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The Study of Thermal Energy Storage for Thermal Comfort Building

Ahmad Fitri Jamal[1], Zamri Noranai[1*]

[1]Faculty of Mechanical and Manufacturing Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, MALAYSIA

*Corresponding Author Designation

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Abstract: Buildings used one third of global primary energy and the shortage of electricity supply become main concern to the society. To fulfill the demand of the electricity, thermal energy storage is required to supply electricity. The main research of this project is fulfilling the demand of electricity and can explain the importance of thermal energy storage to the community. This study aims to identify the amount of electrical energy can be generated by the thermal energy storage. This study is carried out by identifying the power flow of electricity, energy consumption and the demand of electricity for a certain place and the place that has been taken for this project is Sandakan, Sabah. From the result, it is observed that the demand of electricity is increasing by year because of the increasing of population and by the year of 2018 the shortage of electricity is 60.4 MW. Therefore, the suggestion of construction sensible thermal energy storage using water as medium to supply electricity to Sandakan area is necessary for it. With these proposed measure, thermal energy storage estimated can reduce the shortage of electricity by 8% and supply more electricity per year respectively.

Keywords: Thermal Energy Storage, Energy Consumption, Sandakan

1. Introduction

In this era of globalization, the development of every country in this world is progressing towards the best- and well-known country around the world. This is because the passage of the time that shows the technology nowadays is one of the main reasons for the development of every country. As we can see in Malaysia, our beloved country has many buildings especially in the big city. Buildings represent nearly one third of our global primary energy use, with more than half of that energy going towards heating, ventilation and air conditioning (HVAC). The global worry about the energy problem has become a significant point in recent years. The worldwide energy requirements have expanded widely from the past years and expected will surely be rocketing for the next years.

In order to solve the impact of climatic change, population growth, economy development and rising of global energy request nowadays. So, the efficient of energy management is needed to fulfil the requirement. In fact, this state of affairs shows the necessity for another supply nonetheless reducing the over-reliance on fossil fuels. The fossil fuels are a non-renewable resource that may take many years

Corresponding author: zamrin@uthm.edu.my

to gain the resources. Amongst all the demands, buildings account for 40% of the total energy consumption [1]. The buildings almost consume 60% of energy for the heating, cooling and other system. This is because every process such as heating need energy to be done. Meanwhile, if the energy management cannot be done properly for the building it can cause harmful to the tenants.

Therefore, the thermal energy storage can be considered as one of the next most cost-effective actions in a building energy efficiency implementation plan [1]. It ought to even be noted that electricity employed in lighting, physical science, and appliances finally ends up as a thermal energy that a lot of be managed by the HVAC system, thus economical electricity use is additionally a crucial issue for property buildings. Therefore, the study about investigation of electrical energy generates by the thermal energy storage was carried out. The objectives of this study are to identify what thermal energy storage, compare the classification of thermal energy storage, study benefits and importance of it and fulfil the demand of electricity for the society. By the end of this study, the anticipated result of this project is that reduce the shortage of electricity supply per year through the sensible energy storage.

2. Materials and Methods

This chapter discusses the method/process of conduction this case study in more details starting from identification of the area of study until all the necessary data and result were obtained. The purpose of this chapter is to help a better understanding on methods used in this case study by providing clearer guidelines and explanation/discussion for every method used in this research.

2.1 Passive and Active Cooling

In this project, there are two method of cooling which are passive and active cooling. The passive cooling happens by the natural process in heat transfer. Otherwise, the active cooling happens by the force of mechanical devices. This project will more focus to the passive cooling because of the natural process of heat transfer happens in the tank.

2.2 Tariff

Sabah Electricity Sendirian Berhad (SESB) has 27 types of tariffs applicable for different type of buildings. Tariff is selected according to energy and function of the building. The tariff is important to know the costs of electricity for certain places especially Sandakan area. The details of the tariff are shown in Table 1.

Table 1: Details SESB Tariff Rate

	SESB rate	
Category	Unit	Rate
All kWh	RM/kWh	0.3254
For each kilowatt of maximum demand per month	RM/kW	0.30
Minimum monthly charge	RM	550

2.3 Suggestions of Thermal Energy Storage

The sensible thermal energy storage is chosen for the construction of thermal energy storage. The water has been chosen as the medium for the tank. This is because water has high specific heat capacity and easy to get it. In addition, water is a renewable resources and low costs which can minimize the total costs by the government.

2.4 Energy Consumption

The energy consumption is the amount energy used by hour. The higher the energy consumption, the higher the electricity bill because of the amount of the

$$Energy\ consumption = Watt\ (W) \times hours(h) \quad \text{Eq. 1}$$

3. Results and Discussion

The results and discussion section present data and analysis of the study. Analysis of data is a process where the data collected is being analysed according to the objective of the study. The result obtained were discussed accordingly.

3.1 Sandakan Energy Consumption 2018

Table 2: Electrical Consumptions and Costs

	Sandakan	
2018	Energy consumption (MW)	Total (RM)
January	9.548	2,311,547.23
February	9.134	1,997,320.82
March	10.543	2,552,435.00
April	11.753	2,753,586.86
May	10.978	2,657,747.45
June	12.379	2,900,251.15
July	9.293	2,249,813.00
August	10.644	2,576,886.85
September	8.932	2,092,660.42
October	11.789	2,854,088.61
November	11.322	2,652,608.74
December	10.985	2,659,442.14

The table shows that the electrical consumptions and costs in Sandakan area for the whole 2018 year. From the table, the energy consumption is different by the month because of

Energy consumption January = 7 103 710 kWh

Electricity bill January = RM 2,311,547.23

3.2 Power Flow in Sandakan

Figure 1 shows the power flow in Sandakan for 2018. The demand of the electricity is higher than the generation of the electricity. This situation makes the shortage of 60.4 MW of electricity to the consumers.

