DECISION MAKING ON PROJECT FEASIBILITY USING CAPITAL BUDGETING MODEL AND SENSITIVITY ANALYSIS. CASE STUDY: DEVELOPMENT SOLAR PV POWER PLANT PROJECT

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ABSTRACT

This study explore the practice of Capital Budgeting using elements such as: Payback Period, Discounted Payback Period, Return on Investment (ROI), Net Present Value (NPV), NPV Index, Internal Rate of Return (IRR) to provide the analysis required by company for deciding whether a project offered is feasible(or not) to be executed. It is a formal process used for evaluating potential investments that are significant in amount. It is a tool for maximizing a company's future profits since most companies are able to manage only a limited number of large projects at any one time. (EduPristine, 2015). The project used in this paper as case study, is a project for building a Twenty Mega Watt (20 MW) Photovoltaic Power Plant (PV Power Plant) for one of the Independent Power Provider in Eastern Area of Indonesia. The questions the company would like to answer is, can Capital Budgeting approach assist them in deciding whether project is feasible to be executed and how far the CAPEX can be stretched if the company still want to meet the target tariff set by the project owner (USD 0.70 / kwh). Using Capital Budgeting approach, author able to show that with the estimated investment of USD 17 Million, the project is feasible to be executed only if the right technology mix is selected. Detail results were discussed and presented in conclusion.

Keywords: Decision making, Capital budgeting model, net present value, internal rate of returns, project feasibility, Solar, PV

1. INTRODUCTION

Indonesia's economy has experienced steady growth emerging from the Asian financial crisis of 1997-1999, averaging stable of five to six percent of annual growth rate. The strength of the country's economy was formerly based on its considerable oil and gas exports (Tharakan, 2015) and that include for powering Indonesia's power plants. Since the Industrial Revolution, oil and natural gas have played an instrumental role in economic transformation and mobility in everyday life for the majority of the world's population. However according to (BP Petroleum, 2019), Indonesia's reserves start depleting from 22.8 to 19.4 GBO and within 11 years will no longer have the crude oil. Another research found that from the point of views of oil investors, the oil business is not as attractive as before, unless the oil prices increase significantly, together with lowering cost of financing and operating (Daryanto & Primadona, 2018). According to (Rohimat, 2016), there are many countries which rely on oil revenue and end up falling and collapse. The biggest company in the world, Schlumberger, cut off their worker around 34,000 staffs in 2014 and 10,000 staffs in 2016. Petronas Malaysia dismissed 1,000 employees in 2016 In Indonesia, Chevron would terminate their contracts in East Kalimantan after 50 years of operation and dismiss around 1,500 employees due to decline in the efficiency.

As an archipelago country that consists of more than 17,000 islands, Indonesia is gifted with many forms of renewable resources. The result is outline in table 1.1 below.
Are based on the assessment conducted by (Directorate General of New and Renewable Energy and & Conservation. Government of Indonesia, 2016).

Table.1 Renewable energy resources in Indonesia

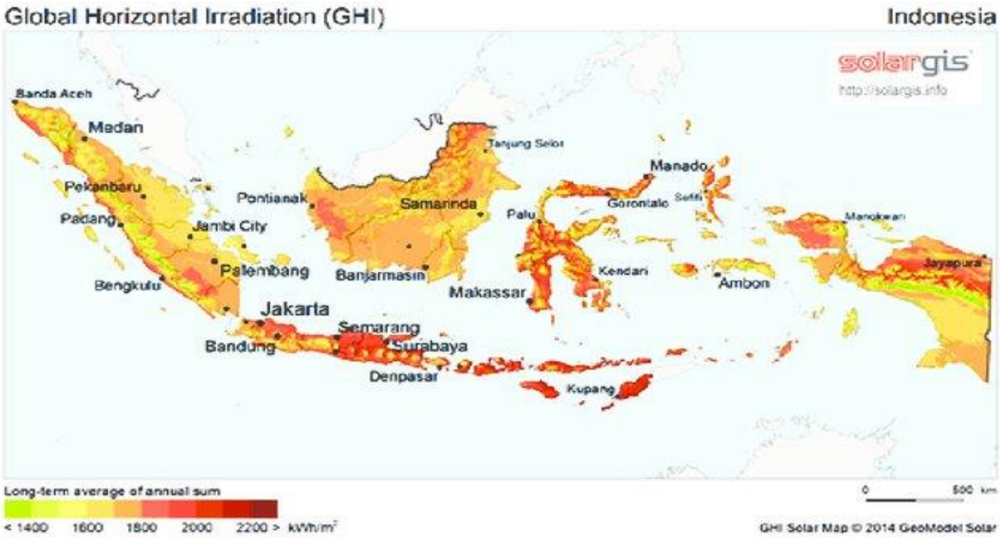
Source	Potential Power Generation
Hydropower	75 GW
Geothermal	29 GW
Biomass	33 GW
Solar Photovoltaic ("PV")	208 GWp (4.80 kWh/m²/day)
Wind Power	61 GW (3 – 6 m/s)
Ocean	18 GW

