THE DESIGN AND KEY FEATURES OF AN ENERGY EFFICIENT PETROL STATION - TOWARDS ACHIEVING AN AEMAS EMGS STAR RATING

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ABSTRACT

Malaysia has taken several approaches to address the impact from climate change. One of the key approaches is via setup of Energy Management Gold Standard (EMGS) certification system. EMGS provides excellence in energy management system particularly on infrastructure that consumes a lot of energy. Petrol Stations being one of such infrastructures, generally consumes a lot of electricity. Although, this type facility is not focused nor implemented with any Power Quality and Energy Efficiency improvement as well as Sustainable Energy Management Systems (SEMS). In addition, there has never been a PETROL station being awarded with AEMAS EMGS certification. Thus, the research purpose is to study and investigate the design features of an energy efficient petrol station to meet the relevant standards and AEMAS EMGS requirement. The scope is to cover a typical petrol station with a grid connection at 0.415kV. This research proposed ten (10) steps towards improving the power quality, energy efficiency and energy management system of a petrol station. The results were able to outline several design features that could qualify a Petrol station to be an energy efficient petrol station. The project has also established a new formulation and integrate three main core topics of Power Quality, Energy Efficiency and Energy Management system towards ensuring sustainable energy savings via structured approach, towards energy efficiency improvement. This project outcome is hoped to instigate effort towards establishment and pursuance of petrol station with reputable AEMAS EMGS certification, and at the same time reduce the GHG emission, sustain energy efficiency improvement and secure savings of electricity bills expenses.

ABSTRAK

Malaysia telah mengambil beberapa langkah dalam mengatasi isu perubahan cuaca. Salah satu nya adalah melalui program pensijilan 'Energy Management Gold Standard (EMGS)'. EMGS dapat membawa kecekapan dalam sistem pengurusan tenaga, terutamanya kepada infrasrtuktur yang banyak menggunakan tenaga. Stesen minyak yang merupakan salah satu daripada fasiliti terbabit tidak pernah mengambil langkah penambah baikan kualiti dan kecekapan tenaga atau sebarang sistem pengurusan tenaga. Juga, tiada stesen minyak yang pernah dianugerahkan dengan pensijilan AEMAS EMGS. Jadi, kajian ini dijalankan dengan tujun untuk melahirkan rekabentuk teknikal dan spesifikasi stesen minyak demi memenuhi standard dan kriteria AEMAS EMGS. Skop kajian ini merangkumi stesen minyak dengan tenaga elektrik dari utiliti pada bekalan kuasa voltan rendah 0.415 kV. Kajian ini telah menggariskan sepuluh (10) langkah yang boleh dilaksanakan bagi memperbaiki kualiti kuasa, kecekapan tenaga serta mewujudkan sistem pengurusan tenaga yang mampan. Hasil kajian telah berjaya menggariskan beberapa ciri-ciri rekabentuk klasifikasi yang dapat memenuhi kehendak stesyen minyak yang cekap tenaga. Projek juga telah mencadangkan sebuah formula bagi mengintegrasikan tiga teras utama seperti Kualiti Kuasa, Kecekapan Tenaga serta kaedah pengurusan tenaga lestari bagi menjamin penjimatan tenaga yang berkekalan. Hasil daripada projek ini diharap dapat membawa perubahan kepada stesen minyak ke arah kecekapan tenaga melalui sistem pengurusan tenaga yang mampan. Ianya juga diharap dapat melayakkan stesen minyak dengan pensijilan AEMAS EMGS, juga dapat mengurangkan pelepasan GHG, mengekalkan kecekapan tenaga serta memberi penjimatan bil elektrik.

