ERROR CORRECTION FOR TEBA APPLICATION IN A BUILDING MANAGEMENT SYSTEM

Janaka Gunatilake

(8311)

Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

January 2012

ERROR CORRECTION FOR TEBA APPLICATION IN A BUILDING MANAGEMENT SYSTEM

Janaka Gunatilake

(8311)

Thesis submitted in partial fulfillment of the requirements for the degree Master of Science

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

January 2012

DECLARATION

I declare that this is my own work and this thesis/dissertation 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.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

The above candidate has carried out research for the Masters/MPhil/PhD thesis/ Dissertation under my supervision.

Signature of the supervisor: Date

ACKNOWLEDGEMENT

I wish to acknowledgement and express my sincere thanks to my supervisor Dr.K.T.M.U Hemapala for the technical support and advise he gave me to work on a research having a greater opportunity to development which in the Building Automation Industry of Sri Lanka. I am also grateful to Prof. Lanka Udawaththa and all other members of Department of Electrical Engineering, University of Moratuwa for the support given to me from the beginning of Electrical Installation Msc Class.

I would also like to thank all reviewers who attended in the progress review presentation for giving me their valuable comments and guidance.

Without the help and support given by Staff of Energy Management Systems (Pvt) Ltd, I would not have been to able to complete this research project in time and I am very thankful to them for their support.

Finally I wish to thank my parents and my wife for unwavering and resolute support given while this dissertation is being prepared.

ABSTRACT

Every increase in the unit cost of Energy just magnifies the importance of conserving energy and can't accomplish that without tracking its use. More than ever, sub-metering is being applied in industrial as well as the traditional commercial and residential applications to encourage conservation and increase productivity. Smart Energy monitoring & Billing is new concept in the word and near future need the requirement & regulations for the smart Energy Billing for smart Building Owner and Tenant Energy User.

Smart Energy monitoring & Billing is new concept for Sri Lanka and near future need the requirement & regulations for the smart Energy Billing. In Present many of the countries in the word are decided to intended regulations for commercial building & other energy consumers in their country.

Although sub-metering can be used to perform most critical functions such as equipment monitoring, trending, alarming, predicative maintenance, communication, and power quality analysis. This research will concentrate on Tenant billing of the Energy.

Cooling Energy billing is one of the particular areas of the energy billing in commercial building sector Including Electrical Energy Usage, Cooling Energy Generation, and Cooling Energy Distribution & Tenant Side Air Handling Unit Energy Consumptions.

The thesis is based for identification of existing billing method for cooling Energy billing and introduced new strategy for chilled water cooling energy billing system. Using existing building energy billing system one month period real time energy data and mathematically functions analyzed new algorithm for error correction. In this error correction algorithm introduced estimation method for cooling energy loss & stored energy in the chilled water piping System. The data simulation for the new method the existing energy billing error reduced around 50% of existing real time energy billing system. That strategy application of chilled water energy billing system be more smart Billing for tenant & building owner.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

LIST OF ABBREVIATIONS

Abbreviation	Description
A	Ampere
AC	Alternative Current
AC	Air Conditioning
AHU	Air Handling Unit
AMR	Automated Meter Reading
BAS	Building Automation System
BMS	Building Management System
BTU	British Thermal Unit
CDD	Cooling Degree Day
CPP	Cost per person
CT	Current Transformer
DC	Direct Current
DCS	District Cooling System
DDC	Direct Digital Controller
E	Total Electrical Energy Input to the Central AC Plant
EBI	Enterprises Building Integrator
EIS	Energy Information System
E_r	Total electrical energy input to the AC Plant in *kWh.*
e_r	Total electrical energy input to the AC Plant in *kWh*
HDD	Heating Degree Day
IP	Internet Protocol
IT	Information Technology
kWh	Kilo Watt Hour
LAN	Local Area Network
m/s	Meters per second
mA	Mille Ampere
MF	Maintenance Factor

Q_b	Balanced Cooling Energy in the System
Q_h	Heat flow rate in *kW*
Q_i	i^{th} AHU Consumed Energy
Q_p	Chiller Generated Cooling Energy
Q_r	Total Cooling load for AC Plant (Zone 1 & 2) only for time t in *kW.*
Q_S	Stored Cooling Energy of the System
Q_T	Total refrigererent tons generated at the AC plant
Q_t	Total refrigererent tons used by tenant AHU
R	Rate of change for Electricity *Rs/kWh.*
RF	Radio frequency
RTU	Remote Terminal Units
SCADA	Supervisory Control and Data Acquisition
SQL	structured query language
SS	Stainless Steel
TCP	Transmission Control Protocol
TEBA	Tenant Energy Billing Application
$\boldsymbol{TEB_t}$	Tenant Energy Bill
VA	Volt Ampere
WAN	Wide Area Network

LIST OF APPENDICES