Power Factor Monitoring and Load Management Using Smart Metering Techniques

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Abstract

The world has experienced a rapid increase in the load during last decade. Power Systems have been interconnected to enhance the capability of the system to deal with the ever increasing demand of the load. Another burning issue is the worst effect of this high load demand on the Power Quality of the system. Inductive loads affect the Power Factor and Uninterruptable Power Supplies (UPS) also acts as Load on our Power System not only unavailability of the Power Demand but also affecting the systems working efficiency. The project deals with the Monitoring of Load and Power Factor, it also encompasses the interfacing of solar energy to provide backup in case of absence of main supply. By incorporating Smart Meter Techniques Capacitor Bank would also be employed for Power Factor improvement.

1. Introduction

The thesis is based on Smart Meter techniques [1], which deals with the monitoring of load and power factor issues. It also includes the interfacing of solar energy to provide backup in case of absence of main supply and transmit data to the location specified and Capacitor banks are used for the improvement of Power Factor. Basically this project is related to solve the power generation issues in Pakistan. And the purpose to explore this issue is to compete with the energy crises of Pakistan. The task in this project is totally to propose an efficient system of power utilization and monitoring by making the combination of different electrical and electronics techniques, so that system would be able to supervise the Electricity usage. [2]

Pakistan's power system suffered from severe short-fall from early 2000 to date due to the exponential increase in the load; especially in commercial sector. The lack of planning and wrong investment in power sector has resulted in increased short-fall. This shortage in generation capacity is still faced by Pakistan.

2. Problems Faced by the Power System of Pakistan

Problems Currently Being Faced In the Power System:

- Power Losses Due To far away Power Generation
- Power Theft
- Low Power Factor
- Increasing Fuel Cost
- Depletion of Natural Resources
- Poor Power Quality

One of the options that are currently available is to improve the way; the Power is being utilized in our domestic system. For this purpose we can use Static Capacitors at our domestic level so that the power can be more efficiently used.

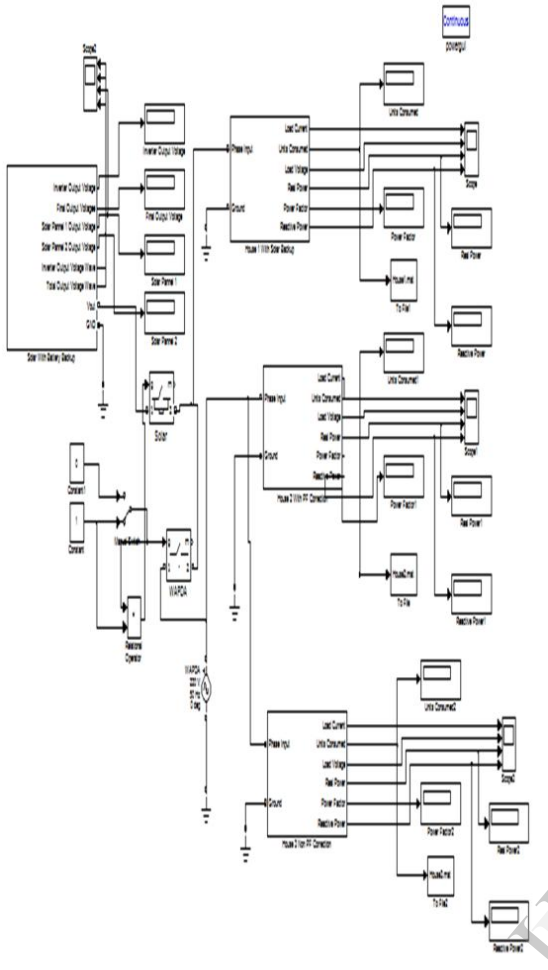
Another option is to use Renewable Energy Resources (Solar Energy) to provide back-up in the absence of electricity from WAPDA. So that the UPS does not act as load on our Power System.

