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A Review of Grid tied Solar Wind Hybrid Power System and Evaluation of Investment Efficiency for a Case Study in Vietnam

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ABSTRACT: Solar power and wind power are the two most developed renewable energy sourcesin the world. Hybrid solar wind power systems combine solar arrays and wind turbines to continuously generate electricity to serve the local loads. Vietnam currently does not use many hybrid wind-solar power systems for areas connected to the national power grid.This paper reviews grid tied solar wind hybrid power system and evaluate investment efficiency of a case study in Vietnam.
KEYWORDS: solar power, wind power, grid tied hybrid power system.

I. INTRODUCTION

Currently, in order to meet enough electricity usage while minimizing environmental pollution, countries around the world are exploiting renewable energy sources [1,2] to replace traditional energy sources. Among renewable energy sources, solar power is playing an important role in the economic development of countries [3,4]. Countries around the world are strongly researching the development of solar power and evaluating the potential of this energy source as extremely large and contributing greatly to fighting climate change. Electricity generated from solar power is playing an important role in the power supply system for power grids of countries around the world [5].

In 2020, despite the effects of the Covid-19 epidemic [6,7], the installed capacity of all renewable energy sources worldwide still grew. Of which, the total accumulated installed capacity of solar power by the end of 2020 reached 760.4 GW [8], accounting for 27.1% of all renewable energy sources. Comparing the total cumulative solar power capacity in 2019 of 621.1 GW [8] with the total cumulative solar power capacity in 2020 of 760.4 GW [8] shows the growth in solar power capacity in 2020 it will increase by nearly 139.3 GW [8]. This shows that countries around the world are being heavily affected by the Covid-19 epidemic but solar power installation capacity is still growing and is not too affected by the pandemic.

Rooftop solar power [9] is assessed to be distributed in nature, consumed on-site, and generated mainly during the day, which will reduce the pressure on the grid load at peak noon and reduce the burden. on investment in the power system, and minimize the use of electricity generated from fossil energy sources that are polluting the environment.

In a rooftop solar power station, the power converter (Power Conditioning System - PCS) has the important task of converting direct current from solar cells into alternating current and transmitting it to the local power grid. However, the efficiency of the PCS set in the rooftop solar power stationis low because the power generation ability of solar panels (PV) depends heavily on the weather and solar radiation. It becomes weak when weather conditions are unfavorable. The operating rate of PCS in good weather is about more than 90% while it is about 10% to 60% in bad weather. At night, the operating rate of PCS is 0% because there is no PCS at this time. sunlight.

Therefore, solar power stations can be used in combination with other renewable power sources such as wind power to ensure that the operation of the home's electrical load is maintained stably thanks to renewable power sources and minimize use. grid power.

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II. OPERATING PRINCIPLE OF GRID TIED SOLAR WIND HYBRID POWER SYSTEM

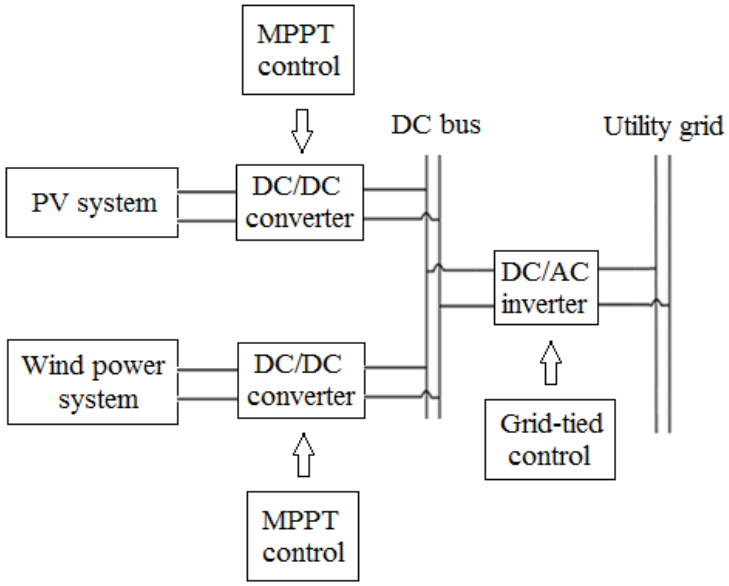

Figure 1. Principle diagram of the grid tied solar wind hybrid power system

Typical solar-wind hybrid power systems connected to the grid are shown in figure 1. Hybrid solar wind power systems combine solar arrays and wind turbines to continuously generate electricity to serve the local loads, while the grid can act as a source or a backup system. Excess electricity output from renewable power sources is sold to the grid and the grid can provide electricity to meet load demand when needed.

