CSC Steel Towards Sustainable Development via Energy Management

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SYNOPSIS

CSC Steel Sdn. Bhd. (CSC Steel) is the first iron and steel company in Malaysia obtained ISO 50001:2011 (EnMS) certification in year 2013 and we are in the 9th year of the implementation of ISO 50001.

In line with the sustainable green policy of our parent company, China Steel Corporation in Taiwan, CSC Steel is committed to participate in the green economy and green growth, all the future major tasks will take reduction of industry's environmental footprint and sustainable operation management into consideration by adopting market best available technology and practices. Hence, environmental sustainability is always one of CSC Steel priorities in meeting the applicable standards and regulations set by the Malaysia Government.

The effect of Climate Change due to Green House Gas (GHG) emission has become stronger every year now. It is very important that all of us to take action to reduce GHG emission immediately. In this paper, we will share some experience of implementing EnMS based on ISO 50001 model and continues working on improving energy performance via Energy Conservation Committee (ECC) and also develop objective target to achieve energy savings while maintaining or improving operation performance. Since most of our energy is generated from fossil fuel, improving energy efficiency will reduce GHG emission and subsequently reduce the impact of Climate Change.

We are proud to introduce an in-house energy monitoring tool, Utility Monitoring System (UMS), and share our experience on how the system assists us in our daily energy monitoring and improvement task.

In response to the Malaysia Government's aspiration to improve Malaysia Small & Medium Enterprise (SME) productivity and competitiveness, CSC Steel plan to adopt Industry 4.0 into our processes in the near future for continual improvement in productivity and cost saving.

Keywords: CSC Steel Sdn Bhd (CSC Steel), Energy Management System (EnMS), Baseline, Significant Energy Use (SEU), Energy Performance Indicator (EnPI), Energy Planning, Utility Monitoring System (UMS), Climate Change, GHG emission.

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1.0 Introduction

Iron & steel industry is one of the fundamental industries for the country. Facing the demand of higher quality steel products. Ornasteel Enterprise Corporation (M) Sdn Bhd incorporation in November 1991. The company started with Cold Rolling Plant then set up the Group Steel plant for Continuous Galvanising Line and Colour Coating Line started commercial production in year 1998 and 1999 respectively. Following year 2000, China Steel Corporation of Taiwan (CSC) had acquired its first offshore steel companies Ornasteel and Group Steel company. Since then, the company fully operated under the management of CSC from Taiwan. In January 2004, Ornasteel Holdings Berhad was incorporated and at the same year the company successfully listed on Main Board of Bursa Malaysia. In June 2008, the company name changed to CSC Steel Holdings Berhad and CSC Steel Sdn. Bhd. respectively (CSC Steel). CSC Steel is a mid-stream flat steel producer and marketer of pickled and oiled steel coils, cold rolled steel coils, galvanized steel coils and pre-painted galvanized steel coils, overall manufacturing process as per Fig.1.0.

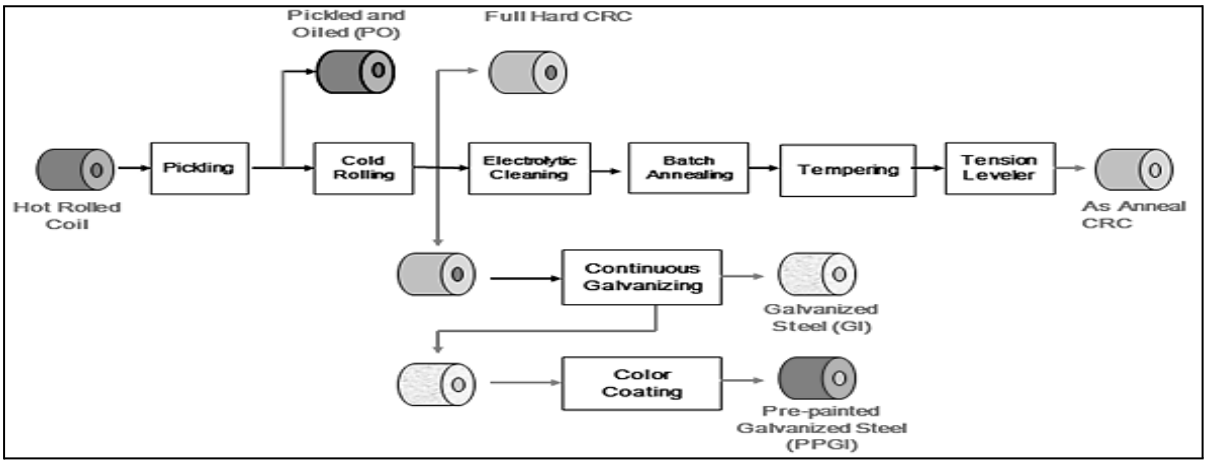


Fig.1.0 CSC Steel's production process flow

CSC Steel main energy uses in manufacturing factory are Natural gas and Electricity. Natural gas is used in production lines' furnaces for heating process and it is also used in boilers to

