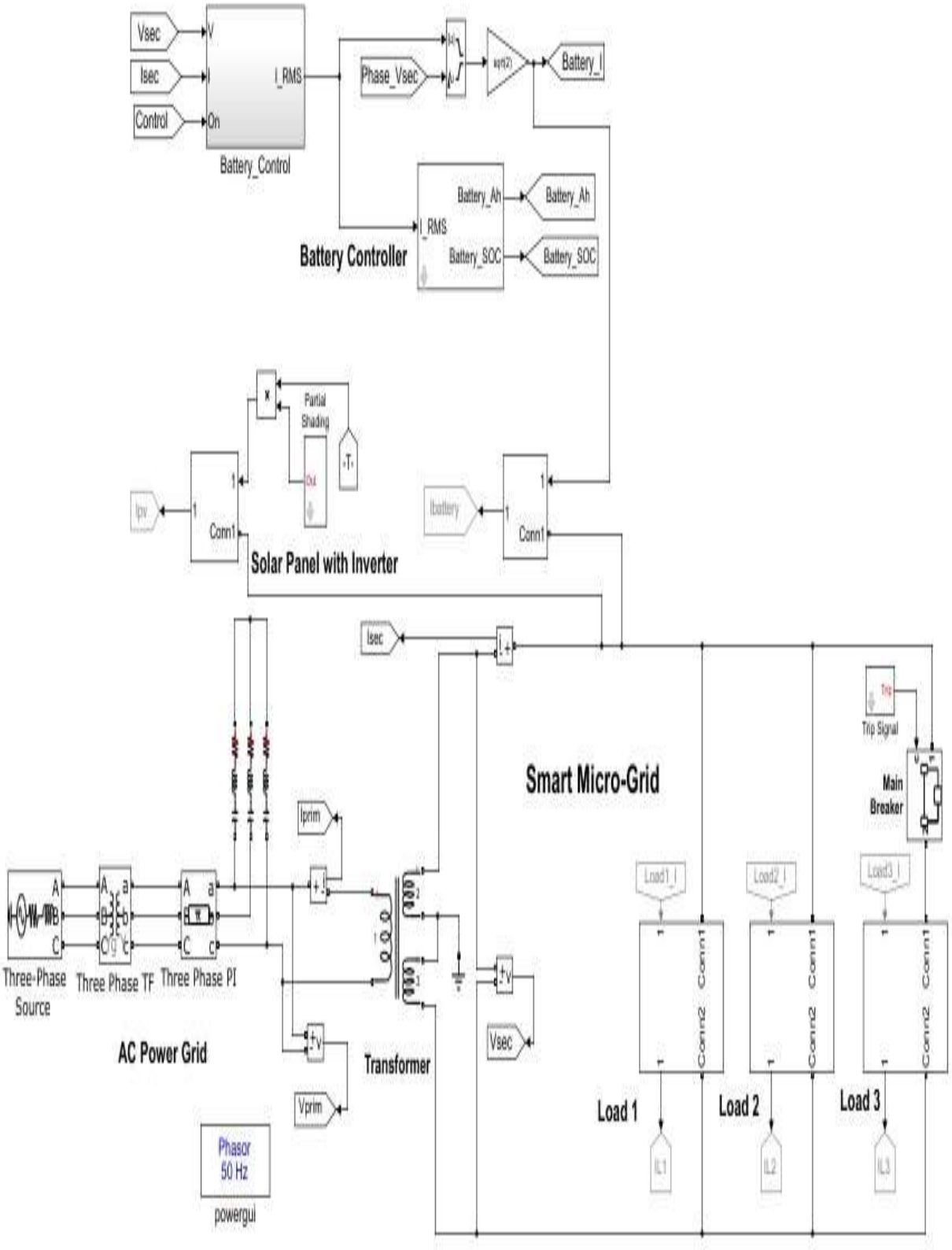

Fig 3: Smart microgrid design in Simulink

4. Simulation Results:

The simulation results below in figure shows the output waveform of the power generated with help of PV plant and the secondary AC grid, the first display scope is showing the waveform of the power generated by the PV and the maximum value is taken at 5000MW approx. The second display scope is showing the waveform of AC connected grid and the maximum value is taken at 4000MW approx. The third display scope is showing the power through the load side. All the values can be monitored by using the field data devices and by using the simulation we can find the real time performance in our smart grid system.

