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Solar PV Project Implementation Feasibility Study based on Feed-in Tariff in Malaysia

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Abstract

This paper illustrates the solar PV project implementation feasibility study based on Feed-in tariff embark by Malaysian government. The objectives of this study are to increase the awareness about the benefit of Feed-in Tariff (FiT) and to design a framework for solar PV project implementation in Malaysia. FIT is established to offer a guaranteed pricing structure for renewable energy production such as wind, solar, biogas and biogas. This could encourage greater investments in a renewable energy field in Malaysia. The framework is started by explaining the project lifecycle to set the milestone follow by explain the project Work Breakdown Structure (WBS) and Organization Breakdown Structure (OBS). Finally a proper project scheduling is established ensure a success project implementation.

Key words-Feed-in Tariff, Solar PV, Project Management, Framework, WBS, OBS, Schedule

1. INTRODUCTION

Due to world oil reserves that has been depleting recently, a lot of efforts have been done to find the alternative form of energy. Solar generation has become one of the important sources of energy due to its cost, installation and supporting government policies. Statistic shown that between year 2004 to 2009, the total global grid-connected solar PV capacity has increased to a total of about 21 GW annually (Muneer. W et al., 2011). In order to foster the renewable energy activities in

Malaysia, the National Renewable Energy policy has been embarked by introducing Feed-in Tariff (FiT).

FiT is established to offer a guaranteed pricing structure for renewable energy production such as wind, solar, biogas and biogas. This could encourage a greater investment in a renewable energy field in Malaysia. Furthermore, player in this sector need to investigate the optimal technique to maximize the renewable energy resources to gain highest profit.

The objective of national renewable energy (RE) policy is to ensure the renewable energy resources utilization could provide reserve to the national electric supply. A feed-in tariff (FiT) is a kind of mechanism designed to encourage the investment in renewable energy sectors. It offers long-term purchasing contracts to anyone who produces renewable energy based on the cost of energy generation commonly due to different technology. For instance wind power has lower per-kWh price than solar PV because solar has higher generation cost, typically based on the cost of generation of each different technology (Radhika. P et al., 2011). FiT also enable users to sell excess power to the power grid thus encourage more people to adopt renewable energy sources.

China has passed a feed-in tariff for wind and made moves towards a feed-in tariff for PV. Thailand has passed a policy that it calls a feed-in tariff in July 2010. The legislation would also create a sustainable energy development authority to manage the program. One reason for Malaysia's embrace of progressive renewable energy policies may lie in its role as a destination for solar manufacturing, at a scale particularly impressive for its small size and population of only 28. 2 million. Global industry leader First Solar has four plants in Malaysia with a total annual module capacity of 720MW while Sun Power is also constructing manufacturing facilities in the nation. There are several potential impacts of national RE policy towards Malaysia economy. First of all government will save an external cost to mitigate CO_2 emissions that cost RM50 per tonnes. Besides that renewable energy business revenue can generate income tax up to 1. 75billion to the government. It also can create more than 52000 jobs to construct, operate and maintain RE power plants (Harris, 2012). The objectives of this study are to increase the awareness about the benefit of Feed-in Tariff and to design a framework for solar PV project management in Malaysia.

2. PROJECT LIFECYCLE

This solar PV project can be divided into construction and operation work. The construction work will take about 4 months while the operation work takes about 21 years. The project life cycle can be divided into 5 major phases.

2. 1 Concept and Initialization

As to start for the project, a license from Suruhanjaya Tenaga (ST) is needed. It is permit to make interconnection with Tenaga Nasional Berhad (TNB). Therefore the project has to follow the standard requirement in term of technical and safety aspect. The structures, electronics, control and cables need to pass the requirement by utilities for grid power projects. Developer need to submit the report, certificate and first progress report.

2. 2 Design and Development

There are basically three main design process during the project development which are PV integrated system design, structural design and electrical design. Integrated system design refers to how to integrate the components effectively. Structural design is based on the layout and location of the PV generator that need to be installed. While the electrical design is to optimize the performance of the solar system in order to meet the technical specification and safety requirement. The PV power project developers have to optimize the capacity of electricity capacity. It can be done by utilizing lower cable losses, efficient electronics, enhancing incident radiation by implementing of automated panel changing tilt angles as well as maximizing of power transfer from PV modules to electronics and the grid. The developer also need to provide several information such as hours of sunshine, duration of plant operation and the quantum of power fed to the grid. This required a proper instruments and data logger. This data is crucially important during reimbursement from TNB to estimate the generation in kWh of the PV array installed.