3. Objective

The principle objective of the proposed study is to improve the power factor of the domestic consumers in Pakistan as they constitute the major portion of the electricity consumers in our country. Then the system will be integrated with a Solar panel to charge the battery which will provide back-up when power from the supplier is not available or the voltage variation is out of limits.

Broadly speaking the objective of such a system is to improve the utilization of power and try to devise a system that is free from theft and unwanted loading.

4.Simulation



5. Working

Simulink model of analytical model of Smart Metering System consists of three model houses House 1 with solar backup provides energy consumption for the house in the absence of WAPDA supply.

The other two houses give comparative analysis of Power Factor Correction.

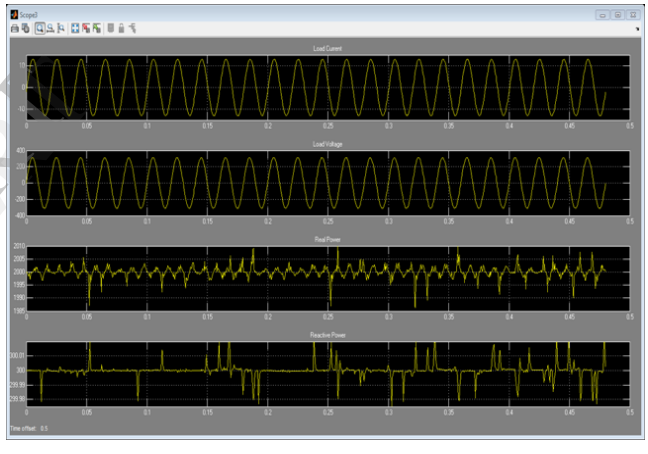
House 3 is with no power factor correction and it is also shown by the waveforms of active and reactive power that energy supplied to that block suffers more losses and voltage regulation as the system is not in a very efficient working state.

This ultimately also effects the overall power consumption as reactive power loss due to inductive load on the system is not compensated. House 2 is the model which is provided with the power factor correction mechanism. Waveforms of Active and Reactive powers for house 2 also depicts that the system suffers much less fluctuation in power consumption and is smooth as reactive power compensation is provided to the system.

The voltages in case of House 2 are also much more stable and in the range of WAPDA supply. If the systems under goes any change in load the PFC mechanism works accordingly to bring the voltages and power factor to the prescribed range.

The overall working capacity of the system also improves which is shown in the voltages supplied by the supplier as shown in the voltmeter given at the start of the model. This is because the system working conditions are improved and for the same load applied system is having compensation of lost Reactive Power.

6. Results of the Simulation



The figures give comparative analysis of Power Factor Correction.

House 3 is with no power factor correction and it is also shown by the waveforms of active and reactive power that energy supplied to that block suffers more losses and voltage regulation as the system is not in a very efficient working state.

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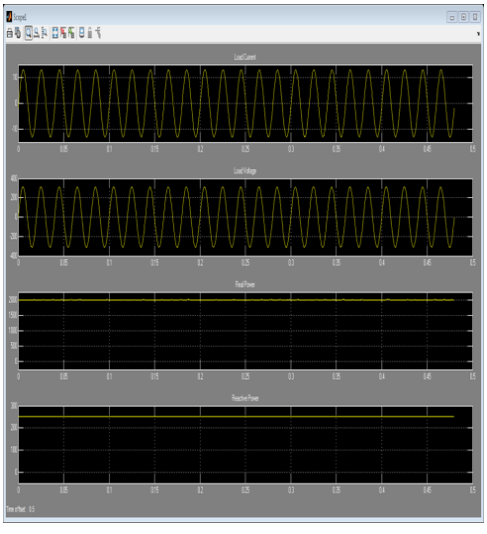
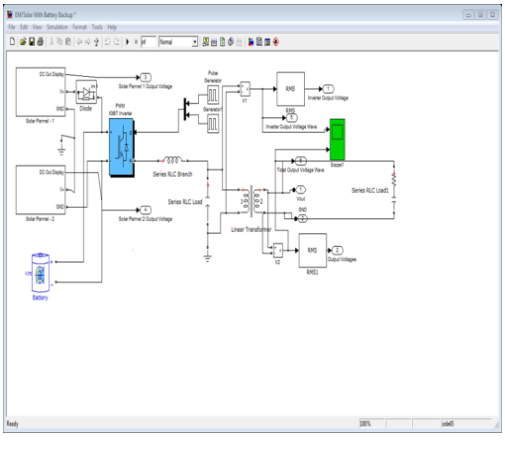


