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DETERMINING THE ROOFTOP SOLAR POTENTIAL OF TRA VINH UNIVERSITY

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Abstract

Solar energy is the fastest growing energy source in renewable forms, the development of solar power brings many economic and social benefits. To avoid negative impacts when connecting to the grid, it is necessary to identify and evaluate the potential and impact of rooftop solar power projects. In this study, the potential and impact of the rooftop solar power project was determined by Tra Vinh University by analytical methods and by application of specialized simulation software. The research results show that the real and simulated two-phase project with a total capacity of 300 kWp has a very high feasibility with the percentage difference in output between the simulated data and the data. actual phase I and phase II are 1.5% and 2.45% respectively. Project with total investment capital for phase I is 140,441$ and phase II is 226,483$, after 11.6 years simple payback for phase I and 9.6 years simple payback for phase II, with an output of 146,590 kW/year and 285,560 kW/year, respectively. The greenhouse gas emission limit is 4,634.2 t.CO_2 over the 25-year operating life.

Keywords: Renewable energy, Solar energy, Tra Vinh University, PVSystem software.

1. Introduction

In the context that Vietnam's energy industry in particular and the world in general are facing difficulties such as rapidly increasing demand, fossil energy sources become scarce and requirements on CO_2 discharged into the environment. From the actual requirements and problems, it is imperative to promote efforts to find alternative clean energy sources and use this energy efficiently and economically. According to the International Energy Agency (IEA), CO_2 emissions in 2020 stand at 31.5 million tons, down 4.6% compared to 2019. This situation proves that efforts to reduce the causes of climate change have been more effective than expected. This result is due to the change in awareness and habits of using different forms of energy in China, the US and the countries of the European Union (EU) [1]. Developing renewable energy for electricity generation, especially solar energy, is the direction that investors and the Government of Vietnam focus on exploiting, contributing to reducing CO_2 emissions, slowing down the transformation process. global climate.

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Tra Vinh is a coastal province in the Mekong Delta with great potential in developing rooftop solar power. According to statistics by July 2021, the province has more than 1152 rooftop solar power systems of organizations and individuals that have been invested and connected with a total capacity of 42,496 kWp [2]. Along with the development of rooftop solar power in the province, Tra Vinh University also has the potential to develop rooftop solar power based on the existing roof area.

The determination of the potential of solar power projects has been researched by a number of domestic and foreign authors. In the world [3] has studied and compared the simulation results of photovoltaic output evaluation software. The article introduces the function of the software (PVGIS, PVWatts and RETScreen) used to estimate and calculate the photovoltaic output, presents the basic differences in usage and results after the calculation. when applying them to practical photovoltaic systems of different parameters. From there, the outstanding features and accuracy of each type of software are presented, comparing and finding the right software for each area of use and different system specifications [4].

In the country, there have been studies to evaluate the influence of grid-connected solar power plants on the local distribution grid [5]. The research has pointed out the impacts of solar power plants when connected to the grid such as: reverse power flow, overvoltage, loss, increase in reactive power, quality and harmonics. The article used ETAP software to evaluate and compare the results of capacity trend, voltage stability and harmonic effects of the power grid in the presence and absence of solar power plants. From there, the research team proposes ways to deal with the impacts when the penetration rate (%) of solar power is connected to the local grid. Applying PVSyst software to real projects to support project design, simulation and analysis for a 210 kWp solar power system consisting of many solar panels connected together and working in parallel with the grid to power the load according to the On-Grid configuration [6].

From the discussion base of the studies and from the actual situation, the research paper determines the rooftop solar power potential of Tra Vinh University, the purpose of determining the theoretical potential, the potential Technical and economic potential of the rooftop solar power project of Tra Vinh University and comparison between actual project data in operation with simulated data to show the effectiveness of the two phases of the project.

2. Rooftop Solar Power Project at Tra Vinh University

Tra Vinh University is located at Tra Vinh City, with an area of three deployed blocks of 2100 m2. Tra Vinh University has installed the rooftop solar power project with two phases in three buildings A1, B1, B2 with the project scale according to Table 1.

Table 1. Tra Vinh University solar project

Information	**Unit**	**Quantity**	
		Phase I (A1)	Phase II (B1,B2)
Total Capacity	kWp	100	200
Instalation Area	m^2	600	1500
Number of PV Installed	panel	274	488
Inverter 3 phase 82,8 kW	package	1	2
Capacity of PV	Wp	365	410
Power Optimizer	package	137	252
Type		Mono	Mono
Band		Leapton	Leapton
Energy Produced	MWh	388,06	430,12
Reduction CO_2 Emissions	tons	154,806	169,020
Finish day		25/12/ 2019	31/12/ 2020

Tra Vinh University has built and put into use the first two projects of the project including:

• Phase I with a total capacity of 100 kWp installed on an area of 600m2, the total electrical energy generated by June 30, 2022 is 388.06 MWh, which

has reduced 154,806 tons of CO_2 emissions into the environment.