Djohra Saheb-Koussa [10] evaluated a grid-connected hybrid wind-solar power system in Algeria as competitive compared to a conventional grid power system with a COE cost of electricity produced by the system of 0.4 USD /kWh. Jenkins [11] studied the possibility of applying a grid-connected hybrid wind-solar power system at Al-Marj University, Libya, the results showed a hybrid power system configuration with 150kWp of solar power and 100kW of power. Research of Shabbier Ahmed Sydu [12] shows that by integrating two renewable energy resources into an optimal combination, the impact of solar and wind sources working alone can be addressed, part and the overall system becomes more reliable and economical to operate. This proposed system facilitates improvement of power quality, ensuring continuous and reliable supply to loads.

III. EVALUATION OF INVESTMENT EFFICIENCY OF A CASE STUDY

This study examines the design options for solar and wind power systems for factories in Central region, Vietnam.According to the useful area that can be installed, the total number of modules that can be installed is calculated to be 104 PMT strings, of which 101 strings include 18 535 Wp monocrystalline silicon solar panels installed in series. 3 strings each consisting of 17 monocrystalline silicon solar panels535 Wp installed in series.

Of which 1,869 535Wp (1000kWp) solar panels are installed in the Northeast - Southwest direction.

+ Connection method:

- 101 strings, each string consists of 18 panels (modules) connected in series to form a string with a total capacity of 9.63 kWp, voltage 750.6 VDC, current 12.9A.
- 3 strings each string consists of 17 panels (modules) connected in series to form a string with a total capacity of 9,095 kWp, voltage 708.9 VDC, current 12.9A.
- Connect 104 strings to 08 inverters100kW.
- The solar power system is connected to an intermediate electrical cabinet between solar power and wind power.

The system uses 5 EOX M-21 wind turbines with rated capacity of 100kW/1 turbine.
The total installed capacity of wind turbines is 500kW. The wind turbine system is connected to an intermediate electrical cabinet between solar energy and wind power.
The hybrid wind and solar power system is connected to the low voltage part of the 2500kVA transformer station to provide power for the plant's loads.The hybrid power system can generate electricity of3,867,967kWh/year to serve the power needs of the factory.

Financial analysis aims to consider the financial feasibility of the project and the effectiveness of investment decisions.
Cash flows in economic and financial analysis include:
Project's revenue stream: Electricity sales revenue.
Project expenditure stream:
Investment.
Costs for operation and maintenance.
Corporate income tax.
The investment efficiency of the project is evaluated through the following criteria:
- Internal rate of return: IRR
- Net present value NPV.
- Payback period Thv
•Total investment
The total investment of the project is 1,095,000 USD (one million and ninety-five thousand dollars) equivalent to 25,185,000,000 (Twenty-five billion one hundred and eighty-five million VND).
• Computation time
The project's operation period is 20 years.
• Capital structure, exchange rate
- 40% equity with equity cost of 7%/year.
- Loan capital is 60% with loan cost of 8%/year.
• Costs of production and business activities:
- Property insurance expenses: proportional to the total remaining property value.
- Electricity and water costs for operation and maintenance: 3% of annual revenue.
- Management costs: 4% of annual revenue.
- Repair costs: 2% of annual revenue.
- Insurance cost: 0.2% e-commerce.
- 5 year depreciation period for Inverter.
- 10 year depreciation for other equipment.

The effectiveness problem is evaluated based on 2 options:
Option 1: 81.7% of the electricity output generated from renewable energy is consumed by the load and the remaining 18.3% of the electricity output is not sold to the national grid, the project financial efficiency is as follows:
- NPV = 10,553,271,000 VND >0: Pass
- IRR = 11.34% >7.12%: Pass
- B/C = 1.41 > 1: Pass

Option 2: 81.7% of the electricity output generated from renewable energy is consumed by the load and the remaining 18.3% of the electricity output is sold to the national grid at a unit price of 5.89Uscent/kWh (According to draft FIT 3 in 2021), the project financialeffectiveness is as follows:
- NPV = 14,267,788,000 VND >0: Pass
- IRR = 12.79% >7.12%: Pass
- B/C = 1.52 > 1: Pass

In case the electricity produced from the hybrid wind and solar power system sold to the grid is bought back by EVN at a price of 5.89Uscent/kWh, the project is most effective according to option 2, however in this case if the excess electricity generated from the hybrid power system is not purchased by EVN, the project will still achieve financial efficiency according to the data of option 1.

IV. CONCLUSION

Installing solar wind hybrid power systems for industrial plants not only brings financial efficiency to businesses but also reduces greenhouse emissions and reduces pressure on power supply to the local power grid. methods, etc. Therefore, it can be widely deployed and applied in many practical applications.

When evaluating the economic efficiency of a case study project based on financial indicators such as net present value NPV, internal rate of return IRR, payback period Thv, ratio of revenue and cost B/C of the project. Financial indicators can beaccepted.

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