generate steam for heating up chemical solutions in process line. Electricity is used to power up utilities and machineries. CSC Steel's approach to sustainable production is by way of integrating greater efficiency into our products and services.

In year 2013, CSC Steel was the trailblazer in Malaysia's iron and steel industry to obtain Energy Management System (EnMS), ISO 50001:2011 certification and has been upgraded to ISO 50001:2018 in year 2020. Conformance with ISO 50001 requirement, CSC Steel established a baseline of energy use and regularly conduct energy reviews to determine significant energy use, monitor and measure energy consumption via self-developed system, namely Utility Monitoring System (UMS). CSC Steel was focused on the significant energy use of cold rolling mills, galvanizing lines, colour coating lines, and utilities such as water pumps and air compressors. Additionally, creating an energy management programme and action plans that effectively reduce energy cost and consumption.

Entering the era of Industry 4.0, it's a new trend in the industrial revolution and focuses on improving the manufacturing efficiency. Energy efficiency is an integral part of industry 4.0 and CSC Steel also committed to improve energy management system integrated with Industry 4.0 such as Big Data and Artificial Intelligence through collaborate with Local University such as University Tunku Abdul Rahman.

CSC Steel committed in adopting energy efficiency measures to reduce carbon footprint while improving overall competitiveness and conduct energy conservation measures in all stage of activities, utilize energy efficient technology and production output efficiently. The on-going energy efficiency and conservation projects include production revamping project, lighting, motors, viable speed drive, fan and pumps, integrated boiler and compressed air systems.

2.0 Energy Management System

2.1 Systematic approach - PDCA

CSC Steel's energy management system is based on Plan-Do-Check-Act, a systematic PDCA approach to improve energy performance. By integrating energy management into business practices and establishing processes for continuous improvement of energy performance and associated energy costs, CSC Steel can become more competitive. Additionally, an energy management system using a high structural framework ensures compatibility with other relevant ISO management systems, minimizing disruption to business operations. The PDCA systematic approach as follows:

Plan - Understand the context of the organization, establish an energy policy and an energy management team, consider actions to risks and opportunities, conduct an energy review by gathering, analysing and interpreting energy data. This energy intelligence is then used to identify Significant Energy Uses, energy baselines, energy performance indicators, objectives and energy targets and action plans necessary to deliver results in accordance with opportunities to improve energy performance. There are a variety of resources required include human resources, specialized skills, technology, data collection infrastructure and financial resources.

Do - Implement the energy management action plans, operational and maintenance controls, ensure competence and consider energy performance in procurement.

Check - Monitor and measure processes and the key characteristic of its operations that determine energy performance again the energy policy and objectives. Internal audits are performed to have a good view of the management system. During management meetings, Top Management will lead energy management team with member make-up of department and section heads, committee members to continuous implementation and maintenance of the energy management system.

Act - Take action to continually improve energy performance and the energy management system.

2.2 Energy Management Framework

CSC Steel top management, Managing Director of the company committed ensuring the energy management system to achieve continual improvement of energy performance and established an integrated energy policy as a framework for setting and reviewing the energy impact, energy objectives and targets and be communicated to all employees, all persons working for or on behalf of the company.

CSC Steel top management acknowledge that the best approach for implementing an effective energy management system is by appointing energy management representative, establishing Energy Management System Committee directed by managing director and establishing Energy Conservation Committees directed by department manager. Both as an energy team was ensure the continued operation of the energy management system and managed activities for continual improvement. A regular meeting was conducted for discuss and set energy management program, action plan, assign responsibilities, and review the documented implementation program and activities.

