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Proposed Model for Energy and Cost Savings via Power System Automation in Bangalore, India

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Abstract - *Energy is a critical component of economic growth. The increased wealth that comes with economic development promotes demand for more and better energy services. A virtuous circle of improvements in energy infrastructure and economic growth has been established in several countries. The process, however, is just getting started in the rest of the world. Distributed power technologies have the ability to kick-start the virtuous cycle of energy development and economic development. Electrical energy is commonly recognised as a necessary component of human life. Energy is the primary driver of economic growth and is essential to the modern economy's survival. The long-term supply of energy from sources is critical for future economic growth. The terminology "power system" refers to a group of equipment that make up the physical systems that produce, transfer, and dispense electricity. The act of autonomously operating the power system via instrumentation and control devices is known as power-system automation. The Tesla Powerwall is based on the power system automation idea. In this paper, a case study of Tesla Powerwall being used in American homes was undertaken, which not only helped them save energy and money, but also stabilised the grid at peak load.*

***Key Words*: Energy forecast, Power system, Tesla Powerwall, Batteries, Peak to Off-peak Ratio, Time Based Control**

1.INTRODUCTION

The need for electrical energy in growing countries and most populated countries is enormous. But we know that production of electricity is done at one place and used at another place so transmission and distribution of electricity through large cables is necessary which leads to a huge energy loss. As the demand for energy is so high so need for minimizing energy loss is also at most important. The performance efficiency for electricity producing stations are enhanced by taking various steps. Energy conservation technology may reduce up to 40% of total losses in transmission and distribution systems. This technology also improves efficiency of electrical appliances at the end users.

There are astonishing progress from Indian power sector since independence. India has a total capacity of more than 2,10,000 MW in 2013 which was jus 1434 MW in 1945. Transmission lines are laid to every corner of the country earlier which was restricted to only urban and industrial spaces. But the exigency for electricity is never came down than the supply. To improve power sector there are various electricity corporation boards developed in India. namely power grid corporation limited (PGCL), National hydro-electric power corporation (NHPC), state electricity boards (SEB) etc. However, even after taking so many measures India is facing power shortage and also high demand in peak time at the rate of 11% and 8% respectively.

Fossil fuels like coal, oil that has taken years to form is on the verge of depleting soon. In last 200 years we have consumed 60% of all resources. For sustainable development we need to adopt energy efficiency measures. Today 85% of primary energy sources come from non-renewable and fossil sources. These reserves increasing consumption and will exist for future generations. Energy survey conducted revealed that there is requirement of improvement in energy generation efficiency, improvement in energy transportation (transmission & distribution systems) and enhancing the performance efficiency of use end apparatus.

1.1 Power System Automation

Power system automation simply means automating the controlling devices of a power system. Power system automation allows the devices to make intelligent decisions according to the real time data available from the sensors embedded in the system. The automation of the power system leads to automatic control of the power input to the system to maintain high efficiency and reliability depending on operational requirements. The automation of the power system has become even more complicated after major innovations in the field of computer hardware and software. The development of sensors, amplifiers, recorders, control devices, valves and measurement technologies have enabled measurement of many parameters which were not initially possible and other performance monitoring functions that provide a detailed picture of the system's condition in real time. Power system automation is slowly being implanted in products ranging from home appliances to power plants.

2. TESLA POWERWALL

Batteries! We are used to finding them in our cameras, cars toys and what not! But Elon musk has suggested that we put them in our homes. The Tesla Powerwall concept is fairly simple. Lowering the electricity cost by consuming less during the peak hours and more during off peak hours when it's cheaper and more ecologically friendly to generate it or even a better case scenario is when paired with solar panels, it reduces the home's reliance on city's power grid by generating electricity and in some cases giving back to the grid. Powerwall is an expensive product. But the truth of the matter is that, thanks to its features, there is no other

product in the market to compete with it. This advantage of the Powerwall comes from its power system automaton features which is integrated to the IoT platform using the Tesla app. So, for anyone who needs a backup solution for power outages would anyway choose the Powerwall because of its advantages compared to any other product available in the market.

Powerwall gives its users the ability to store energy for later use. It works in tandem with solar to provide energy and cost savings and other benefits. The Powerwall system comes with smart controls for the customization by the owner by using the Tesla app for energy monitoring and metering. The system learns from the energy use at home over time and adapts itself to the usage patterns. It can receive over-the-air updates that may add new features or enhance the existing features. Tesla Powerwall has an energy capacity of 13.5 kWh.