Figure 1: Rooftop solar power project (phase I)

• Phase II with a total capacity of 200.08 kWp is installed on an area of 1500m2, the total electrical energy generated by June 30, 2022 is 430.12 MWh, which has reduced 169,020 tons of CO_2 emissions into the environment. school.

Figure 2: Rooftop solar power project (phase II)

3. Project Data and Product Output

The rooftop solar power project of Tra Vinh University includes two phases, phase I with a capacity of 100 kWp was completed and put into use on December 25, 2019, phase II with a capacity of 200 kWp was completed. on December 31, 2020, bringing the total capacity of the whole project to 300 kWp. According to statistics from the system's energy management page, to June 2022, the total output of the whole project reached 818 MWh, playing an important role in supplying power to the load.

Table 2: Total Project Output

Time	Total output phase I (MWh)	Total output phase II (MWh)	Total produced project (MWh)
2019	2,857		2,857
2020	158,928	3,117	162,046
2021	144,383	278,617	423,001
06/2022	82,3	148	230,3

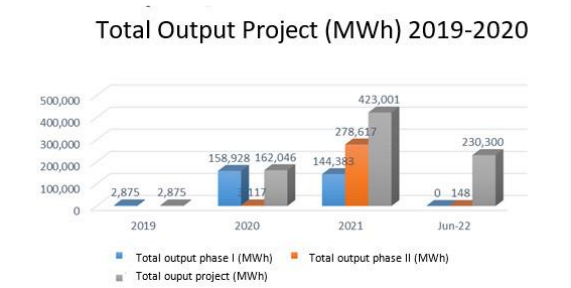


Figure 3: Power produced of the project in 2019-2022

According to Figure 3 in 2021, the rooftop solar power project of Tra Vinh University has the most electricity output connected to the grid, the total energy produced: 423,001 MWh.

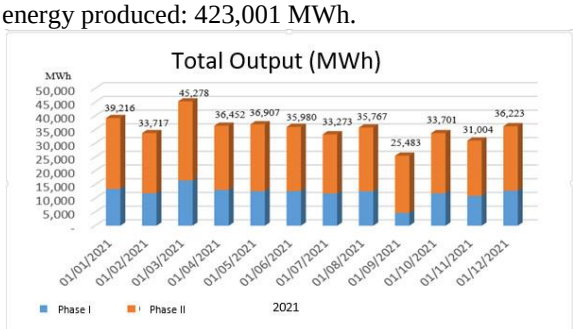


Figure 4: Power produced of the project in 2021

The survey results show that March 2021 is the month with the highest yield compared to the average of other months in 2021 with produced of 45,329 kWh.

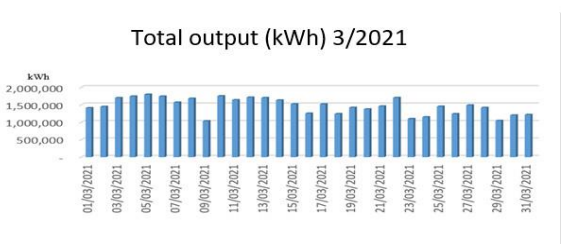


Figure 5: Power produced chart in March 2021

4. Assessing The Economic Potential With Pvsystem Software

To determine the economic potential of the project, the study uses PVSystem software and compares the results with statistics from the actual project such as: system output, power output loss, assessment on CO_2 emissions to the environment and based on data on investment capital and other costs, calculate the number of years to payback of the project.

4.1 Phase I

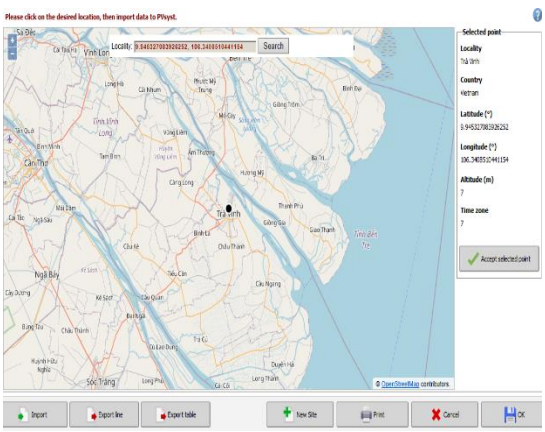
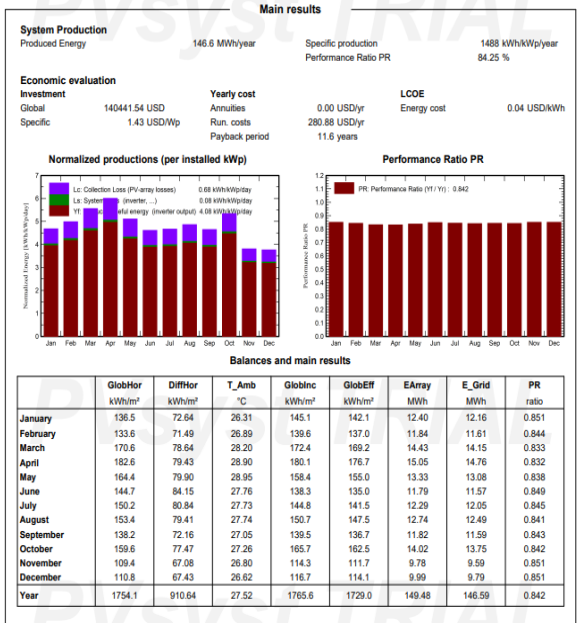


