EXPERIENCE IN DEVELOPING SOLAR HYBRID SYSTEM FOR RURAL ELECTRIFICATION IN MALAYSIA

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INTRODUCTION

- There are 99.9% community in Malaysia was electrified by National Grid sources.
- How about another 0.1%??
- Most of them were living in rural area which located too far from our National Grid sources.
- Usually, there are using stand alone generator to produce electricity for their houses.
- Cost of energy to produce 1kWh is too high due to high cost of diesel and maintenance of the diesel generator set.
- So, as solution, TNB has develop an alternative method in giving supply to this small community known as Solar Hybrid System.

MODE OF SUPPLY

Modes	Typical	Alternative
Grid Extension		
Diesel Stand Alone		
Solar Hybrid System		

ISSUES AND CONCERNS OF REMOTE AREAS POWER SUPPLY

Grid extension:

- High cost
- Need extensive and complicated installation works.
- Need high voltage system to carry current over long distance.
- Geography obstacle i.e Islands
- No contribution towards renewable energy.
- Pollution shifted to power plants

ISSUES AND CONCERNS OF REMOTE AREAS POWER SUPPLY

Diesel Stand Alone:

- Generator set starting failure, requiring unscheduled site visits for fault rectification/ need on-site operator.
- Generator engine life is low due to high running hours.
- For isolated area, fuel logistic and handling increase operational cost.
- Underload operation shall cause poor fuel economy, reduced reliability, shortened engine life, and high operation and maintenance costs.
- Pollution from engine emission.

SOLAR HYBRID CONCEPT

- Integrates multiple power sources, using intelligent controls to manage the system operation.

- Increased reliability due to multiple power sources.

- The configuration of PV, Battery and Genset shall be based on budget and economic & technical optimisation.

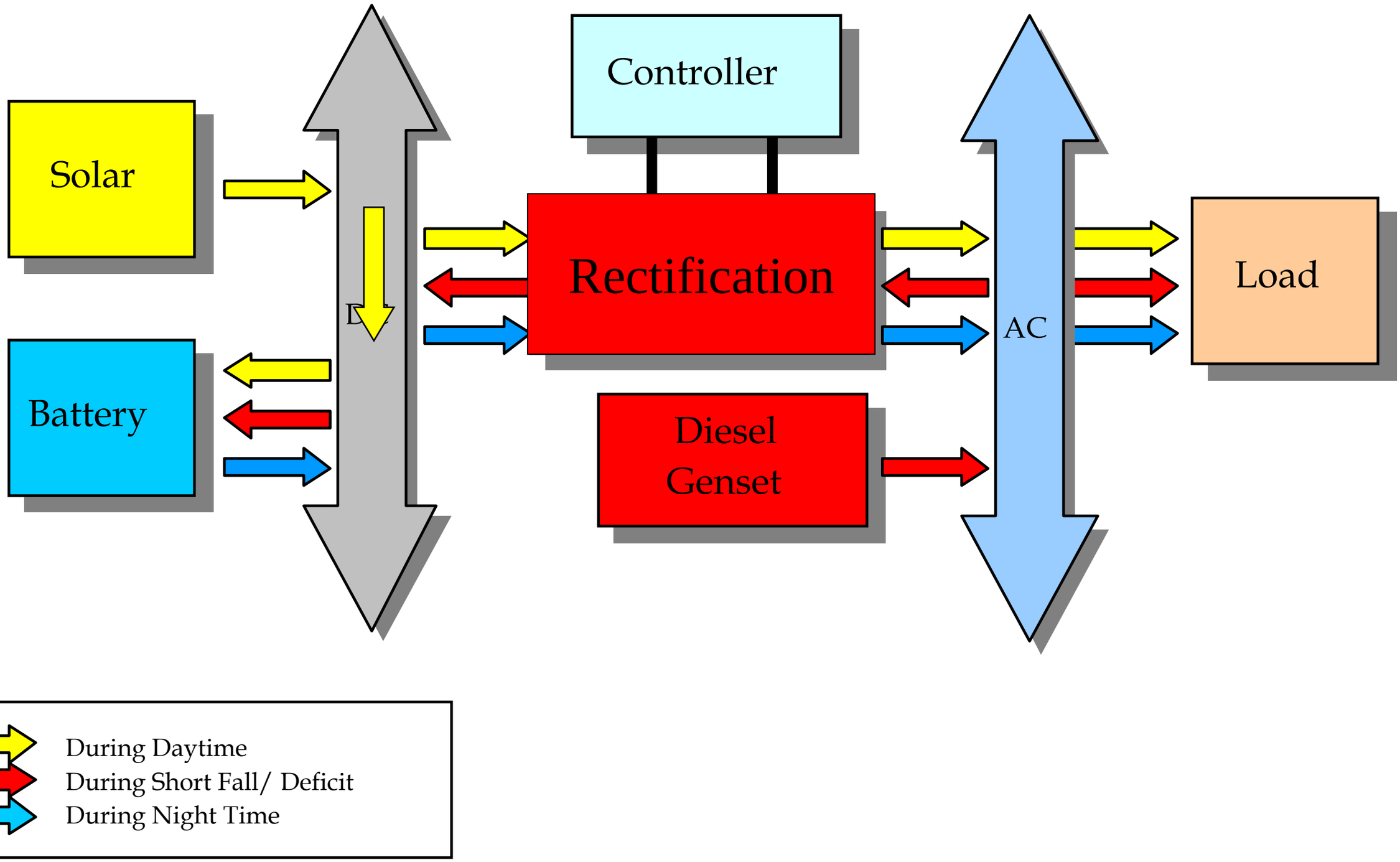
DESIGN OBJECTIVE

- To provide 24 hours reliable electricity supply to the user
- To reduce usage of diesel fuel & maintenance cost.
- To maximize the uses of renewable energy.
- Remote and on-site plant control system to monitor and control the system.
- To get high reliability system, with support/ back-up whenever needed.
- To gain low & optimised generation cost.

