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Pre-feasibility Study for the Provision of Environmentally Friendly Energy Supply for the Maliau Basin Field Studies Center

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Author: Prof.Dr. Kamarulazizi Ibrahim
Centre for Education and Training in Renewable Energy and Energy Efficiency, CETREE
Universiti Sains Malaysia, Penang, Malaysia
Tel/Fax: +60 04 657 5444

Report

PRE-FEASIBILITY STUDY FOR THE PROVISION OF ENVIRONMENTALLY FRIENDLY ENERGY SUPPLY FOR THE MALIAU BASIN FIELD STUDIES CENTER

Prof. Dr. Kamarulazizi Ibrahim
Centre for Education and Training in Renewable Energy and Energy Efficiency
CETREE
Universiti Sains Malaysia
Penang

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1.0 TERM OF REFERENCE

The pre feasibility study will be based on the information already gathered by CETREE and cover:

a) **Demand**
Energy Demand of the Buildings
Solar design elements for the buildings
Selection of materials
Natural ventilation
Electrical appliance (light, fan, air-con?, kitchen appliance, laboratory equipment etc.)
Defining of average expected use of the facilities

b) **Supply**
Based on the energy demand the energy system have to meet to design an hybrid solution based on:
- Pico – Mini Hydro
- PV placed – e.g. around the Heliport and over the Badminton court
- Diesel Gen-set as reserve

c) **Investment cost and operation cost**

Based on the above demand and supply suggestion to provide roughly economical figures for comparison between a traditional solution compared to an EE and RE friendly solution.

- Ideas for possible subsidiary funds

2.0 CETREE DESIGN TEAM

Consultants

1.	Professor Dr. Hj. Kamarulazizi Ibrahim	(Photovoltaic))
2.	Assoc. Prof. Fauziah Sulaiman	(Material)
3.	Dr. A. Malik A. Rahman/ AP Dr. A.Majid Ismail	(Passive solar)
4.	Dr. Zaidi Abdullah	(Electrical savings)
5.	Dr. Sharifah Fairuz Syed Fadzil	(Day lighting)
6.	Dr. Mohd. Zin Kandar	(Energy-auditing)
7.	Dr. Mohd. Rodzi Ismail	(Air-conditioning)
8.	Mr. Ahmad Shadzli B. Abdul Wahab	(Mini/Pico Hydro)
9.	Mr. Morten Sondergaard	(Adviser)

3.0 INTRODUCTION

3.1 Design Elements

The Maliau Basin Studies Centre, Sabah, Malaysia has been zoned to be developed as the eco-friendly centre – respecting the conservation area of the Maliau Basin. Being designated as such the client wishes naturally to portray all the elements that define the term "Eco-Friendly".

Therefore apart from the tropical events and physical cues, another dimension recommended as part of the concept, is the adaptation to tropical climate whilst parallel to it is being eco-friendly to the flora and fauna. Easiest approach is air-conditioning the interior. Air-conditioning is very energy demanding and thus not eco-friendly. Maintenance is also high for it uses a big portion of energy consumption as compared to other installations. A more inexpensive alternative is the electric fan.

Further reduction in energy consumption can be achieved by means of first designing with the principles of passive solar building element and technology base on the understanding of the climatic data i.e. the sun path, air temperature, prevailing winds and relative humidity over a period of a specific time, normally during worst case condition.

CETREE can approach the Eco-friendly project in Maliau Basin in two ways:

Either CETREE start from scratch and design accordingly.
Or if there are already existing designed buildings, then our approach is to do retrofitting and provide advice for the client for the detailed design of the buildings, the equipment and the energy supply system.

In this particular project since buildings have already been partly designed and approved at planning stage, major overhauling is discouraged. Thus option number 2 is the approach.

As was mentioned earlier, with option 2 in mind and after analyzing the localized climatic data, our strategy is:

First – recommend the necessary passive solar design elements
Second – all electrical appliances to be analyzed carefully for lowest possible energy consumption and eventually use air-conditioning only at selected interiors.
Third – design a powers supply to meet the above mentioned supply based on a hybrid combination of RE with a diesel gen-set as stand-by.

