Economic and Financial Analysis of Amorphous Solar Power Plant : The Effect from Energy Yield Degradation

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Abstract

Regarding to an insufficiency of world energy by the fossil fuel were fast decreased and will be exhausted very soon, but the energy consumption has growth in line with the population increasing. The electricity were become to the necessities of people life and driven of the world business and strategy, thus the renewable energy is the suitable choice for the sustainable solution. The consideration of renewable energy also needed to consider the factors about the feasibility and suitable of project, regarding to the limited of resource, location, local culture, population affection, the pollution emission and etc. The present technology of the photovoltaic (PV) is still highly costing and the efficiency can be improved in order to maximize efficiency, so the investor need to collect and study the worth and return of project. In general the photovoltaic modules has life time about 20-25 years and the almost of Power Plant costing be the Photovoltaic modules about 80% of portion. Then the Photovoltaic modules degradation will effect to the energy yield and benefit of project which is depend on many factors such as the temperature, moisture content, the damaged of modules, etc. This research is considering the effecting about the degradation of 2 MW amorphous photovoltaic power plant about the energy yield output to effect the capital cost of project, the return of the investment when the amorphous photovoltaic module was degrade the efficiency by 0.5 – 1.0% per year by using Payback Period (PB), Net Present Value (NPV) Internal Rate of Return (IRR) to simulation both straight line degradation method, to back degradation method to find out though the break even point of project and the degradation percentage that unacceptable to investment. This research output applicability to determine to others amorphous photovoltaic power plant project by adjustment some information and factors to each project site.

Key words : Economic and Financial Analysis, Amorphous Solar Power Plant, Energy Yield Degradation

1. Rational for Study

Nowadays the electricity consumption situation is the critical time because the electric is the necessity of life the fossil combustion such as oil, coal and gas was be caused of the carbon dioxide liberation, the ocean, breed and clay was absorbed the toxic by half-and-half, the remaining carbon dioxide will sustain in the atmosphere over a century. The Renewable Energy as solar power is the solution of this problems because it's be the clean and sustain energy and be the key strategies of the country to drive the business and country development. Thailand is suitable for solar power because has high potential of the solar radiation about 750W/m^2 with temperature about 30°c whole year or potential of solar radiation be about 5 kWh/m^2 to cover area 510x109 m^2, from this information included the abandon area 5.6 x10m^2 or 10,000 x10m^2 GWH to support the electricity production by amorphous photovoltaic solar cell. Degrading to the a-SI PV Power Plant investment is highly cost and have the degradation problem to decrease PV efficiency to product the electricity output and CO_2 emission quantities also to effect to the earning of annually energy yield and profit and loss of project which the investor need to consideration. This research focus on finding the relation effective of the degradation effect of a-SI PV to the project investment by consider on economic and financial factor by using Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR) and Payback Time Period (PB) to proof under the condition of Thailand policy as including adder support policy to investment and use estimation CO_2 emission rate at 0.5057 tCO_2/MWh from baseline emission factor of Thailand's national electricity system in 2007.

2. Research Methodology and Processing

This research is simulated by consideration many factors and variables that effect to the investment and energy yield from the a-Si PV Power Plant System and get result by

1. Collect Data

2. Calculate NPV, EIRR, FIRR, BCR, PB

3. Sensitivity analysis (3 cases: Degradation rate, Discount rate, and Cost of Land Rental and Loan Installment Interest effect.)

The main factor to determine and consideration for project investment is considered to the economic and financial aspect as the following;

1. Net Present Value : NPV

The NPV for defined as the total present value of a time series of cash flows of project for each year are represent by the formula :

$$NPV = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+i)^t}$$

2. Internal Rate of Return : IRR

The IRR for finding rate of return used in capital budgeting of project for each year are represent by the formula:

$$IRR = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+i)^t} = 0$$

3. Benefit and Cost Ratio : BCR

The BCR is an indicator use in the formal discipline of cost-benefit analysis, that attempts to summarize the overall value for money of a project for each year are represent by the formula:

$$BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t} = 0}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t} = 0} = \frac{PVB}{PVC}$$

4. Payback Time Period: PB

PB is the number of years it take before the cumulative forecast cash flow equals the initial payment, it's tells how long it takes to recover capital and financing costs are represent by the formula :

PB = Cost of project / NPV

3. The Analysis Result

The analysis of 2 MW Amorphous PV Power Plant Project focus on degradation effect to the economic and financial aspect by indicators as NPV, IRR, BCR and PB which found that the increasing degradation ratio is mainly direct effect to the decreasing to the energy yield and CO_2 emission trade will be decreasing to effect to project benefit as NPV, IRR and BCR were decreased and payback time period of project were expansion.