7. Solar Interface



Simulink model of analytical model of Smart Metering System consists of three model houses House 1 with solar backup provides energy consumption for the house in the absence of WAPDA supply.

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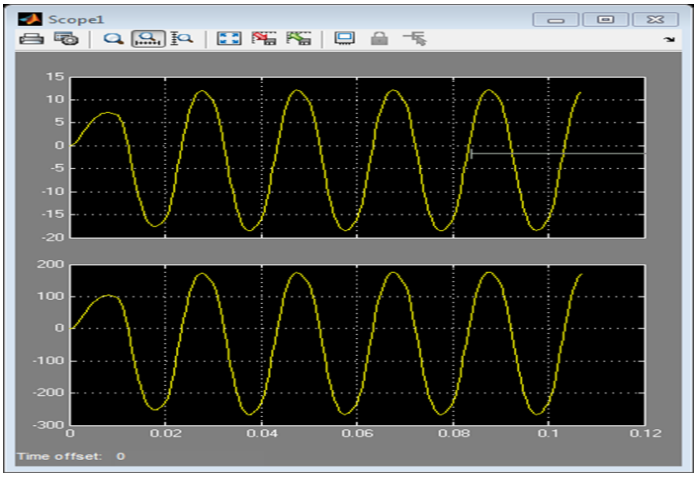

8. Conclusion

Simulink model of analytical model of Smart Metering System is presented in this thesis. By giving the site assessment parameters the authority will be able to monitor the Power Factor of a Domestic Consumer and at the same time a comparative result can be obtained of the System having Solar Energy as back-up source (for the charging of battery through a converter) and System without Solar source.

It is observed from the work that consumption of Electricity becomes much more efficient by using techniques of Power Factor Monitoring and applying Capacitors for the Correction of Power Factor. Slight change in the System parametric quantities like, Active Power and Reactive Power [45] [46] results in a change in Power Factor, which is then picked and altered in accordance of the equations applied for the calculation of Power Factor [47].

Incorporating the solution suggested we can improve the Power Factor without have to enhance our KVA capacity [48]. Simulink model of a Power System is presented with three houses under observation having Solar Energy as back-up source in case of absence of Electricity; house having Power Factor correction mechanism and house without any of the correction or alternation.

The Simulink model also shows the voltages and waveform for the existing system component and the portion of the system with the Power Factor Improvement scheme. The overall increase in the Total system voltage and improvement in the wave quality are also depicted. Similarly the voltages and waveform of having Solar Energy as back-up

source (for the charging of battery through a converter).

The consumer having employed techniques (Power Factor Correction and Solar Energy for the charging of battery through a converter) of efficient consumption shows a much better usage of the supply at disposal. Thus, saving Electricity from wastage as every electricity unit saved is equal to an electricity unit generated.

9. References

[1] "Smart Metering Technology", 11/09/2013.

http://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf

[2] "Consumption of Electrical Energy", 13/09/2013.

http://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf

[3] Equation 11.25, Chapter 11, J. David Irwin and R. Mark Nelms, "Engineering Circuit Analysis", 10th edition

[4] Equation 11.28, Chapter 11, J. David Irwin and R. Mark Nelms, "Engineering Circuit Analysis", 10th edition

[5] Chapter 11, J. David Irwin and R. Mark Nelms, "Engineering Circuit Analysis", 10th edition

[6] Article 6.10, Chapter No. 6, V.K. Mehta and Rohit Mehta, "Principles of Power System", First Multicolor Illustrative Edition.