Source: (Directorate General of New and Renewable Energy and & Conservation. Government of Indonesia, 2016)

But this results are based on a technical assessment only but do not necessarily consider the financial or economic viability of individual projects. Locations also play an important factor (i.e. as some renewable energy resources are located in areas with very low electricity demand). As such, some renewable energy projects may not be economically feasible.

Specifically in Solar PV, despite having naturally high solar penetration across most part of the country as described in figure I.2 below but the deployment currently remains limited (estimated to be 106 MWp) (Mulyana, 2017).

Figure 1. Solar Radiation Map of Indonesia (Muchlis, Moch and Permana, 2003)



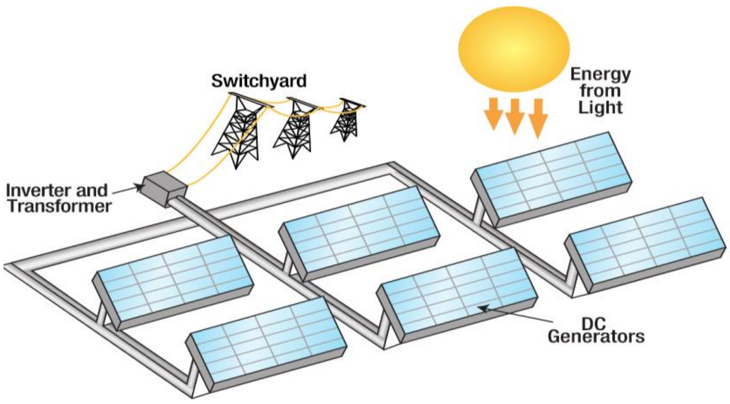
This study objective is to apply capital budgeting technique to provide comprehensive economic and financial feasibility analysis for PT. SunPower Indonesia (SPI), one of an Independent Power Producer ((IPP) because the company need to make a decision whether a project in building 20 MW PV power plant for powering an industry complex can give profitability for the company and adding their footprint in Indonesia power industry. The capital budgeting model used to analyze data and the indicators were Payback Period (PP), Discounted Payback Period (DPP), Net Present Value (NPV), NPV Index, and Internal Rate of Return (IRR) were used to analyze the data, and sensitivity analysis.

This study is organized into nine sections. Section one captures the introduction, section two, the technical characteristics for a solar installation oriented to electricity production will be described. Section three highlight the literature review about previous researchers that used the Capital Budgeting Technique in decision making process, section four discuss the methodology, section five discuss the assumptions used in the study, section six highlights the finding and analysis, section seven highlights the limitation in the study and section seven captures the conclusion and recommendation.

1. PHOTOVOLTAICS POWER PLANT (PV POWER PLANT)

PV power plant basically a facility that converts sunlight or the irradiation from the sunlight into electricity using three main equipment which are: Photovoltaic panels or PV panels as the main equipment of the facility, Inverter and Transformer as pictured in figure 3 below.

