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An Assessment of a Return from Carbon Credit of a Hybrid Solar Rooftop System

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***Abstract*—This paper presents an assessment of a return from carbon credit of a hybrid solar rooftop system. 25.68 kW is capacity of a photovoltaic system. The objective is assessed a return from carbon credit in 25 years of factory in Thailand. Reducing greenhouse gas emissions is a trend currently being campaigned in Thailand. Thailand has a target net zero greenhouse gas in 2065. The study considers energy is produced by solar panels, and carbon credit from photovoltaic system, and assessment a return from carbon credits. The result found that carbon credits in 25 years is 368.29 tons of CO_2 equivalent (tCO_2eq). The assessment a return from carbon credits in 25 years is 11,162.74 baht.**

Keywords—Assessment a Return, Carbon Credit, Hybrid Solar Rooftop System

I. INTRODUCTION

Thailand places great importance on the greenhouse gas problem, which is a global problem. Therefore, in 2014, Thailand established the greenhouse gas management organization (TGO) to set standards related to measurement, reporting, verification, and certification quantity of emissions. Reduction and compensation of greenhouse gases include promoting project development and marketing for buying and selling certified greenhouse gas quantities [1]. Projects that can be developed into greenhouse gas reduction projects is shown in Figure 1.

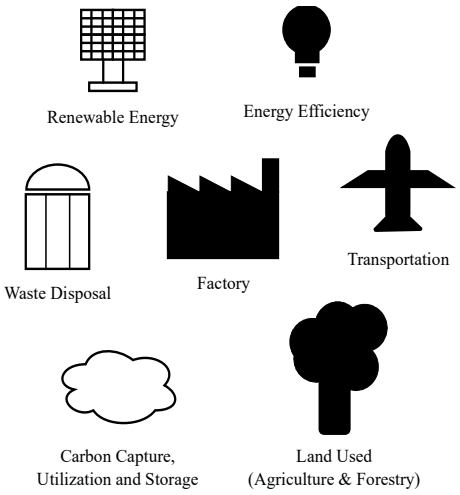

Fig. 1. Projects that can be developed into greenhouse gas reduction projects

The approach to reducing climate change by finding ways to reduce greenhouse gas emissions and providing replacement for greenhouse gas emissions or carbon dioxide emissions is called "Carbon Credit". Carbon credits are like certificates that show the reduction of greenhouse gas in the atmosphere from projects that prevent or reduce greenhouse gas emissions. Countries that can reduce their greenhouse gas emissions will receive carbon credits that they can sell to other countries that exceed their greenhouse gas emissions. The buyer of carbon credits is from 41 members countries of the developed world, while the seller is from 150 members countries from the developing world [2].

In 2014, Aamir Mehmood, Furqan Ali Shaikh, and Adeel Waqas analyzed solar photovoltaic applications for six pakistani domestic sectors, each with a different climate and geographic location. RETSCREEN software was used to create a model assessed based on NPV, IRR, payback period and greenhouse gas emission reductions. The results showed that installing a 5 kW standalone PV system resulted in a 0.6-0.7 tCO_2eq reduction in greenhouse gas emissions [3]. In 2018, Putthadee Ubolsook, Chatkaew Chailuecha, and Surat Sedpho estimated greenhouse gas emissions from installing a 500 kW photovoltaic system. A case study of smart grid system in university of phayao Thailand. This research estimates a 20 year solar cell life (2016-2035) as well as a plan to reduce greenhouse gas emissions. The results showed that the electricity generated by the solar cells in the smart grid system was 912.5 MWh per year. Greenhouse gas emissions reduced by 9,908.97 tCO_2eq per year. [4]. In 2022, J. Chen, X. Yu, Z. Shi, Y. Luo, R. Yang, S. Yan, and Y. Lou designed and simulated a 10 kW residential rooftop on grid solar power generation system. In Luohe City, Henan Province. JLS60P-260 photovoltaic modules and X3-10.0-T series inverters were installed. The results produced electricity 15,421.72 kWh per year and reduced greenhouse gas 352.64 tCO_2eq [5].

