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Valuation of Solar-Wind Power Plant Project and Impact on Stock Price

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ABSTRACT

In Thailand, the Energy Policy and Planning Office, Ministry of Energy, has gradually developed a number of plans to promote renewable energy, such as the Alternative Energy Development Plan 2015–2036 (AEDP, 2015) and Power Development Plan 2010–2030 (PDP2010). This study examines valuation of power plant projects with two categories of renewable energy: Solar power plants and wind power plants in Thailand. The valuation model shows the amount of electricity generated by solar energy and that generated by wind energy in each day and factors affecting electricity generation, such as cloud cover, temperature and wind speed. The amount of electricity generated is then used to calculate the net present value (NPV), interest rate of return, payback period, and %change of stock price when the project is announced, which can be used to support investors' decision making process.

Keywords: Renewable Energy, Valuation, Solar Power, Wind Power
JEL Classifications: Q2, Q4, G11

1. INTRODUCTION

Renewable energy becomes more and more popular due to the fact that it is collected from renewable resources, which are naturally replenished. Most of the renewable energy sources are clean and have no environmental impacts. Statistically, the cost of investment in renewable energy clearly decreases. Oppositely, a significant increase in work positions in the renewable energy sector clearly reflects development in renewable energy. In Thailand, the Energy Policy and Planning Office, Ministry of Energy, has gradually developed a number of plans to promote renewable energy, such as the Alternative Energy Development Plan 2015–2036 (AEDP2015) and Power Development Plan 2010–2030 (PDP2010).

In valuating renewable energy, apart from the amount of money invested in the power plant project, there are external factors affecting the value of the power plant, such as temperature, cloud cover, and wind speed. This article investigates the valuation of solar-wind power plant projects using a model and simulation process to forecast the amount of electricity generated in each day. The results are further used to valuate power plant projects and impact of investment in power plants on the company's stock price.

This article will apply a model to valuation of power plant projects of three companies, namely (1) Energy Absolute Public Company Limited (EA), (2) Electricity Generating Public Company Limited (EGCO), and (3) BCPG Public Company Limited (BCPG).

Each company has conducted the studies of two categories of renewable energy: Solar power plants and wind power plants in Thailand. Such model shows the amount of electricity generated by solar energy and that generated by wind energy in each day and factors affecting electricity generation, such as cloud cover, temperature and wind speed. The amount of electricity generated is then used to calculate the net present value (NPV), interest rate of return (IRR), payback period (PB), and %change of stock price when the project is announced, which can be used to support investors' decision making process.

2. LITERATURE REVIEW

There are studies of power plant projects, including a case study on the management of the development of a large-scale power plant project in East Asia based on Design-build Arrangement by Ling and Lau (2002), which investigates the project environment, such as efficiency, budget, time, and quality of the project. Another study is Lake Sihwa Tidal Power Plant Project by Bae et al. (2010), which looks into the structure and construction methods. Valuation of power plant projects is another topic that has been widely studied, such as Monte Carlo Methods for Appraisal and Valuation: A case study of a nuclear power plant by Rode et al. (2001) and Valuation about Remaining Service Life of GBM Hydraulic Power Plant Units Technical and Economic Aspects by Hara et al. (1994). One more topic that gains more interest is valuation of renewable power plant, such as Valuation for Renewable Energy: A Comparative Review by Menegaki (2008), which gathers methods for analysis of profit and cost of renewable energy projects. One of the most popular methods is contingent valuation method, which includes environmental factors into the valuation. Jeon and Shin (2014) propose a new long-term technology valuation method for renewable energy technologies that combines system dynamics with Monte Carlo simulation. Monjas-Barroso and Balibrea-Iniesta (2013) evaluates an investment project on renewable energy based on wind power models the main uncertainties that affect this kind of project, such as the cost and production of electric power, investment costs and consumer price index. Using real options analysis methods, Lee and Shih (2010) propose a policy benefit evaluation model that integrates cost efficiency curve information on renewable power generation technologies. Koundouri et al. (2009) study the construction of a wind farm in the area of Messanagros in the island of Rhodes, Greece using data from a double-bounded dichotomous choice contingent valuation study.