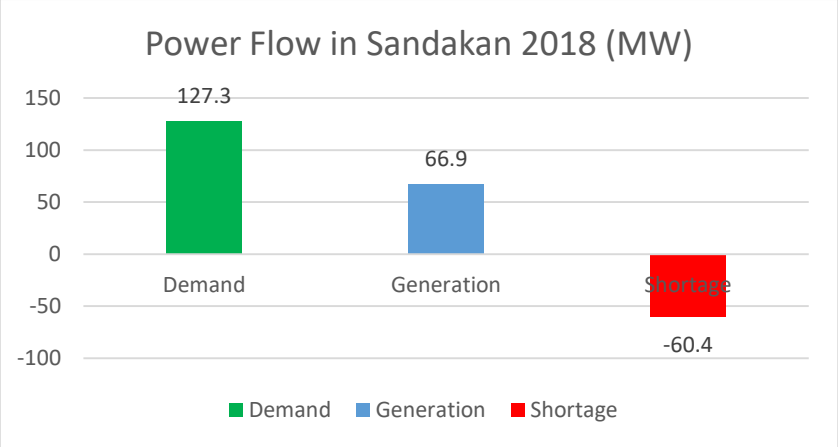

Figure 1: Power Flow in Sandakan 2018

3.3 Analysis Estimation Energy Produce by Thermal Energy Storage

In this subtopic, it will discuss more about the characteristics of the tank and the estimation of the energy produces by the TES:

Table 3: Characteristics of Tank

Characteristics	Value
Diameter	25 m
Height	20 m
Poisson's ratio	0.28 N/A
Elastic modulus	2.1e+11 N/m^2
Shear modulus	7.9e+10N/m^2

Table 3, shows the characteristics of the tank. The information of the characteristics is very important for the calculation of the energy produce from the sensible heat storage.

$$Q = \rho V \, Cv \, \Delta T \qquad \text{Eq. 2}$$

Q = 17.658 MW per year

For minimum efficiency = 17.658 MW × 0.5 = 8.829 MW

For maximum efficiency: = 17.658 MW × 0.9 = 15.8922 MW

The minimum efficiency has been taken for the value of estimation energy produce by the thermal energy storage. This is because any possibilities of unexpected problems had to been considered also.

3.4 Estimation Power Flow for 2022

Figure 2 shows the estimation of power flow in 2022. By the construction of the thermal energy storage, it can generate 8.829 MW per year. Hence, the thermal energy storage can supply the electricity to the consumer. In addition, it also can help to reduce the shortage of electricity which can also reduce the costs borne by the government.

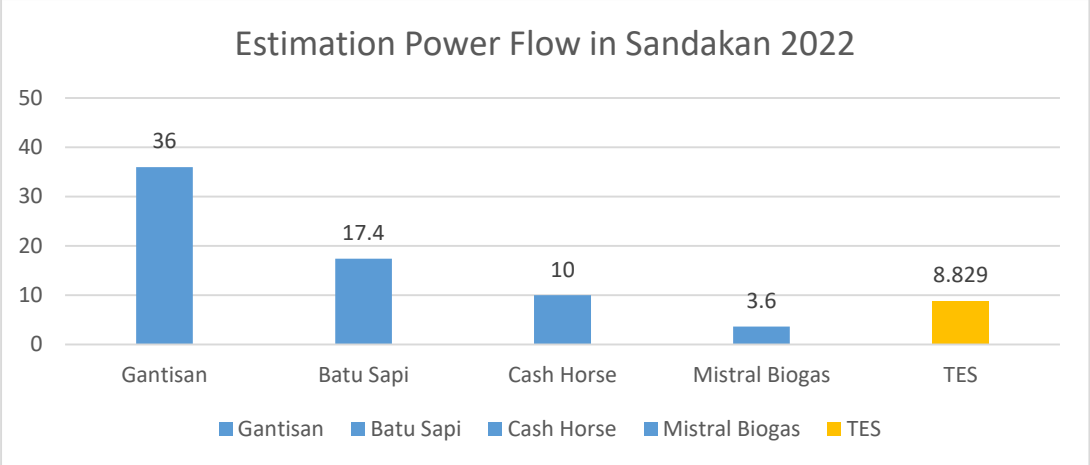

Figure 2: Estimation Power Flow in 2022

Power generates by TES per year = 8.829 MW

Percentage target reduce shortage = 8%

Total percentage saving = $\frac{8.829\ MW}{60.4\ MW} \times 100\%$ = 14.62% (achieved)

4. Conclusion

This study is considered success as the estimation of energy generates by the thermal energy storage is successfully estimated and reduce the shortage of the electricity for a certain place such as Sandakan area that has been chosen for this project has been proposed. By the idea of construction of the thermal energy storage for Sandakan, it can help in reducing the shortage of the electricity in Sandakan area by 14.62% in the future and save RM 344 752.26. With this result, it can reduce costs borne by the government and helps to fulfil the demand of electricity for the community.

In addition, the sensible heat storage is suitable for thermal energy storage to be focused in this country. This is because it is one of the cheapest among the other of thermal energy storage. Water is chosen as the medium for the sensible heat storage. This is because water has high specific heat and easy to get. Furthermore, the research and development (R&D) need to support new material and focus more about thermal energy storage for this country in the future.

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