3.2 Energy Efficiency (EE)

Efficient use of energy normally termed Energy Efficiency (EE) means using less energy to accomplish the same task. This translates into a "lower cost of doing business" and the production of less, polluting emissions into the atmosphere.

EE can be achieved by using currently available technology and by effectively managing the use of energy required.

For example, advanced technology has developed compact fluorescent lamps (CFLs) which offer the same level of lighting as incandescent lamps, but they use about 75% less energy and last much longer. Similarly, high efficiency electrical appliance as low energy fridge can permit dramatic energy savings over conventional alternatives.

Obviously, EE equipment is more costly than the conventional alternatives, but the overall energy cost savings greatly exceed these initial higher costs.

Experience has shown that the industrial and commercial sectors can save approximately 5% on their electricity bills and their overall energy use just by paying more attention to consumption patterns. An even much higher saving can be achieved if the energy consumption is included in the design phase. This represents an untapped potential for energy savings that can be realized with little or minor investments and will usually lead to a better performance in the overall operation of the business including the lower operation cost.

Introducing good energy housekeeping procedures or an energy management system, where energy consumption is monitored to reveal wastage, gives an overview of the potential for energy savings and a method to apply and evaluate the benefits and feasibility of improvement measures.

3.3 Renewable Energy (RE)

Renewable energy initiatives are supported by Government policies and scheduled in official planning documents such as the Eighth Malaysia Plan (five years) and Outline Perspective Plan (ten years). Both plans have integrated RE as a significant element in the overall energy sector as the nation's fifth fuel source. To assist the growth of this viable alternative, various government programmes have been developed.

During the Eighth Malaysia Plan, the overall demand for energy is expected to increase at 7.8% per annum. Considering the vast potential inherent in RE, it could be a significant contributor to the national energy supply. Government studies show that Malaysia's own RE sources are technically sufficient enough to support the current annual fuel requirements for electricity generation.

The Eighth Malaysia Plan (2001-2005) supports RE development
The main objectives of the energy sector of the Eighth Malaysia Plan are as follows:

- Ensuring adequacy and security of fuel supply as well as promoting the utilization of gas and renewable energy;
- Ensuring adequacy of electricity supply as well as improving productivity and efficiency;
- Developing energy-related industries and services as well as increasing local content;
- Promoting Malaysia as a regional center for energy-related engineering services; and
- Encouraging efficient utilization of energy, particularly in the industrial and commercial sectors.

For remote areas RE is normally regarded as an interesting alternative. For conservation areas RE is vital in order to ensure an energy supply without pollution and noise. It is believed a combination of supply system on various RE sources will provide an adequate and environmental supply for the centre.

4.0 DEMAND

Based on the energy demand of the building, a few possible ways to optimise the expected energy requirement is suggested.

4.1 Solar Design Elements for the Building

Briefly this report helps the designers to understand the energy consequence of their basic decisions in the design of passive elements of a building, and to offer them invaluable information so as it can be implemented on energy issues to generate form instead of responding to the designated spaces that have to be accommodated. There should be an energy-form relationship in the quest for architectural form as a part of manifestation of the energy flows that are inherently present in any building. It is hoped that after going through this report the interested reader would be able, with some experience, to create form that is influenced by the natural behavior of the sun, wind and day lighting. In simple language the mindset should be trained to manipulate strategies to create forms to manifest the energy process.

Passive means of cooling and day lighting are closely tied to building form than active systems. The recommendation is to first and foremost to approach from the passive cooling technology, followed by the conventional mechanical systems and the photovoltaic applications should be seriously be considered for further savings is very rewarding.

Below is a list of the many variables and considerations that can be applied depending on the actual location of the building. These variables can be applied selectively or all of them when carefully designed from the initial stage, otherwise as retrofits. The variables considered here are thought to be relevant for this particular project until further detail feasibility study at the actual site is done. There may be few more variables that can be added and those mentioned here can be replaced or deducted totally.