Figure 2. Solar Power Plant Overview (Keemin, 2019)



PV cell, also known as a solar cell, directly converts light energy into electrical energy without the need for chemical reactions or fuel. The majority of solar panels are composed of numerous silicon wafers wired together to produce direct current (DC) electricity. The generated electric energy can be stored in suitable batteries or can be feed into the electric network by using a device named inverter, which is used to convert this DC electricity into alternating current (AC). Indeed since PV plants are able to feed AC electricity directly in to the network through the use of very efficient inverters the PV solar energy has boosted the implantation of PV solar energy plants because the simplicity and lower cost of this systems with respect to those using batteries. Indeed determining exact electrical output depends on complex factors, such as the angle, direction and efficiency of the panels, sunshine, temperature and weather. Electrical output varies and is dependent upon factors such as the amount of available light, the position and angle of the solar panels, ambient temperature, the efficiency of the panels and the voltage supplied by the system. Calculating how many kilowatt-hour (kWh) of electricity are produced by a solar system is often a challenged activity because conditions can change in seconds, but a good estimate of the average power production can be made using straightforward techniques. Keeping panels clean, in full sunshine and pointing directly toward the sun will maximize output (Pradas-Guaita, Sanchez Ruiz, & Mari Soucase, n.d.).

Below are some explanation on the main equipment used in PV power plant:

a. SOLAR PANELS

According to (Sendy, 2017), PV panels is a power system to absorb and convert sunlight into electricity. There are two types commonly used in the industry, Monocrystalline (MI) and Polycrystalline (PI) types. MI is the first module that was introduced. As the name suggested, it is created from a single continuous crystal structure and can be identified from the solar cells which all appear as a single flat color. While PI has the newer technology rather than the MI. The performance and efficiency of the panels were slightly lower than the mono type. However because of the cheaper method by which it can be manufactured, this type of panel becomes more preferable in the market.

b. INVERTER

Solar Inverter (SI) is a device that transforms DC battery or solar panel voltage into mains type AC power. It is an integral part of a systems, it means if solar inverter is of poor quality, overall system performance can be greatly impacted. Two types of SI are Central Inverter (CI) and String Inverter (SI), with the basic differences as shown in table 2 below.

Table 2. Basic Performance of Solar Inverters

Central Inverters	String Inverters
≥2MW per inverter (mechanized lift)	<100KW block size (2-man lift)
Transformerless, typically with non-standard AC voltages	Transformerless, typically with standard AC voltages(380V/400V/480V)
Field serviceable to maintain operating life	Not field serviceable
Typically a grounded design	Typically a floating design
5-year warranty, typically with parts and labor	10* year warranty, typically with parts only
Typically single MPP per inverter	One or multi-MPP per inverter

* Note a standard 10-year warranty is valid in US and Canada, typically 5 years for the rest of the world.

Source: (Scheneider Electric, 2016)

c. TRANSFORMER

A transformer is a device that transfers electrical energy from one electrical circuit to another through mutual (electromagnetic induction) and without change in frequency. Transformers are an important part of electrical systems (Flanagan, W.M, 1993). In PV power plant, transformer is used as step up equipment that transforms the AC current with medium voltage into high voltage of the network.

Renewable, like Solar Power Plan is nevertheless looking attractive to be utilized not only to support environmental policy around emission, urban air pollution which currently becoming a major issue in Indonesia but it also improving cost profile and ability to be deployed in more decentralized manner with quicker turn around. Table 3 provides the insight on the advantage and disadvantages from PV power plant.

Table 3. Advantages and Disadvantages of Solar Energy

ADVANTAGES OF SOLAR ENERGY	DISADVANTAGES OF SOLAR ENERGY
It is believed as one of the clean and renewable source of energy. The source is abundance, especially for country like Indonesia and free to take. The initial cost to build PV power plant is less costly than building other type of power plant. E.g. thermal power	To build the power plant requires a lot of land which will be used as long as the power plant is there. The battery to store the energy is still costly. The output of PV power plant is intermittent since it is heavily depends on sunlight.

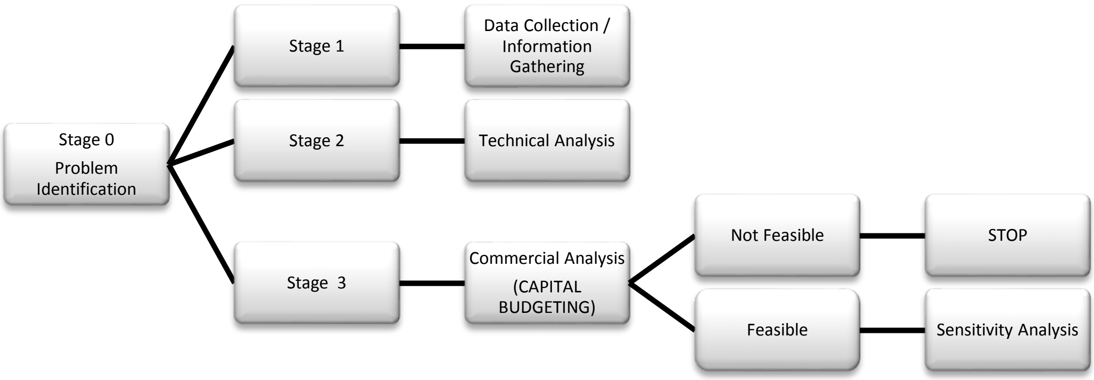
plant. Solar panels could be used to generate electricity in remote areas as long as there is good irradiation.	The production of PV panels still has pollution effect.

