

THE MISSION, CHALLENGES, AND POTENTIAL OF SOLAR ENERGY DEVELOPMENT IN VIETNAM

Nguyễn Thị Hồng Mai

Lecturer, Faculty of Economics,
Ho Chi Minh City University of Economics and Finance, Vietnam

Correspondence: mainth@uef.edu.vn

KEYWORDS:

Renewable Energy,
Solar Power System,
Environmental
Management,
Sustainable
Development.

DOI :

10.65176/IJLM.V2I2.07

JEL Classification :

Q42, Q48, Q01

ABSTRACT

Vietnam has increasingly acknowledged the critical role of sustainable energy in its long-term development strategy, particularly in response to the projected depletion of fossil fuel reserves and the escalating effects of climate change. Among the sustainable energy sources that need to be exploited, solar energy is emerging as a renewable energy source that plays a key role in Vietnam's sustainable development strategy. With its advantages of natural conditions, high radiation intensity, and long sunshine hours, Vietnam has great potential for exploiting and applying solar energy. Adopting and implementing a strategic orientation for sustainable energy development by 2030 and a vision for 2045 is another way the Vietnamese government has demonstrated its dedication to priorities. These initiatives promote the supply of reliable, superior, and affordable energy sources for long-term socioeconomic growth, contributing to environmental preservation. However, the development and exploitation of solar energy still face many challenges, including limitations in transmission infrastructure, unstable policy mechanisms, high initial investment costs, and issues related to the storage and management of renewable energy sources. This study focuses on analysing the mission of solar energy in contributing to ensuring energy security, reducing greenhouse gas emissions and promoting green growth in Vietnam; at the same time, pointing out the main challenges, potential for solar energy development and proposing practical solutions to effectively exploit the available potential. With the right guidance and sustained policy support, solar energy has the potential to play a significant role in Vietnam's energy transition and long-term environmentally friendly economic growth.

1. Introduction

In the context of the climate crisis and the decline of fossil fuels, the world is accelerating the energy transition towards carbon neutrality by 2050, in which renewable energy plays a central role (UN, 2023; IEA, 2023). Solar energy has emerged as a key source owing to its competitive cost and almost limitless development potential. In 2024, renewable energy is expected to account for 92.5% of the total new global electricity capacity, with solar energy leading the way at 77.3% (Shahan, 2025). In Vietnam,

the rapid increase in electricity demand has placed great pressure on the national energy system. During the period 2002–2022, electricity consumption increased by more than eight times, reaching 240 TWh in 2022 (IEA, 2024), with an average growth rate of 7%/year in the period 2021–2025 (Vietnam Integration Journal, 2024). In response to this reality, the Government committed to achieving “zero” net emissions by 2050 at COP26 (Climate Action Tracker, 2023) and concretised it by Power Plan VIII under Decision 500/QĐ-TTg (Government of Vietnam, 2023).

With an average radiation level of 4–5 kWh/m²/day, Vietnam has significant potential for solar power development (Vietnam Energy Forum, 2019).

This study focuses on three main objectives: (1) analysing the role of solar energy in ensuring energy security, reducing emissions, and supporting green growth; (2) clarifying policy, infrastructure, and financial challenges; and (3) proposing sustainable development solutions based on international experience and the solar energy potential in Vietnam.

2. Literature Review & Methodology

2.1 Literature review

Solar energy is considered a key renewable energy source due to its availability, environmental friendliness, and wide range of applications, from household scales to large power plants. The integration of storage technology and hybrid systems has improved their efficiency and reliability (Obaideen et al., 2023). Currently, there are four main forms of solar energy: rooftop, utility-scale, hybrid, and floating solar. Rooftop solar is particularly important in the move towards “net-zero energy” projects (Dong et al., 2023), whereas large-scale projects play a pivotal role in meeting the global electricity demand (Obaideen et al., 2023). In addition, hybrid and floating solar systems offer advantages in terms of efficiency, reduced storage costs, and optimised land use (Cuce et al., 2022; Nasir et al., 2023; Wang et al., 2024). However, major challenges remain, including supply intermittency, the need for advanced forecasting technology, and linkages to Sustainable Development Goals beyond SDG7 (Kroposki, 2013; Obaideen et al., 2023).