THE SUITABLE CRITERIA FOR SOLAR HYBRID SYSTEM

a) Distance from existing grid sources more than 15-20km depend on load demand
b) No planning for grid extension in next 5 years
c) Enough space and no shading
d) Accessible for fuel delivery and routine maintenance work

SOLAR HYBRID OPERATION



ANALYSIS & SIMULATION

Solar Hybrid system was designed using HOMER simulation software

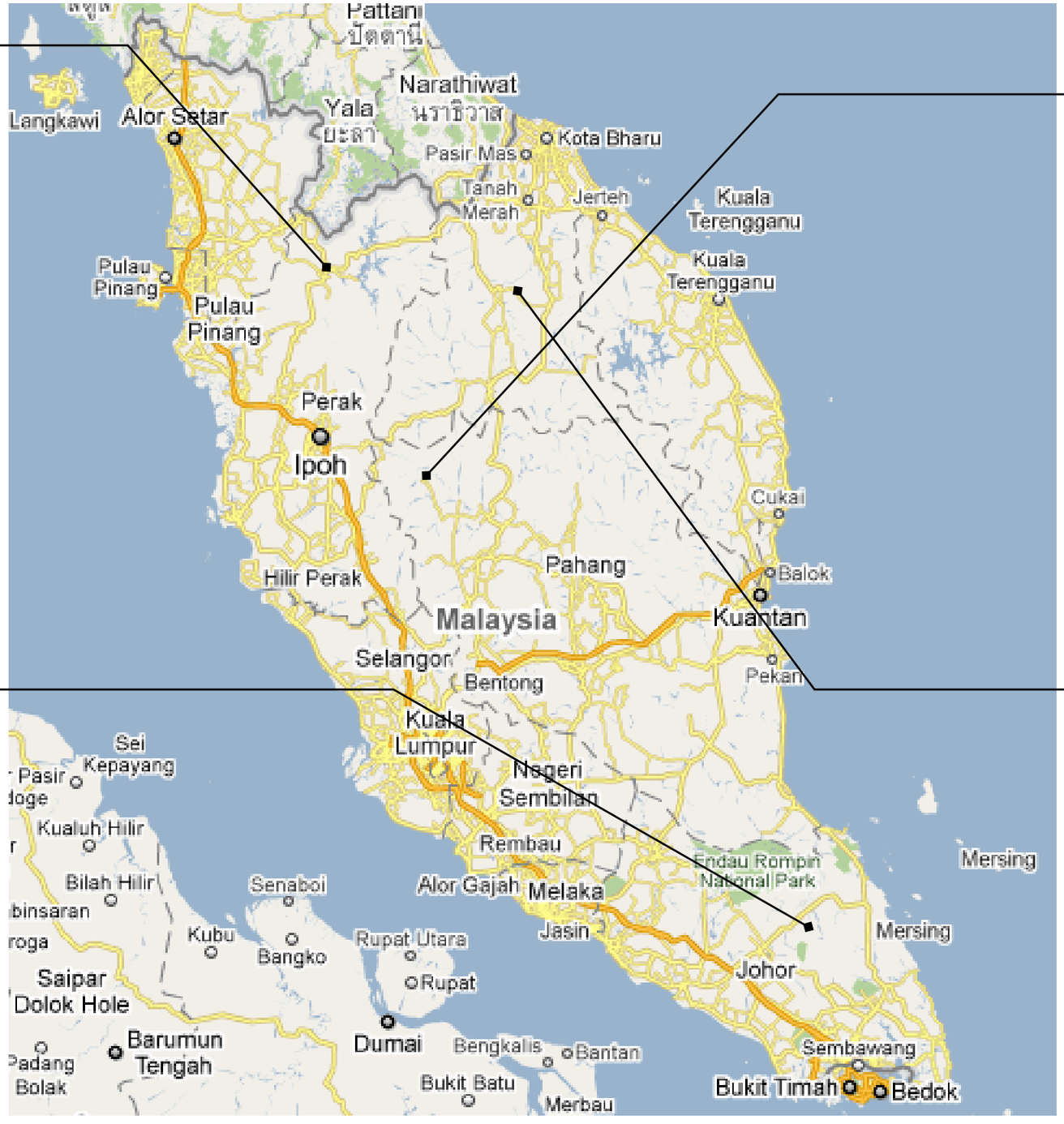
HOMER

The Hybrid Optimization Model for Electric Renewables (HOMER) software is developed and copyrighted by the Midwest Research Institute ('MRI') and U.S. National Renewable Energy laboratory (NREL)

19 NOS SOLAR HYBRID STATION (RURAL SCHOOL)

PERAK D

1. *SK RPS Dala, Gerik*
2. *SK Sg. Tiang, Gerik*
3. *SK Pos Piah, Kuala Kangsar*
4. *SK Kuala Mu, Kuala Kangsar*
5. *SK Pos Tenau, Slim River*



PAHANG A

1. *SK Telanok, CH*
2. *SK Lemoi, CH*
3. *SK Senderut, lipis*
4. *SK Lenjang, Lipis*
5. *SK Titon, Lipis*

