SMART METERING FOR DEMAND MANAGEMENT AND ENERGY CONSERVATION

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate has carried out research for the Masters under my supervision.

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Prof. S.P. Kumarawadu

Signature of the supervisor: Date:

Dr. D. P. Chandima

To my

Parents

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ABSTRACT

This research study focuses on demand management and energy conservation through smart metering. The discussion here is based study on smart metering and implementation of new methodologies to promote energy conservation via two way interaction. Smart metering, a key element of the so-called smart grid, has been touted as a great bright hope that will enable residential and industrial electric customers to cut their usage, thereby reducing greenhouse gases as well as their monthly bills. Smart meters are still evolving and many developers try to add new features to provide more interaction between the consumer and the supply authority.

Improved measurement technology by displaying all per phase information and three phase information on LCD at the meter side, automatic meter reading, power quality and exported energy measuring capability are the main features of the implementation. Electricity demand forecasting for 15 minutes, maximum demand warning for industrial consumers, energy and cost forecasting for better energy conservation are the originality of this research.

The digital meter was developed using ADE7758 energy measuring chip and 18F452 PIC microcontroller. The data are sent to a remote server via SMS using SIM900 GSM module.PCF 8583 real time clock IC was used to read the time and generate alarm signals. The phase information, frequency, active energy, exported energy, power quality measurements, electrical demand, date and time are sent to the server. The server handles the incoming SMS, processes the data, displays and stores the required information. Energy consumption and its cost, average daily energy consumption and cost prediction for the month are calculated in the server side.

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The demand forecasting algorithm is developed for industrial smart metering applications. Electricity demand within 15 minutes is forecasted by analyzing demand pattern. The warning signal is generated when the demand is higher than the user specified value. Therefore if there is a sudden increase in demand this methodology helps to identify and warn the consumer via SMS. The expected demand within 15 minutes, percentage value of the expected demand as a ratio to user specified demand and remaining time to reach the demand are calculated and sent to the consumer to take any actions to drop down the demand. This warning signal will be beneficial to the industrial consumers who are interested in save on maximum demand charge through proper load management.

Keywords: smart metering, demand management, energy conservation, three phases, automatic meter reading, remote server, electricity and cost forecasting, demand forecasting, maximum demand warning, Industrial consumers

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LIST OF ABBREVIATIONS

Abbreviation	Description
A	Ampere
AT	Asynchronous Terminal
CEB	Ceylon Electricity board
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
hrs	Hours
Hz	Hertz
I2C	Inter-Integrated Circuit
kVA	kilo Volt Ampere
kVAh	kilo Volt Ampere hour
kVAmin	kilo Volt Ampere minutes
kvarh	kilo var hour
kW	kilo Watt
kWh	kilo Watt hour
LCD	Liquid Crystal Display
LKR	Sri Lanka Rupees
min	Minutes
MCU	Micro Controller Unit
MOV	Metal Oxide Varistor
MV	Medium Voltage
P.F	Power Factor
RMS	Root Mean Square
RTC	Real Time clock
SMS	Short Message Service
SPI	Serial Peripheral Interface
TOU	Time of Use
V	Volt
W	Watt

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