Therefore, this paper an assessment of a return from carbon credit of a hybrid solar rooftop system. This paper assesses the amount and return of a hybrid solar rooftop system based on electric power production data simulated with the PVsyst program, which calculates the approximate price to guideline for future studies and research.

The factory divides three sections viz 100 kVA, 400 kVA, and 800 kVA, respectively. Factory install a hybrid solar rooftop system two section viz 100 kVA, and 800 kVA. In this paper focus 100 kVA section. The section 100 kVA install hybrid solar rooftop system capacity 25.68 kW. The background of this factory wants to reduce an electricity bill and used electricity at night. Therefore, select to install a hybrid system (use a battery). The roof of factory 100 kVA is shown in Figure 2.

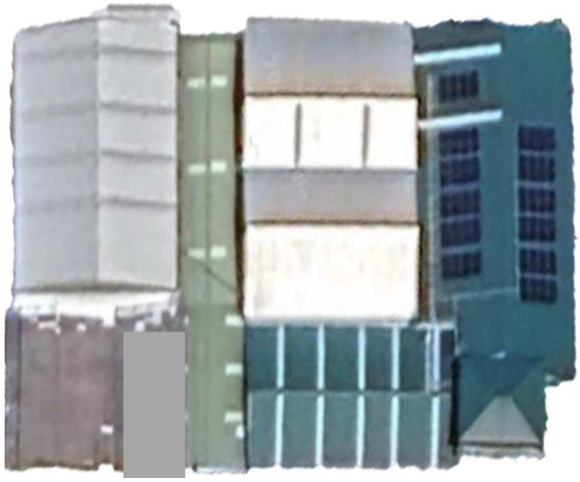

Fig. 2. The roof of factory 100 kVA

Installation solar panel on the factory roof is shown in Figure 3.

Fig. 3. Installation solar panel on the factory roof

Figure 3 shows, installation divide two orientation. The first orientation: tilts is 5° and azimuth is -70°. The second orientation: tilts is 5° and azimuth is 110°. The factory roof has 48 modules. The capacity of module is 535 W.

II. Calculation on Greenhouse Gas Emission

The amount of greenhouse gases that can be reduced in terms of carbon dioxide equivalent (CO_2eq) can be calculated as equation 1.

$$ER_y = BE_y - PE_y \quad (1)$$

From equation 1

ER_y is amount of greenhouse gas emission reduction from project implementation in year y (tCO_2eq per year).

BE_y is baseline emission in year y (tCO_2eq per year).

PE_y is project emission in year y (tCO_2eq per year).

Equation 1 is based on the Thailand voluntary emission reduction program calculation method.

The production of electricity from solar energy in this research paper falls within the scope of calculation according to the methodology for producing electricity from renewable energy to replace the use of electricity from the transmission system or distribution system [6]-[7] can be calculated as equation 2.

$$BE_y = BE_{EG,y} = \left(EG_{PJ,y} \times 10^{-3}\right) \times EF_{grid} \quad (2)$$

From equation 2

BE_{EGy} is amount of greenhouse gas emissions from electricity generation of grid in year y (tCO_2eq per year).

EG_{PJy} is amount of electricity produced from the photovoltaic system in year y (kWh per year).

EF_{grid} is greenhouse gas emissions from electricity generation of grid (tCO_2eq per MWh).

The EF_{grid} in equation 2 for solar power projects is 0.4401 tCO_2 per MWh (Referring to the value of greenhouse gas emissions from the production/ consumption of electricity for projects and activities to reduce greenhouse gas emissions 2022) [8]. Assuming to be constant throughout the period considered in this research. *PE* is equal to zero because no fossil fuels and electricity are used in the greenhouse gas reduction project.