CSC Steel constantly seek achievable reductions in energy consumption, and this is achieved through Top-Down and Bottom-Up Project Management Strategies to constantly monitoring and analysing the consumption of energy and encourage staff at all levels to be involved with and participate in energy efficiency and conservation management as per Fig 2.0.

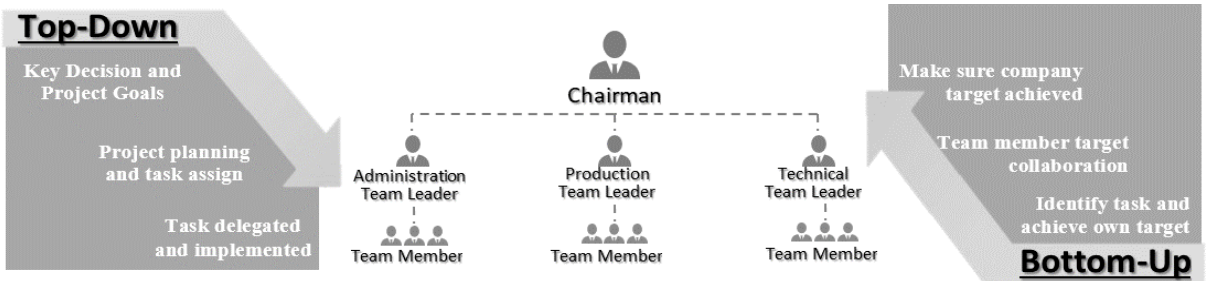


Fig 2.0: CSC Steel Top-Down and Bottom-Up Project Management Strategies

3.0 Sustainability Program

The biggest priorities of CSC Steel is continuously reduce energy consumption, and strive to minimize emissions and waste to contribute to the flourishing life of human, flora and fauna. Hence the implementation of environmental preservation and energy management program planning further enhances the effectiveness of environmental protection and sustainability.

3.1 Environmental Preservation

On the environmental conservation front, CSC Steel has been certified for ISO 14001:2015 Environmental Management Systems with an effective control measures.

(1) GHG Emission Reduction

CO_2 is one of the greenhouse gases that contribute to global warming and climate change. The most effective way to reduce CO_2 emissions is to improve the overall energy efficiency and reduce the energy consumption. CSC Steel adopted solar panels in year 2021 in order to get cost effective electricity and also because solar energy produces zero greenhouse gases (GHG) and it's inexhaustible and renewable, since it comes from the Sun. Furthermore, CSC Steel are planting trees around the factory not only to beautify the work environment but also to reduce the carbon footprint. The implementation of energy management programs from 2019 to 2021 has achieved a carbon emission reduction of total 3,266 tonnes.

(2) Waste Management

CSC Steel ensures that scheduled waste are properly placed, stored, arranged, transit or sent with prior written approval from the Director General of Environmental Department, Malaysia (DOE). The scheduled wastes generated were 100% recycling and recovery via DOE licensed contractor and fully comply with Environmental Quality (Scheduled Wastes)

Regulations 2005. CSC Steel also implemented the "Cradle to Cradle" cycle in waste management system to ensure the sustainability of environmental development. The 100% recycling and the 3R (Reduce, Reuse, and Recycling) activities is continually carried out in the company to align with local government policy zero disposal.

(3) Effluent Discharge

By holding the commitment of contributing to environmental cleanliness and zero pollution, wastewater is treated at CSC Steel Wastewater Treatment Plant to assure that it complies with Environment Quality (Industrial Effluent) Regulations 2009 Standard B before exiting the drainage of Industrial Estate that connecting to the river. CSC Steel conducted daily internal monitoring and quarterly external monitoring for effluent discharge sample and measured result were below 75mg/L, which are compliance with Standard B, Chemical oxygen demand baseline on 200mg/L.

(4) Ambient Air Quality

CSC Steel stacks emission control parameters lie within the limits specified under the Environment Quality (Clean Air) Regulations 2014. The ambient concentrations for all parameters are monitored in three surrounding residential areas so that it does not exceed the limits of the Malaysian Recommended Air Quality Standards. CSC Steel process line operation maintains the emitted ambient air quality and ensures that it would not affect the surrounding residential areas. The ambient air quarterly monitoring was conducted at three residential area by external parties and all measured result were under 52µg/m^3 which are compliance with ambient air Standard for Particle Matter (PM10) baseline on 100µg/m^3.