Southeast Asia presents significant potential at the regional level but is also plagued by barriers to its realisation. In Malaysia, carbon reduction mechanisms and pathways are seen as drivers for expanding the solar PV market share (Govindarajan, Muthuvel, & Ramasamy, 2023). Within ASEAN, despite an average annual growth rate of 43% in solar and wind power between 2015 and 2022, the region still needs to add approximately 229 GW of new capacity to achieve the Net Zero 2050 target (Dalapati, 2023; Ember, 2023). Thus, although solar power offers huge potential, its realisation requires synchronisation in policy, finance, infrastructure, and technology.

2.2 Methodology:

This study uses document analysis and synthesis and policy comparison based on reliable secondary data sources from government reports, international organisations (World Bank, IRENA), and recent research papers. It also refers to international experiences from China, Germany, Thailand, and Malaysia compared with the context of Vietnam to draw appropriate lessons, thereby proposing solutions in terms of policy, infrastructure, finance, and technology. The novelty of this study lies in the system approach, which combines the analysis of natural potential with aspects of energy security, emission reduction, socioeconomic impacts, and international integration. In contrast to previous studies, this study selectively compares international experiences and proposes a practical integrated solution package. In particular, this study identifies solar energy as a strategic pillar associated with the Net Zero 2050 target and green growth.

3. Mission of solar energy

In the context of energy development in Vietnam, the mission of solar energy can be viewed in three basic aspects: energy security, greenhouse gas emission reduction, and promotion of socio-economic growth. First, Vietnam is highly dependent on imported fossil fuels, especially coal and liquefied natural gas. In 2023, Vietnam imported approximately 51.1 million tons of coal, with a total value of more than 7.1 billion USD, reflecting the increasing dependence on imported coal to meet energy demand (General Department of Customs, 2024). Therefore, solar power development is not only a new source of supply but also a strategic tool to reduce import pressure, increase energy system autonomy, and strengthen national energy security.

Second, solar energy plays an important role in realising the commitment to net-zero emissions by 2050 that Vietnam made at COP26. In 2022, solar power helped Vietnam avoid emitting approximately 27 million tons of CO₂, equivalent to nearly 10% of the total emissions from the electricity sector. This not only demonstrates the contribution of solar power to the goal of reducing greenhouse gas emissions but also affirms its role as a pillar in the strategy of green growth and sustainable development.

Finally, solar power also has the responsibility to promote socio-economic growth through creating

added value and green jobs. By 2022, the solar power industry in Vietnam is estimated by IRENA to create more than 115,000 jobs, ranging from installation, operation, and maintenance to equipment manufacturing. Simultaneously, the rapid development of this sector is opening up opportunities to form supporting industries, such as manufacturing solar panels, inverters, and related electronic equipment, promoting the process of economic restructuring towards high technology, environmental friendliness, and integration into the global value chain (Asian Development Bank, 2023).

In summary, the mission of solar energy for Vietnam does not stop at meeting the increasing energy demand but is also associated with the goal of ensuring energy security, fulfilling the commitment to reduce greenhouse gas emissions, and creating momentum for sustainable socio-economic development associated with the Sustainable Development Goals (SDGs).