Figure 6: Location of project weather data

Tra Vinh belongs to the area with high radiation, the average annual is 4.93 kWh/m2/day. It can be seen that these are favorable conditions for solar power production. GlobHor's annual average radiation intensity is 1,754.1 kWh/m2. Power generation efficiency of the plant PR = 84.25%, Power output in the first year reached 146.59 MWh. The month with the largest electricity production is April with 14.76 MWh, the month with the lowest electricity output is December with 9.79 MWh as shown in Figure 3. Figure 4 shows the absorption coefficient of solar panels. according to the change of the inclination angle of the panel.



	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	136.5	72.64	26.31	145.1	142.1	12.40	12.16	0.851
February	133.6	71.49	26.89	139.6	137.0	11.84	11.61	0.844
March	170.6	78.64	28.20	172.4	169.2	14.43	14.15	0.833
April	182.6	79.43	28.90	180.1	176.7	15.05	14.76	0.832
May	164.4	79.90	28.95	158.4	155.0	13.33	13.08	0.838
June	144.7	84.15	27.76	138.3	135.0	11.79	11.57	0.849
July	150.2	80.84	27.73	144.8	141.5	12.29	12.05	0.845
August	153.4	79.41	27.74	150.7	147.5	12.74	12.49	0.841
September	138.2	72.16	27.05	139.5	136.7	11.82	11.59	0.843
October	159.6	77.47	27.26	165.7	162.5	14.02	13.75	0.842
November	109.4	67.08	26.80	114.3	111.7	9.78	9.59	0.851
December	110.8	67.43	26.62	116.7	114.1	9.99	9.79	0.851
Year	1754.1	910.64	27.52	1765.6	1729.0	149.48	146.59	0.842

Figure 7: Simulation results of phase I

Amount of energy generated at standard conditions: 170.5 MWh loss due to panel temperature (10.47%), loss due to inverter operation (1.93%), loss due to panel irradiation (0.95%), conductor resistance loss (0.78%), optimization loss (0.68%) and other losses… Then the remaining power output is 146.6 MW

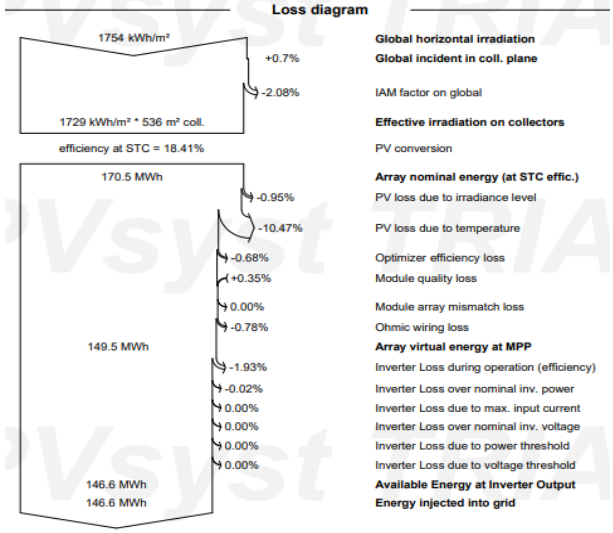


Figure 8: Stage I Loss

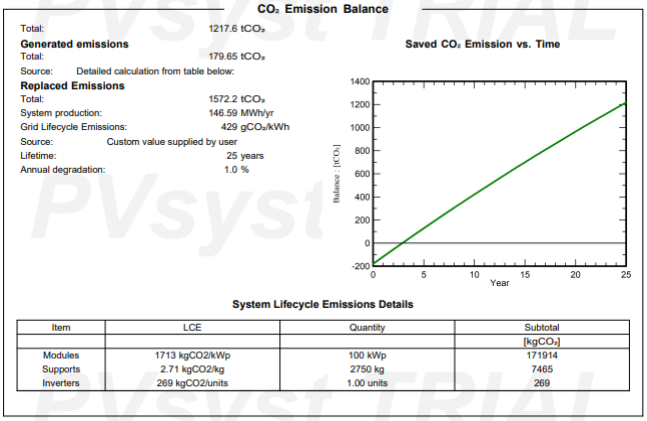


Figure 9: CO_2 emission reduction phase I

With a CO_2 emission factor of the grid of 429 gCO_2/kWh, it is estimated that in the 25 years of existence of the system, 1,572.2 tons of CO_2 will be reduced, contributing to protecting the surrounding environment and creating a green landscape. For phase I, the selling price of solar power of the project is 0.083 USD/kWh [7].

