TNB Experience in Developing Solar Hybrid Station at RPS Kemar, Gerik, Perak Darul Ridzuan

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Abstract. This paper will discuss on TNB experience in developing Solar Hybrid Station at RPS Kemar, Gerik, Perak. TNB has been approached by KKLW to submit proposal to provide electricity in the rural area namely RPS Kemar. Looking at area and source available, Solar Hybrid System was the best method in order to provide electricity at this area. This area is far from national grid sources. Solar Hybrid System is the best method to produce electrical power using the renewable energy from Solar PV, Battery and Diesel Generator Set. Nowadays, price of petroleum is slightly high due to higher demand from industry. Solar energy is good alternative in this country to practice in order to reduce cost for produce of electrical energy. Generally, Solar will produce energy during daytime and when become cloudy and dark, automatically battery and diesel generator set will recover the system through the hybrid controller system.

1. Introduction
Solar Hybrid System is operates automatically to supply the load using combination of Solar PV, Battery, Diesel Generator Set and Inverter Controller System. In this scheme, the priority of energy source shall be solar energy. If the solar energy insufficient to supply the load, the energy stored in battery will be used by discharging the battery. After certain period, the battery will reach its depth of discharge, and then the Inverter Controller shall instruct the diesel generator set to run, serve the load and charge the battery. Once the battery is fully charged, the diesel generator set will shut off to allow other energy source i.e Solar and Battery to supply the load. 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. From Jetty Kemar, 4WD can be rented for transportation to the administration centre and the distance is approximately 15 minutes.

2. Load Profile
Based on finding and discussion with JAKOA, the tabulated number of consumer as Table 1.

Besides of this number of houses, there also have a few government building such as school, clinic, police station, shop and Surau. Based on KKLW need statement in this project, energy consumed per house shall be 8kWh and maximum demand (MD) shall be 1kW. Load profile was forecast based on previous similar experience and number & type of consumer. 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 consume per day is about 3013kWh/day. The high demand during the night time was contributed by Hostel in the school. Besides of this number of houses, there also have a few government building such as school, clinic, police station, shop and Surau. Based on KKLW need statement in this project, energy consumed per house shall be 8kWh and maximum demand (MD) shall be 1kW. Load profile was forecast based on previous similar experience and number & type of consumer. 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
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![Location of Solar Hybrid RPS Kemar, Gerik, Perak.](image)

**Figure 1.** Location of Solar Hybrid RPS Kemar, Gerik, Perak.

**Table 1.** Number of houses

| 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** |

3. Design Configuration

Based on the load profile and to suite with KKLW 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.

Plant installation data are shown in figure 2 for Solar PV, figure 3 for diesel generator set, figure 4 for Battery and figure 5 for Inverter.

Single line diagram for Solar Hybrid System at RPS Kemar was shown in Figure 5.

This power from Solar Hybrid Station have been distributed to consumer using the 11kV network and 2 x 1MVA step up transformer vector group YND11 before step down to 415V. It happened because the end point of consumer located far from the Solar Hybrid Station and will cause a voltage drop. This system is design based on two couple system which AC + DC couple. The reason why it was design in such away because to get the best efficient energy from Solar PV during the daytime (AC Couple) and the Solar energy stored in the battery to be use in night time (DC Couple).

4. Station Performance

Since commissioning on 30 November 2012, the performance of the station as follows:
Table 2. Component and configuration

| Component                          | Configuration          |
|------------------------------------|------------------------|
| Solar PV                           | ● 850kWp               |
| Diesel Set Generator               | ● 2 x 350kW            |
|                                    | ● 2 x 450kW            |
| Bi-Directional Inverter c/w controller | ● 600kVA              |
| PV Inverter                        | ● 250kVA               |
| Battery                            | ● 4800kWh              |

Figure 2. Solar PV

Table 2. Solar specification

| 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%            |

Figure 3. Diesel Generator Set

Table 3. Generator specification

| Generator Type    | Synchronous |
|-------------------|-------------|
| Generator Speed   | 1500 rpm    |
| Engine Maker      | Volvo Penta |
| Alternator Maker  | Sincro      |
| Voltage           | Y 415/240   |
| Frequency         | 50 Hz       |
| Power Factor      | 0.8         |

Figure 4. Battery

Table 4. Battery specification

| Battery Manufacturer | System Sunlight |
|----------------------|-----------------|
| Battery Type         | Flooded Lead Acid|
| Country of Origin    | Greece          |
| Battery Model        | 20 OPzS 2500    |
| Capacity             | 2500Ah          |
| Nominal Voltage      | 2VPC            |

Figure 5. Inverter

Table 5. Inverter specification

| 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            |
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:

\[
\text{RE fraction} = \frac{\text{Total RE generation based on kWh meter}}{\text{Total RE + Diesel generation based on kWh meter}}
\]

RE fraction is higher compare to design due to low load. Based on previous experience, load will increase from time to time due to economic growth at that place.

5. Analysis of Saving on Diesel Consumption
Solar has generated 89.35MWh energy to supply the load. Based on that figure, it already saves fuel consumption 26,715 liters 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).

6. Conclusion
System Solar Hybrid is the best solution for Rural Electrification to reduce the diesel consumption. With the current station performance, the station was operating successfully. The current total estimated saving on diesel consumption at Solar Hybrid Station RPS Kemar is the great achievement.

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