4. Potential of solar energy development and lessons from some countries

4.1 Potential of solar energy

Vietnam has outstanding potential for solar power development owing to its favourable natural conditions, especially in the southern and central regions. Vietnam has an average solar radiation level of 4.0 to 5.0 kWh/m²/day, with some areas reaching a peak of 5.5 kWh/m² (EVN, 2024). Provinces such as Ninh Thuan, Binh Thuan, and Tay Ninh are particularly favourable for solar energy development because of their warm and sunny climate. On average, the country has approximately 1,800–2,100 h of sunshine per year, creating favourable conditions for both large-scale projects and distributed rooftop systems. In some areas of the Central and South, there are an average of approximately 300 sunny days per year. Vietnam is ranked among the countries with the highest radiation levels in the region, affirming its strategic advantage in promoting energy transition (World Bank, 2022).

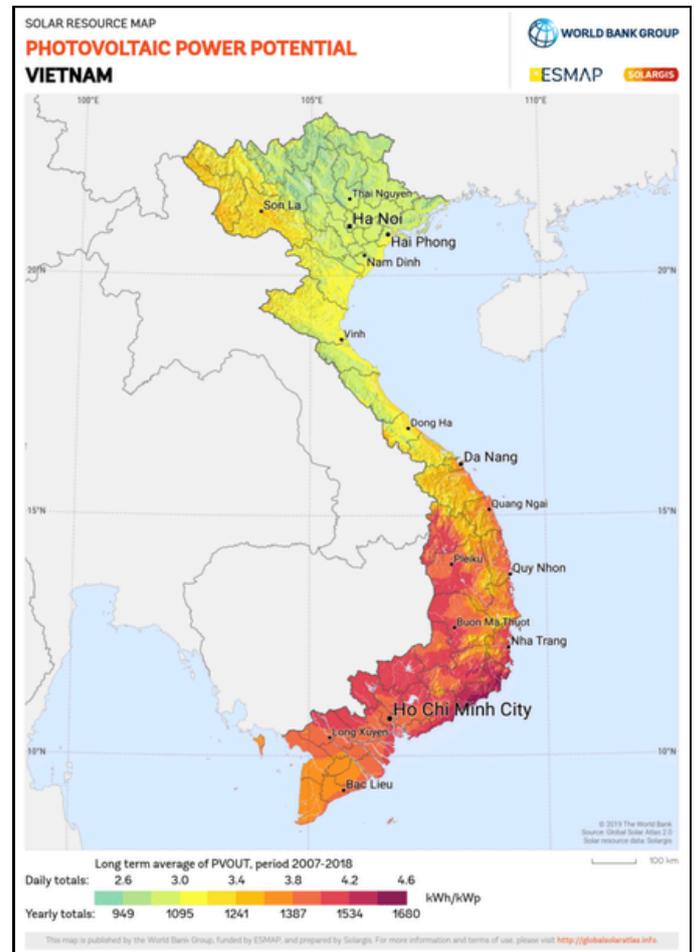


Figure 1: Solar radiation map by Global Horizontal Irradiation (GHI) value in Vietnam

Source: Solargis. (2021). Solar resource maps & GIS data: Vietnam

In terms of technical potential, Vietnam is estimated to be able to exploit up to 1,646 GW of solar power, of which 1,569 GW is on land, and 77 GW is on water, with an appropriate transmission infrastructure and policy framework (Trade.gov, 2022). In addition, global solar power production costs continue to decrease, facilitating scale-up in Vietnam (Danish Energy Agency & Electricity and Renewable Energy Authority, 2024).

In terms of policy, Power Plan VIII aims to increase the proportion of solar power to 34% of the total capacity by 2050, while increasing storage capacity from 300 MWh (2030) to 26 GWh (2050), thereby minimising the risk of supply disruption and improving the stability of the national grid (MOIT, 2023). The updated National Power Development Plan (PDP8) sees solar power as the foundation, with a target of 73 GW of capacity by 2030.