However, there is no article investigating the valuation of solar-wind power plant projects using a model and simulation process to forecast the amount of electricity generated each day in Thailand.

3. DATA AND METHODOLOGY

This model shows the probability distribution of electricity generation from solar energy for 12 h and from wind energy for 24 h a day. Factors affecting the change in amount of electricity generated from solar energy and wind energy are included in the analysis.

3.1. Solar Power Generation

Based on the solar power generation model, there are two factors affecting solar power generation, including cloud cover and temperature. Variables relating to model construction are summarized in Table 1.

3.2. Wind Power Generation

Based on the wind power generation model, the main factor affecting wind power generation is wind speed. Variables relating to model construction are summarized in Table 2.

3.3. Replication for Using in Thailand

The cases of Thai solar and wind power plants are described in this section.

Table 1: Variables relating to solar power generation

Variable	Description
Max solar power	Maximum solar power generation capacity in megawatts
Solar shape	Solar shape model using PERT distribution method, which is continuous probability distribution defined by minimum, most likely and maximum values as per production hours
Cumulative percentage	Cumulative probability function is used to determine the probability of solar shape from the initial solar shape value to the hour that we want to calculate in order to include change in solar shape in each period in the analysis
Base power output	Amount of electricity generated from solar energy when no other factors, such as cloud cover or temperature, are involved
Solar power output	Amount of electricity generated from solar energy when other factors, such as cloud cover or temperature, are included in the analysis
Cloud cover	Fraction of the sky obscured by clouds. If the resulting value is 1, it means ordinary cloud cover whereas 0 means no cloud cover
Bernoulli	Bernoulli's principle on "balance of pressure and speed of fluid states that if the flow level does not change when the speed of fluid increases, the fluid pressure will decrease." This theory is used to explain a number of phenomena regarding movement of fluids. This model adopts Bernoulli's principle in a random form to forecast cloud cover in a particular area
Cloud cover percent	Percentage of cloud cover is calculated by uniform random method to determine the percentage of cloud cover in each hour. The built-in correlation method is adopted to show relationship with cloud cover percentage in the previous hour
Cloud cover correction	Percentage of solar output per cloud cover is calculated by establishing power reduction as linear equation with a 30% reduction of solar output for 100% cloud coverage. The chance of cloud coverage can be increased from 0% to 100%
Average temperature	Temperature has a slight impact on solar power output. The solar power output will slightly decrease if the temperature increases
Temperature correction	Percentage of solar power output in accordance with temperature change. When the temperature is higher than 25°C, the solar power output will be reduced by 10% of the temperature of 20°°C. When the temperature is lower than 25°C, the solar power output will increase at the same rate

3.3.1. Energy Absolute Public Company Limited - EA

EA has invested in power plant business, both solar and wind power plants, which is in line with Thailand's Power Development Plan 2010–2030 (PDP2010) that promotes electricity production from renewable energy concurrently with environmental protection. The Company's investment projects will enhance its long-term stability. The description of each plant is described below.

3.3.1.1. Solar power plant in Phitsanulok province

Weather information is obtained from the Meteorological Department, Matong Sub-district, Phrom Phiram District, Phitsanulok Province. Cloud amount used by Meteorological Department to describe sky condition include overcast sky, cloudy sky, partly cloudy sky, and fair sky. On 18 March 2018, the cloud amount in such area throughout the day is 10% partly cloudy and 90% clear sky. Temperature data on 18 March 2018 showed minimum temperature was 23.0°C and maximum temperature was 36.0°C. The model is tested using data of EA's solar power project in Phitsanulok Province.

Project Company	EA Solar Phitsanulok Co., Ltd.
Location	Matong Sub-district, Phrom Phiram District, Phitsanulok Province
Total Area	Approximately 2,000 rai
Capacity	90 megawatts AC, 133.92 megawatts DC
Adder	6.5 Baht/kilowatt-hour for a period of 10 years
Privileges from BOI	Receive an exemption from corporate income tax on net profit obtained from operating business for the period of 8 years and receive corporate tax deduction on net profit at 50% of normal tax rate for 5 years after that
Investment	8,500 million Baht

Electricity generation from solar panel was estimated and summarized in the Table 3. The uncertainty analysis using@risk was also applied.