2. 3 Implementation and Construction

Solar PV systems offer renewable energy solutions for every situation. The necessary components to integrate solar power into the homes and businesses consist of solar panels, mounting structures, controller, inverter, batteries, enclosure, wiring, meter, and a breaker box. These components can come as a complete assembly designed to provide safe and reliable power. The battery comes in a strong, lightweight, corrosion resistant enclosure for protection of harsh and severe weather conditions. Likewise, the other components come in a similar housing that is environmentally protected and can be secured to prevent theft. The configuration of these components into a complete solar PV system will provide a dependable power source with hours of battery backup. There are several steps need to be done after the constructions of the solar generator completed that are (GPEKS, 2010):-

- The developer need to obtain a four quadrant meter from the distributor. The data of electrical production is transmitted hourly via phone line.
- The developer has to set up a separate generator account with TNB.
- The TNB assessor will inspect the connection to the local electricity distributor's system and if pass the test TNB will award the inspection certificate.
- After all the required approvals are complete, the developers need to sign connection agreement with the TNB that comprise of the roles and responsibilities of each party that will be mandated by TNB under the *Distribution System Code.*

2. 4 Commissioning and handover

The performance of the grid connected PV power plants need to be monitored to ensure satisfactory operation. ST as the authorities will visit the power plant regularly to provide their feedback and recommendation to TNB for further improvement.

Beside ST, the plant is opened for inspection by the officials from TNB, concerned state nodal agency and ministry for performance monitoring. The developer is required to submit the annual report of the company and annual progress report about the project.

2. 5 Solar Maintenance and Warranty

The maintenance process of a solar PV system is an integral part of the system design. Solar PV systems are an arrangement of components that require routine maintenance that can be performed with some basic tools and minimal training. Checking connections and battery fluid levels can be accomplished very easily by the user. Major repairs and periodical maintenance should be performed by a professional. The most likely failures and easiest to repair are the connections, fuses, and switches. Preventive maintenance is the least costly of all maintenance. An important maintenance measure is to keep the solar panels clean (M. H. Jali et. al. 2014).

The durability of solar power makes it an attractive alternative power provider. With routine maintenance, solar PV systems will generally last over 20 years. The longest-lived component of a solar PV system is the solar panels. The highest maintenance item is the batteries; especially the flooded lead acid batteries. Most solar panels are designed to withstand all of the rigors of the environment including arctic cold, desert heat, tropical humidity, winds in excess of 125 mph, and one-inch hail at a constant speed. The high quality solar panels are designed to last at least 30 years and carry a 20 year warranty. The solar panels represent around 45 to 55 percent of the total cost of a solar energy system. Therefore, the solar panel price is the greatest deciding factor in sizing of a system power system.

Other components, like the charge controller and inverter, usually have a two year parts and labor warranty with an option to purchase an extended warranty. There are also more expensive inverters and charge controllers that have a warranty up to five years without any extended options. The charge controller and the inverter typically represent around 20 percent of the total cost of a solar PV system. These two items are very reliable and have few failures. If a failure does occur, it is easily evident because house power is not available (Shri Rangam Brokers, 2010).

3. PROJECT WORK BREAKDOWN STRUCTURE (WBS)

Figure 1 shows the overall project breakdown stricter for the solar PV project planning. It can be described as:-