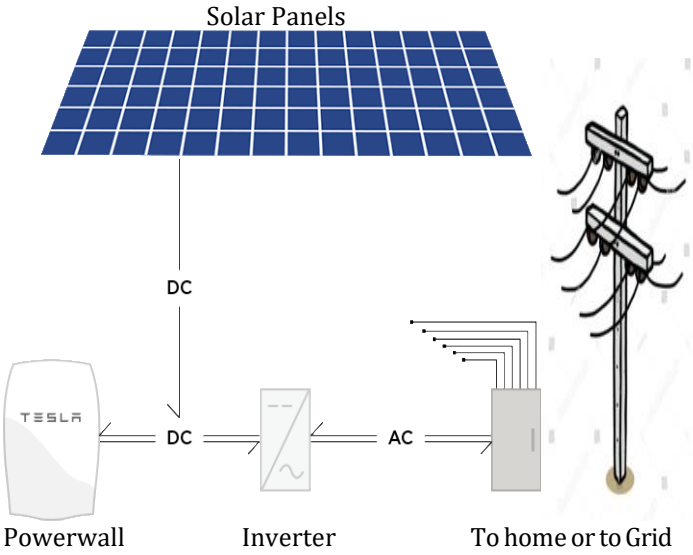

Fig -1: Working of Tesla Powerwall

2.1 Time based control

If the electricity rates vary during the day with respect to the consumer demand, it is called time-of-use plan. The electricity rates vary with respect to the time of the day, day of the week and the season. Utility companies that supply the electricity generally breaks their plan into two categories:
Peak: This refers to the high demand hours and hence has the highest rate.

Off-peak: This refers to the lowest demand hours in a day and hence has the lowest rates.

Time based control in the Tesla Powerwall intelligently decides when to charge and discharge thus by maximizing the cost savings.

2.2 Energy forecast

The tesla Powerwall is always learning the patterns of energy usage for the home and the seasonal solar production. Based on this data, Powerwall is always running an energy forecast. This energy forecast aids in optimizing the energy usage for the home. For example, the Powerwall prioritizes charging when the rates are low (off-peak) and discharging when the rates are high (peak), if the forecast shows that the home will be using energy from the grid at a high-cost time.

3. PROPOSED MODEL FOR BANGALORE, INDIA

In India, there is no product currently available in the market which works similarly to the tesla Powerwall. Hence a cost savings model is proposed here that can be a reality if the a company comes with a product similar to the Powerwall or even if tesla itself manufactures and sell the Powerwall in India. The model is based on the electricity consumption of a metro city in India, called as Bangalore also known as the silicon valley of India, with a population of 12 million.

A Bangalore household consumes around 255 kWh of electricity per month. Assuming there are 30 days each month, we can say each Bangalore household consumes approximately 8.5 kWh of electricity per day.

With the current average rate plan, followed by the Bangalore Electricity Supply company Limited (BESCOM), The cost of 255 kWh electricity will be = (30 kWh * 3.75) + (70 kWh * Rs. 5.2) + (100 kWh * Rs. 6.75) + (55 kWh * Rs. 7.8) = Rs. 1580.5

Assuming a peak to off peak ratio of 2; gives 2.8 kWh off peak and 5.6 kWh peak usage per day

To completely accommodate for the peak demand, we need at least a 6 kWh battery

Assigning peak rate of Rs. 8 per unit and off-peak rate of Rs. 3 per unit we get the total cost of electricity per day

= (2.8 kWh * Rs. 3) + (5.6 kWh * Rs. 8) = Rs. 53.2

Therefore, the total cost of electricity per month = 30 days * Rs. 53.2 = Rs. 1596

This model if implemented will have a cost savings of approximately Rs. 1596 for each household in Bangalore, India.

4. CONCLUSIONS

The proposed model does not takes into account possible maintenance costs like in the case of a battery failure. While this is covered under warranty for the five years, it would adversely affect the device's cost saving ability because the battery would be unusable while its being repaired or replaced. If a company can release a product with the necessary specifications, cost savings are possible for a household in Bangalore, India. The expected cost savings in electricity over a period of 5 years is Rs. 50,000 which

equates to an ROI within a period of 5 years as long as the cost of battery remains in the cost bracket of Rs. 40,000 to Rs. 50,000.

REFERENCES

[1]. Harshad V. Dange., Vamsi k. Gondi.: 'Powerline Communication Based Home Automation and Electricity Distribution System', IEEE Trans. Process Automation conf. 12189567 doi:10.1109/PACC.2011.5978900.

[2]. Veselin Skendzic., Armando Guzma.: 'Enhancing Power Systems Automation through the use of Real-Time Ethernet'. IEEE Trans., Power Systems conf.[2006], 9253127 doi;10.1109/PSAMP.2006.285416.

[3]. L. Pantoli., M. Muttillo., G. Ferri., V. Stornelli., T. Gabriele.: 'A Low Cost Flexible Power Line Communication System', L'Aquila, Italy[2017]. LNEE volume 431., doi:10.1007/978-3-319-55077-052.