(5) Boundary Noise

Noise monitoring along the factory boundary total 24 points is continuing carried out in quarterly basis. Both daytime and night-time boundary noise levels are similar and consistent where all measured noise levels are below the stipulated DOE recommended limit of 65 dB(A) and 55 dB(A), respectively.

3.2 Energy Management Program

3.2.1 Renewable Energy

The major renewable energy saving achieved in CSC Steel was Solar Panel system installed in year 2021. Solar Photovoltaic (PV) System use PV cells to convert solar energy into electricity through photovoltaic effect. The PV cells consists of layer a semi conducting material and when the PV cells exposed to the sunlight, it absorbs photons and release free electrons which then creates an electric field across the layers causing electricity to flow.

However, the electricity generated is in direct current (DC), thus, an inverter uses to convert the solar generation from DC to alternating current (AC) before connect and feed-in to the CSC Steel electrical system. It has generated total solar energy of 6,169,019MJ/year and this initiative is expected to achieve a carbon emission reduction of 408.05 tonnes annually.

3.2.2 Energy Efficiency and Conservation

It is a hidden truth that, energy consumption is a critical factor that drives the business continuity and quality of end-end manufacturing system. Energy efficiency and conservation are related and often complementary or overlapping ways to avoid or reduce energy consumption. CSC Steel always evaluate the performance of the machineries and equipment periodically by applying new technologies.

There are several technical solutions that apply at CSC Steel to directly lower energy costs for consumers and potentially reduce greenhouse gas emissions associated with energy use, some implemented key projects such as:

(1) High Efficiency Boiler

CSC Steel installed high efficiency boiler and the high efficiency boiler able to maximize heat transfer and load demand and also integrating and centralize steam supply. The high efficiency boiler design with economiser, the function of economiser to use waste heat from flue gas to increase water inlet temperature able to reduce natural gas consumption and also reduce carbon emissions by 1,174.29 tonnes annually. This boiler also equipped with automatic blowdown-control system used to optimizes surface-blowdown rates by regulating the volume of water discharged from the boiler in relation to the concentration of dissolved solids present to reduce blow down rate and save energy at least 4%. With the deaerator, boiler life span able to expand and reduce chemical for remove oxygen in overall boiler system.

(2) Variable Speed Drives

Motors with variable load during production can improve energy efficiency by installing Variable Speed Drive, the load of the motor can be adjusted based on the require output, typically efficiencies of 97% or more are available at full load. For example, variable speed drives was installed to the coolant pump and linked to the process Programmable logic Controller to control pump speed according to process condition to reduce pump energy consumption.

(3) High Efficiency Motors

In recent years, the cost of owning premium efficiency (IE3) motors has dropped significantly with gradually increase in electricity cost, it is now financially viable to use IE3

motors instead of standard efficiency (IE1) motors. IE3 represents the highest energy efficiency whilst IE1 represents the least energy efficiency. For example, the motor efficiency for 22kW 4 poles IE1 motor is 91%; the efficiency for the same IE3 motor is 94.5%. CSC Steel is continuously evaluating and gradually replacing motors with IE3 units.

(4) High Efficiency Pumps

CSC Steel have been continuous improve the cooling water system by reviewing water pump capacity and replacing old inefficient pump with high efficient unit to suit the usage. The water pump also operates using stainless steel impeller to increase the efficiency of the pump system and thus result in energy savings. Depending on its design, the stainless steel impeller can increase overall pump efficiency at least 4.5%.

(5) Compressor System

Air compressor is one of the Significant Energy Uses all the while in CSC Steel, thus the energy consumption of air compressor is always under monitoring in UMS system as per Fig 3.0 and evaluate to continuously improve the energy performance, and some implemented key improvement such as centralized the compressed air system, adopt higher efficiency unit, enhance the regulator system to match usage and optimise compressed air consumption.