Considerations:

THE BUILDING SITE :	*Location* *The Site*
THE BUILDING DESIGN:	*Building Materials* *Reducing Radiant Heat* Natural Ventilation

4.1.1 The Building Site

The building site is where a building will be erected. Designers are to be aware of the environment of the site, its microclimate and the physical features. Untampered environment would not be suitable for settlement. Therefore modifications by humans to suit their living conditions are to be executed wisely with care and consciousness without causing imbalance to the microclimate. Understanding and identifying the cooling elements of a building site and incorporating them into the building design as a whole would help reduce heat island in the surrounding region.

4.1.1.1 Prevailing Winds in the Valleys

Prevailing winds are usually experience at sloping terrains and valleys. Cold air at night is heavy and would move down towards the bottom of the valleys. It can be cold to appoint where fog and frost normally do happen even in the tropical climates. When the sun begins to appear the air gradually gets warmer and warm air becomes buoyant and gradually move up towards the atmosphere. In this way one can experience air movement constantly by the hill-slopes and valleys

4.1.1.2 Existing trees and the strategic planting of new trees

It is advisable first and foremost to identify the types of vegetation if there are any existing ones that would contribute to the cooling effect of the site after completion of building construction. Trees that provide shade without restricting the path of wind at human height should highly be retained. If it is not possible to retain existing trees of significance, then it is better to locate possible areas where shade can be provided by replanting later on. This decision will run parallel to orientation of the sun which will be mentioned later on. Also when choosing a tree for strategic replanting, the shape of the tree canopy is very important. Any tree with an umbrella type of shape is more appropriate than trees for decorative purposes which contribute very little in terms of cooling the immediate surroundings. The Christmas-shaped tree like the pine trees are mainly planted for the majestic effect. These types of trees when planted in rows and in straight lines provide a strong direction of an avenue, but very little shadow and frequently blocks the wind path are the two drawbacks which is not appropriate for thermal comfort as was mentioned earlier. Vegetation should be maximized, and where possible, man-made structures or surfaces, such as streets and roofs should be shaded by trees with big canopies.

4.1.1.3 Hard versus soft surfaces

Shrubs and turfed surfaces absorb heat and prevent reradiating to the air mass immediately above. These climatic benefit of landscaped ground cover is seldom considered. Hard landscaping is not only aesthetically pleasing but also of minimal maintenance. Soft landscaping needs constant maintenance such as trimming and mowing at regular intervals. The relationship of lawn and other living ground cover surfaces to non-evaporating surfaces (driveways, streets, roofs) will in part determine neighborhood air temperatures. These in turn, will influence the cooling load on houses in the area, as well as the suitability of natural ventilation as a cooling strategy.

4.1.1.4 Evaporative cooling

Malaysia frequently experience tropical rain normally called as convection rain. Usually convection rain happens suddenly after one experience an extraordinary warm weather as compared to other normal days. We welcomed such rain because it cools the ground, hard landscape, roads and buildings. This is one way of natural cooling which is beyond the control of man. We can imitate such a situation for the surrounding atmosphere whenever we find that that particular day is a bit too warm for comfort. Cooling outdoor atmosphere by evaporative mechanisms can help to provide outdoor comfort by lowering air temperature surrounding the building. This in turn help to reduce the cooling load transmitted through the building envelope and makes effective the much needed natural ventilation. The denser cool air will tend to flow downhill. The outdoor space enclosed with a wall or fence such as courtyard designs often with fountains or spray jets is a good way of cooling the mass of air surrounding it..

4.1.2 The Building Design

After considerations have been given to the natural elements surrounding the building site and a building design proposed, further thoughts on the building envelope itself are to be carefully executed. This is to make sure that the natural endowments that have been considered are not jeopardize by the wrong decisions made in the building construction. This section concentrates only on domestic buildings.

4.1.2.1 Building materials

The types of building materials make a lot of difference in contributing to the overall thermal comfort in a domestic building. Simple physics would tell us any dense material such as concrete would absorb heat readily and releases heat very gradually. During the daytime when exposed to the sun, it absorbs and stores heat and at night time it releases heat to the immediate air around it because of the absence of sun and the night air is cool. Since heat travels from hot to cold, the cool air is warmed up by the heat which was stored during the day. The thermal performance of a brick wall house would behave almost similar to the concrete house. Contrastingly, timber absorbs heat readily and release heat readily as well. This accounts for the traditional Malay house being very cool during the early mornings, very hot during mid-day and cool at night.