III. Policy in Thailand

A. Thailand National Economic and Social Development Plan

In 2023-2027 Thailand has a National Economic and Social Development Plan. In milestone 10: Thailand is a circular economy and low carbon society of thirteenth plan. The goals, indicators, and targets have three targets. Target 1 is increasing values through the circular economy and efficient use of resources. Target 2 is sustainably conserve, rehabilitate and utilize natural resources. Target 3 is establish a low carbon sustainable society [9].

In target 3 has a proportion of renewable energy in the final energy consumption increases by no less than 24 percent by 2027.

B. Thailand's carbon neutrality pathway

Thailand has given priority to reducing carbon dioxide emissions in the energy sector, which is the main cause of greenhouse gas emissions. Thailand has drafted Thailand integrated energy blueprint (TIEB) to guide relevant agencies to transition to a clean energy system and achieve the goal of a carbon neutral country by 2050. Five policy of Thailand integrated energy blueprint is shown in Figure 4.

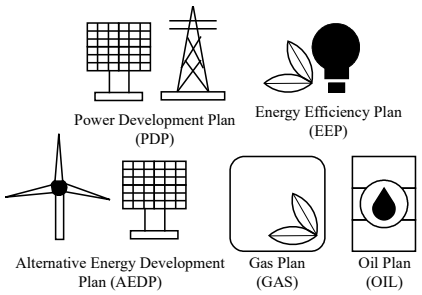

Fig. 4. Five policy of Thailand integrated energy blueprint

Figure 4 shows, five policy of Thailand integrated energy blueprint viz power development plan, energy efficiency plan, alternative energy development plan, gas plan and oil plan.

C. Thailand's net zero greenhouse gas emission pathway

Emissions after 2050 meet the IPCC 1.5° approach, in which Thailand is expected to achieve a balance between emissions at source and sink disposal by 2065. Coal phasing technology and negative emissions in the energy sector, such as air capture and storage, contribute to Thailand net zero emissions [10].

IV. Reduction an Efficiency of Solar Panel

Reduction an efficiency of solar panel is shown in Table I.

TABLE I. Reduction an Efficiency of Solar Panel

Year	Efficiency of solar panel	
	Percent reduction per year	Efficiency of solar panel per year
1	2.00	98.00
2	0.55	97.45
3	0.55	96.90
4	0.55	96.35
5	0.55	95.80
6	0.55	95.25
7	0.55	94.70
8	0.55	94.15
9	0.55	93.60
10	0.55	93.05
11	0.55	92.50
12	0.55	91.95
13	0.55	91.40
14	0.55	90.85
15	0.55	90.30
16	0.55	89.75
17	0.55	89.20
18	0.55	88.65
19	0.55	88.10
20	0.55	87.55
21	0.55	87.00
22	0.55	86.45
23	0.55	85.90
24	0.55	85.35
25	0.55	84.80

Table I shows, the efficiency of solar panel reduces two percent in the first year and 0.55 percent in the next year. In the year 25 the efficiency of solar panel is 84.80 percent.

V. Results

In this paper assess amount and return of carbon credit in 25 years. From data PVsyst program, the first year hybrid solar rooftop system produces energy 35.85 MW. Therefore, greenhouse in the first year is calculated as follows.

$$BE_y = (35{,}850 \times 10^{-3}) \times 0.4401$$
$$= 15.77\ tCO_2eq\ per\ year$$

$$ER_y = 15.77 - 0 = 15.77\ tCO_2eq$$

The price of carbon credits from solar energy. The information as of June 29, 2023. The average price of solar energy is 30.31 baht per ton [11].

$$The\ return\ of\ carbon\ credit = 15.77 \times 30.31$$
$$= 477.98\ Baht$$

The results assess amount and return of carbon credit in 25 years is shown in Table II.