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AC	-	Alternating Current
ACA	-	Air-Conditioned Area
ACE	-	ASEAN Centre of Energy
ACI	-	Annual Cost Indicator
AEMAS	-	ASEAN Energy Management Scheme
AHU	-	Air Humidifier Unit
ATM	-	Automated Teller Machine
ATS	-	Automatic Transfer Switch
BEI	-	Baseline Energy Index
BS	-	Bonus Strategy
CEM	-	Certified Energy Manager
DB	-	Distribution Board
DSTATCOM	-	Distribution Static Compensator
EDG	-	Emergency Diesel Engine Generator
EAC	-	Energy Accounting Centre
EE	-	Energy Efficiency
EM	-	Energy Management
EMGS	-	Energy Management Gold Standard
EMI	-	Electromagnetic Interference
EMS / EnMS	-	Energy Management System
EnPI	-	Energy Performance Indicator
ESC	-	Energy Steering Committee
ETI	-	Energy Transition Index
EV	-	Electric Vehicle
GAMS	-	General Algebraic Modelling System
GDP	-	Gross Domestic Product
GFA	-	Gross Floor Area
GHG	-	Green House Gas
GITE	-	Green Technology Investment Tax Exemption

GTFS	-	Green Technology Financing Scheme
GTMP	-	Green Technology Master Plan
HVAC	-	Heating, Ventilating, and Air Conditioning
IEC	-	International Electrotechnical Commission
IEEE	-	Institute of Electrical and Electronics Engineer
II	-	Initial Installation
ISO	-	International Standard Organization
JPC	-	Joint Project Committee
KASA	-	Kementerian Air dan Sumber Asli
kWh	-	Kilo Watt Hours
LED	-	Light Emitting Diode
MA	-	Maintenance Activity
MGTC	-	Malaysia Green Technology and Climate Change Corporation
NCCP	-	National Climate Change Policy
NDC	-	Nationally Determined Contribution
NGTP	-	National Green Technology Policy
NGV	-	Natural Gas Vehicle
OFI	-	Opportunity For Improvement
PA	-	Public Addressing
PES	-	Power and Energy Society
PM	-	Power Monitoring
RE	-	Renewable Energy
RFI	-	Radio Frequency Interference
RM	-	Ringgit Malaysia
SDG	-	Sustainable Development Goals
SEMS	-	Sustainable Energy Management System
SLD	-	Single Line Diagram
STP	-	Submerged Turbine Pump
SVC	-	Static VAR Compensator
THD	-	Total Harmonic Distortion
TNB	-	Tenaga Nasional Berhad

UNEP	-	United Nations Environment Program
UPS	-	Uninterruptible Power Supply
WC	-	Working Committee
WEF	-	World Economic Forum

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CHAPTER 1

INTRODUCTION

1.1. Introduction

Global warming is a major threat across the globe these days. Global warming is considered when there is an increase in average air temperatures near the surface of Earth. This phenomenon has been observed closely by climate scientists. Based on the amount of data gathered and detailed observations of various weather phenomena, it indicates that the Earth's overall temperature has risen in a significant number since the beginning of the Industrial Revolution that begins in 1760 (Michael, E.M and Henrik, 2020). The rise of earth temperature is caused by the Green House Gas (GHG) and carbon emission. This climate change poses challenges for all sectors of an economy all over the world.

Malaysia has taken several pragmatic approaches to address the adverse impact from climate change caused by GHG and carbon emission. For instance, Malaysia has taken a constructive role by introducing the Energy Management Policy in commercial and industrial buildings to minimize energy waste as an effort to reduce GHG and carbon emissions. This is in line with the global energy management trend and our national commitment to mitigate global climate change through various Energy Conservation Program, carried out on private, commercial and industrial premises.

Several potential prospects for energy efficiency and areas for cost-effective energy conservation measures to reduce GHG and carbon emissions have been identified. One of the strategies implemented is via establishment of the Malaysia Green Technology and Climate Change Corporation (MGTC) on 7th April 2010. MGTC is one of the agencies under the Malaysian Ministry of Environment and Water (KASA). It is mandated to drive the Malaysia deliverables and progress under the scope of Green Growth, Climate Change Mitigation and Green Lifestyle. At present, MGTC plays the key role as one of the main

catalysts for green economic growth regulated by three national policies, (1) National Green Technology Policy (NGTP), the (2) National Climate Change Policy (NCCP) and the (3) Green Technology Master Plan (GTMP).