JOHOR

1. *SK Peta, Mersing*
2. *SK Punan, Kahang*
3. *SK Tanah Abang, Mersing*
4. *SK Tunjuk Laut, Kota Tinggi*
5. *SK Ladang Mutiara, Kluang*

KELANTAN A

1. *SK Blau, Gua Musang*
2. *SK Sri Permai, Gua Musang*
3. *SK Balar, Gua Musang*
4. *SK Pulat, Gua Musang*
5. *SK Bihai, Gua Musang*

24 NOS SOLAR HYBRID STATION (RURAL VILLAGES)

PERAK

1. *SSH Sg Tgh, Gerik*
2. *SSH Melela, Gerik*
3. *SSH RPS Kemar, Grik*

Langkawi

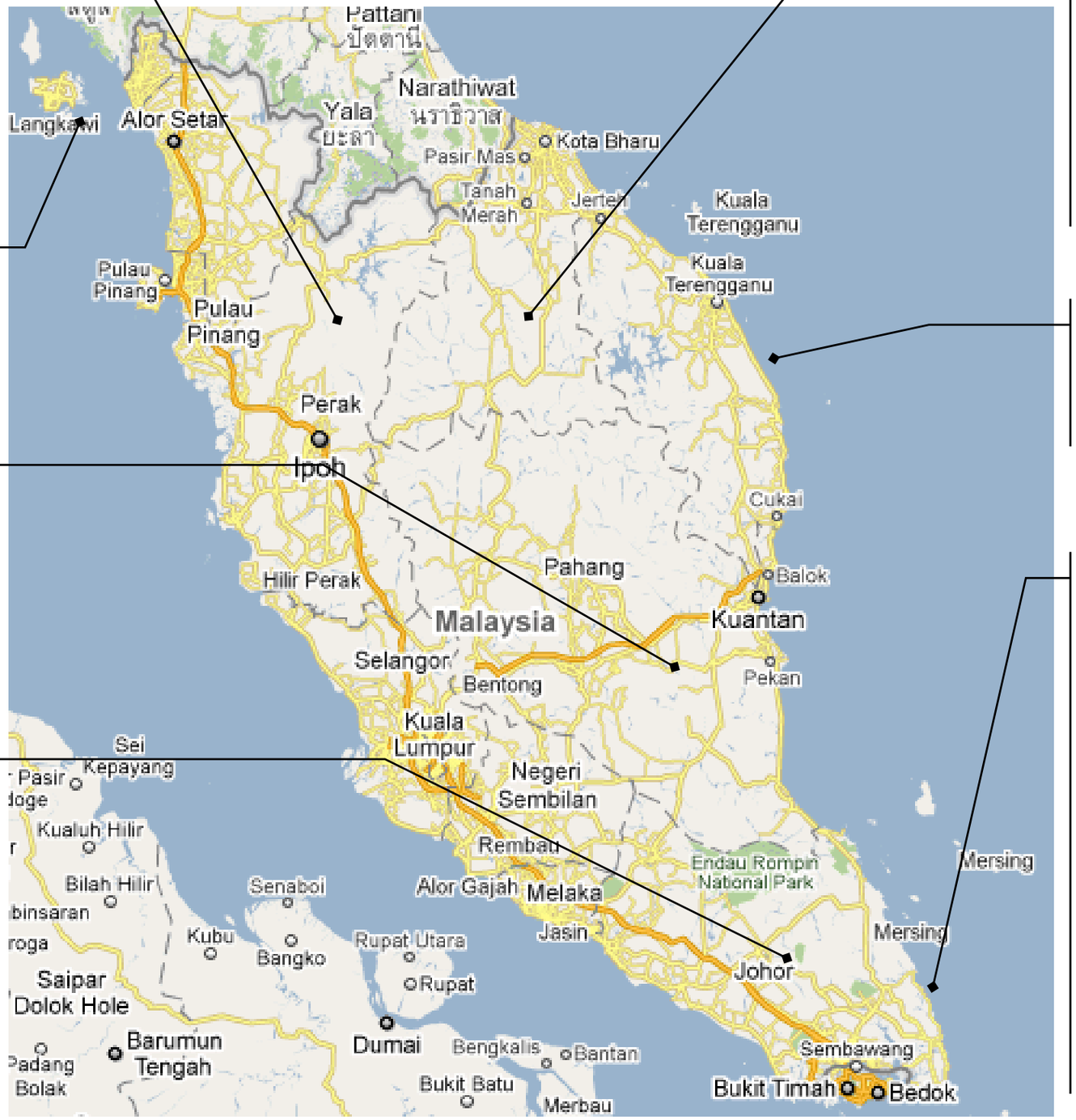
1. *SSH Gunung Machinchang, Langkawi*

PAHANG

1. *SSH Ganuh, Muadzam,*
2. *SSH Kg. Denai, Rompin*

JOHOR

1. *SSH Peta, Mersing*
2. *SSH Punan, Kahang*
3. *SSH Tanah Abang, Mersing*
4. *SSH Peroh, Kluang*
5. *SSH Tjg Tuan, Mersing*



KELANTAN

1. *SSH Blau, Gua Musang*
2. *SSH Pos Pulat, Gua Musang*
3. *SSH Aring 5, Gua Musang*

TERENGGANU

1. *SSH P. Perhentian*
2. *SSH P. Kapas*

JOHOR (MERSING)

