# AN EFFECTIVE SOLUTION FOR MONITORING AND OPTIMIZING ENERGY UTILIZATION FOR SMART GRID

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## *Abstract*

***India's century-old electrical grids brought the nation inexpensive, abundant power and changed the way the country worked filling homes, streets, businesses, towns and cities with energy. What they also did was pay little regard to the environment. Unidirectional by nature, the grids were designed to distribute power, not to manage a dynamic global network of energy supply and demand. The result is, today India's grids account for some of the highest transmission and distribution losses in the world, at around 27%. This inadequacy could possibly become an obstacle to the country's progress in the years to come. Regardless, a report earlier this year on the top 10 smart grid countries by the research firm Innovation Observatory ranked India No. 3 behind the U.S. and China. Smart grid refers to an improved electricity supply chain using digital technology. It enables monitoring, analysis, control and two-way communication between the electrical delivery system and the consumer end. Smart grids use sensors, digital meters and controls and analytical tools to automate, monitor and control flow of energy and hence provide detailed and timely information on energy consumption. In this paper the proposed system with effective solutions for multiple problems faced by India's electricity distribution system such as varying voltage levels experienced due to the varying electrical consumption, power theft, manual billing system, and transmission line fault for single phase electricity distribution system also various techniques used for the energy optimization along with the consumption scheduling algorithm using linear programming method are mentioned***

***Keywords: Smart grid, Optimization, Simplex algorithm.***

## I.INTRODUCTION

### A. Definition of Smart Grid

A smart grid is a digitally enabled electrical grid that gathers, distributes, and acts on information about the behavior of all participants (suppliers and consumers) in order to improve the efficiency of electricity services or it is a technique used to increase the connectivity, automation and coordination between the suppliers, consumers and networks that perform either long distance transmission or distribution. The objectives of smart grid are: fully satisfy customer requirements for electrical power, optimize resources allocation, ensure the security, reliability and economic of power supply, satisfy environment protection constraints, guarantee power quality and adapt to power market development. Smart grid can provide customer with reliable, economical, clean and interactive power supply and value added services.

### B. Comparison of Smart Grid with Existing grid:

Smart grid has many advantages as compared with existing grid some of the advantages and the comparison with the existing grid is given in Table 1

| Existing Grid | Smart Grid |
|---|---|
| Electromechanical | Digital |
| One-way communication | Two-way communication |
| Centralized generation | Distributed generation |
| Few sensors | Sensors throughout |
| Manual monitoring | Self-monitoring |
| Manual restoration | Self-healing |
| Limited control | Pervasive control |
| Few customer choices | Many customer choices |

Table 1 Smart Grid compared with Existing Grids

The proposed system with effective solutions for multiple problems faced by India's electricity distribution system such as varying voltage levels experienced due to the varying electrical consumption, power theft, manual billing system, and transmission line fault for single phase electricity distribution system also various techniques used for the energy optimization along with the detail mathematical model

of consumption scheduling algorithm using linear programming method are mentioned.

This paper is organized as follows: Section II describes the related work of smart grid. Section III describes the block diagram of system. In section IV the details of optimization algorithm mentioned. Section V describes conclusion and future scope and Section VI describes the references.

## II. RELATED WORK

Oncor electric delivery smart grid Initiative 2009 Byron Reid [12]: In this paper the system which replaces existing meters with smart meters, development of the program automatically retrieve and evaluate fault records from micro-processor based relays. It also provides an secure reliable and cost effective communication system.

Smart grid design for efficient and flexible power networks operation and control 2009

In this paper the method for the development of dynamic stochastic optimal power flow(DSOPF) technology as a tool needed in smart grid design as a tool needed in smart grid design.Also the meaning or definition of smart grid & characteristics are also given.

The path of the smart grid .Hassan Farhangi [2010]

In this paper the evaluation of tomorrow's technology ,smart grid drivers ,comparision of smart grid with existing grids,evaluation of smart grid ,smart grid pyramid alongwith smart grid transition and standards is given.

Building a new smarter smart grid through better renewable energy information . cameronw potter [2009]

The method of renewable energy (weather driven,non scheduled sources) integration using a smart grid is mentioned and how the access renewable energy in a smart grid ,forecasting renewable energy in a smart grid is also mentioned . Also variability patterns must also be understood in terms of short term behaviour(Daily ,Monthly Or Yearly )

An integer Linear programming based optimization for home demand side management in smart grid.[2011]

This paper gives an idea to minimize the peak hourly load in order to achieve an optimal (balanced) daily load schedule, which is able to schedule both the optimal power and the optimal operation time for power shift able appliances respectively. The optimization is based on linear programming.

Autonomous demand side mamagement based on Game – Theroretic energy consumption scheduling for the further smart grid[2010][10].