3.3.1.2. Had Kanghan Wind Farm Projects 1-3

Wind turbine is a device used to convert the kinetic energy in the wind into mechanical energy. Then, the mechanical energy is utilized. In other word, when the wind blows through the turbine, the kinetic energy is transferred to the turbine blades to cause the turbine to rotate. This energy from the rotation can be utilized. The generator connected to the shaft of the wind turbine will distribute electricity through the power control system and further feed it into the system. The amount of electricity generated will depend on the speed of the wind, the length of the blade, and the location of the wind turbine. EA has 8 wind power plant projects with total capacity of 386 megawatts. For the current projects, there are three wind power plant projects with a combined capacity of 126 megawatts in Nakhon Si Thammarat Province and Songkhla Province, totaling 3 projects with a total investment of 10,400 million Baht (Table 4).

Table 2: Variables affecting wind power generation

Variable	Description
Max wind power	Maximum wind power generation capacity in megawatts
Wind power output	Wind power output is equal to 0 when the wind speed is<5 knots and increase non-linearly to 100% for the wind speed of 5–20 knots. Wind power generation is steady at 100% for wind speed from 20 to 40 knots, decreases by 30% for wind speed of more than 40 to 60 knots, and is equal to 0 when wind speed is more than 60 knots

The company received adder 3.5 Baht/kilowatt-hour for 10 years and receive an exemption from corporate income tax on net profit obtained from operating business for the period of 8 years and receive corporate tax deduction on net profit at 50% of normal tax rate for 5 years after that.

Three wind power plant projects (Had Kanghan Wind Farm Projects 1–3) with a combined capacity of 126 megawatts in Songkhla Province and Nakhon Si Thammarat Province. Weather information was obtained from the Meteorological Department. According the data in March 18, 2018, Ranot District, Songkhla Province reported wind speed of 11.1 km/h. Hua Sai District, Nakhon Si Thammarat Province reported the wind speed of 15.0 km/h. Pak Phanang District, Nakhon Si Thammarat Province reported the wind speed of 15.0 km/h.

The model is tested using data of EA's three wind power plant projects in Nakhon Si Thammarat and Songkhla. For Had Kanghan Wind Farm Project 1, the variables used in the model were summarized in Table 5.

For Had Kanghan Wind Farm Projects 2 and 3, the variable used in the model were summarized in Table 6.

3.3.2. Electricity Generating Public Company Limited - EGCO

EGCO currently operates both domestic and overseas power plants. Its seven solar power plants and three wind power plants have reached commercial operation.

Table 3: Variables used in the model

Variable	Value
Max solar power	90 MW
Solar shape	RiskPert (0, 6, 12)
Cum percent	Risk Theo Target (Solar Shape, Index Hour)
Cloud cover	
Cloud cover	Risk Bernoulli (Bernoulli)
Bernoulli	0.1
Cloud cover percent	Cloud cover percent=risk uniform (0, 1) เป็นค่าเริ่มต้น Cloud cover percent=Risk uniform (80% *cloud cover percent of previous hour, min [20% *cloud cover percent of previous hour, 1])
Cloud cover correction	Cloud cover correction=1 - (is cloud cover * power reduction * cloud cover percent)
Temperature	
Average temperature	Risk normal (36.0, 23.0)
Temperature Correction	Temperature correction=1-(average temperature-25) * (20% * 10%)

Table 4: The wind power projects

	Project name	Capacity	Location	Status
1	Had Kanghan Wind Farm 1	36 MW	Ranot District, Songkhla Province	Finished and start selling electricity to EGAT since March 2017
2	Had Kanghan Wind Farm 2	45 MW	Hua Sai District, Nakhon Si Thammarat Province	Finished and start selling electricity to EGAT since June 10 2017
3	Had Kanghan Wind Farm 3	45 MW	Pak Phanang District, Nakhon Si Thammarat Province	Finished and start selling electricity to EGAT since June 23 2017