4.1.2.2 Reducing radiant heat

Shape and orientation – The amount of solar heat received by the surfaces of a house can be minimized for any period of the year through the manipulation of the orientation and shape of the building plan with respect to the sun and also different building heights.

Roof shape and roof pitch – Roofs are the most exposed surfaces to the sun. In fact it is exposed all parts of the day until sunset. The effect of roof shape and roof pitch on solar gain depends on the sun angle. When the sun is high, all roofs of the same horizontal area intercept the same amount of sunlight. At lower angles, high pitches roofs increase exposure area and therefore increase solar gain from intense insolation. In Malaysia the hottest part of the day would be from between 12.30 pm to 3.30pm where at least about 700 watts/m2 would be experience for about four hours. Therefore design of a roof should take a different pitch to minimize absorption of heat by insolation. If a beam of sun insolation spread over a bigger surface area the absorption is less intense than being concentrated on a smaller surface area. A lower pitch facing the morning sun but a steeper pitch facing the afternoon sun would be recommended. Flat roof should be avoided at all times in design of buildings in tropical climates unless mitigating elements to reduce temperature are being considered together in the initial design. Staggering the height and orientation of roofscape is a better option. Staggered roof would provide some shading and this is better than none at all.

Provide shading for walls exposed to the sun – The absorption and release of heat from solar insolation is happening outside the building envelope and thus prevents any heat build-up in the building.

Use of planting next to building skin – Climbing ivy or any sort of creeping plant is a useful climatic protection when grown next to the building skin because it performs several functions simultaneously. The most obvious benefit is its shading ability. A dense cover of planting will intercept the sun's radiation before it reaches the building skin, thereby reducing the exterior surface temperature and the amount of heat conducted into the interior, very much like the function of the louvers. If, for example, an ivy cover on a wall trellis transmits only half of the sunlight striking it, it will cut the solar gain at the surface by 50%. The process of evaporation and transpiration damps the surface thus lower surface temperature than the surrounding air by 1C to 2C. One disadvantage of planting is that it traps air near the surface of the building, thereby decreasing the effect of breezes in washing away the boundary layer of heated air. In Malaysia any breeze that is strong enough to ripple the leaves which will certainly override this disadvantage, and the positive cooling effect of evaporation of water from the leaf surfaces will also counteract against overheating of this air layer. Another option is to aligned potted plants along the exterior walls

Use roof and wall spray –Exterior building surfaces exposed to the sun can benefit from the cooling effects of surface evaporation through a variety of techniques. The two major types are roof ponds, which must be planned as an integral part of the structure, and roof sprays or washes, which can be built-in retrofitted to most conventional residential roofs. The primary function of a roof spray system is to relieve the roof surface of the solar load by dissipating solar heat as it arrives at the roof surface thus imitating the rain. Houses without attics or with poorly insulated overhead assemblies are the most likely beneficiaries of roof spraying techniques. The foremost effect of roof spraying is to lower the temperature of the roof surface. In addition to the possible interior cooling benefits, it washes the exterior walls of the structure with a curtain of falling cool air. In a fairly efficient operation, over 90% of the solar load upon the roof can be alleviated. Roof surface temperatures commonly in the range of 140-160F can be reduced to 80-100 F under hot sunny conditions Spray mists along the ridge of the roof are very cheap to install, at least about 60 sen per spray head and the rest is the piping. It uses very little water to wet the roof. Use only when the surrounding environment is extraordinarily warmer than usual.

Wall spray is also another mode of cooling the building fabric.

Use heat reflective materials on surfaces oriented to the sun – When solar radiation strikes an opaque building surface, a portion of the heat is reflected away and the remainder absorbed, the amount of reflection and absorption depends on the type and description of material used. It is commonly acknowledged that painting a house a light color will keep it cooler. Whitewashing a dark wall or roof can considerably reduce solar heat gain, as characterized by buildings in the hot dry climate such as those in the North African countries. Other reflective materials are mostly used as insulation materials to reflect solar heat rather than sun rays. Theses are normally located in between walls exposed to the sun and under roof finishes. These reflective materials are mostly made out of aluminium sheets for its thinness and durability.