MGTC steers and implements several key initiatives and programs that will provide and able to achieve a long -term impact of Malaysia Nationally Determined Contribution (NDC) to reduce the intensity of greenhouse gas emissions by 45% based on Gross Domestic Product (GDP) by 2030[1]. The program under MGTC are also expected to increase the rate of Malaysia GDP from green technology, by RM100 Billion and is expected to generate an estimated number of 230,000 green jobs.

There are several key programs spearheaded by MGTC. For instance, MyHIJAU Mark Certification Program, Green Technology Financing Scheme (GTFS), Green Technology Investment Tax Exemption (GITE) and AEMAS EMGS certification program. This research paper will focus on the MGTC AEMAS EMGS certification program to assess on its applicability in qualifying a petrol station as part of the certification program beneficiary. The second chapter of this research proposal will cover some literature review on the key process and criteria as stipulated under the AEMAS EMGS certification program. It will also cover some literature on the philosophy of an energy efficient approach as well as power quality issues, and mitigation that normally concerns at petrol station installation. Reference shall be made to several literatures as well as international standards such as IEC 60364-8-1 Low Voltage Electrical Applications, Part 8-1, Functional Aspects – Energy Efficiency and IEEE standard 1159.2019, IEEE Recommended Practice for Monitoring Electric Power Quality. Chapter 3 will take a closer look on an actual petrol station example. A general methodology of the research implementation shall be outline, particularly looking into potential implementation and application of power quality and energy efficiency features on the electrical equipment and system at the petrol station. Data to be gathered, testing, troubleshooting and assessment requirement, will also be covered in this chapter. This research proposal paper will be concluded with Chapter 4 where the hypothesis and expected outcome of this research shall be presented.

[1] Comparison will be made against GHG emission intensity in 2005.

1.2. Research Background

Energy Efficiency has been in every country's agenda in the world today (WEF, 2021). Paris Agreement (2015), set the tone for every country to gear up efforts to improve Energy Efficiency and reduce GHG emissions. Malaysia under the focus execution by Malaysian Green Technology Corporation (MGTC), have taken pragmatic approach in driving and promoting Energy Efficiency improvement across all business entities and industries. Based on its significant role in driving Energy Efficiency in Malaysia, MGTC has been appointed by the ASEAN Centre of Energy (ACE) as the certification body for Energy Management Gold Standard (EMGS) in Malaysia. Based on (MGTC, 2019), EMGS is a certification system delivered under the ASEAN Energy Management Scheme (AEMAS) based on excellence in energy management. AEMAS started in 2010 but was only officially launched a year later in 2011. EMGS is a regional certification owned by the ASEAN Centre for Energy (ACE) and is currently implemented by eight (8) ASEAN member countries. It is supported by the European Commission and the United Nations Environment Program (UNEP). EMGS empower organizations with a Sustainable Energy Management System (SEMS) approach, where cost savings are not only achieved, but maintained and also improved over time. Under the EMGS program, companies will also get comprehensive training for their energy managers who will lead their company in Energy Efficiency goals.

EMGS program is established based on ISO 50001, Energy Management System standard. The standard specifies requirements for establishing, implementing, maintaining and improving an energy management system. The intended outcome of this standard is to enable organization to follow a systematic approach in achieving continual improvement in energy performance. The standard will require organization to undertake energy efficient measures to improve and increase energy efficiency utilized by the electrical equipment based on references to international standards. One of the key prominent international standards related to energy efficiency is IEC 60364-8-1 Low Voltage Electrical Applications, Part 8-1, Functional Aspects – Energy Efficiency.

IEC 60364-8-1 provides a systematic approach to a continual assessment of energy efficiency in a building / installation. The standard will also provide design requirement for an efficient electrical installation that will allow energy management process to be undertaken to suit all user's needs, and in accordance with an acceptable investment.

As the Energy Efficiency become the focus in every electrical equipment installation, organization should not lose sight in ensuring a good power quality in respective electrical distribution network. Poor power quality / reliability often leads to reduced energy efficiency (Phillipe, 2016). Any power quality issues, such as overvoltage, undervoltage, phase imbalances and harmonics can adversely impact electrical equipment and its energy consumptions. Issues and concerns pertaining to power quality along with mitigation techniques is further defined and elaborated in IEEE standard 1159.2019, IEEE Recommended Practice for Monitoring Electric Power Quality.