[4]. K. S. Swarup., P. Uma Mahesh.: 'Computerized data acquisition for power system automation', IEEE Trans, Power India Conf. 8957110 doi:10.1109/POWERI.2006.1632484.

[5]. K. P. Wacks.: 'Utility load management using home automation', IEEE Trans., International Conference on Power Systems doi: 10.1109/30.79325., Volume: 37, Issue: 2 May 1991.

[6]. Shafik Ahmad.: 'Smart metering and home automation solutions for the next decade', IEEE Trans, ETNCC., 12121430, doi: 10.1109/ETNCC.2011.5958516, Udaipur, India.

[7]. J. Yao., S. Yang., Z. Gao., Z. Yang.: ' Development trend prospects of power dispatching automation system', Article [2007], Publication, 293353696.

[8]. J. Zhang., Z. Chen.: 'The impact of AMI on the future power system', Article[2010]., Publication on Researchgate dated January 2010, 298502548.

[9]. Sudhir Kumar., Jitendra Kurmi.: 'Scenario of Home Automation in India', Article[2020], Publication on Researchgate dated March 2010, 339643135 Volume 8, Issue 2010.

[10]. Deepti Agarwal., Sushmita Gupta., Sukirti Katheria., Bipin Kumar Verma.: 'A Review on Home Automation Using Smart Phone', Review Paper IJCSE., doi:10.26438/v7i5.219222., Volume 7, Issue 5, May 2019.

[11]. Satish Palaniappan., Naveen Hariharan., Naren T Kesh., Vidhyalakshmi S., Angel Deborah S.: 'Home Automation Systems - A Study', International Journal on Comp App., Volume 116-No.11, April 2015.

[12]. Satyendra K. Vishwakarma., Prashant Upadhyaya., Babita Kumari., Arun Kumar Mishra.: 'Smart Energy Efficient Home Automation System using IoT', IEEE Trans, 188690244., doi: 10.1109/IoT-SIU.2019.8777607.

[13]. Avirup Basu., Abhishek Nandy., Manisha Biswas., Raja NAnd Sharma., Risab Biswas.: 'Home Automation Using Energy Usage', IEEE Trans, WECON[2018], 18883313., doi:10.1109/WECON.2018.8782049.

[14]. Rizwan Majeed., Nurul Azma Abdullah., Imran Ashraf., Muhammad Faheem Mushtaq., Muhammad Umer.: 'An Intelligent, Secure, and Smart Home Automation System', Research Articlefrom Hindawi, Volume 2020, Article ID 4579291, 14pages.

[15]. Dhiren Tejani., Ali Mohammed A. H. Al-Kuwari., Vidyasagar Potdar.: 'Energy conservation in a smart home', IEEE Trans, DEST[2011], 12130999., doi:10.1109/DEST.2011.5936632. Daejeon, SouthKorea.

[16]. K. Rajagopal., Vaishali Mahajan., Subhasis Sen., Shishir Divkar.: 'Energy Efficient Smart Home Automation Adoption', IJITEE[2019], ISSN:2278-3075, Volume 8, Issue 11S, September 2019.

[17]. Sravan Kumar B., L. Ramesh.: 'Review and Key Challenges in Battery to Battery POwer Management System', IEEE Trans, International Conference CCUBEA[2019], 19733185., doi: 10.1109/ICCUBEA47591.2019.9129162. Pune. India.

[18]. Chul-Young Park., Seok-Hoon Hong., Su-Chang Lim., Jun-Ho Huh., Jong-Chan Kim.: 'Inverter Efficiency Analysis Model Based on Solar Power Estimation Using Solar Radiation', Article Review Paper., Published on 1st October 2020.

[19]. R. M. Ferreira., N. Janse Van Rensburg., A. L. Nel,: 'A Study into the efficiency of embedded solar photovoltaic cells in double roman shaped roof tiles', IEEE Trans, ICREGA[2018], 17703475, doi: 10.1109/ICREGA.2018.8337608.

[20]. Liang Chu., Feikun Zhou., Jianhua Guo.: 'Investigation of Cycle life of li-ion power battery pack based on LV-SVM', IEEE Trans, MEC[September 2011], 12339697., doi: 10.1109/MEC.2011.6025783. Jilin. China.

[21]. Cong Truong., Maik Naumann., Ralph Karl., Marcus Muller., Holger Hesse., Andreas Jossen,: 'Economics of Residential Photovoltaic Battery Systems in Germany: The case of Tesla powerwall', Article published on 2016, Volume 2, Issue 2.

[22]. Peter Stenzel., Nils Heyermann., Maren Wenzel., Peter Markewitz., Martin Robinius., Klaus Gorner,: 'A Techno-Economic Analysis of Battery Energy Storage Systems in Combination with Micro CHP Systems for Single-Family Houses', IRES[2019], Volume 4, Issue 5, 2019.