Table 5: Variables used in the model

Variable	Value
Max Wind Power	36
Wind Power Output	Max wind power * IF (wind speed≤5.0%, IF [wind speed≤20, [wind speed/20]^3, IF [wind speed≤40, 100%, IF [wind speed≤60, 30%, 0%]]])
Wind speed	
Wind speed	Risk Lognorm (11.1–2.5, 11.1+2.5)

Table 6: Variables used in the model

Variable	Value
Max Wind Power	45
Wind Power Output	Max wind power * IF (wind speed≤5.0%, IF [wind speed≤20, [wind speed/20]^3, IF [wind speed≤40, 100%, IF [wind speed≤60, 30%, 0%]]])
Wind speed	
Wind speed	Risk Lognorm (15.0–2.5, 15.0+2.5)

Table 7: Description of the solar power plant at Roi Et

Project Company	Electricity Generating Public Company Limited
Size	VSPP
Location	Roi Et
Capacity	8 MW
Contact period	5 years and renew contract every 5 years
Selling price	8 Baht/MW
Share holder	ENGO 100%
Start date	June 22, 2012
Investment	56 Million Baht/unit

3.3.2.1. SPP5 solar power plant in Roi Et province

The description of the solar power plant was summarized in Table 7.

Weather information was obtained from the Meteorological Department located in Roi Et Province. The cloud amount reported on March 18, 2018 was 70% partly cloudy and 30% clear sky.

The temperature station reported the minimum temperature of 24°C and maximum temperature of 36°C. The model is tested using data of EGCO's solar power project in Roi Et province. Table 8 showed the summary of variables used in the model.

3.3.2.2. Chaiyaphum wind farm

Chaiyaphum Wind Farm Power Project with a total capacity of 80 megawatts, located in Chaiyaphum Province, with the investment value of 23 million Baht/unit. The describion of the project was summarized in the Table 9.

Table 8: Variables used in the model

Variable	Value
Max solar power	8 MW
Solar shape	Risk Pert (0, 6, 12)
Cum percent	Risk Theo Target (solar shape, index hour)
Cloud cover	
Cloud cover	Risk Bernoulli (Bernoulli)
Bernoulli	0.7
Cloud cover percent	Cloud cover percent=risk uniform (0, 1) Cloud cover percent=risk uniform (80% * cloud cover percent of previous hour, min [20% * cloud cover percent of previous hour, 1])
Cloud cover correction	Cloud cover correction=1-(is cloud cover * power reduction * cloud cover percent)
Temperature	
Average temperature	Risk normal (36, 24)
Temperature correction	Temperature correction=1-(average temperature-25) * (20% * 10%)

Table 9: Project description

Project company	Electricity Generating Public Company Limited
Size	SPP
Location	Chaiyaphum
Capacity based on the contract	80 MW
Capacity based on share holder	72 MW
Starting date	December 16, 2016
Investment	23 Million Baht per unit

Weather information from the Meteorological Department reported the average 7-day weather information during 11–17 March 2018 of Chaiyaphum Province and wind speed of 26.74 km/h. The Model is tested using data of EGCO's wind power project in Chaiyaphum Province (Table 10).

3.3.3. BCPG Public Company Limited - BCPG

3.3.3.1. Solar power plants in Ang thong province and Bang Pa-in district

BCPG is one of the largest private power producers in Thailand and operates solar power plants with installed capacity of 182 megawatts in Thailand. Moreover, its solar power plant projects in Japan have a total installed capacity of 236 megawatts and the Company aims to invest in power generation projects around the world with a goal of operating 1,000 megawatts of renewable energy by 2020. Table 11 showed the summary of project overview.

Weather information of Ang Thong Province from the Meteorological Department reported the cloud amount on

18 March 2018 was 40% partly cloudy and 60% fair sky. Temperature was minimum temperature of 25°C and maximum temperature of 37°C. The model is tested using data of EGCO's solar power plant in Ang Thong Province (Table 12).

Weather information of Phra Nakhon Si Ayutthaya Province from the Meteorological. Department reported the cloud amount on 18 March 2018 was 50% partly cloudy and 50% fair sky. The minimum temperature was 24°C and maximum temperature was 36°C.