Use of insulation materials – There are many in the market that helps to reduce roof space heat build up such as the Coolbatts which is common in Malaysia. It is placed on top of ceilings to prevent heat build up in the roof space from radiating the air just below the ceiling and conducting heat to the ceiling fabric thus transferring to the walls.

4.1.2.3 Natural ventilation

Some basic air movement principles need to be understood first before designing natural efficient energy-conserving buildings and systems. Wind originates from the sun's energy. The solar radiation heats up the earth. The earth then absorbs, reflects and reradiates the heat thus causing a zone of low pressure because the heated air above the earth becomes less dense and buoyant. It will ascend to the higher levels of the earth atmosphere. The vacuum it creates while leaving its original position is filled up by air from a zone of high pressure. The movement of air from the zone of high pressure to the zone of low pressure is wind. Therefore wind occurs only when there are these two zones happening.

Wind deflectors – Use of wing walls and louvers to direct wind flow into the interior. Projections from the surface of the building shell can be used to increase the volume and velocity of air flow into the structure and to alter the flow pattern of air as it enters and travels through the interior. In less ideal site conditions these appendages to the building shell can enhance the building's ventilating ability but they are not a substitute for proper site planning and orientation. Wind-directing devices may be either horizontal or vertical, and either fixed or operable. Both vertical and horizontal devices act through a damming effect that blocks and changes the direction of air flow.

Shape and orient the building shell to maximize exposure to breezes – For simple rectangular shapes, typical of housing, wind currents are best exploited for natural ventilation by orienting the building shell so that its longer façade is approximately perpendicular to the flow of prevailing breezes. Where a prevailing breeze direction does not exist, the building can be shaped, or oriented to capture or funnel the flow of wind through its interior. In plan, for example L-shaped configuration will act as an effective air dam. In section, a high façade on the windward side of the building also will increase surface air pressure, which is the driving force of ventilation design. A traditional response to maximizing ventilation is to elevate the building to be exposed to higher wind velocities, like the traditional Malay village house.

Open plan interior helps promote interior air flow – No obstructions such as internal partitions and other physical obstacles to air movement in the interior of a building will obviously allow uninterrupted air movement generated by wind from outside thus bringing in fresh 'new' air to replace the static stale air inside. Such open plan houses are normally found in traditional Malay village houses. Even the interior of a house has little partition but cluttered with furniture and other modern household gadgets will also reduce air movement inside the house. The diagram shown here is using water flow visualization to see how wind enters a house and its path inside the house.

Air shafts – Hot air rises. In a building this natural process is termed as *stack effect.* With the combination of body heat, light sources, cooking activities and building internal reradiating, the creates the potential for internal air flow even under calm outdoor conditions. The efficiency of the stack effect to cause air movement depended very much on how easily air may rise within the house. Air flow would be restricted in a well partitioned interior, whereas tall studio spaces and open-walled balcony rooms encourages generous air movement. Roof monitors called the jack roofs are designed to release hot air from the interior by the stack effect so that no hot air is trapped underneath the ceiling. In tropical climates in Malaysia, most of the time the stack effect is slow to rise naturally to provide an adequate change of fresh air. A gadget called the turbine ventilator can be installed on the roof to facilitate the required velocity to get rid of internal heat. When there is alight wind above it will cause the turbine to move at a faster speed which in turns will suck out the air underneath it. Therefore a good amount of cross ventilation can happen when wind comes in through the windows or other forms of fenestration. Obviously, any type of ventilating stack is well suited for power assisting by an electric fan. This aids in the exhausting of interior hot air as well as encouraging air circulation within the dwelling.