Source: (Various resource, 2019)

2. METHODOLOGY

To accomplish this study, the steps are: (1) Data collection/Information Gathering; (2) Technical Analysis; (3) Commercial Analysis. These are expressed on figure 4 below.

Figure 4. Methodology (Author, 2019)



The data collection is critical for the success of the study. The data collection aims at gathering the required technical data on one hand and on the other, informal data about the overall context resulting assumptions that will be used for the study.

Examples of data required such as: Project location data including solar resources, land constrains, site boundaries, etc.

The objective of technical analysis phase are to deliver the conceptual design of the integration of PV power plant to the existing grid including determine the limitation of the PV power Plant. It will include the identification of the best technology configuration that can deliver an effective yet efficient project.

The last step is the commercial analysis that aim to provide indicative investment cost (CAPEX) for different technologies. The cost data shall be retrieved from several reputable suppliers by means of non binding price. These cost will be the main focus of this study because it will become the variables used to calculate all the elements in Capital Budgeting. Sensitivity analysis will be calculated only when the project is feasible otherwise.

This paper will focus on the commercial analysis based on the technology selection that is available on the market.

3. LITERATURE REVIEW

The decision of whether to proceed and decide which in this case study is the PV power plant development project, involves determining the investment rate of return can contribute the highest profitability for the company. In this study, the use of capital budgeting is important because it creates accountability and measurability.

(Anthony, Hawkins, & Merchant, 2011) defines as alternative choice of decisions making to those that involve relatively long-term differential investments of capital. There are five elements involved in capital investment calculation, which are IRR, Economic life (number of years for which cash inflow are expected, amount of cash inflow per annum, the size of investment and terminal value (if any). According to (Gitman & Zutter, 2015), Capital Budgeting is the process of evaluating and selecting long-term investments that are consistent with the firm's goal of maximizing owner's health.

According to (EduPristine, 2015), Capital budgeting is a company's formal process used for evaluating potential expenditures or investments that are significant in amount. It involves the decision to invest the current funds for addition, disposition, modification or replacement of fixed assets. The large expenditures include the purchase of fixed assets like land and building, new equipments, rebuilding or replacing existing equipments, research and development, etc. The large amounts spent for these types of projects are known as capital expenditures. Capital Budgeting is a tool for maximizing a company's future profits since most companies are able to manage only a limited number of large projects at any one time.

From several literatures, there are many formal methods are used in Capital Budgeting, techniques or variables such as:

- Net Present Value (NPV)
  The Net Present Value (NPV) is the result by subtracting a project's initial investment (CF0) from the present value of its cash inflows (CFt) discounted at a rate equal to the firm's cost of capital (Gitman & Zutter, 2015).
  The net present value decision tool is a more common and more effective process of evaluating a project and based on the NPV criteria, a project can be accepted only if the NPV value is positive and rejected if the value is negative.

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - CF_0$$

- Profitability Index

  Profitability Index (PI) is the ratio of payoff to investment of a proposed project. It is a tool for ranking projects (if there is more than one possibility) because it allows company to quantify the amount of the value per unit of investment.
  PI calculates ratio between ratio between the present value of future cash flow and the initial investment or can be written as follow (Gitman & Zutter, 2015):

$$\text{Profitability index} = \frac{\text{PV of future cash flows}}{\text{Initial investment}} = 1 + \frac{\text{NPV}}{\text{Initial investment}}$$

- Payback Period

  Payback period is a method of evaluating the feasibility of an investment opportunity in the number of years required to return the initial cash outlay that has been spent for the investment. Calculation of payback period is derived from the cash inflow each year deducted with the amount of principle payment to the bank and the interest repayment, so the company can see the true cash inflow on that period (Titman, S., Keown & Martin, 2011).