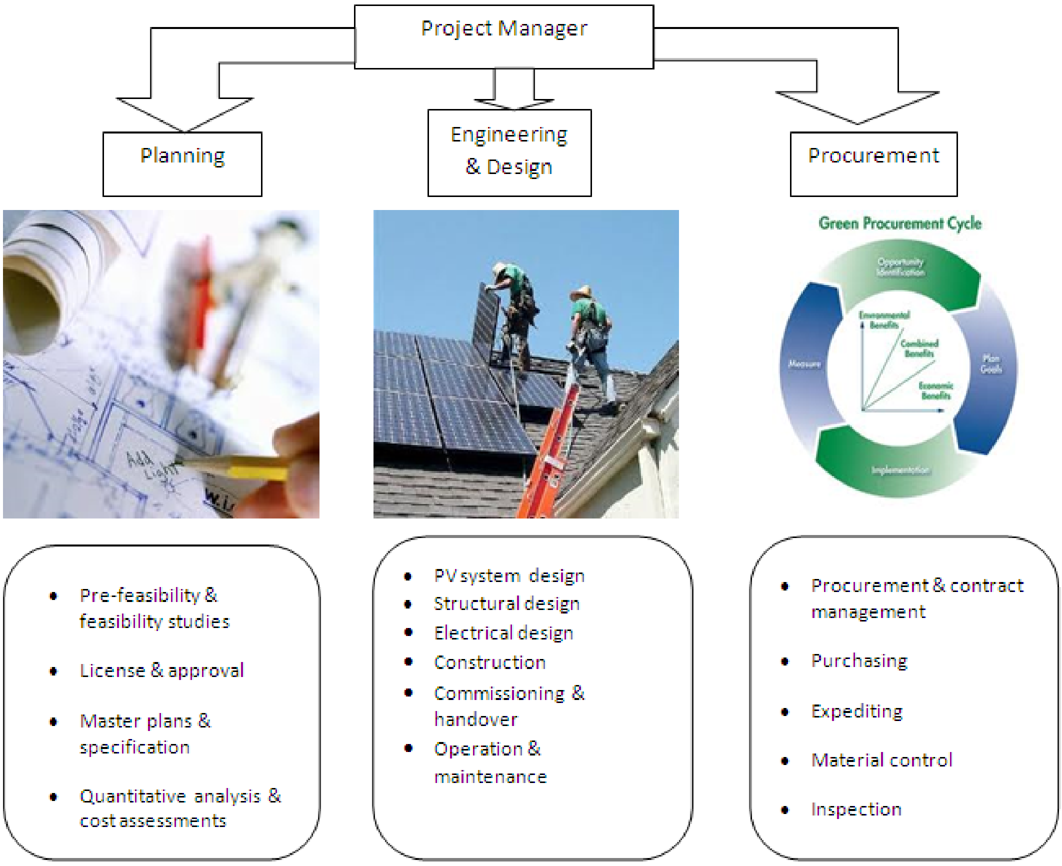

Figure 1. Block diagram of the project breakdown structure

3. 1 Planning

i. Pre-Feasibility and Feasibility Study

A pre-feasibility study is dependent on the investment involved and size of the project. A feasibility study is an important and valuable step in order to start on the project because it required a large amount of investment money and procedure [4].

ii. License and approvals

This process is one of the most important step during planning to ensure all the technical specification has been addressed to acquired permits and approval from the authority. This can avoided noncompliance to the authority guidelines after project completion which could lead to additional cost. In additional the master plan and costing also has to be include the approval process from the authority.

iii. Master plans and specification

Planning unit should establish master plan schedule and also technical plan summary for the project to be executed as a guideline to everyone involve in the project. The technical plan must according to the specification requirement from the authority.

iv. Quantitative analysis and cost assessments

This step is vital to ensure a smooth project implementation. The costs are highly depending to the size of project because bigger project will definitely require a lot of material used. More material purchasing will reduce the per unit material. Therefore the size of project needs to be carefully defined before doing cost assessments [4].

3. 2 Engineering and Design

i. PV System

The PV system that comprise of components such as solar panel and inverter need to be design according to the specification and budget required. This happen after the thorough selection process has been conducted on which component of the system will be used for the project.

ii. Structural Design

The structural design involves the location and layout consideration of the solar system to be installed on the building. The selected location and layout need to be design as to make sure it will not interfere with the normal arrangement or function of the building. Therefore the design should not distract the main activity inside the building.

iii. Electrical Design

The electrical design is estimated by the size of the project and desired requirement by the project manager that is within the allowable capacity by the authority. It involves the power output that is developed to ensure high efficiency achieved.

iv. Construction

It is important to ensure the construction phase follow the design intent. It needs a very strong management team to achieve the plans because failure of meeting the electrical and safety specification could cause unforeseen consequences such as accident [4].

v. Commissioning and Handover

Before handover the project, the PV generator need to go through robust testing and commissioning process to ensure no problem such as quality and breakdown issues. This process is crucially important because the solar system might prone to malfunction due to error during the installation process such as incorrect connection etc. Therefore before handover all the possible incident that can occurred need to be tested.

vi. Operation and Maintenance

There are several duties during the operation and maintenance of the PV plant. The process is highly rely on the maturity of the technology. The duties are to keep the array clear from any trees, monitor the electronic system failures, mechanical tracking system maintenance and replacing and servicing the damage component inside the system [4].

