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The Case of the Energy Solution to the Eco-tourism Model for Sustainable Development using PV/T Technology

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Abstract— Eco-tourism derives its nature towards sustainable development. Energy conservation is a way approach towards sustainability. Malaysia enjoys majority of the tourist from different parts of the world through the year. To derive an energy management for sustainable energy usage the peak demand analysis is highly critical. A model infrastructure of Taylor's University is taken as sample energy audit structure as it encloses a hotel aiming towards use of natural resources. A initial analysis on the power demand requirement is studied. From the analysis it is inferred that the average peak demand is about 3000kW and if through appropriate management of proper kilowatt sustainability could be implied. The analysis pertaining to the computations of power analysis to stabilise the load requirement, equally the economics of the system is improvised by about 7.33%. A model PVT schematic is proposed and the initial results are presented.

Keywords- peak demand, energy management, economics

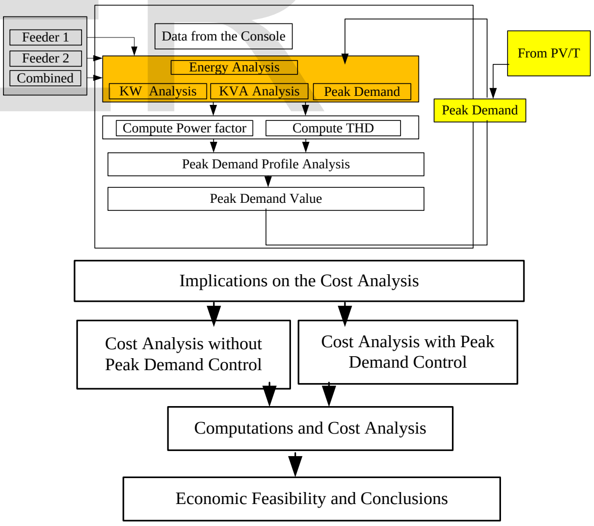
I. INTRODUCTION

The most common factor influence the energy management is the active energy consumption (KWh), the reactive energy consumption (KVARh) and the peak demand (KW). Conventionally the utility system put their effort on the reduction of KWh consumption and on addressing the reactive energy demand to improvise the power factor. However for the medium voltage and high voltage consumers' proper KW demand management implies to reduce the use of contracted power, adjusting to the new requirement and avoiding the demand limit penalties [1].

II. METHODOLOGY

A. Power Management

Figure 1 shows the concept in the power management. As can be seen the power management is interlinked and the possible energy management between the KW and KVAr the net power consumption can be reduced. In order to find the demand requirement to propose new system architecture to address the demand requirement the peak demand analysis is to be investigated. Peak demand is thepower consumed over a predetermined period of time, typically between 8 to 30 minutes. The power is calculated using a power demand meter, which records the highest KW value in the period of measurement, over a month's time. The purpose of demand control is not to exceed the contracted maximum demand limit. The common way is to isolate the non-critical load during peak hours. A number power demand modeling and analysis, towards optimization of demand curve [2] as well as forecasting [1] are the subjects of interest in recent years. However, accuracy and resolution of the model are important [3]. We have utilized the data on energy management from the Taylor's University, Malaysia laced at latitude of 3°07'51.99"N and longitude of 101°59'11.77"E. The demand analysis is based on the utilized power between Jan 2011 till April 2013. Our initial study is to derive the average peak demand requirement and suggest a KW management system for energy sustainability. From our study a detailed proposal on the energy management by suggesting a KW framework is to be presented towards the end of this research work.



(a)

(b)

Figure 1. Research Methodology
(a) Methodology (b) Economic Study

B. Taylor's Power System Architecture

Figure 2 shows the schematic of the electrical power distribution network. The network is supplied with high voltage 11KV /415 V electrical supplies with four incoming transformer power supply (2 Nos. 2500KVA and 2 Nos. of 1600KVA consisting of a primary side main vacuum circuit breaker and switchgear at secondary side with the