The model is tested using the data of EGCO's solar power plant in Phra Nakhon Si Ayutthaya Province (Table 13).

3.3.3.2. Nabas wind farm, the Philippines

This wind power project with a total capacity of 50 megawatts is composed of a commercial 36 megawatts wind power project and a 14 megawatts wind power project under development, located in Nabas on the Visayan Islands of the Philippines (Table 14).

Weather information from the Meteorological Department Report on 18 March 2018 in Nabas, the Philippines with the wind speed of 20 km/h. The model is tested using data of BCPG's wind power project in Nabas, the Philippines. For the 36 megawatts wind power project in commercial operation, the variables used in the model were summarized in Table 15.

For the 14 megawatts wind power project in commercial operation, the variables used in the model were summarized in Table 16.

4. RESULTS

4.1. Solar and Wind Power Outputs from Simulation

Simulation is performed to estimate the daily solar and wind power generation of the (1) Energy Absolute Public Company Limited – EA (2) Electricity Generating Public Company Limited – EGCO (3) BCPG Public Company Limited – BCPG by applying the probability function, which is a dependent variable in electricity generation to determine the output of daily power production.

4.1.1. Energy Absolute Public Company Limited - EA

1. Solar Power Plant in Phitsanulok Province: The average solar output is 556.19 megawatts/day whereas the maximum production is 817.63 megawatts/day and the minimum production is 302.94 megawatts/day, with standard deviation of 67.51. The maximum production is during 9 AM–3 PM.
2. Had Kanghan Wind Farm: The average wind power output is 588.61 megawatts/day with the maximum production of 3,024.00 megawatts/day, and the minimum production of 0 megawatt/day, and standard deviation of 554.35. The amount of electricity produced from wind energy each day is quite steady.

The total power output (solar and wind power), the average daily output is 1,141.79 megawatts/day. The maximum output of 3,603.58 megawatts/day and minimum output of 310.04 megawatts/day with standard deviation of 558.92. It is found that in the morning when the sun rises, especially during the daytime at around 9 AM–3 PM, the maximum amount of electricity can be produced.

4.1.2. *Electricity Generating Public Company Limited - EGCO*

1. SPPPS Solar Power Plant in Roi Et Province: The solar power production graph, the average output is 563.57 megawatts/day with maximum output of 815.65 megawatts/day, minimum output of 314.82 megawatts/day, and standard deviation of 63.05. It is found that the maximum amount of electricity can be produced during the daytime at approximately 9 AM–3 PM.
2. Chaiyaphum Wind farm: The average power output is 1,166.32 megawatts/day with the maximum output of 3,024.00 megawatts/day, and the minimum output of 0 megawatt/day. Standard deviation is 658.78. It is found that the amount of electricity produced from wind energy each day is quite steady.

Table 10: Variables used in the model

Variable	Value
Max Wind Power	80
Wind Power Output	Max wind power * IF (wind speed≤5.0%, IF [wind speed≤20, [wind speed/20]^3, IF [wind speed≤40, 100%, IF [wind speed≤60, 30%, 0%]]])
Wind speed	
Wind speed	Risk Lognorm (26.74–2.5, 26.74+2.5)

Table 11: Project description

Project Company	Bangchak Corporation Public Company Limited
Size	VSPP
Location	Ang Thong Province and Bang Pa-in District
Capacity	12 MW
Contract period	25 years
Share holder	ENCO 100%
Starting date	June 22, 2012
Investment	56 Million Baht per unit

Table 12: Variables used in the model

Variable	Value
Max solar power	5 MW
Solar shape	Risk Pert (0, 6, 12)
Cum percent	Risk Theo Target (solar shape, index hour)
Cloud cover	
Cloud cover	Risk Bernoulli (Bernoulli)
Bernoulli	0.4
Cloud cover percent	Cloud cover percent=risk uniform (0, 1) cloud cover percent=risk uniform (80% * cloud cover percent of previous hour, min [20% * cloud cover percent of previous hour, 1])
Cloud cover correction	Cloud cover correction=1-(is cloud cover * power reduction * cloud cover percent)
Temperature	
Average temperature	Risk normal (37, 25)
Temperature correction	Temperature correction=1-(average temperature-25) * (20% * 10%)