- Discounted Payback Period

  The discounted payback period is a capital budgeting procedure used to determine the profitability of a project. The calculation starts with the cash flow of a project must be estimated and broken down into periods. These cash flows are then reduced by their present value factor to reflect the discounting process. With the assumption of a large cash outflow to begin the project, future discounted cash flows are net against the initial outflow. The discounted payback period is calculated when the inflows equal the outflows (Merzi & Daryanto, 2018).

- Internal Rate of Return (IRR)

  The internal rate of return (IRR) is a discount rate that is commonly used to determine how much of a return an investor can expect to realize from a particular project. IRR is considered one of the easier methods by which to develop an immediate idea of the percentage of return that will be returned in each alternative (Galli, 2017). There are two types of IRR which are: Project IRR and Equity IRR.

  The project IRR gives the rate of return from the whole project, calculated by presuming that there is no debt portion in the project financing. It calculates the rate of return considering the cash flows from the project only (i.e. except financing cost). Project IRR will remain same irrespective of capital mix of the project while Equity IRR is what final earned by owners on the company on their part of investment and calculating the Equity IRR only cash flow for the Equity Shareholders are considered. It gives rate of return earned by the Equity Shareholder on the money invested by them.

- Levelized Cost of Energy (LCOE)

  LCOE (Levelized Cost of Energy) is defined as the energy price ($ per unit energy output) for which the Net Present Value of the investment is zero and it represent the lifetime average cost of energy for this project (Blumsack, n.d.).

  LCOE is defined as the solution to the following equation:

$$\sum_{t=0}^{T}\frac{C_t+M_t}{(1+r)^t}=\sum_{t=0}^{T}\frac{LCOE\times Q_t}{(1+r)^t}=LCOE\sum_{t=0}^{T}\frac{Q_t}{(1+r)^t}$$

where Ct represents all capital costs incurred in year t (these may be zero except during the first few years of the project); Mt represents all operational costs incurred in year t, and Qt represents the total output of the project in year t. The term Ct + Mt represents the annual costs of the project (which may include payments on capital, fuel, labor, land leases and so forth). The term Qt represents the annual energy output of the plant.

- Weight Average Cost of Capital (WACC)

WACC is the minimum acceptable return a company should earn on any investment that it makes. It reflects the expected average future cost of capital over the long run, determined by weighing the cost of each specific type of capital by its proportion in the company's capital structure (Gitman & Zutter, 2015).

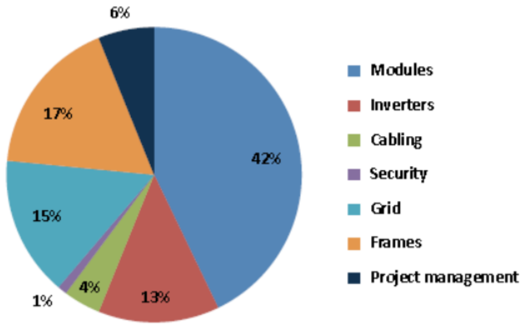
- Sensitivity Analysis

Sensitivity analysis is described as a technique for investigating the impact of changes in project variable on the base-case (most probable outcome scenario) (Iloui & Csiminga, 2009). The purpose of the sensitivity analysis are 1) Help to identify the key variables which influence the project cost and benefit stream.; 2) Help investigate the impact on project key variables (e.g. IRR); 3) Help asses whether the project decision are likely to be affected by such changes.; 4) Identify the preventive action which could mitigate possible negative effect on the project.

4. COMMON COST ELEMENTS IN PV POWER PLANT PROJECT

There are many elements in building PV power plant. A breakdown of cost for a typical is presented in figure 3 below which is based on multi-megawatt, ground mounted installation(without sun tracker).
Deviation from the average may occurs due local taxes, local content rules and variability on labor rates and project management (International Finance Corporation, 2015).

Figure 3 Average Breakdown Cost for a Ground-Mounted Solar PV Project (International Finance Corporation, 2015)



As can be seen, the main drivers on building the PV power plants are the equipment which is why, right technology selection plays an important factor in delivering cost effective project.