In this paper an autonomous demand side management system based on game theory is given for distributed demand side energy management system.Also the game theory alongwith the distributed algorithm along with the method to minimize peak to average ratio.

ICT reference architecture design based on requirements for future energy market places[2010][4]

In this paper an architecture for offering a set of extensibility points to existing solutions for increased flexibility in moving energy market , it is based on the idea for open energy market places in regional power distribution networks, enabling load management and transfer security management along with the requirements of the ICT is also given.

Architecture and communication of an electric vehicle virtual power plant [2010]

In this paper an system for an electric (EV) based vehicle to grid(V2G) integrating virtual power plant (VPP),based on the trip prediction algorithm and associated optimization problems along with the trip forecasting, communication infrastructure requirements, session initiation protocol is also given in the paper.

Demand responce and distribution grid operations : opportunities and challenges [2010][11]

In this paper changing the business process of demand response scheduling and implementation by integrating demand response with distribution grid topology , comparison of the existing DR scheduling with proposed DR scheduling is given.

Opportunities and challenges of wireless sensor networks in smart grid[2010][5]

In this paper an overview of the application of WSNs for electric power systems environment is given also an link quality measurements and experimental setup mentioned with Tmote sky modes to obtain the solution of the many problems.

Taking demand side response to the next level[2010]

In this paper how the utilities are changing right now and do the smart grid ,information and communication technology affect Demand Response(DR) also the policies and regulatory processes for it are mentioned.How United States will position in global market in future is given.

Smart transmission grid applications and their supporting infrastructure. Anjan Bose[2010][6].

In this paper an application and supporting infrastructure of an smart transmission grid is given. The structure is real time alongwith the substation information architecture also the applications and transition to the new architecture of the proposed systems are given.

End to End communication architecture for smart grid.[2011][3]

In this paper a problem of network integration ,a combination of gateway and tunnelling solutions is proposed which allows end to end connection between application servers and field nodes ,the requirements for the communication systems ,network topologies , communication architecture and how to achieve an end to end communication alongwith the technique of message rating and delivery.

Smart meters for power grid-challenges ,Issues, Advantages and status[2011]

In this paper various features and technologies that can be integrated, with a smart meter alongwith several applications, advantages, comparisons of conventional energy meters with smart meters is given.

A Dynamically reconfigurable architecture for smart grid[2011]

In this paper an smart grid management platform built on the distributed programming paradigm is proposed which is based on information model. The proposed system can be used for controlling and measuring the electrical power consumption for large scale and heterogeneous infrastructure. Reconfigurable platform for power management ,communication middleware Embedded meter devices, deployment and configuration in particular scenario is also given in the paper.

The development of a smart distribution grid testbed for integrated information management systems(I2MS's). It provides a modelling environment with sufficient dada sources for the I2MS design. Also the power system dada flow modeling along with the threshold setting is given.

New challenges to power system planning and operation of smart grid development in china[2010]

In this paper the main research contents ,detailed implementation plan and anticipated goals of 9 key technologies ,development of smart grid in china also new challenges to power system planning are mentioned in the paper.

Smart grid initiative for power distribution utility in India [2011]

In this paper an survey is given about recent developments in Indian grid, need for design of Indian grid in line with US , financial health of the Indian grid , also the main driver for smart grid initiative in India also the methodology for smart grid project implementation in India & challenges for smart grid project implementation in India.

Analysis of smart grid security standards [2011]

In this paper an analysis of smart grid security standards & security classified protection standards along with some security topologies is mentioned.

Investment benefit analysis & evaluation model of smart grid [2010]

In this paper an investment benefit analysis of the smart grid along with an cost effectiveness model of smart grid is given for this particular analysis some measuring parameters are considered.

Proof-of-concept of smart fault current controller with a super conducting coil for the smart grid [2010][2]

Fault current controller (FCC) named "Smart FCC",it consists of an superconducting coil with a freewheeling diode if necessary. In this paper concept of smart FCC along with operation principle for the simulation a commercialized circuit simulator , CASPOC2003 was used. The results are compared with variations in delay angle & peak fault current [KA] changes.

## III. BLOCK DIAGRAM AND DESCRIPTION

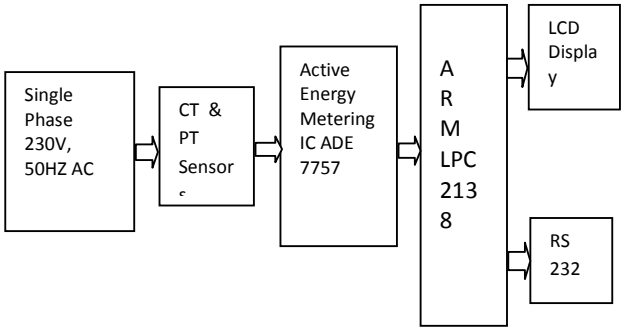


Fig 1. Block Diagram For monitoring of Energy Utilization

Initially the 230 V 50 Hz supply is given to the circuit

1.CT & PT Sensors:

Current Transformer sensor is step down transformer (5A :50mA) and Potential Transformer sensor is also a step down transformer( 230V: 9V).