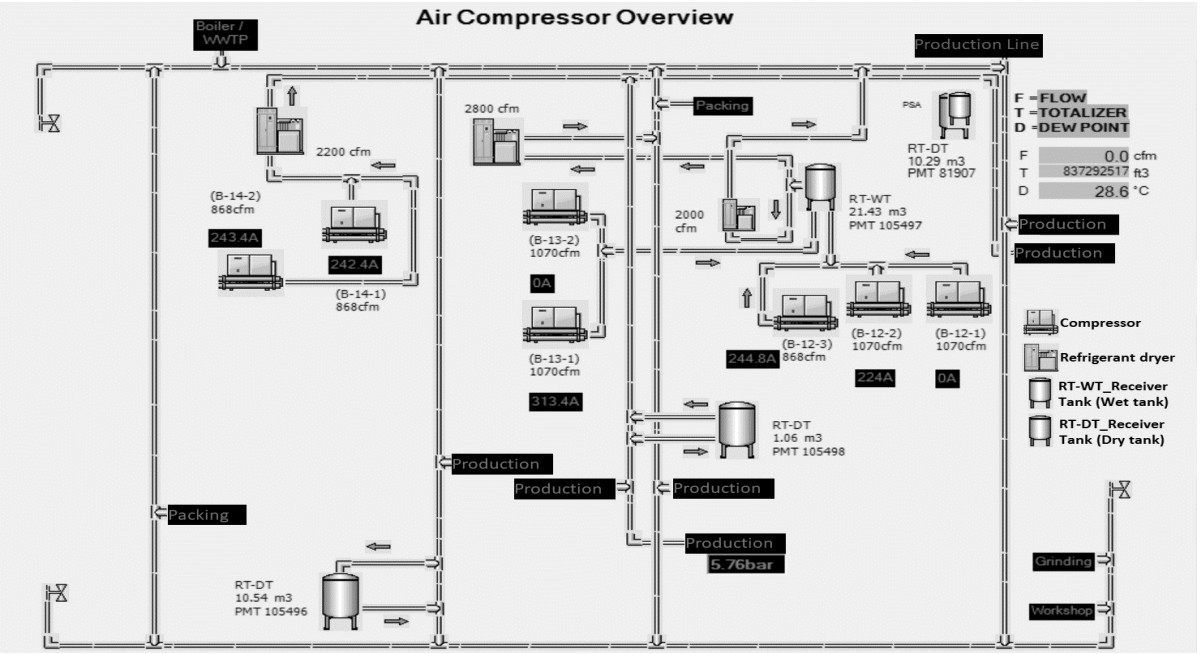


Fig 3.0: CSC Steel Air Compressor Overview through UMS System

Various type of air blow-off nozzles were used in CSC Steel production line for cooling effect, cleaning effect and etc. Using preferred nozzle type and correct nozzle offset angle purging are important for optimizing compressed air utilization according to process conditions, and further cost-savings can be achieved.

(6) Process optimization

CSC Steel encourage staff to study and analyse production operations from time to time to improve its performance, which will further enhance energy usage and effectively reduce energy costs and consumption caused by the production process such as parameter optimization setting, e.g. variable speed, temperature control and etc.

(7) Efficiency Lighting System

LED lighting technology with lower power consumption for desired lumen output as well as considerably long lifespan and higher efficient are becoming the norm. Thus, CSC Steel lighting system started replace to LED such as 400W Metal Halide high bay light to 150W LED, 200W High Pressure Sodium (HPS) streetlight to 70W LED, HPS flood light and Fluorescent tube to LED type. After the high bay light was replaced with LED, the average luminance increased from 70lx to 200lx is also enhance the brightness for the workplace.

3.2.3 Reward scheme

In order to encourage all staffs in the companywide level work together in energy efficiency and conservation, there were two type of reward scheme was created for employees involving. In the event of discovering any energy opportunities at the place of work can be proposed by using the Energy Saving Proposal (ESP), however for significant energy opportunities with a specific complete improvement plan can be further proposed according to Engineering Proposal Reward. It helps create an internal recognition programme, which reward success of CSC Steel's employees in energy efficiency and conservation.

3.3 Green Products

CSC Steel's green products is a sustainable product designed to minimize its environmental impact. In 2014, CSC Steel had been accredited with the SIRIM Eco-label certification (Green Coated Steel) for realZINC and realcolor patented product. "Eco-labelling" is a voluntary method of environment performance certification, offering an option to eco-conscious consumers of environmental friendly & sustainable product.

In year 2015, CSC steel's realZINC and realcolor patented product had been accredited with MyHijau mark to supply green products to domestic customers with added value of their products. The objective of MyHijau programme is to enhance current green products and services through standards compliance especially that related to environment.