5. PREVIOUS RESEARCH ON CAPITAL BUDGETING MODEL AND SENSITIVITY ANALYSIS

There are many researches using capital budgeting model to assist them in making decision on their project. A journal written by (Primadona, A; Tjendrasa, 2016) uses Capital Budgeting Model to four different Production Sharing Contract Company (PSC) model system, using parameters such as Net Present Value (NPV) and Internal Rate of Return (IRR), which are quite an effective parameters and widely used of an investment analysis. The initial cost of investment still need to be calculated by the PSC. (Mentari & Daryanto, 2018) perform a feasibility analysis of the project in Vietnam also using capital budgeting model. The project in the study was a Diversification of Project Nam Con Son 2 phase 2 Pipeline in Vietnam. (Irawati & Daryanto, 2018) uses Capital Budgeting model to review feasibility of a project on replacing current pipeline material into using pipeline (PE) or polyamide pipeline (PA) for future project. The indicator that they used to analyze data and indicators are Payback Period (PP), Return on Investment (ROI), Net Present Value (NPV), Profitability

Index (PI), Discounted Payback Period (DPP), and Internal Rate of Return (IRR). The finding shows that PE is more efficient than PA if the pressure requirement is less than 10 bar.
(Borgonovo & Peccati, 2004) discuss the usage of sensitivity analysis of valuation equation in investment decision. According to them, financial decision are commonly supported via a point value of some criterion of economic relevance (net present value, economic value added, internal rate of return, etc.), while they focus on local sensitivity analysis and similar to this study, (Coria, Penizzotto, & Pringles, 2019) also perform economic analysis of photovoltaic projects in Argentina where they used the NPV method as the valuation index.

6. RESULT AND DISCUSSION

The assumptions used in the calculation are: 1) The source of funding for initial investment came from 50% long term debt and 50% equity; 2) Weight Average Cost of Capital is 10%; 3) Corporate tax 25%; 4) Interest Rate 10%; 5) Inflation rate 5%; Target Tariff is USD 0.70/kwh; Expected Commercial Operation Date is Q1 2020; 6) Land cost is zero dollar (USD 0) since it is provided by the project owner; 7) 40% of Module need to be replaced every 10 years; 8) additional maintenance cost for Central Inverter is USD 10,000 per year; 9) Panel degradation: Year 1 = 2.5%, the following years (2-20 years) = 0.7%; 10) System lifespan 20 years.

Another data used for the calculation is the performance of each possible combination of panels and inverters. There are four (4) possible combinations which are: 1) Monocrystalline (M1) + Central Inverter (CI); 2) Monocrystalline (M1) + String Inverter (SI); 3) Polycrystalline (P1) + Central Inverter (CI); 4) Polycrystalline (P1) + String Inverter (SI).

The following table shows the summary of each possible technology scenario based on the product datasheets from several manufacturer:

Table 4 Technology Performance

Combination (Panel + Inverter)	DC Capacity (MWp)	MWh Yield	System Availability	Fix Cost per annum (USD)
M1 + CI	29.1	47.791	99.992%	10,000
M1 + SI	29.1	47.791	99.999%	0
P1 + CI	26.1	42.842	99.992%	10,000
P1 + S1	26.1	42.842	99.999%	0

Source: Product Datasheet various Panel & Inverter Manufacturers, 2019

Table 5 shows the budgetary price from each possible technology selection. The information was based on quotations from several panel and inverter manufacturers.

Table 5 Budgetary Price for CAPEX

	MODULE CAPACITY (Wp)	LAND	MODULE ($)	INVERTER ($)	BOP ($)	OTHER ($)	TOTAL ($)
M1 + CI	29,106,000	0.000	9,444,897.00	1,091,766.06	6,009,915.78	4,311,826.55	20,858,405.38
M1 + SI	29,106,000	0.000	9,444,897.00	1,373,512.14	6,178,375.81	4,354,233.24	21,351,018.19
P1 + CI	26,082,000	0.000	6,885,648.00	978,335.82	5,385,508.94	3,746,061.04	16,995,553.80
PI + SI	26,082,000	0.000	6,885,648.00	1,230,809.58	5,536,466.63	3,784,061.84	17,436,986.06

Source: quotation from various panel and inverter manufacturer, 2019

But since each technology configuration has different output capacity, to get the comparable analysis, the cost has to be converted into cost per energy produced ($/wp). The result can be obtained just by dividing the cost ($) by the module capacity and the result can be seen on table 6 below.