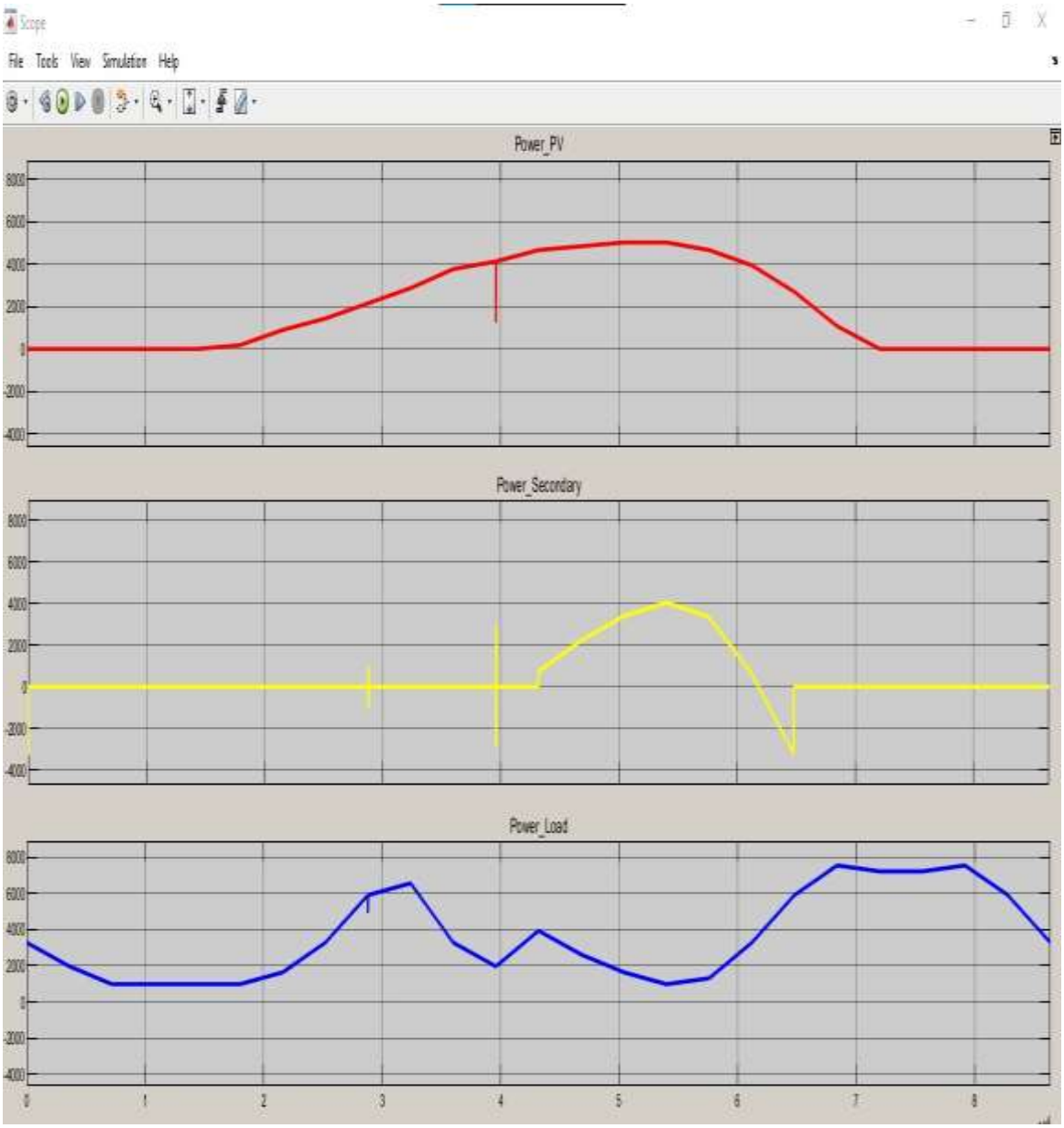

Fig 4: Power generation output waveform

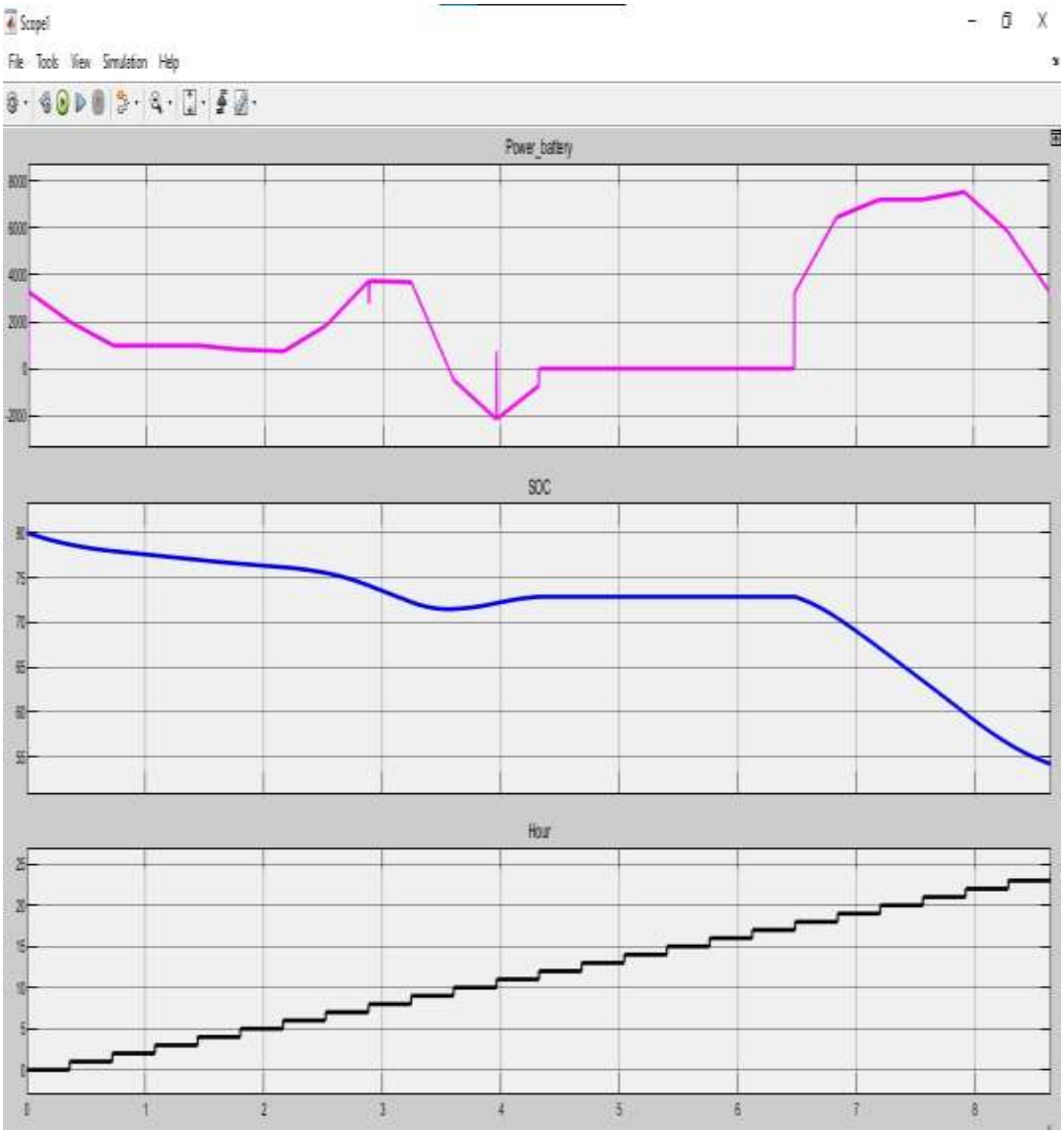

Fig 5: power battery, SOC, Time duration

The above figure shows the wave forms for the power through the battery, the waveform for the state of charge and the time duration. The above graph clearly shows how the power is varying with respect to time.