In addition, CSC Steel's green products also contribute in green building. SRI is defined as solar reflectance index which is an indicative measurement of the coolness of roof surface. Green Building Index (GBI) is an environmental rating system for buildings which developed by Pertubuhan Arkitek Malaysia and Association of Consulting Engineers Malaysia. CSC

Steel's realcolor Thermoshield product provide excellent heat reflection that can achieved SRI ≥29 and the coating surface with hydrophilic material provide the self-cleaning function that resulting the surface looks new and clean as dirt can be washed by rainwater.

3.4 Originality and Unique

3.4.1 Utility Monitoring System (UMS) development

To integrating all the energy data, an in-house energy monitoring tool, Utility Monitoring System (UMS) has been developed by CSC Steel to monitors electricity, steam, natural gas, cooling water and compressed air consumption, in addition to provide real-time energy usage, reports (daily, monthly, yearly) and trend graphs.

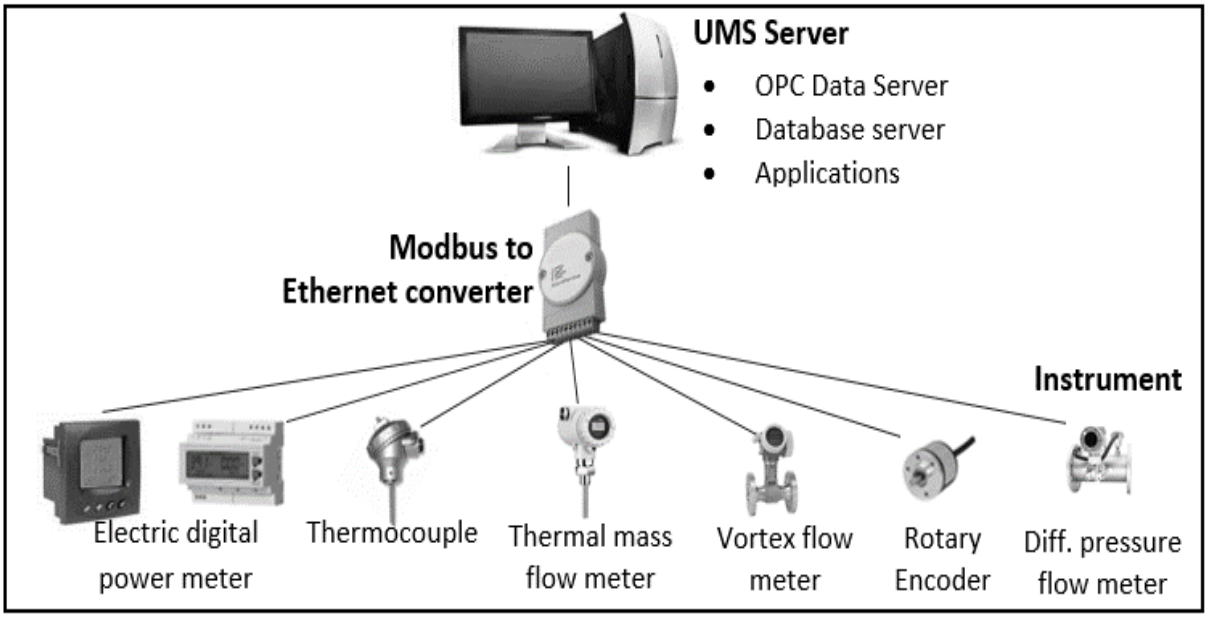


Fig.4.0: CSC Steel self-developed UMS system architecture

UMS using common OPC protocol to collect data from equipment as per Fig 4.0. The communication protocols used are Modbus RTU and Modbus TCP (Ethernet). Various equipment signal output will be converted into Modbus RTU, and finally converted to Modbus TCP (Ethernet) protocol. The data is then read by an OPC data server running in the UMS server, and stored in the database. The UMS HMI is the application that displays all energy information to the user.

UMS is an important tool that helps us understands the energy usage pattern of each process line and utility demand to define energy significant use, monitor the electricity maximum demand and perform energy management effectively. Any abnormality of energy

consumption can be easily discovered and corrective action can be performed instantly. With the data and analysis, we able to justify the energy performance and saving.

3.4.2 Monitor and control the Electricity Maximum Demand (MD)

One of the biggest contribution of UMS is Electricity MD Monitoring and Control. The self-developed electricity MD monitoring in UMS system provides statistical analysis that helps energy management team to setup an achievable MD target for each month as per Fig 5.0.