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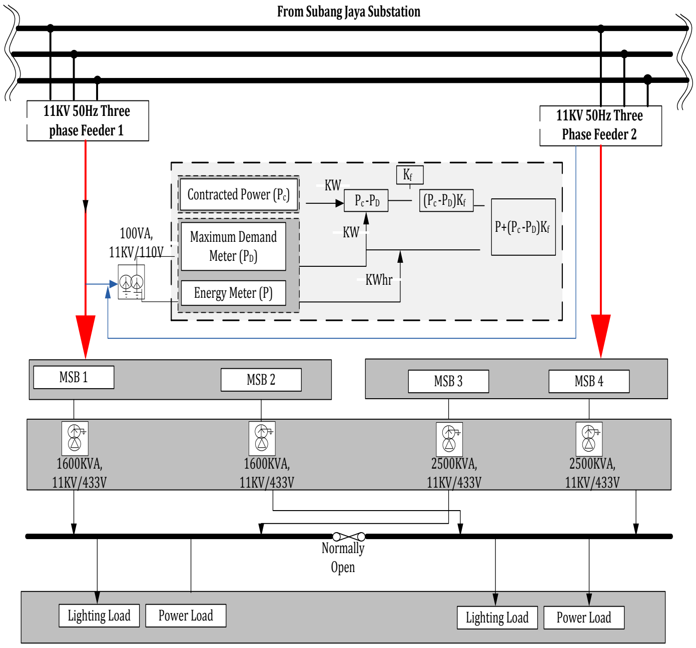

Figure 2. Power System Architecture for the Peak Demand Computations

distribution switch board (essential and non essential) switch board, TNB metering panel, sub switch board, distribution board, and final sub circuit. The facility was support with one number of generator set located at generator set room at Block D with handling capacity 1200 KVA. All the electrical installation cable used PVC and XLPE/PVC except external electrical installation uses PVC/SWA/PVC. The main switch boards for block A & B is located at the ground floor Block B and Block C, D and E is located at Block D roof Top. Various number of sub switch board at individual riser at every floor of each building for power distribution, lighting and air-conditioning systems.

(a) Main Switch Board

(i) Main Switch Board 1: The main switch board 1 (MSB 1) located at Block B level 1 it distribute to Chillers switch board consist of one numbers of 2500Amps TPN ACB (Air circuit breaker) inclusive earth fault relay an over current relay for protection.

(ii) Main Switch Board 2: MSB 2 located at Block B level 1 it distribute serve for Block A (Ground Floor – Roof Top) & Block B (Ground Floor till 4th floor) for power and lighting. Serve for lift block A (2 lift) and block B (1 Lift). Switch Board consist of one numbers of 2500 Amps TPM ACB.

(iii)Main Switch Board 3: MSB 3 Located at Block D Roof Top – 4000 Amps TPN ACB. Serve all fire fighting system and pump, Lift block D, E, .Exhaust Fan Block C.D & E. lighting and power, Total number of Lift (10nos.)

(iv) Main Switch Board 4: MSB 4 Located at Block D Roof Top. Consist of 4000 Amps TPN ACB. Serve to VRV Air-conditioning at Block C, D & E.

(b) Power Load

Heat Ventilation and Air-Conditioning System – HVAC

Chillers – 4 Nos. Daikin screws type with 400 tons each capacity, Chilled water pumps – 4 Nos, Condenser water pump – 4 Nos., Cooling Tower – 4 Nos., AHU's, FCU's. Two chillers are in current operational condition.

VRV System

Lift

Lift 13 units in total: Brand KONE. Block A – 2 Units, Block B – 1 Unit, Block C – 4 Units, Block D – 3 Units, Block E – 3 Units

Culinary Kitchen

Heating element, refrigeration, Cold room, Bain Marie etc.

Motor and Pumps

6 Nos. - Domestic water supply pump ,8 Nos. - Buster pump

(c) Lighting System

Type of lighting: Corridor light, Room light, Staircase light, External compound light, Signage light, Car park, Street Light

C. Electricity Profile

Figure 3 shows the active power consumption of the system for the year 2012. A significant active power consumption in jan-feb highly due to the break semester of the university. However the consumption of the reactive power is rising due to the use of highly non-linear loads during the operational conditions of the university. Figure 4 shows the graph on the reactive power consumption during the same period of investigations.