Use double roof and wall construction for ventilation within the building shell – Double walls and roofs can be used as independently designed devices to perform as retrofitting. When double wall or roof is exposed to sunlight, the heated air column inside will attempt to rise by natural convection. If openings are provided at both top and bottom, the wall will ventilate itself, effectively washing away the excess solar heat gain and maintaining an internal temperature near that of outdoor air. A double wall popularly known as the "Trombe" wall, named after a French Engineer, can be used but should be considered carefully when used in the tropical climate. This design uses the concept of collecting the sun's heat in a cavity to generate a fast moving stack effect that would siphon off the air from the interior. It is best to face either the afternoon sun where the intensity is greater. This would be a simple design if used in cold and temperate climates but for buildings in the tropics the danger of heat transfer by conduction may be a possible threat, unless there is a gap.

Orient door and window openings to facilitate natural ventilation from prevailing breezes – Outdoor breezes create air movement through the house interior. Good natural ventilation requires locating openings in opposing pressure zones. The driving force of ventilation is increased (i.e. more of the wall is exposed to maximum pressure) if the building is elongated and sited with the long façade facing into the wind. One means of ensuring good and uniform ventilation is to utilize louvers.

Use louvered wall for maximum ventilation control – At times when cross ventilation is capable of producing comfort conditions within a dwelling, the best wall will be no wall. This is commonplace in many tropical climates, where a house may consist of little more than a raised platform and roof to block the sun. Houses in these climates could still benefit from a device that facilitates nearly unrestricted air movement, but which can be closed at will to exclude the elements. The louvered wall is such a device. As in the previous section on louvered openings for windows, the louvered walls too not only allow wind to pass through but also provides natural lighting during day time. These louvered walls can either be fixed and inclined or manually and/or electronically controlled when vertically designed. Other variations the different types of ventilation blocks.

4.2 Identification Of Energy Saving Measures And Devices

4.2.1 Lighting

Use compact fluorescent lamps (CFLs), even though they are more expensive to purchase, they use less power to produce the same amount of light as compare to for example incandescent lamp.

Use the right amount of light for the need at the right place, e.g., brighter for reading, dimmer for watching TV or video, etc.

Ordinary fluorescent lamps give about two times the light of an incandescent bulb.

Where possible, use photo-electric switches, timers and dimmer controls to save energy further.

4.2.2 Fans

Fans are cheap but reliable, and are thus not replaced frequently. However, technological developments make the new fans more energy efficient than the older ones. Check the coefficient of performance (COP) of the fan. A ceiling fan should be 3.5 m^3/min/W or better.

Ensure that the fan is not blocked from behind, as the resistance to the air flow will reduce its performance, or make it operate in an "overload" condition. Fans only circulate the air, and should be operated with possibility for external air exchange, to use the cooler outside air when possible.

4.2.3 Home Entertainment

Home entertainment equipment such as TV, radio, stereo and video is quite energy efficient, but different manufacturers may still have different power requirements for similar appliances. Equipment graded under "Energy Star", or similar standards is efficient, and should be selected where available.

4.2.4 Computers

Purchase a computer that has an energy star label. The more the number of stars, the more efficient is the computer with regard to energy consumption. Check that the computer has a sleep mode. Flat screen monitors are far more efficient than conventional types (using cathode ray tubes). Lap-top, or note-book computers, consume much less energy (less than 30%) of desk to PCs.

4.2.5 Refrigerator/ Freezer

Check for the energy rating and labelling of the refrigerator. The nameplate data will give the wattage of the equipment. An upright freezer uses more energy compared to a chest freezer.

4.2.6 Oven and Microwave Oven

Choose a microwave ovens rather than conventional types as they use less energy and cook faster. They are also useful for quickly heating (reheating) food. A microwave oven saves up to 75% of energy for cooking compared to conventional electric oven because of its lower power demand and quicker cooking time.

4.2.7 Air Conditioner

Choose the correct size air conditioning unit with respect to the room size. Look for the Energy Efficiency Ratio (EER) of the air conditioner. EER for 1 hp units range from 8 to 10. The higher the EER the more efficient is the unit. Check the energy star rating of the unit. The more the stars, the more efficient is the air conditioner (up to a maximum of 6). Check the airflow rate, (normally in cubic feet per minute, or cfm); the higher the rate (between 200-300 cfm for a 1 hp unit) the faster the cooling and the better the air circulation.