Chapter 2 will further elaborate all the above literatures and references in great details to further assess the potential application of power quality and energy efficiency measures on the electrical equipment and system at the petrol station. This is with the aim to ensure its able to meet and fulfil the need of AEMAS EMGS certification requirement.

1.3. Problem Statement

World Economic Forum (WEF) in its 2021 report have reported that Malaysia have shown a stable sign towards improving its energy efficiency to attain a better Energy Transition Index (ETI). Malaysia has been clustered as one of the countries under 'Emerging and developing Asia', has improved at the fastest rate compared to other regions within the last decades. Although, it is forecasted to face a significant challenge in the near future, as there seems to be an increase in Energy demand per capita (currently at 18%) and is projected to double by 2050 (WEF 2021).

It has been reported that around 17 to 20% of the total building electrical energy consumed in commercial building in Malaysia is contributed by the lighting systems (Moghimi et al., 2013) and (Siti et al., 2020). This lighting system become second highest of electrical energy consumption after air-conditioning system. As this electrical equipment are among the key equipment installed in petrol station; improving the power quality and energy efficiency via sustainable energy management system (SEMS) concept will reduce the energy consumption and demand, reduce energy intensity and further reduce GHG consumption.

1.4. Objectives of The Study

The objectives of the study are listed below:

1. To study and investigate requirements for the design of energy efficient electrical equipment based on AEMAS EMGS, IEC 60364-8-1, and IEEE 1159 standards.
2. To determine design features of an energy efficient Petrol Station with power quality mitigation techniques, that can reduce nuisance electrical power quality disturbances with lower energy consumption operations.
3. To implement Energy Efficient approaches as per AEMAS EMGS scheme, and establish formula to determine the confidence level or readiness towards pursuance and attainment of EMGS Gold star rating qualification and secure a sustainable economic savings from lower energy consumptions.

1.5. Scopes of The Study

The scope of the research is bounded by the following:

1. Studying the process to qualify Petrol Station to meet AEMAS EMGS scheme.
2. Establishing design features of an energy efficient Petrol Station with consideration of energy efficient electrical equipment along with power quality mitigation effort towards attaining lower energy consumption operations.
3. The design, measurement, and verification shall be in accordance with the International Standard Organization (ISO) Standard ISO 50001 Energy Management Systems and IEC 60364-8-1 Low Voltage Electrical Installations – Part 8-1: Functional Aspects Energy Efficiency.
4. Performance evaluations will be based on reduction of energy consumption, electricity bill savings, GHG emission reduction realization and attainment of EMGS certification.
5. The design scope of this research is limited to a standard and typical petrol station design, with a grid connected power supply at lower voltage 0.415 kV nominal voltage distribution. The petrol station may be equipped with Natural Gas Vehicle (NGV) filling station and Electric Vehicle (EV) charging station as an optional consideration.

1.6. Significance of The Study

The significances of the research are to contribute towards establishment of clear guideline and definition for an energy efficient petrol station for industry reference and emulation – adhering to industrial standards and accreditation.

This is to further strengthen industry as well as Oil & Gas retailer's position as the leading organization in changing the landscape of energy industry towards higher Energy Efficiency operation. With this effort, it is envisioned that it will be able to support National Sustainable Development Goals (SDG) contribution and commitment towards Paris Agreement 2015.

Figure 1.1 An Energy Efficient Petrol Station with AEMAS EMGS Certification.

1.7. Thesis Outline

The project work is going to be presented in 5 chapters. Chapter 1 will provide brief introduction with background of the work performed. The problem statement is defined with clear objectives, scopes and significance of the study will be outlined in the chapter. The second chapter will then provide detailed elaboration on the literature review topics along with the research gaps found in the existing study coverage. Based on the gaps, a detailed methodology is proposed and outlined in Chapter 3 for further project implementation. Chapter 4 will further cover the study and assessment outcomes in details prior to the overall outcomes were concluded in the final Chapter 5.

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