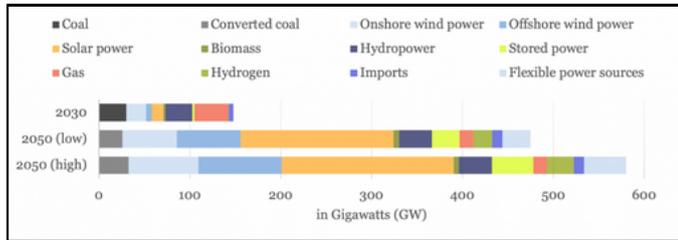


Figure 2: Vietnam’s projected energy mix under the PDP8. **Source:** Greene Finance & Development Centre

On demand, an economic growth of 5–7%/year is forecast to continue to put great pressure on energy security in the context of fossil fuel decline and negative impacts on the environment; therefore, solar power is considered a green and sustainable solution, playing a pivotal role in the energy transition and reducing greenhouse gas emissions (World Bank, 2025).

In addition, the strong participation of international corporations such as First Solar (USA), JA Solar

(Hong Kong) and Trina Solar (China), with production projects in Cu Chi, Bac Giang and Thai Nguyen, has strengthened Vietnam’s position in the global value chain of the solar energy industry, affirming its development potential based on the combination of natural advantages, national policies and international integration.

4.2 Lessons from some countries

International experiences show that solar energy development policies and plans play a decisive role in expanding the scale and ensuring the sustainability of the industry. Pioneering countries have succeeded thanks to a combination of stable policy frameworks, appropriate support mechanisms, and synchronous investment in infrastructure and industrial value chains. The following table summarises the lessons learned from China, Germany, Thailand, and Malaysia.

Table 1: Summary table of solar energy development policies and lessons learned for Vietnam

Country	Source	Source	Highlight results	Lessons for Vietnam
Thailand	Sovacool et al., 2022	- Transparent bidding; - Development of FPV combined with hydropower	- World’s largest FPV project (45 MW, 2021) in Ubon Ratchathani	- Innovate the FPV – hybrid model to increase supply stability
China	Liu et al., 2021	- Stable FIT (2009–2019); - Strong infrastructure investment; - Support the PV industry chain.	- Capacity > 390 GWp (2022); - Deep module price reduction; Curtailment reduction	- Need to synchronise the grid; - Develop domestic supporting industries
Germany	Fraunhofer ISE, 2023	- EEG law with decreasing FIT; Encourage rooftop solar	- More than 2.2 million rooftop systems (2022); - Renewables account for 46% of electricity	- Promote rooftop solar to disperse sources and reduce grid pressure
Malaysia	Sovacool et al., 2022	- LSS (Large Scale Solar) program through competitive bidding	- Cost reduction to 4–5 USc/kWh (2022)	- Transparency in bidding, reduce solar power costs

Source: Compiled by the author

From the above experiences, in order to promote sustainable solar energy development, Vietnam needs a long-term policy strategy that both motivates investment and supports technological innovation and synchronous infrastructure construction.

5. Challenges of solar energy development

Despite its key role in the energy transition strategy, solar power development in Vietnam still faces many technical, infrastructural, and technological challenges. Projects mainly concentrated in Ninh Thuan and Binh Thuan, the areas with the highest radiation in the country (4.5–5.2 kWh/m²/day), are facing serious constraints due to the asynchronous transmission grid, leading to overload and capacity cuts in the period 2020–2021 (EVN, 2022). In addition, new energy storage technology is still in the testing phase and has not reached commercial scale, while volatile renewable energy, such as wind and solar, accounted for approximately 24% of the total installed capacity in 2022, putting great pressure on the balance of the power system (MOIT, 2021). Therefore, the lack of large-scale storage solutions remains a fundamental barrier that directly affects the long-term stability and reliability of the national grid.