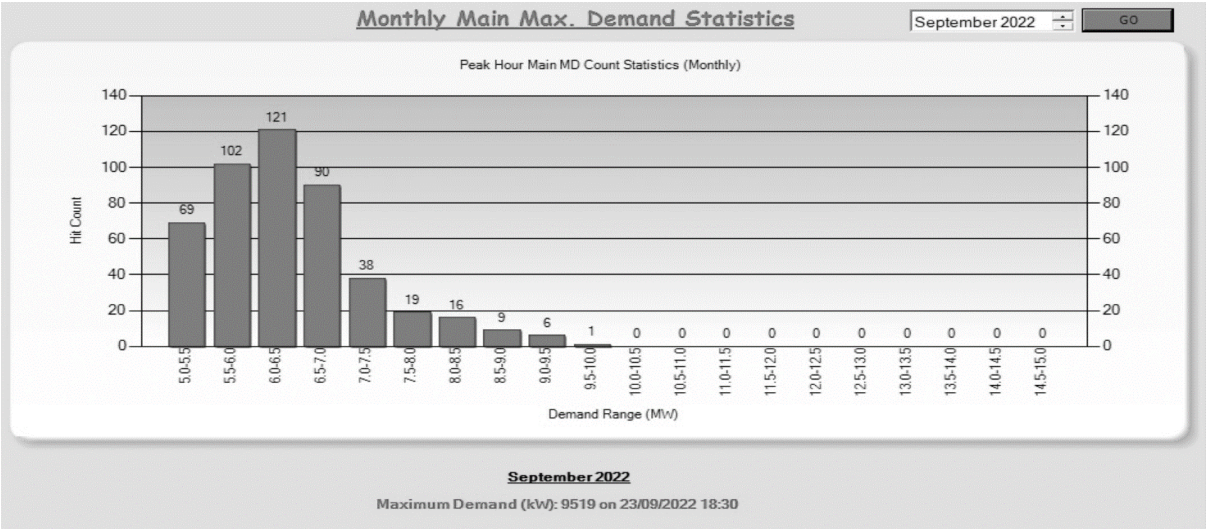
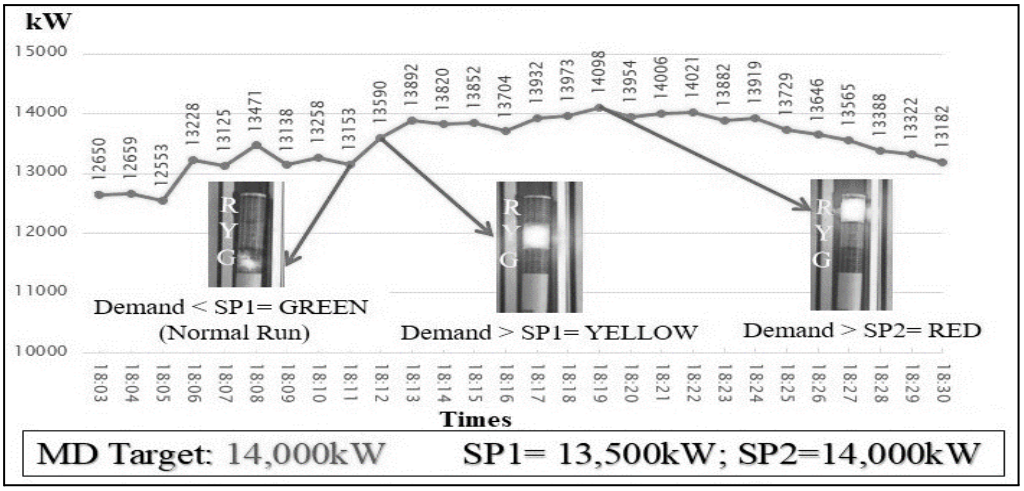


Fig 5.0: UMS Maximum Demand Statistics

MD is affected by the amount of equipment being operated at the same time and it's monitored in real-time and production personnel will be notified by demand indicators if the MD has exceeded respective set point as per Fig 6.0. Demand indicators had been installed in



all production lines, which can display three colours of GREEN, YELLOW and RED.

Fig.6.0: UMS Maximum Demand Indicators in real-time

When the predicted demand value reaches the warning value, the warning light will turn on YELLOW for warning. When the predicted demand value reaches the target value, the warning light will light up in RED. The main controller of the operating unit will operate according to the response measures set at the YELLOW or RED light, and it is expected that the MD can be controlled below the target value. Other than existing control that limits selected process speed according to predicted demand value, CSC Steel also uses exclusive production planning technique to schedule those high power demand to run at off peak periods.