3. 3 Procurement

i. Procurement and contract management

All the potential suppliers and vendors need to be identified and pre-qualified according to the project quality plan. The standard procedure for procurement process is invite to tender to compile the bid package for the suppliers to quote and tender adjunction to scrutinize the tenders and compile the technical and commercial bid tabulation to ensure complete and detail comparison.

ii. Purchasing

After decided which supplier win the tender, the person in charge need to raise the order to purchase the items. The purchase order should be a standalone document, superseding all previous documentation and correspondence and must be formally accepted by the supplier.

iii. Expediting

Expedite is a process to make sure the order happen on time. Person in charge have follow up the order from time to time.

iv. Material control

The material list generated should give all the product details, manufacturer, model number, specification, type, rating, level of inspection for the project manager information.

v. Inspection

The material need to be inspect thoroughly upon the arrival to the site to make sure the items is within the specification and quality that been agreed with the supplier.

vi. Logistics

The deliver items for the constructing the solar generator need to be safe keeping and retrieval. The transportation also needs to be arranged systematically.

4. PROJECT ORGANISATION BREAKDOWN STRUCTURE (OBS)

By referring Figure 1, there are 3 main people assign to the subsection. All of them reported to the project manager. He is responsible to ensure the entire project planning run smoothly such as pre-feasibility study and feasibility study, project planning and implementation, master plan and specification and finally quantitative analysis and cost assessment. He needs to explain all the planning strategy to all other unit to make sure the understanding about the project. In additional, he has to emphasise on the budget relocation for this project, the schedule and also the specification target to ensure the project achieve the quality desired.

The engineering and design unit is responsible to provide a range of executive engineering and design solutions to deliver the safe and sustainable engineering and design including preliminary and final engineering design, location selection, layout, Installation, technical support and finally testing and commissioning. The unit leader have to ensure that the process work properly and report progress activity daily to the project manager. He also has to follow every unit progress to make sure all works complete on time. Besides, he also responsible to improves design and quality of the project execution during the implementation.

The procurement unit is dedicated to provide a range of executive tailored procurement services. The unit leader is committed to maintain the highest standards for full range of related services such as procurement and contract management, purchasing, expediting, material control, inspection as well as logistic across order management to confirmed delivery of goods or services in compliance with the Ethic Code of Conduct. Besides, he also has to compromise to the green procurement cycle that are plan growth, opportunity identification, measure and finally implementation to ensure balance between economic benefit and environmental benefit.

5. SCHEDULE PLANNING

Finally the project task needs to be schedule systematically by considering duration and predecessors of the project activity as shown in Table 1. The duration allocated has to be realistic with the project activity because any delay could cause the project do not meet the dead line. Some tasks that required 2 or 3 predecessors are more important because it need it predecessors to be completed in order to start their activity

Table 1. Project list of tasks

No	Description Activity/Task	Duration (Days)	Predecessors
Concept and initialization phase			
1	Pre-feasibility & feasibility study	5	-
2	License & approval application	3	1
3	Master plan & specification	4	2
4	Quantitative analysis and cost estimation	3	2
Design and development phase			
5	PV system design	6	3, 4
6	PV structural design	5	5
7	PV electrical design	5	5
Implementation and construction phase			
8	Procurement and purchasing	3	6, 7
9	Construct all the PV component	30	8
10	Obtain the meter	2	9
11	Setup account	2	9
12	Get interconnection approval	3	9
13	Get safety check approval	5	10, 11, 12
14	Sign connection agreement	2	13
Commissioning & handover phase			
15	Perform electrical current analysis	5	14

16	Perform apparent power analysis	7	15
17	Perform statistical analysis	8	15, 16
18	Perform environmental assessment	5	17
19	Perform Impact assessment	6	18
20	Install tracking system	8	19
21	Install fail-safe circuitry	4	19
22	Install built-in lightning protection system	5	19
23	Test all the monitoring system	8	20, 21, 22
24	Submit progress report	3	23
25	Ready for handover	4	24

6. CONCLUSION

This paper has described thoroughly the framework for Solar PV project management. Project lifecycle need to include the operation and maintenance of the plant that can be divided into 5 major phases. Project work breakdown structure (WBS) need to segregate clearly to ensure the smooth operation and avoid the overlapping of job scope between each unit. Project organization breakdown structure (OBS) described the responsibility of each unit leader. Finally all the project activity needs to be arranging carefully to make sure the project completed on time.

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