1. *SSH Kg Buau, P. Pemanggil*
2. *SSH Kg. Pak Kaleh, P. Pemanggil*
3. *SSH Kg Duku, P. Sibu*
4. *SSH Kg. kampa, Pulau Besar*
5. *SSH telok Berhala, P. Aur*
6. *SSH Tlk Meriam, P. Aur*
7. *SSH Tjg Balang, P. Tinggi*
8. *SSH Pasir Pjg, P. Tinggi*

14 NOS SOLAR HYBRID STATION AT SABAH

SSH Pulau Banggi

RURAL SCHOOL

1. *SSH SK Malinsau*
2. *SSH SK Senderut*
3. *SSH SK Togop darat*
4. *SSH SK Togop laut*

BELB Fasa 1 & 2

1. *SSH Sinulihan,Tuaran*

BELB Fasa 1 & 2

1. *SSH P. Lubukan, Sandakan*

BELB Fasa 1 & 2

1. *SSH Meligan 1, Sipitang*
2. *SSH Meligan 2, Sipitang*

BELB Fasa 1 & 2

1. *SSH Monsok, Tambunan*

BELB Fasa 1 & 2

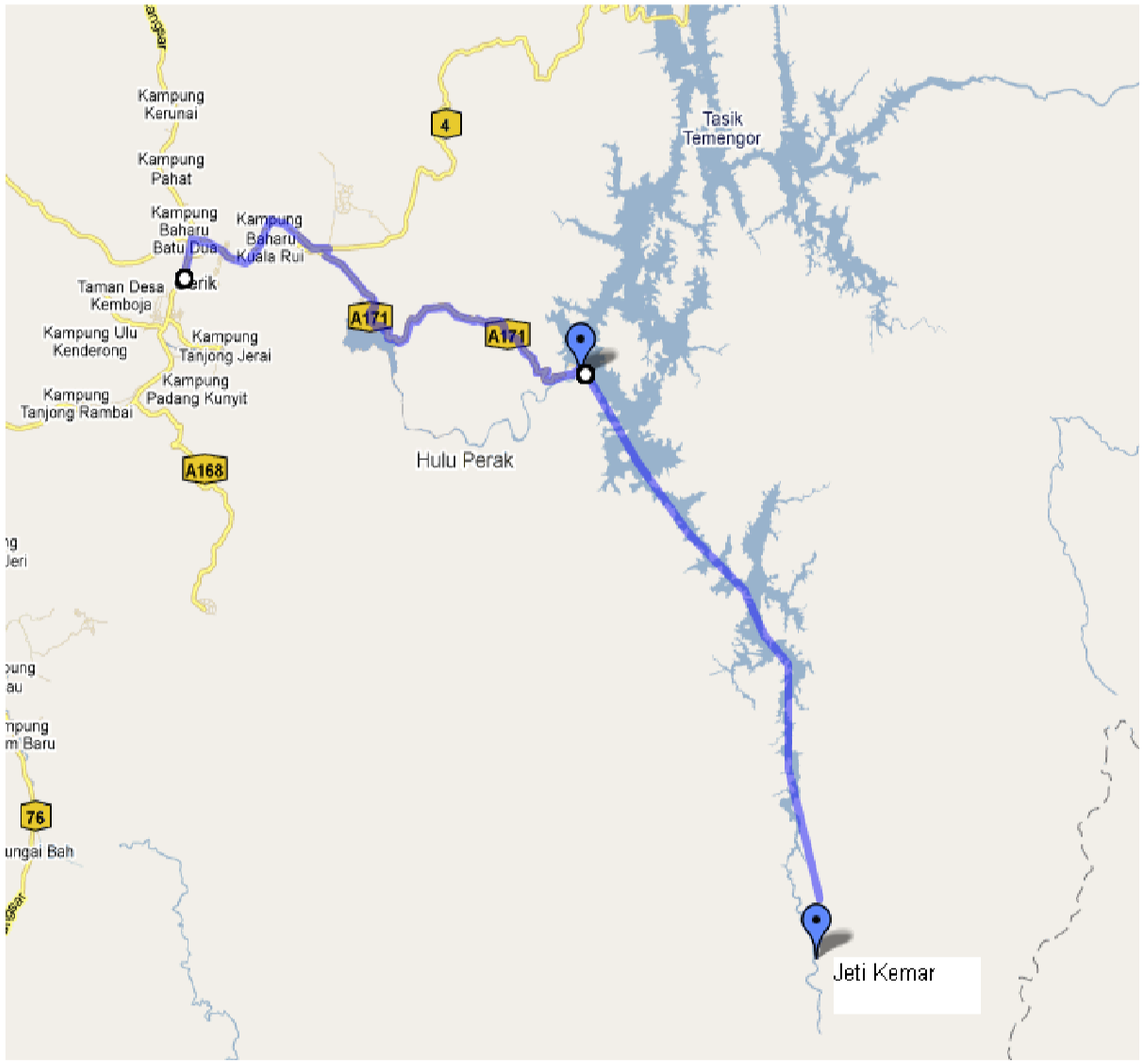
1. *SSH Pagalungan, Nabawan*

SSH Kalabakan, Tawau

LOCATION OF PROJECT

- Solar Hybrid Station is located in RPS Kemar, Gerik, Perak and coordinate N 05° 12.038’ , E 101° 23.765’.

- The site is accessible via speed boat ride from Jetty Banding or Jetty Trojen Tasik Temenggor, Gerik which takes 1 hour journey to reach Jetty Kemar.



LOCATION OF PROJECT

- From the Jetty Kemar, 4Wd can be rented for transportation to the administration centre and the distance is about 6km from the jetty which the journey is approximately 15 minutes.