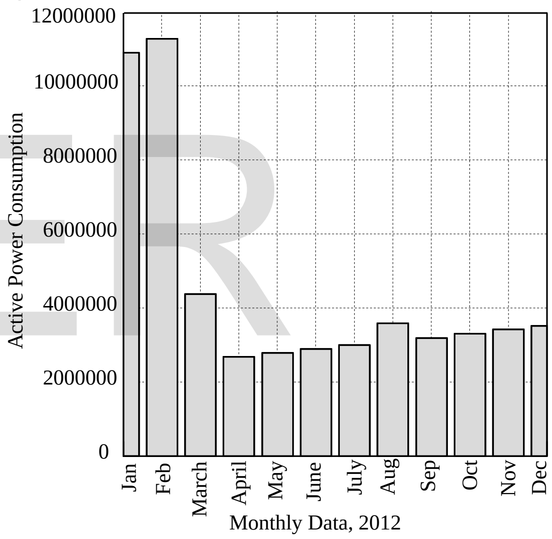

Figure 3.Active Power Consumption, 2012

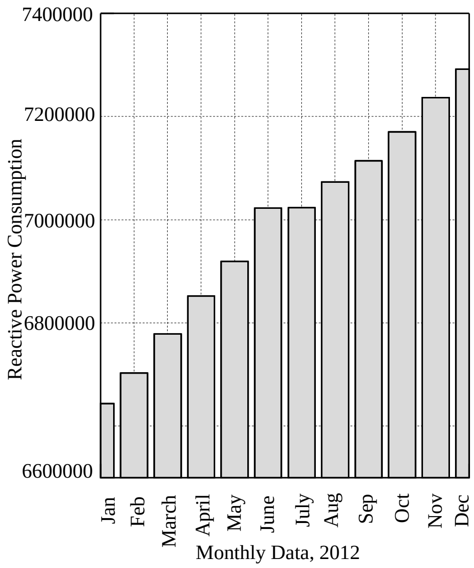

Figure 4. Reactive Power Consumption, 2012

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D. Peak Demand Analysis

The maximum demand is measured in pre-defined interval (e.g. 30 minutes or 15 minutes) through duly sealed and calibrated energy meter at main substation. A typical consumer has to pay fixed charges on the basis of peak demand from the tenaganasional considering the type of industry and operation pattern of the equipments. The peak demand is calculated as below:

Peak Demand (P_D) = Connected Load (CL) * Load Factor (LF) / Power Factor (PF) (1)

LF = UF * DF (2)

where, CL is the total connected load in the facility (kW)
LF is the load factor, UF is the utility factor DF is the demand factor
PF is the system average power factor
Utility Factor and Diversity Factor can be finding out by the time profile of load and usage of the equipment. All equipments of facility may not operate at similar time and also may not run with full load.
Hence, Diversity Factor in percentage = Installed load / running load. Obtaining higher peak demand results with the higher minimum fixed charges plus higher deposit, and penalty is exeterd when the peak demand exceeds the agreed value.
The computation procedure for the demand analysis and the net KW demand is as below. Let the contracted power be (P_C), the peak demand is (P_D) then the power used in excess (P_E) is computed as

$$P_E = P_C - P_D \quad (3)$$

where P_{Dm} is the actual peak demand value from the maximum demand meter and K_d is the demand factor

$$P_D = P_{Dm} X K_d \quad (4)$$

The penalty by the supplier to the utility is computed as where K_P is the penalty factor. Therefore the actual KW value (P_A) computed is given by