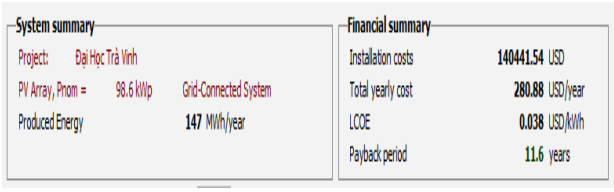


Figure 10: Recovery time period I

With a total estimated cost of 140,441.54 USD, maintenance cost is 0.2%/year compared to the initial cost, estimated payback period is 11.6 years.

4.2 Phase II

For phase II, the total project cost is 226,483.52 USD, maintenance cost is 0.2%/year compared to the initial cost, estimated payback period is 9.6 years as shown in Figure 11 .

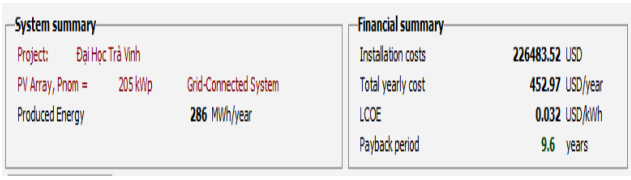


Figure 11: Payback Period II

5. Compare Simulation Results With Actual Data

Table 3: Comparison of simulation results and actual data

	In Fact		PvSystem Software	
	Phase I	Phase II	Phase I	Phase II
Produced (kWh)	144.380	278.650	146.590	285.560
Payback (year)	11,6	9,9	11,6	9,6
CO_2 Emission (tCO_2/year)	57,6	111,1	62,9	122,5

Evaluation: Through Table 3, it can be seen that there is a difference between the criteria given for comparison between the actual data collected through the project's energy management page and the data using the PvSystem software. The simulation is set to the same parameters as the current system under ideal conditions. As follows:

o Output of the system in each phase (kWh) when comparing between reality and software: the difference in phase I is 2,100 kWh (equivalent to 1.5%), phase II difference is 6,910 kWh (equivalent to 1.5%). equivalent to 2.4%).

o The payback time of each stage depends on the output of each respective period: in phase I, due to the difference in output but not too large, the real and simulated payback time is the same 11.6 years; stage II due to the difference between reality and simulation 0.3 corresponding to 3 months

o The amount of CO_2 emission reduction (tons of CO_2/year) in each period is calculated and simulated based on the output of each respective period: in stage I, the amount of CO_2 emission reduction of the simulation data is more. 5.3 tons of CO_2/year compared to actual data; In phase II, the reduction in CO_2 emissions of the simulated data is 11.4 tons more CO_2/year than the actual data.

6. Conclusion

After research and implementation, some results have been obtained as follows:

- Determining the potential and suitable attic area at Tra Vinh University, the potential suitable attic area at Tra Vinh University 28,887 m2 with a total installed potential capacity of 4,815 MWp.

- Assessing the rooftop solar energy potential of the project and determining that the radiation potential is about 1802.4kWh/m2/year, equivalent to 4,935 kWh/m2/day.

- Introduction of PVSystem software to serve the implementation of rooftop solar power projects, namely calculation and simulation of project output, system output loss, CO_2 emission reduction and evaluate the economic potential of the project.

- Comparative analysis of actual projects and simulation results show that the feasibility of the rooftop solar power project of Tra Vinh University with two phases has been implemented with a total capacity of 300 kWp. very high rate of the project through the two phases has been implemented with the percentage difference in output between the simulated data and the actual data with phase I, phase II is 1.5% and 2.45% respectively. corresponding.

- Results of financial potential analysis for the rooftop solar power project of Tra Vinh University: The rooftop solar power project of Tra Vinh University with the total investment capital for phase I is $140,441.52 and phase II 226,483.52 $, after 11.6 years for phase I and 9.6 years for phase II, the project will get a simple payback, with simulated output of 146,590 kW/year and 146,590 kW/year, respectively. 285,560 kW/year.

- Limiting greenhouse gas emissions to 4,634.2 t.CO_2 during its 25-year operating life.

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