- The proposed area of Solar hybrid Station is located at the administration centre

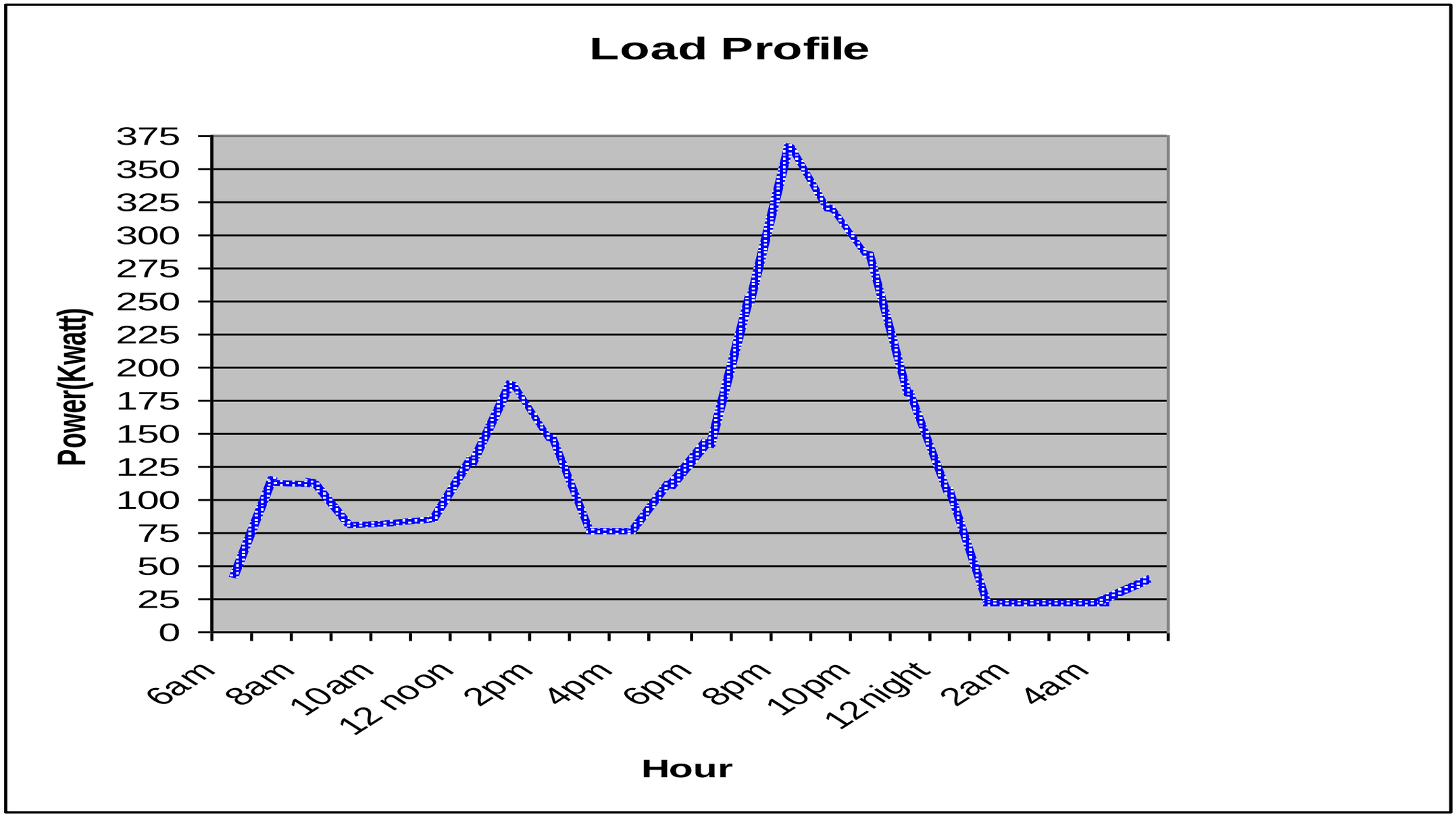
LOAD STUDY

Based on the findings and discussion with our Client, the tabulated number of consumer as follows:

BIL	VILLAGES	VILLAGERS	HOUSES
1	KAMPUNG LERLAR	208	17
2	KG RANTAU	448	19
3	KG SENANGIT	186	27
4	KG LEDIOU	153	12
5	KG JARAU LAMA	237	22
6	KG JARAU BARU	108	26
7	KG SHAH	222	20
8	KG RALAK	212	12
9	KG CHUWAU	186	23
10	KG BADAK	158	17
11	KG BANUN	73	23
12	KG PENDERAS	112	3
13	KG BAL	577	45
14	PUSAT PENTADBIRAN	-	10
15	KG KATONG	295	30
16	KG AKEI	135	24
	TOTAL	**3093**	**276**

There are two peak period stipulated on the profile which comes from operation of government building on the daytime and night activity on the night time. Based on the above profile the max demand is about 365kW and the energy

LOAD PROFILE



DESIGN CONFIGURATION

- Based on the load profile and to suite with client design requirement which need 70% energy generates will come from Solar energy and battery will only allow one (1) complete cycle charge and discharge per day, the design configuration as follows:

Equipment	Capacity	Number (s)
Solar PV	850 kW	3696 nos. (230W/pv)
Battery	4,800 kWh	960 cells (2v@2500AH/cell)
Inverter & Controller	850 kW	200kW x 3 nos, 250kW x 1 no.
Diesel Genset	350kW, 450kW	350kW x 2 nos, 450kW x 2 nos.
Distribution System	Step-up tx (0.415V/11kv) – 2 x 750kVA RMU (2S + 1F) x 2 nos. Step-down tx (11kV/0.415V) x 3 nos. (PE)	

DESIGN CONFIGURATION

Solar PV

Solar energy daily is to determine the energy by the Solar PV to meet atleast 70% of energy consumption for the system.

$$E_{sys} = P_{array\_stc} \times PSH_{period} \times f_{temp\_ave} \times f_{dirt} \times f_{mm} \times \eta_{pv\_inv} \times \eta_{inv}$$

Battery

Battery capacity required is to determine the ability of the battery to meet the energy consumption based on autonomy days that have been underline by Client.

$$\text{Capacity Required} = \frac{\text{Energy Required x } T_{autonomy}}{\text{System Voltage x Depth of Discharge x Number of Bank}}$$

Generator

The power from generator will be use to charge the battery and to provide the AC power supply to consumer. Therefore, generator capacity shall be consider a sum of max demand and minimum power to charge the battery.

PLANT INSTALLATION DATA

SOLAR PV

Solar Type	: Poly-Crystalline
Solar Manufacturer	: AUO Corporation
Country of Origin	: Taiwan
Solar Model	: ECO DUO PM 200POO
Module Power Rated	: 220Wp
Module Efficiency	: 13.8%

GENERATOR

Generator Type	: Prime Mover
Generator Speed	: 1500 rpm
Engine Maker	: Volvo Penta
Alternator Maker	: Sincro
Apparent Power	: 350 & 450 kVA
Voltage	: 415/240 V
Frequency	: 50 Hz
Power Factor	: 0.8
Control Module	: EasyGen Woodward

PLANT INSTALLATION DATA

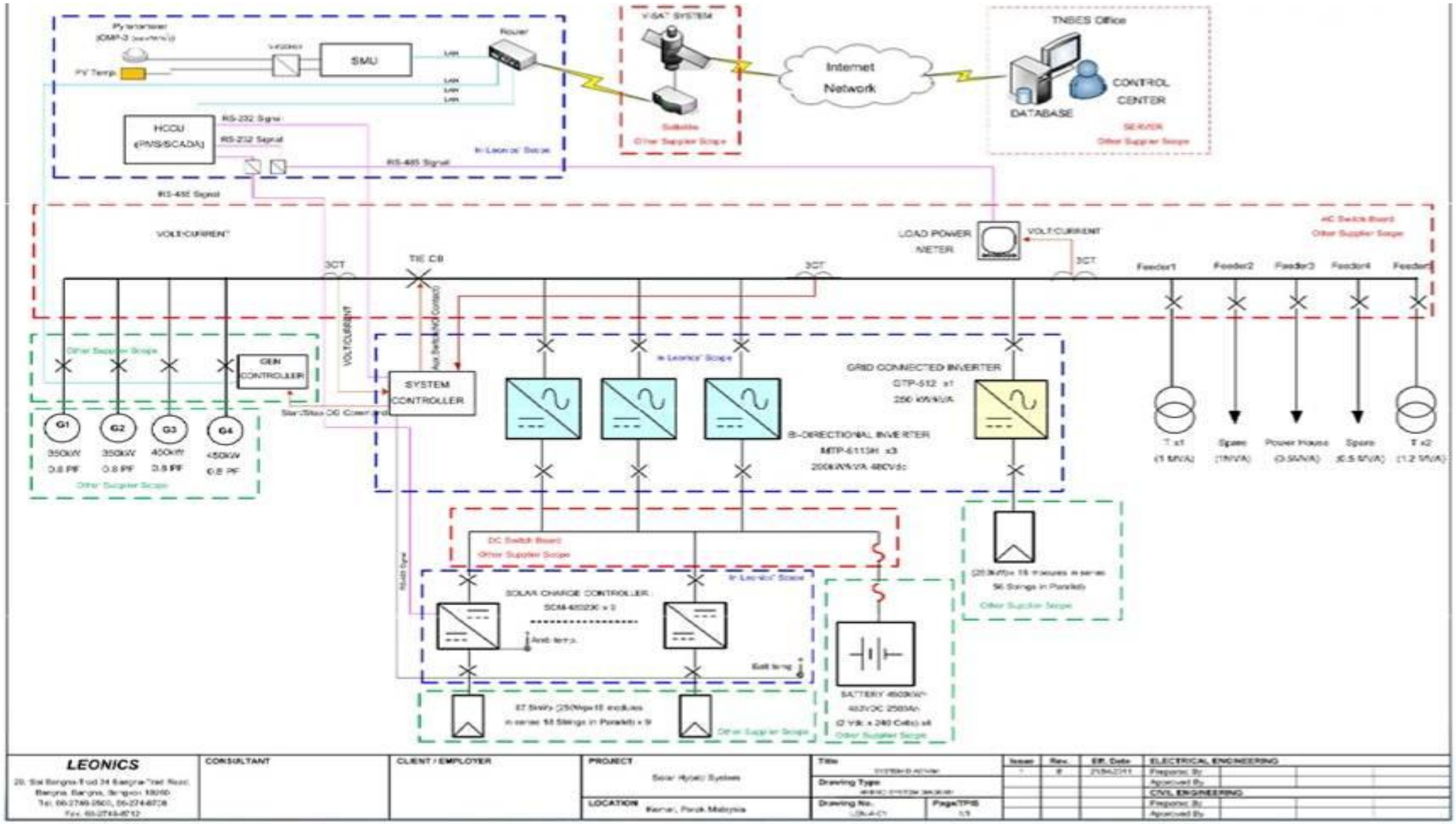
BATTERY

Battery Type	: Flooded Lead Acid (OPzS)
Battery Manufacturer	: System Sunlight
Country of Origin	: Greece
Battery Model	: 20 OPzS 2500
Capacity	: 2500Ah
Nominal Voltage	: 2.0VPC