Conclusion and future scope:

A new generation of grid technology is being developed by smart microgrid in the fields of power management, automation of power generation and control to the other energy sources via energy storage devices. The dynamic and distributed control mechanisms are discussed using the Managing General Agents (MGAS) framework in a report above In line of this, the reports may serve as a reference point for future regulations that will direct the Indian power system to deploy the Smart grid in collaboration with RES.

A grid connection for power generation is an important factor of the study that was intended to build on photovoltaics and the design of photovoltaic grid connections in the Indian state. Furthermore, only few other micro grid and hybrid power-related projects have a power storage system that is expected to be completed soon. The ongoing research vision will be purposefully act as an advocate for the position and national development strategies in power and capacity in relation to the present and future need for power once the entire study has been completed.

Introducing the smart grid in the currently existing power system will enhance the efficiency, reduce the losses and give the better monitoring for the field data devices, research in this area will never stops, more the research

will make smarter the power system. The best way to make the power system smarter is to work more with renewable energy as it is more abundant in nature and is sufficient to fulfil the load demands.

References:

[1] Sinha, A.; Neogi, S.; Lahiri, R.N.; Chowdhury, S.; Chowdhury, S.P.; Chakraborty, N.; , "Smart grid initiative for power distribution utility in India," IEEE Power and Energy Society General Meeting, 2011 , vol., no., pp.1-8, 24-29 July 2011

[2] "The Green Grid: Energy Savings and Carbon Emission Reductions Enabled by a Smart Grid," EPRI Palo Alto, CA: 2008

[3] V.S.K. Murthy Balijepalli, S.A. Kharparde, R.P. Gupta, Yemula Pradeep, "SmartGrid Initiatives and Power Market in India" Proc. Of IEEE Power and Energy Society General Meeting, pp.1-7, Jul. 2010.

[4] Bossart, S.J.; Bean, J.E.; , "Metrics and benefits analysis and challenges for Smart Grid field projects," Energytech, 2011 IEEE , vol., no., pp.1-5, 25-26 May 2011.

[5] "Electricity Act '2003", Govt. of India, New Delhi, 2003 [6] Central Electricity Authority, 2010. [Online] Available: http://www.cea.nic.in/reports/electricity_act2003.pdf

[7] Ministry of Power, Government of India Website. [Online] Available: http://powermin.nic.in, Nov. 2009

[8] Pradeep, Y.; Thomas, J.; Sabari, C.L.; Balijepalli, V.S.K.M.; Narasimhan, S.R.; Khaparde, S.A.; , "Towards usage of CIM in Indian Power Sector," IEEE Power and Energy Society General Meeting, 2011 , vol., no., pp.1-7, 24-29 July 2011.

[9] Central Electricity Authority, 2010. [Online] Available: http://www.cea.nic.in/reports/yearly/energy_generation_10_11.pdf.

[10] Raoot, M.G.; Pentayya, P.; Khaparde, S.A.; Usha, S.; , "Complexities in integrating IPPs in Indian power system," IEEE Power and Energy Society General Meeting, 2010, vol., no., pp.1-9, 25-29 July 2010.

[11] Central Electricity Authority, 2010. [Online] Available:http://www.cea.nic.in/powersecreports/executive summary/201008/index.htm.

[12] Power Grid Corporation of Indian Limited, "Unified Load Despatch & Communications Scheme", Nomination for CSI-TCS Best IT Usage Award, National IT Awards, 2003.

[13] Y. Pradeep, S. A. Khaparde, and Reji Kumar, "Intelligent Grid Initiatives in India", Proc. Of 14th IEEE International Conference on Intelligent System Applications to Power Systems (ISAP), Kaoshiung, Taiwan, Nov 4th–9th, 2007.

14] J. P. Conti, "Let the grid do the thinking," IET Power Engineer, pp. 34– 37, April/May 2006.

[15] Balijepalli, V.S.K.M.; Khaparde, S.A.; Gupta, R.P.; , "Towards Indian Smart Grids" , Proc. Of TENCON 2009 - 2009 IEEE Region 10 Conference, vol., no., pp.1-7, 23-26 Jan. 2009.

[16] Technology Roadmap, Smart Grid, International EnergyAgency (IEA),http://www.iea.org/papers/2011/smartgrids_roadmap.pdf, pp. 6, 2011

[17] The Climate Group http://www.theclimategroup.org).

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