As a result, a significant reduction in MD for Dec 2021 is achieved as compared to the previous months and saving reached 167,940 USD from Year 2020 to 2021. Although the main benefit MD control is cost saving on the Electricity Demand Charges by utility provider, it also helps lowering the load of internal power supply equipment such as transformers and switchgears.

4.0 The keynote of achievement

The implementation of the Energy Management System has improved the energy performance from 2019 to 2021 in 7.6% regarding the baseline defined. The total energy saving during the period 2019-2021 is of about 36.40 million MJ and saving reached 280,971 USD. The increasing number of energy saving indicates that CSC Steel's energy efficient and conservation programme has achieved progress by continuous improvement of energy efficient, identify potential opportunities for the use of renewable energies and increase environmental awareness, equivalent with a reduction of energy consumption and GHG emissions.

With the evidence of achievement in energy management, CSC Steel had participated in National Energy Award (NEA) 2022 spearheaded by the Ministry of Energy and Natural Resources of Malaysia. CSC Steel was proud to be chosen as the WINNER for energy management towards efficient and sustainable process operations in large industry category during the NEA 2022 virtual award ceremony held on 13rd September 2022 as per Fig 7.0. The NEA is one of Malaysia's most prestigious awards that drives the sustainable energy agenda, which aligns with Malaysia's goal of becoming carbon-neutral by 2050, continues to increase industry participation and awareness of sustainable

Fig 7.0: NEA 2022 Award

energy practices, adhering to international standards.

Subsequently, CSC Steel was qualified to participate in the ASEAN Energy Awards (AEA) 2022 and emerged as the winner for the Energy Management in Large Industry category at the AEA 2022 virtual award ceremony held in Cambodia on 15th September 2022 as per Fig 8.0. AEA is Southeast Asia's highest reward for excellence, recognising organisational efforts in sustainable energy management, practices, and efficiency in the region, which was organized by the ASEAN Centre for Energy.

The double recognitions received by CSC Steel has reflected the CSC Steel's commitment towards the sustainable development. It's already formed part of the CSC Steel's culture to embed the ESG thoughts in the business practices. CSC Steel Energy Management System has achieved in adopting energy efficiency measures to reduce carbon footprint while improving overall competitiveness.

Future and Challenges

At the moment, CSC Steel are focused on improving existing facilities and has an on-going energy efficiency programme to ensure continuously break through challenges such as increasing the magnitude of savings; diversifying energy efficiency resources; measuring and ensuring the persistence of energy efficiency savings and integrating energy efficiency savings with a carbon reduction framework. The next development will be emphasised on features in system optimization of compressed air system, cooling water system, and natural gas system.

Further, CSC Steel will be focusing on the implementation of solar energy system and waste heat recovery system. For solar energy system, company planning to adopt a second phase solar system. For waste heat recovery system, planning to utilize the waste gas in order to pre-heat combustion air and used for others heating system.

As a future plan, CSC Steel is committed to improve energy management system integrated Industry 4.0 such as Big Data and Artificial Intelligence. CSC Steel are now optimizing the E-commerce for marketing to enhance the user friendly and continuous the expansion of the FOMOS system (Facility Online Monitoring and Diagnosis System) to other production line for monitoring certain issues such as mill vibrations, and prediction of abnormality in real time to enhance the equipment efficiency and productivity. In future will focus on the installation of IoT in production line which creates the ability to collect data from a board range of devices, and with system integration approach, it helps to do prediction and some counter measure can be performed to optimize the energy consumption.

5.0 Conclusion

Showcasing our energy management efforts at the NEA 2022 and AEA 2022 has certainly put CSC Steel in the limelight, we are gaining recognition from the public as well as within the Malaysian steel industry. The awards gave us the opportunity to learn from other industry players and provided a strong platform where we can understand further on the system implemented in our factory and indirectly become a model for various industries together improve the energy efficiency and increase industry awareness of sustainable energy practices, adhering to international standards.

To align with Malaysia's goal of becoming carbon-neutral by 2050 and succeed in towards sustainable development via energy management in the industry, CSC Steel will continue to establish, implement, maintain and improve an energy management system through progressive adoption of energy efficient technologies, resource conservation and pollution control.