1. The final yield earned with degradation ratio trend will decrease relate with the decreasing of percentage of degradation and effect to NPV, IRR, BCR to decreasing value and PB increasing.

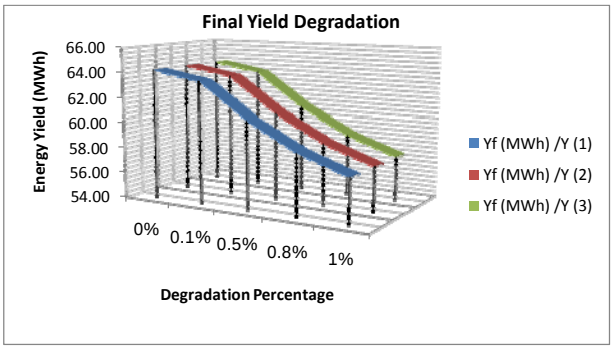

Figure 1 The final yield earned with degradation ratio

The above Figure to show the relation between a-SI PV energy yields with degradation percentage, if the degradation percentage increases then the energy yield will more decreasing in the same direction.

Remark: The Condition of costing effect to Degradation;

Yf (MWh) /Y (1) : Final Yield by Fixed Degradation- No Land Cost, No Loan Installment Interest.

Yf (MWh) /Y (2) : Final Yield by Fixed Degradation- Fixed- No Land Cost and with Loan Installment Interest.

Yf (MWh) /Y (3) : Final Yield by Fixed Degradation- Fixed- With Land Cost and with Loan Installment Interest.

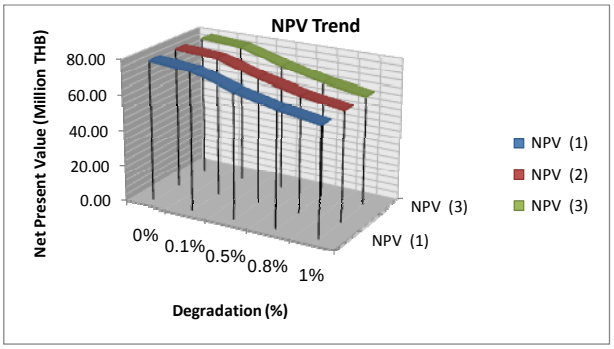

Figure 2 The Net Present Value Trend with degradation ratio

The above figure present about NPV trend relate with PV array degradation, incase PV array increase the degradation percentage effect to Net Present Value were more reducing regarding to the energy yield were decreased. However NPV factor predictive need consideration about inflation ratio trend, adder support policy, interest and etc. which direct effect to NPV.

Remark : The Condition of NPV effect to Degradation ;

NPV (1) : NPV by Fixed Degradation- No Land Cost, No Loan Installment Interest.

NPV (2) : NPV by Fixed Degradation- Fixed- No Land Cost and with Loan Installment Interest.

NPV (3) : NPV by Fixed Degradation- Fixed- With Land Cost and with Loan Installment Interest.

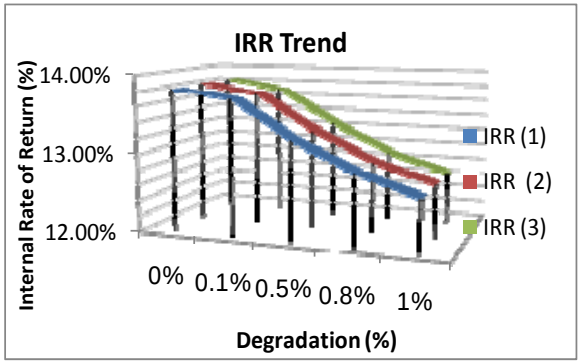

Figure 3 Internal Rate of Return with degradation ratio

The above figure present about IRR trend relate with PV array degradation, if PV array was increasing degrade percentage then Internal Rate of Return will more reducing value regarding to the energy yield were decreased. However IRR factor predictive need consideration about inflation ratio trend, adder support policy, interest and etc. which direct effect to IRR same as NPV, the relation between NPV and IRR is when NPV increase then IRR will also decreasing.