2.Active Energy Metering IC ADE 7757:

The ADE7757 is a high accuracy electrical energy measurement IC. It is a pin reduction version of the ADE7755 with an enhancement of a precise oscillator circuit that serves as a clock source to the chip. The ADE7757 supplies average real power information on the low frequency outputs F1 and F2. These outputs may be used to directly drive an electromechanical counter or interface with an MCU. The high frequency CF logic output, ideal for calibration purposes, provides instantaneous real power information.

3.ARM 7(LPC 2138):

The LPC2131/32/34/36/38 microcontrollers are based on a 16/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with 32 kB, 64 kB, 128 kB, 256 kB and 512 kB of embedded high-speed flash memory. A 128-bit wide memory interface and a unique accelerator architecture enable 32-bit code execution at maximum clock rate. Due to their tiny size and low power consumption, these microcontrollers are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. With a wide range of serial communications interfaces and on-chip SRAM options of 8 kB, 16 kB, and 32 kB, they are very well suited for communication gateways and protocol converters, soft modems, voice recognition and low-end imaging, providing both large buffer size and high processing power.

1. LCD Display:

Available Modules:-

Based on Alphanumeric Displays

- 16×2 ( “16” Represents Columns & “2” Represents Rows )
- 16×1
- 16×4
- 20×2

For system 16×1 is used.

2. RS 232:

DS232A Dual RS-232 Transmitter/Receiver is used with the following features:

a. High data rate - 250 kbits/sec under load
b. 16-pin DIP or SOIC package
c. 20-pin TSSOP package for height restricted applications
d. Operate from single +5V power
e. Meets all EIA-232E and V0.28 specifications
f. Uses small capacitors: 0.1 μF
g. Optional industrial temperature range

## IV.OPTIMIZATION ALGORITHM

The focus of the work in this paper is on power consumption scheduling known as demand-side management. The optimization technique is proposed to schedule the power of individual appliances centralized optimization based on linear programming[1].The consumption scheduling optimization mainly carried out for the home appliances which does not have the fixed power consumption like washing machine or water boiler. Optimization mean is to optimize is to make as perfect effective and functional as possible. The technology optimization is a set of methods and techniques for the design and use of technical systems as fully as possible within the parameters. Engineers and scientists use mathematical modeling to describe the behavior of systems under study. This mathematical program, or optimization problem description, can then be solved using optimization techniques. Linear programming is one class of mathematical programs where the objective and constraints consist of linear relationships. Linear programming problems consist of a linear expression for the objective function and this technique is widely used. There are three types of optimization algorithms. The interior point algorithm used for solving linear programming problems. Interior point is especially useful for large-scale problems can be defined using complex matrices. The active-set algorithm minimizes the objective at each iteration over the active set until it reaches a solution and it is used for small scale problems. The simplex algorithm is a systematic procedure for generating and testing a linear program. The simplex algorithm is the most widely used algorithm for linear programming. The advantages of the simplex algorithm are Simple and easy to implement. It can be used to tackle problems in which there are more than two decision variables. It is a method that can be programmed on a computer fairly and easily.

Implementation of simplex algorithm: Implementation is possible with the help of MATLAB which is a high-performance language used for technical computing. Typical uses include : Math and computation Algorithm development, data acquisition Modeling, simulation, and prototyping Data analysis, exploration, and visualization. Scientific and engineering graphics Application development, including graphical user interface building. Linear Programming Strategies Using the Simplex Method

- Identify the problem
- Formulate the problem using LP
- Solve the problem using LP
- Test the model (correlation and sensitivity analysis)
- Establish controls over the model
- Implementation
- Model re-evaluation

## V CONCLUSION AND FUTURE SCOPE

The proposed system will provide an effective solution for some of the main problems faced by Indian Electricity distribution system like line fault and power theft along with optimizing energy utilization by using an simplex optimization algorithm which is simple and easy to implement. It will reduce the energy wastage and save a lot of energy ,that can be returned back to the grid.The system may able to schedule optimal power and operation time according to user preference and the power consumption pattern. In future it is possible to implement the system for three phase electric distribution system and multiple users to achieve co-operative scheduling in India. Using this proposed system it is possible to save a lot of energy for future use.

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