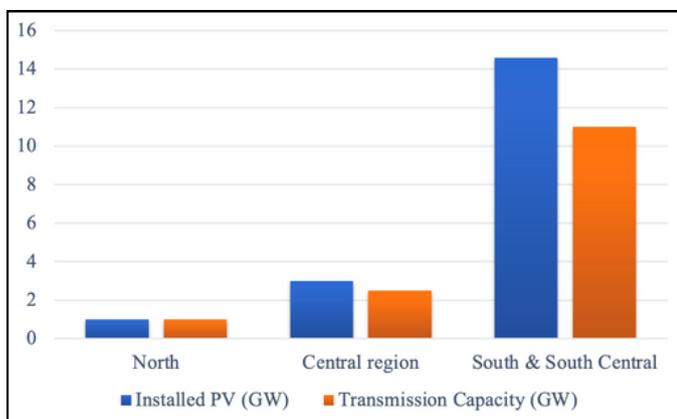


Figure 3: Bar chart comparing installed solar power capacity by region and available transmission capacity (2022). **Source:** Ministry of Industry and Trade, 2021 & Vietnam Electricity, 2022

In addition, the policy framework for solar power in Vietnam remains unstable and is long-term. After the boom period, thanks to the FIT price mechanism (2017–2020), Decision 13/2020/QĐ-TTg expired without a timely replacement mechanism, while bidding and auction implementation were slow, causing many projects to stagnate, especially rooftop solar power after the FIT ended (MOIT, 2024).

In terms of finance, initial investment costs remain high, while access to green credit is limited because

international levels. Long-term support tools, such as tax incentives, preferential credits, and green bonds, have not been developed synchronously, slowing the clean energy transition process (ASEAN Centre for Energy, 2024).

In addition, solar energy poses environmental and social challenges. Solar panel waste after a 20–30 years life cycle could reach approximately 404,000 tons in 2035 and 1.9 million tons in 2045 if there is no effective recycling mechanism, according to a study by the US National Renewable Energy Research Institute published in 2012. If solar power capacity in Vietnam continues to expand according to the set targets, by 2035, it is expected that the amount of end-of-life solar panel waste will reach approximately 404,000 tons, and by 2045, it could reach 1.9 million tons, if there is no effective recycling mechanism. Simultaneously, large projects often use large areas of land, putting pressure on agricultural land funds and sometimes encountering opposition from local communities due to their impact on livelihoods and landscapes.

In short, solar energy development in Vietnam faces multidimensional challenges, including technical, policy, financial, environmental, and social challenges. Identifying and addressing these challenges not only determines the effectiveness of exploiting solar power potential but also directly affects the energy transition process and the country's commitment to sustainable development.

6. Solutions & Recommendations

In the context of Vietnam's commitment to achieving net zero emissions by 2050, solar energy development needs to be guided by a comprehensive package of solutions that combine policy, infrastructure, finance, and science and technology. In terms of policy, the biggest barrier at present is the lack of stability in the pricing mechanism, especially after the end of the FIT tariff in 2020, causing many projects to be delayed (Nguyen & Ha-Duong, 2021). Therefore, it is necessary to establish a transparent, stable electricity price roadmap that is aligned with the net-zero target, and at the same time, adjust Power Plan VIII to prioritise renewable energy to ensure effective integration into the national power system (MOIT, 2023).

In terms of infrastructure and technology, the overload situation in Ninh Thuan and Binh Thuan emphasises the need for synchronous investment in the transmission grid, development of smart grids,

and enhancement of storage systems such as lithium-ion batteries and pumped storage hydropower to minimise capacity cuts. In terms of finance, it is necessary to promote green credit mechanisms, build a fund to support renewable energy, and promote the public-private partnership (PPP) model to mobilise domestic and foreign capital. Therefore, a stable legal framework and long-term capital recovery will be decisive factors in attracting international capital flows, especially green capital.

In the field of science and technology, Vietnam needs to proactively develop solar panel recycling technology to cope with the increasing amount of waste after 2040, while promoting research on new materials, such as perovskite or tandem PV, to improve efficiency and reduce costs. Simultaneously, training high-quality human resources in engineering, power system management, and technological innovation is a prerequisite for ensuring sustainable development and maintaining the competitive advantage of the solar power industry.

