

# **ERROR CORRECTION FOR TEBA APPLICATION IN A BUILDING MANAGEMENT SYSTEM**

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University of Moratuwa, Sri Lanka.  
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Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa  
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January 2012

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

Department of Electrical Engineering

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## DECLARATION

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Dissertation under my supervision.

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Date

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## ABSTRACT

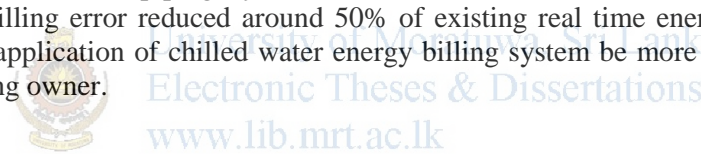
Every increase in the unit cost of Energy just magnifies the importance of conserving energy and can't accomplish that without tracking its use. More than ever, sub-metering is being applied in industrial as well as the traditional commercial and residential applications to encourage conservation and 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.



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## 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 <i>kWh</i> .
$e_r$	Total electrical energy input to the AC Plant in <i>kWh</i>
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 $kW$
$Q_i$	$i^{\text{th}}$ 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
<b><math>TEB_t</math></b>	Tenant Energy Bill
VA	Volt Ampere
WAN	Wide Area Network

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