Table 13: Variables used in the model

Variable	Value
Max solar power	7 MW
Solar shape	Risk Pert (0, 6, 12)
Cum percent	Risk Theo Target (solar shape, index hour)
Cloud cover	
Cloud cover	Risk Bernoulli (Bernoulli)
Bernoulli	0.5
Cloud cover percent	Cloud cover percent=risk uniform (0, 1) cloud cover percent=risk uniform (80% * cloud cover percent of previous hour, min [20% * cloud cover percent of previous hour, 1])
Cloud cover correction	Cloud cover correction=1-(is cloud cover*power reduction*cloud cover percent)
Temperature	
Average temperature	Risk normal (36, 24)
Temperature correction	Temperature correction=1-(average temperature-25) * (20% * 10%)

Table 14: Project describtion

Project Company	Bangchak Corporation Public Company Limited
Location	Nabas, Philippines
Capacity	36+14 MW
Selling rate	Feed-in-tariff at 7.40 Peso/Kilowatt-hour or 5.4 Baht/Kilowatts-hour for 20 years
Share holder	40%
Investment	28.5 million dollar (or 1,004 million baht)

Table 15: Variables used in the model for 36 MW power plant

Variable	Value
Max Wind Power	36
Wind power output	Max wind power * IF (wind speed≤5.0%, IF [wind speed≤20, [wind speed/20]^3, IF [wind speed≤40, 100%, IF [wind speed≤60, 30%, 0%]]])
Wind speed	
Wind speed	Risk lognorm (20–2.5, 20+2.5)

Table 16: Variables used in the model for 14 MW power plant

Variable	Value
Max wind power	14
Wind power output	Max wind power * IF (wind speed≤5.0%, IF [wind speed≤20, [wind speed/20]^3, IF [wind speed≤40, 100%, IF [wind speed≤60, 30%, 0%]]])
Wind speed	
Wind speed	Risk Lognorm (20–2.5, 20+2.5)

The total power output (solar and wind power), the average daily output is 788.25 megawatts/day with the maximum output of 1,997.82 megawatts/day, minimum output of 28.39 megawatts/day, and standard deviation of 724.22. It is found that in the morning when the sun rises, especially during the daytime at around 9 AM–3 PM, the maximum amount of electricity can be produced.

4.1.3. *BCPG Public Company Limited - BCPG*

1. Solar power output, the average output is 83.515 megawatts/day with maximum output of 35.300 megawatts/day, minimum output of 314.82 megawatts/day, and standard deviation of 5.643. It is found that the maximum amount of electricity can be produced during the daytime at approximately 9 AM–3 PM.
2. Wind power output, the average power output is 336.05 megawatts/day with the maximum output of 1,200.00 megawatts/day, and the minimum output of 0 megawatt/day. Standard deviation is 336.05. It is found that the amount of electricity produced from wind energy each day is quite steady.

Total power output (solar and wind power), the average daily output is 423.61 megawatts/day with the maximum output of 1,275.70 megawatts/day, minimum output of 37.59 megawatts/day, and standard deviation of 333.67. It is found that in the morning when the sun rises, especially during the daytime at around 9 AM–3 PM, the maximum amount of electricity can be produced.

4.2. NPV and IRR

NPV is calculated by discounting the operating cash flow with weighted average cost of capital (WACC) of 8.2%; whereas: (1) Seed money (CF0) excludes the value of land; (2) depreciation is charged on the total seed money (excluding the cost of land) divided by the total number of operating years; and 3) Terminal value, excluding land, is equal to 0. In addition, the IRR and PB can also be calculated from operating cash flow (Table 17).