In general, the above solutions not only aim to maximise natural and technological potential, but also to build a transparent, sustainable solar power market that can contribute long-term to Vietnam's energy security strategy and green growth.

7. Conclusion

In summary, solar energy plays a pivotal role in Vietnam's energy transition, contributing to ensuring energy security, reducing greenhouse gas emissions, and implementing the Net Zero 2050 commitment. With its natural advantages and significant technical potential, it is a key energy source in green growth and sustainable development strategies. However, limitations in transmission infrastructure, instability in pricing mechanisms, financial barriers, and environmental challenges after the life cycle of solar panels remain major obstacles. The policy implication is to urgently develop a transparent pricing mechanism, synchronously invest in transmission and storage, promote rooftop solar power, and develop supporting industries and recycling technology to effectively exploit the potential of solar power and enhance the international position in the global energy transition process.

This study is limited by the lack of quantitative modelling and detailed analysis by region. Further studies need to be expanded in the direction of

simulating development scenarios, evaluating the economic and environmental efficiency of new models such as floating solar power (FPV) or hybrid solar-storage systems, and simultaneously analysing more deeply the role of Vietnam in the global renewable energy supply chain.

8. References

ASEAN Centre for Energy. (2024). Vietnam remains hugely promising solar market, but cost of capital hurdles remain. ASEAN Centre for Energy. Accessed through: <https://aseanenergy.org/news-clipping/vietnam-remains-hugely-promising-solar-market-but-cost-of-capital-hurdles-remain/> aseanenergy.org

Asian Development Bank. (2023, August 25). Vietnam tops Southeast Asia in solar photovoltaic supply: ADB. The Investor. Accessed through: <https://theinvestor.vn/vietnam-tops-southeast-asia-in-solar-photovoltaic-supply-adb-d6351.html> The Investor

Government of Vietnam. (2023, May 15). Decision No. 500/QD-TTg approving the National Power Development Plan for the 2021-2030 period, with a vision to 2050 (Power Plan VIII). Government Electronic Information Portal. Accessed through: <https://baochinhphu.vn/trien-khai-quy-hoach-dien-viii-viet-nam-buoc-gan-hon-den-muc-tieu-net-zero-nam-2050-102231128010038908.htm>

Climate Action Tracker. (2023). Vietnam: Net zero targets. Climate Action Tracker. Accessed through: <https://climateactiontracker.org/countries/vietnam/net-zero-targets/>

Cuce, E., Cuce, P. M., Saboor, S., Ghosh, A., & Sheikhnejad, Y. (2022). Floating PVs in Terms of Power Generation, Environmental Aspects, Market Potential, and Challenges. *Sustainability*, 14(5), 2626.

Dalapati, S. (2023). Challenges and opportunities for solar power maximisation in ASEAN. *Energy Reports*, 9, 398–413.

Danish Energy Agency & Electricity and Renewable Energy Authority (Vietnam). (2024). Viet Nam Energy Outlook Report: Pathways to Net-Zero. MOIT & Danish Energy Agency. Accessed through: https://ens.dk/sites/ens.dk/files/Globalcooperation/1_eor-nz_english_june2024_0.pdf

Dong, H., Xu, C., & Chen, W. (2023). Modeling and configuration optimisation of the rooftop photovoltaic with electric-hydrogen-thermal hybrid storage system for zero-energy buildings: Consider a cumulative seasonal effect. *Building Simulation*, 16, 1799–1819.

Fraunhofer ISE. (2023). *Photovoltaics Report*. Fraunhofer Institute for Solar Energy Systems ISE.

Govindarajan, U., Muthuvel, A., & Ramasamy, S. (2023). Solar energy policies in Southeast Asia towards low carbon emission: A review. *Renewable Energy Focus*, 46, 14–25.