TABLE II. The Results Assess Amount and Return of Carbon Credit in 25 Years

Year	The energy was produced (MW)	Carbon credit (tCO_2eq)	The return of carbon credit (Baht)
1	35.85	15.77	477.98
2	35.65	15.69	475.56
3	35.45	15.60	472.83
4	35.25	15.51	470.10
5	35.06	15.43	467.68
6	34.86	15.34	464.95
7	34.66	15.25	462.22
8	34.47	15.17	459.80
9	34.27	15.08	457.07
10	34.07	14.99	454.34
11	33.87	14.91	451.92
12	33.68	14.82	449.19
13	33.48	14.73	446.46
14	33.28	14.64	443.73
15	33.09	14.56	441.31
16	32.89	14.47	438.58
17	32.69	14.38	435.85
18	32.49	14.30	433.43
19	32.30	14.21	430.70
20	32.10	14.12	427.97
21	31.90	14.04	425.55
22	31.70	13.95	422.82
23	31.51	13.86	420.09
24	31.31	13.78	417.67
25	31.11	13.69	414.94
Total	836.99	368.29	11,162.74

Table II shows, the total energy in 25 years is 836.99 MW. In the first year energy is 35.85 MW. In the year 25 energy is 31.11 MW. The energy was generated reduce 4.74 MW between 25 years. The results assess amount of carbon credit is shown in Figure 5.

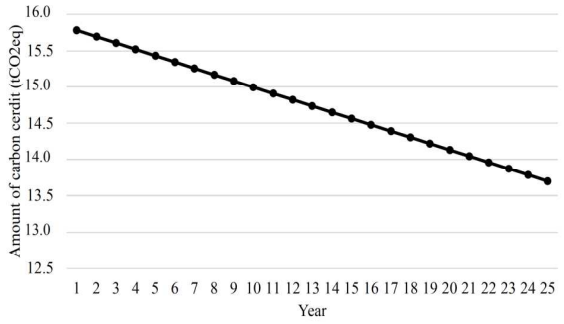

Fig. 5. The results assess amount of carbon credit

Figure 5 shows, the total assess carbon credit in 25 years is 368.29 tCO_2eq. In the first year carbon credit is 15.77 tCO_2eq. In the year 25 carbon credit is 13.69 tCO_2eq. The carbon credit reduces 2.08 tCO_2eq between 25 years. The results assess return of carbon credit is shown in Figure 6.

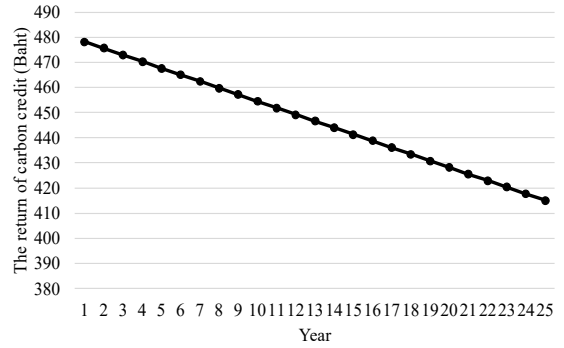

Fig. 6. The results assess return of carbon credit

Figure 6 shows, the total assess return of carbon credit in 25 years is 11,162.74 baht. In the first year return of carbon credit is 477.98 baht. In the year 25 return of carbon credit is 414.94 baht. The return of carbon credit reduces 63.04 baht between 25 years.

In the end, if include the cost of evaluating and certifying the project to be able to sell carbon credits. The returns are not worth the value of the project's appraisal and certification. Due to the small production capacity, but if applied to large size of the solar farm, solar floating and solar rooftop will be worth the investment.

VI. Conclusion

This paper presents an assessment of a return from carbon credit of a hybrid solar rooftop system. The considers produce an electricity energy, and greenhouse gas emission reduction, and return of carbon credit in 25 years. The result found that the total carbon credit in 25 years is 368.29 tCO_2eq. The total return of carbon credit in 25 years is 11,162.74 baht. This project is an application of renewable energy combined with techniques for calculating greenhouse gas reductions. But calculation in this paper is approximate price to guideline for future studies.

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