Remark : The Condition of IRR effect to Degradation ;

IRR (1) : IRR by Fixed Degradation- No Land Cost, No Loan Installment Interest.

IRR (2) : IRR by Fixed Degradation- Fixed- No Land Cost and with Loan Installment Interest.

IRR (3) : IRR by Fixed Degradation- Fixed- With Land Cost and with Loan Installment Interest.

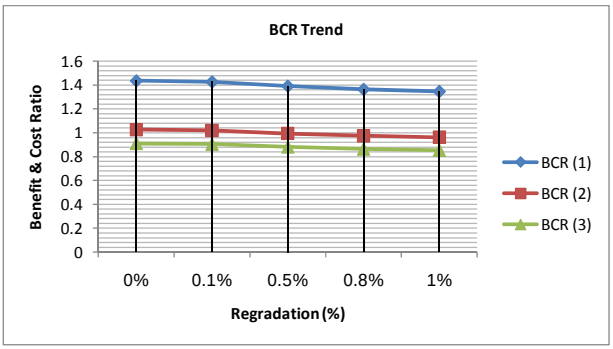

Figure 4 Benefit and Cost Ratio with degradation ratio

The above figure present about BCR trend relate with PV array degradation, if PV array was increasing degrade percentage then benefit & cost ratio will more reducing value regarding to the energy yield were decreased and effect to benefit side decreasing to make cost site ration increasing. BCR factor predictive need consideration about inflation ratio trend, adder support policy, interest ratio and etc. which direct effect to BCR same as NPV, IRR.

Remark : The Condition of BCR effect to Degradation ;

BCR (1) : BCR by Fixed Degradation- No Land Cost, No Loan Installment Interest.

BCR (2) : BCR by Fixed Degradation- Fixed- No Land Cost and with Loan Installment Interest.

BCR (3) : BCR by Fixed Degradation- Fixed- With Land Cost and with Loan Installment Interest.

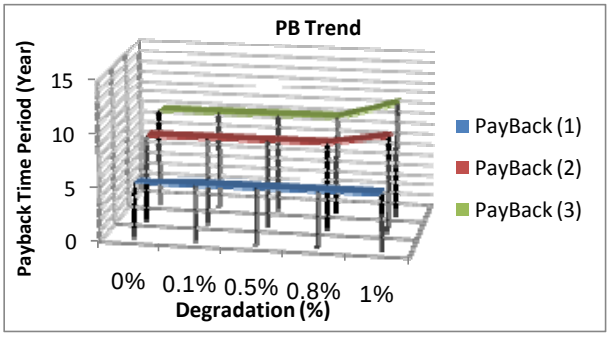

Figure 5 Payback Period relations with degradation ratio

The above figure present about PB trend relate with PV array degradation, in case of PV array was increasing in degrade percentage then benefit & cost ratio will more reducing value, payback time will increase a little bit in case of the investor no land cost and no loan installment (base on sizing of power plant project) and the above to show on Payback (2) and (3) that PB will more increase when project have land rental cost and / or both land rental cost and loan installment interest in project.

Remark : The Condition of PB effect to Degradation ;

Payback (1) : PB by Fixed Degradation- No Land Cost, No Loan Installment Interest.

Payback (2) : PB by Fixed Degradation- Fixed- No Land Cost and with Loan Installment Interest.

Payback (3) : PB by Fixed Degradation- Fixed- With Land Cost and with Loan Installment Interest.

The relation about Adder support to relate with project investment as below.