INVERTER

Inverter Manufacturer	: Leonics Co. Ltd
Country of Origin	: Thailand
Bi-Directional Inverter	: Apollo MTP-6113H-P
PV Inverter	: Apollo GTP-512
Nominal Output	: 415V
Frequency	: 50Hz

Single line diagram for Solar Hybrid System at RPS Kemar



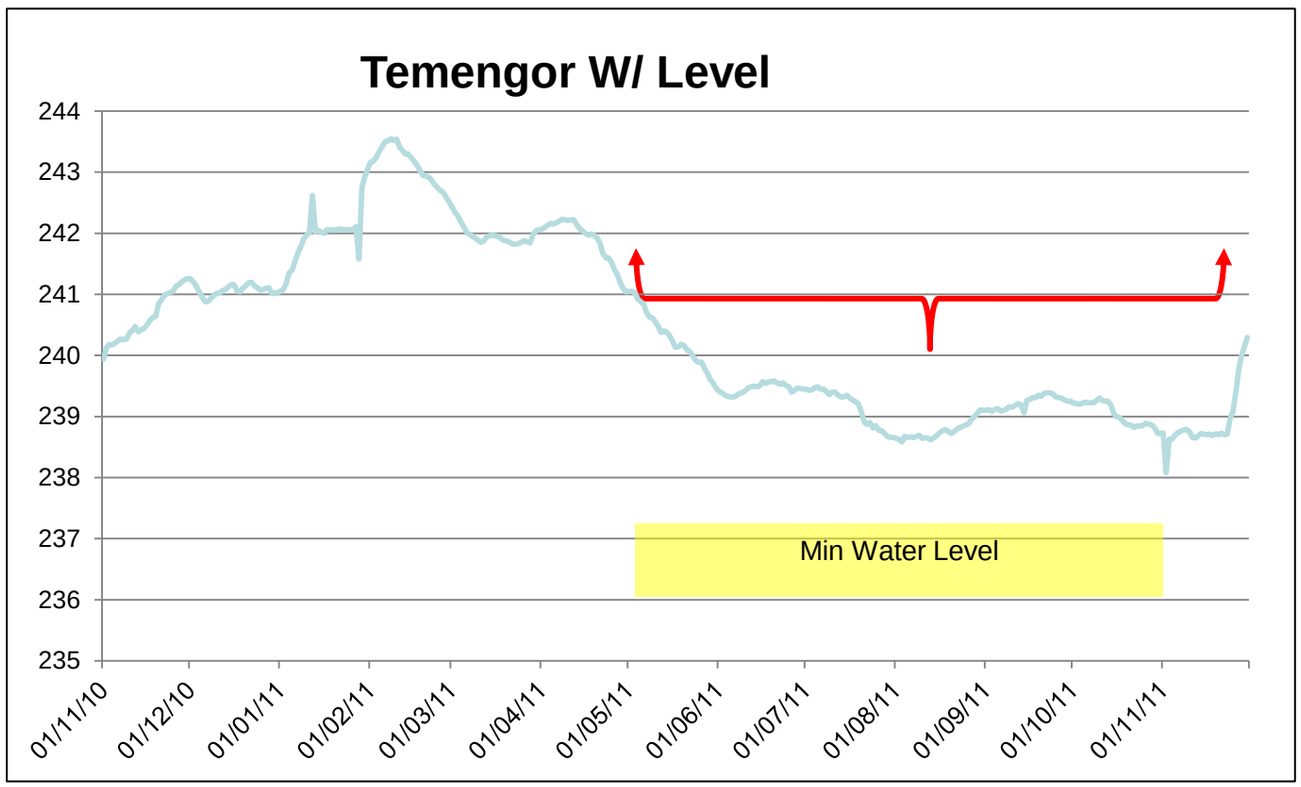
LEONICS 20, Sri Bangsa Pusat 24 Bangsa Pusat Road, Bangsa, Bangsa, Bangsa 59000 Tel: 06-2749 0500, 06-2744 8728 Fax: 60-2744 8712	CONSULTANT	CLIENT / EMPLOYER	PROJECT: Solar Hybrid Systems	Title: SYSTEM DIAGRAM	Issue: -	Rev: 0	Eff. Date: 21/04/2011
				Drawing Type: ARCHITECTURAL DRAWING			ELECTRICAL ENGINEERING: Prepared By / Approved By
			LOCATION: Kemar, Perak Malaysia	Drawing No.: LBUA-01	Page/TPB: 1/1		CIVIL ENGINEERING: Prepared By / Approved By

PANAROMIC VIEW

THE CHALLENGES

- Lake water level will be on min level from May – December each year.
  - This is the major obstacle in any physical activities at site.

Banding Lake water level from Jan 2010 – Feb 2011. Record was taken from TNBG Temenggor Dam.



Jetty Kemar – Min Water level.

Jetty Kemar – Max Water level.

THE CHALLENGES

Due to low level of water, barge can only be landed on this temporary stock pile area

THE CHALLENGES

Due to bad condition of route, our transportation got stuck during delivery the material to site.