5. CONCLUSIONS

5.1. Energy Absolute Public Company Limited (EA)

Data on the daily electricity production of the 90 megawatts Solar Power Project in Phitsanulok Province and Had Kanghan Wind Farm Projects 1–3 with a combined capacity of 126 megawatts obtained from the simulation are used to calculate the NPV, IRR, and PB. With regard to NPV, both the 90 megawatts Solar Power Project in Phitsanulok Province and Had Kanghan Wind Farm Projects 1–3 with a combined capacity of 126 megawatts have positive NPV. The required return is achieved, so is the additional return. The IRR of both projects is larger than WACC, meaning that the rate of return exceeds the expected return. In terms of PB, it is found that the PB of the 90 megawatts Solar Power Project in Phitsanulok Province is 6 years and 8 months whereas that of Had Kanghan Wind Farm Projects 1-3 with a combined capacity of 126 megawatts is 5 years and 3 months.

5.2. Electricity Generating Public Company Limited (EGCO)

Data on the daily electricity production of the 8 megawatts SPP5 Solar Power Plant Project in Roi Et Province and the 80 megawatts Chaiyaphum Wind Farm obtained from the simulation are used to calculate the NPV, IRR, and PB. With regard to NPV, both the 8 megawatts SPP5 Solar Power Plant Project in Roi Et Province and the 80 megawatts Chaiyaphum Wind Farm have positive NPV. The

Table 17. Summary of NPV, WACC, IRR and PB

Project Name	NPV (million Baht)	WACC	IRR	PB
EA				
Solar power plant in Phitsanulok Province (90 MW)	5906	8.20%	20.29%	6 years and 8 months
Had Kanghun wind farm project (126 MW)	4919	8.20%	13.15%	5 years and 3 months
EGCO				
SPPS solar power plant in Roi Et (8 MW)	314	7.42%	14.89%	6 years and 7 months
Chaiyaphom wind farm (80 MW)	2950	7.42%	25.76%	3 years and 11 months
BCPG				
Solar power plant in Angthong ans Bang Pa-in (12 MW)	89	10.69%	13.01%	6 years and 11 months
Nabus wind farm (50 MW)	142	10.69%	13.06%	7 years and 2 months

WACC: Weighted average cost of capital

required return is achieved, so is the additional return. The IRR of both projects is larger than WACC, meaning that the projects' internal rate of return exceeds the expected return. In terms of PB, it is found that the PB of the 8 megawatts SPP5 Solar Power Plant Project in Roi Et Province is 6 years and 7 months and that of the 80 megawatts Chaiyaphum Wind Farm is 3 years and 11 months.

5.3. BCPG Public Company Limited (BCPG)

Data on daily electricity production of Ang Thong Province and Bang Pa-in District Solar Power Plant Projects with a combined capacity of 12 megawatts and Nabas Wind Farm Project in the Philippines with a capacity of 50 megawatts obtained from the simulation are used to calculate the NPV, IRR, and PB. With regard to NPV, both Ang Thong Province and Bang Pa-in District Solar Power Plant Projects with a combined capacity of 12 megawatts and Nabas Wind Farm Project in the Philippines with a capacity of 50 megawatts have positive NPV. The required return is achieved, so is the additional return. The IRR of both projects is larger than WACC, meaning that the projects' internal rate of return exceeds the expected return. In terms of PB, it is found that the PB of Ang Thong Province and Bang Pa-in District Solar Power Plant Projects with a combined capacity of 12 megawatts is 6 years and 11 months and that of Nabas Wind Farm Project in the Philippines with a capacity of 50 megawatts is 7 years and 2 months.

Based on this Model, it can be determined whether one should invest in solar and wind power plant projects or not and how long the PB is. This information can be further used to determine the probability of daily electricity generation.

Moreover, when the information obtained is used to determine an increase in stock value from power plant projects, it is found that mostly the prices of stocks on commercial operation date (COD) will increase in accordance with the increased value of the power plant projects, except in the case of Chaiyaphum Wind Farm Project of EGCO whose closing price on the COD decreased in accordance with the overall market condition at that time.

At present, solar power plants and wind power plants play a more important role in the society as alternative sources of energy. Besides, the public sector requests proposals for power purchase agreements to persuade the private sector to co-invest in the renewable energy projects. Investors can use this model to calculate NPV, IRR, and PB of a specific project and to determine an increase in stock value to support their decision on purchase and sale of stocks. In conclusion, this model can be further developed so that it can be used by companies to make a decision on investment in a new power plant project or by investors to determine an increase in stock value for future projects.

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