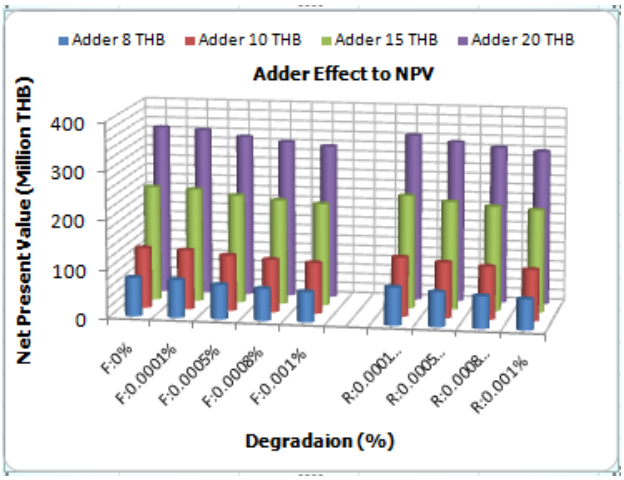

Figure 6 Adder ratio relations with project investment

The sensitivity analysis about what the adder effect to Net Present Value. Project's benefit earning not only relate with both annually energy yield receiving and adder amount support but also to cover about total year to cover the adder support policy. The above figure show that more adder amount support then NPV is more increasing value. Incase PV array degradation percentage more increasing both by fixed or regression method it's will effect to NPV to more reducing value in the same direction, the regression method is reduction to annually energy yield faster than fixed method.

Remark : Project costing condition by exclude land rent and loan installment interest.

F : Fixed degradation method.

R : Regressive degradation method.

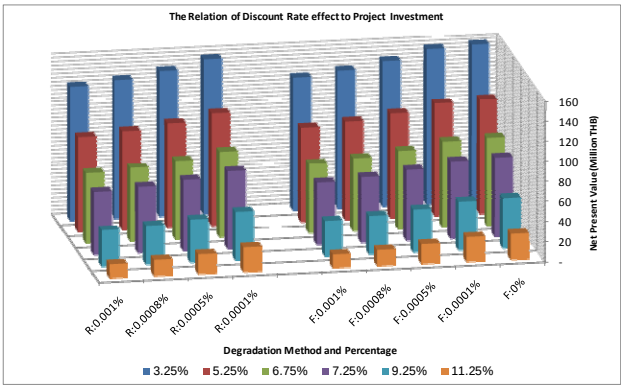

Figure 7 The Relation of Discount Rate effect to project investment.

The above figure present how the relation between PV Degradation ratio with discount rate effect, this graph imply that benefit earning of project decreasing relate with discount rate factor, then increase discount rate will effect to NPV to decreasing and if reduce a discount rate will effect to NPV to increasing.

Remark : This sensitivity simulation by condition of discount rate 3.25%, 5.25%, 6.75%, 7.25%, 8.25% and 11.25%

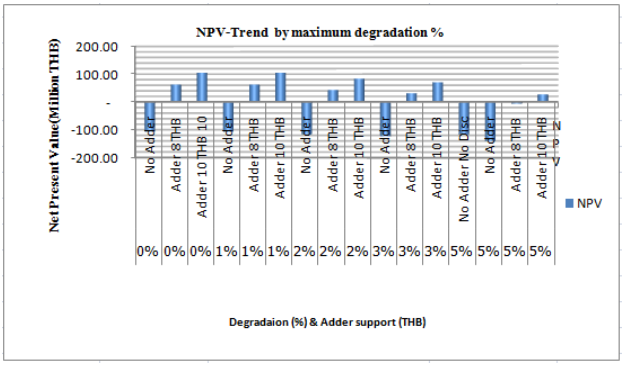

Figure 8 The Relation of NPV with a-SI PV Degradation and Adder Support

The above figure present about NPV trend was effectively when PV array degradation ratio and discount rate ratio has changing, this graph imply how the benefit earning effect when more degradation ratio is effect to NPV, compare by the same adder value support but benefit is lower. Any-way the adder cost factor is one of main factor to the invertor need to consider. Regarding to unless no degradtion effect but also no adder support policy, the project revenue still uncover the investment since first time.

Remark : This sensitivity simulation by condition of degradation ratio at 0%, 1%, 2%, 3% and 5% and add support 0, 8 and 10 THB with fixed degradation method.