THE CHALLENGES

THE CHALLENGES

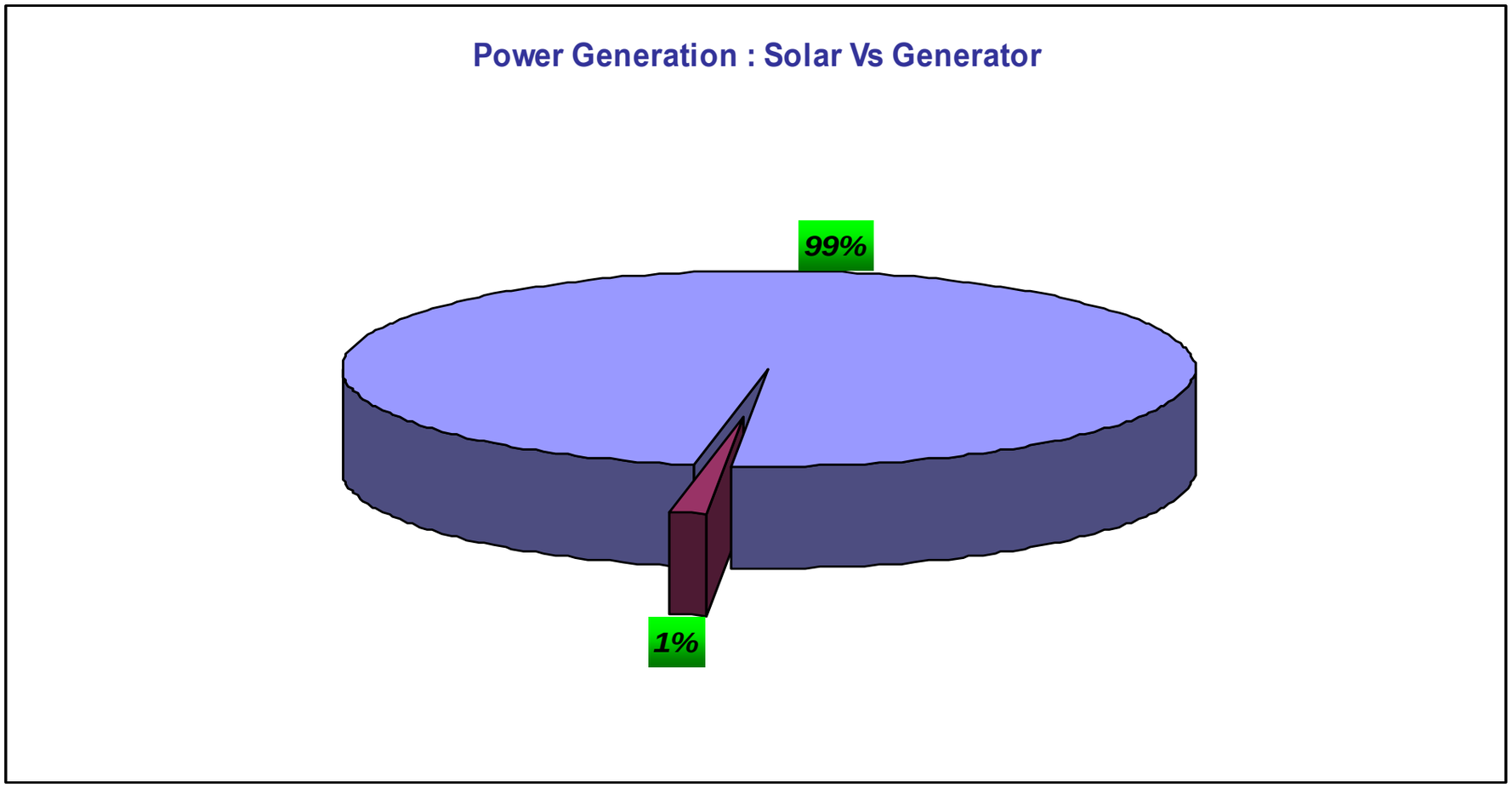
- Granite stone found during the base/ground work excavation.
- 1000 ton of granite stone was taken out from the site.

THE CHALLENGES

The site also being known as animal (elephant) routine route in searching for food.

STATION PERFORMANCE

Since commissioning on the 30 Nov 2012, the station has performance as follows:



Based on above pie chart, it shown that RE fraction of the system were 99% and the remaining 1% come from the diesel Generator Set. RE fraction value was calculated based on the following formula:-

$$= \frac{\text{Total RE generation based on kWh meter}}{\text{Total RE + Diesel generation based on kWh meter}}$$

ANALYSIS OF SAVING ON DIESEL CONSUMPTION

- Solar has generate 89.35MWh energy to supply the load.

- Based on that figure, it already saves fuel consumption 26,715 litres after 2 months in operation.

- From the information available, diesel consumption to generate 1kWh energy is 0.299 liters and price for a liter diesel is RM2.60 (price 2012).

CONCLUSION

- System Solar Hybrid is the best alternative solution for Rural Electrification to reduce the diesel consumption.

- Due to its location and difficulties to access, the logistic becoming the major chunk of the challenges faced by TNB.

- Man & Machine – Not everyone want to work and can work in these kind of environment. Many workers leaving the site on their 1st week of working. Machineries used also very limited because of location, breakdown, machine operator availability etc.

- Even with all of these experience and challenges, TNB are very committed in serving the country and people's necessity with support from

  our government .

- With the current station performance, the station was operate successfully and have a great achievement.

END