Table 6 Estimated Initial Investment (CAPEX - $/wp)

Combination (Panel + Inverter)	Total Cost (USD/Wp)	Land Cost (USD/Wp)	Module (USD/Wp)	Inverter (USD/Wp)	BOP (USD/Wp)	Other (*) (USD/Wp)
M1 + CI	0.717	0	0.325	0.038	0.206	0.148
M1 + S1	0.734	0	0.325	0.047	0.212	0.150
P1 + C1	0.652	0	0.264	0.038	0.206	0.144
P1 + C1	0.669	0	0.264	0.047	0.212	0.145

Result: The calculation of CAPEX shows that the combination of P1+CI provides the lowest cost of investment.

Using the assumptions and technical information, all elements in Capital Budgeting are being calculated. The summary of the calculation is shown in table 6 below:

Table 7. Calculation Result

COMBINATION	LCOE (USD/Wp)	PROJECT IRR	EQUITY IRR	NPV 20 YEARS (USD)	PAYBACK PERIOD (YEAR)	DISCOUNTED PAYBACK PERIOD (YEAR)	PROFITABILITY INDEX
M1 + CI	0.717	8.90%	9.18%	195, 986	8	20	1.01
M1 + S1	0.734	8.33%	8.25%	(569,736)	8	>20	0.97
P1 + C1	0.652	10.50%	11.83%	1,943,962	8	16	1.11
P1 + C1	0.669	9.85%	10.76%	1,240,150	8	18	1.07

Result: From the calculation, the combination of PI with CI, not only provides the lowest capital investment but it is also able to give the highest project IRR (10.50%) while the other combinations are considered not feasible since the IRR is below 10%.

Since the target price is already set by the project owner, then CAPEX sensitivity becomes important. Since CAPEX can impact the other variables in Capital Budgeting model. It is imperative to see how far CAPEX can be increased while still meet the tariff set by the project owner and keep the project IRR above 10% as targeted by the company's management.

Table 7 shows the summary of sensitivity analysis. The CAPEX can only be increased up to three percent (3%) if the company would like to keep the project IRR above 10% otherwise the project will be considered not feasible for execution.

Table 8. Sensitivity Analysis

			TARIFF								
			0.078	0.076	0.074	0.072	0.07	0.06792	0.06337	0.05912	0.05516
CAPEX (USD/Wp)	0.678	104%	11.72%	11.27%	10.81%	10.34%	9.87%	9.38%	8.27%	7.21%	6.18%
	0.671	103%	11.89%	11.43%	10.97%	10.50%	10.03%	9.53%	8.42%	7.35%	6.32%
	0.665	102%	12.06%	11.60%	11.13%	10.66%	10.18%	9.68%	8.56%	7.49%	6.45%
	0.658	101%	12.23%	11.77%	11.30%	10.82%	10.34%	9.84%	8.71%	7.63%	6.59%
	0.652	100%	12.40%	11.94%	11.46%	10.99%	10.50%	10.00%	8.87%	7.78%	6.73%

Source: (Author analysis, 2019)

7. LIMITATION

This study has expanded the literature about capital modeling in the real working world. In the future, it is suggested to compare the result to similar project in other developing country that may have different tax regime or government facility in terms of renewable energy. In addition, the study only focuses on financial aspects. Therefore, the research would be better if also includes the non-monetary considerations, such as SWOT, TOWS, and PESTEL analysis.

8. CONCLUSION AND RECOMMENDATION

The study shows that by using the Capital Budgeting model is able to provide company the analysis from the financial perspective that may help company for evaluating potential investments that are significant in amount. This analysis may help company making the decision to either move forward or not. Taking the example in the study, capital budgeting model able to provide an indicative analysist that with the estimated investment of USD 17 Million the project is able to provide project IRR more than 10%. Payback period of the investment is around 8 years with an estimated NPV of USD 1.9 Million dollar. However, the study also shows that the technology selection plays a very important role in getting the optimum result. The model allows company to get a better idea to know the impact of each technology to the financial.
The recommendation for the company to conduct a non financial analysis that may impact overall cost. The study is also beneficial for the academicians and students to understand capital budgeting model and the practice in real world situation.

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