5.0 SUPPLY

5.1 Estimated Energy Requirement

The total power load was estimated to be 89.97 kW. Distributed into 47.8 kW during the day and 57.84 kW during the night consumption.

The day energy demand was 382.67 kWh and the night energy demand was 360.04 kWh.

The energy requirement can be fulfilled by a stand alone system either with diesel gen-set or photovoltaic energy system (PV) or mini-hydro. So as to ensure a reliable and continuous electrical power supply a hybrid system is proposed. The hybrid system will consist of PV and diesel gen-set as reserve.

5.2 Photovoltaic Energy System (PV)

A photovoltaic energy system consists of the following components; solar modules, power conditioner/ charge controller, batteries, inverter and other normal requirement of a stand alone power station.

Silicon monocrystalline solar modules are rated between 40 to 120 W_p. This power value indicate the maximum power that can be delivered during high noon with clear sky. The output of a solar module depends on the amount of sunlight or solar irradiance, falling on it, so it is important to determine how much solar energy is available at the site. Solar irradiance levels vary during the day with the angle of the sun, with season, with latitude and with climate. Silicon polycrystalline solar modules are more suited for areas that do not have a high margin of direct radiation.

The balance of system, like power conditioner/charge controller, batteries, inverter etc. are standard components in power electronic.

Large amount of money are required initially for PV systems to cover capital costs but then recurrent costs are lower. Hence if there is uncertain funding in the future for fuel or maintenance PV has an advantage.

It is envisaged that the location of the PV system to be around the Heliport and over the Badminton court.

6.0 Investment Cost and Operation Cost

6.1 Proposed System Cost

Based on the information provided on the energy requirement for a 100 kW system a more reasonable hybrid energy supply per day will be 130 kWh/day after taking into consideration the suggested solar design elements for the building and the electrical appliances.

The hybrid system will consists of 750 to 800 modules rated at 120 W_p, 200 to 300 deep discharge batteries rated at 800 Ah giving a five days autonomy, a 60 kW inverter and a back up system consisting of one 10 kW gen-set for charging and one 50 kW gen set for standby.

The PV modules from Kyocera cost approx. RM2 million and added to that the balance of the system, the estimated investment cost is RM5 million. The operational cost on PV is between RM20 to RM30 thousand per year and RM10 to RM15 thousand per year fuel cost.

A stand alone power station using two diesel gen-sets of 100 kW rating, one on standby, 415 V generator and feeder board, 10,000 litre fuel tank etc will cost RM600 thousand. Using a 12 hours operation and a diesel price of RM2/litre, the fuel cost will be RM150 thousand per year. The operation cost which include maintenance, fuel and personnel will be about RM300 thousand per year.

6.2 Possible Subsidiary Fund

There are two possible subsidiary fund to support the renewable energy and energy efficiency components. There are the MESITA (Malaysian Electricity Trust Fund Account) and UNDP/GEF.

6.2.1 MESITA

The Malaysian Electricity Trust Fund Account was set up in 1997 to give support to rural electrification, energy efficiency, R&D in renewable energy and human resource development for the electrical industry. The ministry of energy, communications and multimedia (MECM) is the secretariat for MESITA and co-ordinates all activities of the fund.

6.2.2 UNDP/GEF

United Nations Development Programme/ Global Environmental Facility are international organizations that are assisting Malaysia by supporting activities directed at sustainable development, which include renewable energy and energy efficiency. They provide financial support for renewable energy demonstration projects.

7.0 Others

Recommendation provided are based on the information given and meeting held between CETREE and the Maliau Basin Studies Centre at Kota Kinabalu (5 November 2001).

We have not consider hydro due to a limited information available. We have to visit the site for a reasonable proposal but unfortunately due to financial and time constraints we decide not to proceed further on this proposal.

The calculations that have been done are only a rought guide toward a reasonable implementation of renewable energy and energy efficiency in Maliau Basin Studies Centre. The main purpose of the calculation is to indicate cost comparison. A more accurate cost calculation may require a site visit which include meterological data measurements etc.