International Energy Agency. (2024). *Achieving a net zero electricity sector in Viet Nam: Executive summary*. Paris: IEA. Accessed through: <https://www.iea.org/reports/achieving-a-net-zero-electricity-sector-in-viet-nam/executive-summary>

International Renewable Energy Agency & International Labour Organisation. (2023). *Renewable energy and jobs – Annual review 2023*. IRENA. Accessed through: <https://www.irena.org/Publications/2023/Sep/Renewable-energy-and-jobs-Annual-review-2023>

Kroposki, B. (2013). Guest Editorial: Special Section on Applications of Solar Energy to Power Systems. *IEEE Transactions on Sustainable Energy*, 4(2), 463.

Liu, W., Xu, Y., & Zhao, X. (2021). Policy evolution and effects of renewable energy development in China. *Energy Policy*, 156, 112431.

Ministry of Industry and Trade (MOIT). (2024). *International funding and green finance the key to renewable transition*. MOIT. Accessed through: <https://moc.gov.vn/vn/tin-tuc/1273/72094/international-funding-and-green-finance-the-key-to-renewable-transition.aspx>

Nasir, J., Javed, A., Ali, M., Ullah, K., & Kazmi, S. A. A. (2023). Sustainable and cost-effective hybrid energy solution for arid regions: Floating solar photovoltaic with integrated pumped storage and conventional hydropower. *Journal of Energy Storage*.

Obaideen, K., Olabi, A. G., Al Swailmeen, Y., Shehata, N., Abdelkareem, M. A., Alami, A. H., Rodríguez, C., & Sayed, E. T. (2023). Solar Energy: Applications, Trends Analysis, Bibliometric Analysis and Research Contribution to Sustainable Development Goals (SDGs). *Sustainability*, 15(2), 1418.

Shahan, Z. (2025, March 26). 92.5% of new power capacity added worldwide in 2024 was from renewables. *CleanTechnica*. Accessed through: <https://cleantechnica.com/2025/03/26/92-5-of-new-power-capacity-added-worldwide-in-2024-was-from-renewables/>

Sovacool, B. K., Griffiths, S., Kim, J., & Bazilian, M. (2022). Renewable energy policy, institutions, and industrial development in Malaysia. *Energy Policy*, 162, 112780.

Law Library. (2020, April 6). Decision No. 13/2020/QĐ-TTg on the mechanism to encourage the development of solar power in Vietnam. *Law Information Portal*. Accessed through: <https://thuvienphapluat.vn/van-ban/tai-nguyen-moi-truong/quyet-dinh-13-2020-qd-ttg-co-che-khuyen-khich-phat-trien-dien-mat-troi-tai-viet-nam-439160.aspx>

General Department of Customs. (2024, January 29). Coal imports to reach over 51.1 million tons in 2023. *Vietnam Clean Energy*. Accessed through: <https://nangluongsachvietnam.vn/d6/vi-VN/news/Nhap-khau-than-dat-hon-511-trieu-tan-trong-nam-2023-6-167-23742>

Vietnam Energy Forum. (2019, September 6). Vietnam's solar power market becomes the most attractive with more than 4 GW in just 2 months. *Vietnam Energy Forum*. Accessed through: <https://vietnamenergy.vn/vietnam-solar-power-market-becomes-most-attractive-with-more-than-4gw-in-just-2months-22942.html>

Vietnam Hội Nhập. (2024, April 28). Đảm bảo đáp ứng nhu cầu điện với tốc độ tăng trưởng điện thương phẩm bình quân khoảng 7%/năm. *Vietnam Hội Nhập*. Accessed through: <https://vietnamhoinhap.vn/vi/dam-bao-dap-ung-nhu-cau-dien-voi-toc-do-tang-truong-dien-thuong-pham-binh-quan-khoang-7--nam-47725.htm>

Wang, G., Zhang, Z., & Lin, J.-C. (2024). Multi-energy complementary power systems based on solar energy: A review. *Renewable & Sustainable Energy Reviews*.

World Bank. (2022). *Vietnam Solar Competitive Bidding Strategy and Framework*. Washington.