$$P_P = (P_C - P_D) X K_P \quad (5)$$

$$P_A = [(P_C - P_D) X K_P] + [P_{Dm} X K_D] \quad (6)$$

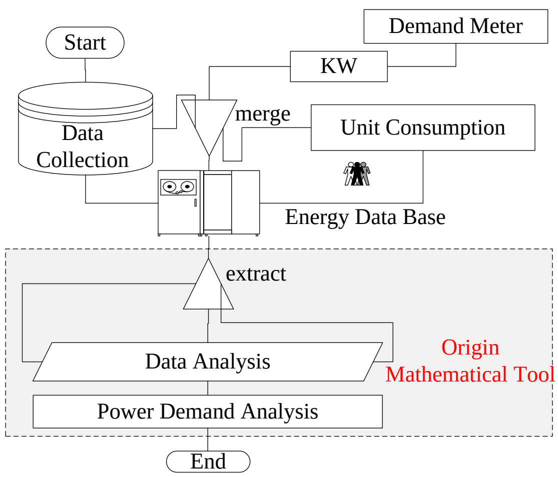

Figure 5. Methodology Employed

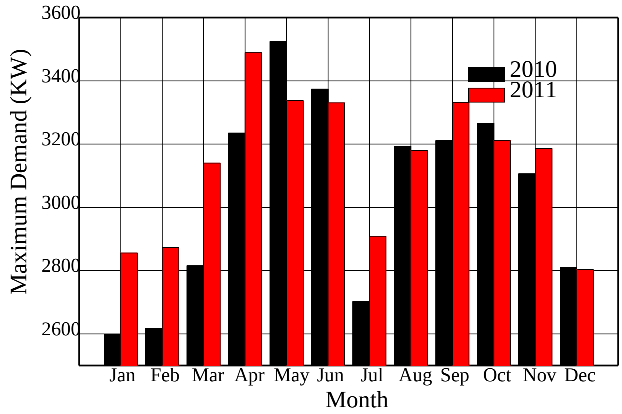

Figure 6. Maximum Demand Energy Consumption

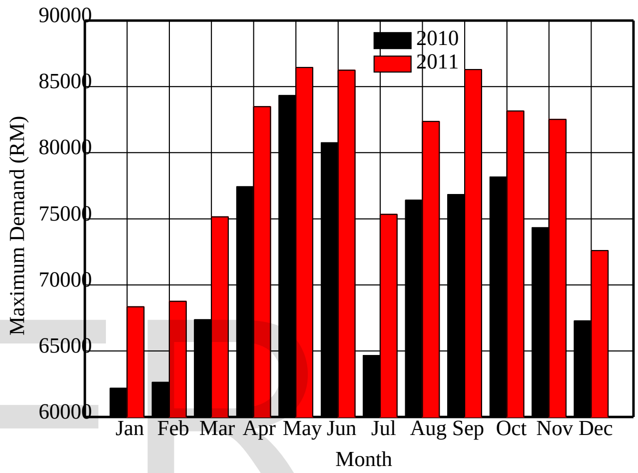

Figure 7. Maximum Demand Economics

The initial investigations on the power demand curve analysis for the look-ahead energy management system is presented in this work. It is inferred that about 20.87% of the pay bill accounted to the peak demand requirement. A sustainable framework based on this analysis would be further investigated.

III. Proposed Architecture

Figure 8 shows the proposed structure in which there is a controller that control the motion of the motor which is tracking the solar intensity based on the insolation in real time. The system comprises a parabolic dish with double layered translucent solar cell frame. A wiping lid is enclosed on both the plate surface. A thermal sensor is embedded on the surface behind the panel. As an instance the thermal storage system of the air conditioning load shifted from the daytime to nighttime. This can be charged in the night and used in place of air conditioners during the day time which is most commonly an alternative to support the tourism industry. The proposed structure is analysed for the thermal behavior in thermo-fluid dynamic software tool. The results of such a system would be documented in our future work.

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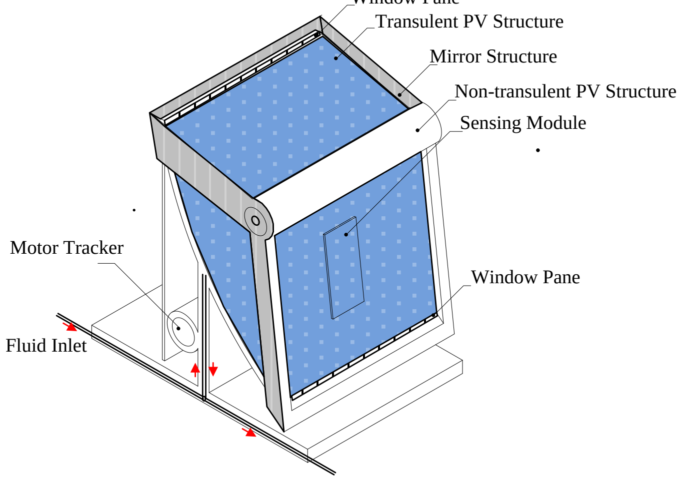

Figure 8. Proposed Structure

IV. Conclusions

Peak Demand analysis for the choice on the tourist center is performed using the energy audit measures. The maximum demand or the peak demand required is computed and using the data the design value of the proposed PV/T is recommended. Using this it is expected that the peak demand would be managed and thereby yielding a self-sufficient system in place. The proposed structure is analysed for the thermal behavior in thermo-fluid dynamic software tool. The results of such a system would be documented in our future work.

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