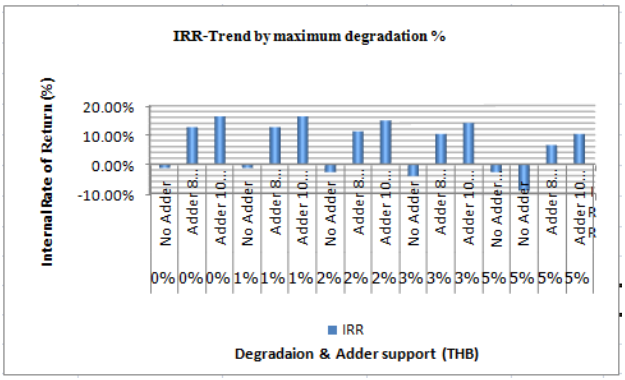

Figure 9 The Relation of IRR with a-SI PV Degradation and Adder Support

The above figure present about IRR trend was effectively when simulate PV array to maximum degradation and by discount rate ratio was changing, this graph imply how the benefit earning effect when more degradation ratio is effect to IRR, compare with the same adder value support but benefit is lower. Any-way the adder cost factor is one of main factor to the invertor need to consider. Regarding to unless no degradtion effect but also no adder support policy, the project revenue still uncover the investment since first time.

Remark : This sensitivity simulation by condition of degradation ratio at 0%, 1%, 2%, 3% and 5% and add support 0, 8 and 10 THB with fixed degradation method.

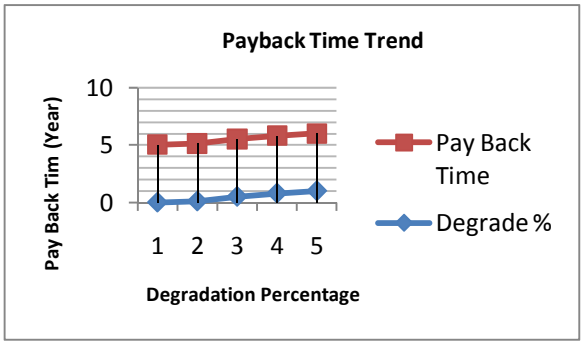

Figure 10 The Relation of Payback Time Period with a-SI PV Degradation ratio

From figure no. 10 as per above to imply that PV array degradation change is effect to payback time period and return of project investment. If the benefit of energy yield earning has reduce then pay back time will be increase and if no degradation or reduce the degradation ratio, the payback time is shorter.

This research to the simulation is consider to choose the condition no land rental and no load interest regarding to finding to clearly of effect to project by without the other variance parameters.

The above figure to imply that the a-SI PV Power Plant Project by without the adder support the simulation result by economic and financial aspect the indicators as NPV, IRR, BCR and PB it unacceptable, and the energy yield trade earning not cover to expense since the first year although to no degradation in project but result of NPV, IRR and BCR still be negative and payback period time were expansion. This sign meaning that adder is main factor to influence the investor to invest the project, more amount adder value per unit will be the motivation many party to induce the investment although the adder time support was decreased but still be interesting because the return of payback were shorten.

4. The Summary of Research

The summarization of sensitivity analysis of 2MW amorphous solar power plant project to show the relation of PV degradation to economic and financial as the following :

- The increasing of discount rate ratio will effect direct to financial indicators as NPV, IRR, BCR to decrease relate with increasing ratio and payback time to extend.

- Adder value will relate with cash-flow to increase NPV, IRR and BCR and support to reduce PB period and make the efficiency of ROI, be the motivation of project investment. Incase solar power plant project without adder support NPV and IRR of project will be negative value since the first year of ROI and be caused of project denial unless the discount rate decrease to zero but still does not cover the project in vestment.

- Increasing ratio of adder will direct relate with payback time period to decrease time of return on investment.

-Discount rate will be rate with NPV, IRR, and BCR to decreasing value as per the discount rate ratio increase.

- The decreasing of PV array will be effect to the annual energy yield by CO_2 emission trade decrease and make a benefit of project decrease.

- Incase price of PV Array price which be 70 % portion of project down the return of investment as payback period will be decrease and NPV, IRR , BCR will increase and be caused to motivate to investment to electricity solar power plant.

- The maximum of degradation should not over 3% because this value make the benefit of project uncover the annual expense and the indicators as NPV, IRR will be the negative value, BCR value lower than 1 and then the degradation to 5% will make the benefit of project is uncover expense since the first year.

5. Acknowledgement

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