Policy for Solar Photovoltaics in Vietnam

Subjects: Energy & Fuels

Contributor: Thi Thuy Hang Le

Vietnam becomes the world's third-largest market for photovoltaic solar in 2020 after a series of policy changes for grid-connected solar power by the Vietnamese government.

solar policy photovoltaic Vietnam feed-in tariffs levelized cost of electricity

1. Introduction

In recent years, solar photovoltaic (PV) energy has grown rapidly and strongly among renewable energy sources (RES) worldwide [1][2][3]. Demand for solar PV is increasing and expanding in many countries around the world, including residential and commercial applications. By 2020, the worldwide installed capacity of solar PV reached 760 GWp, with major growth in the three markets of China, the United States, and Vietnam; see **Figure 1** and **Figure 2** [2][3][4]. Despite the pandemic of Coronavirus disease 2019 (COVID-19), solar power has continued growing sharply, with 140 MW new capacity added in 2020. In some countries, solar PV plays an important role in meeting domestic electricity demand with a coverage of 9.4% in Italy, 10.5% in Germany, 9.8% in Chile, 9.9% in Australia, 8.5% in Japan, and over 8% in Vietnam.

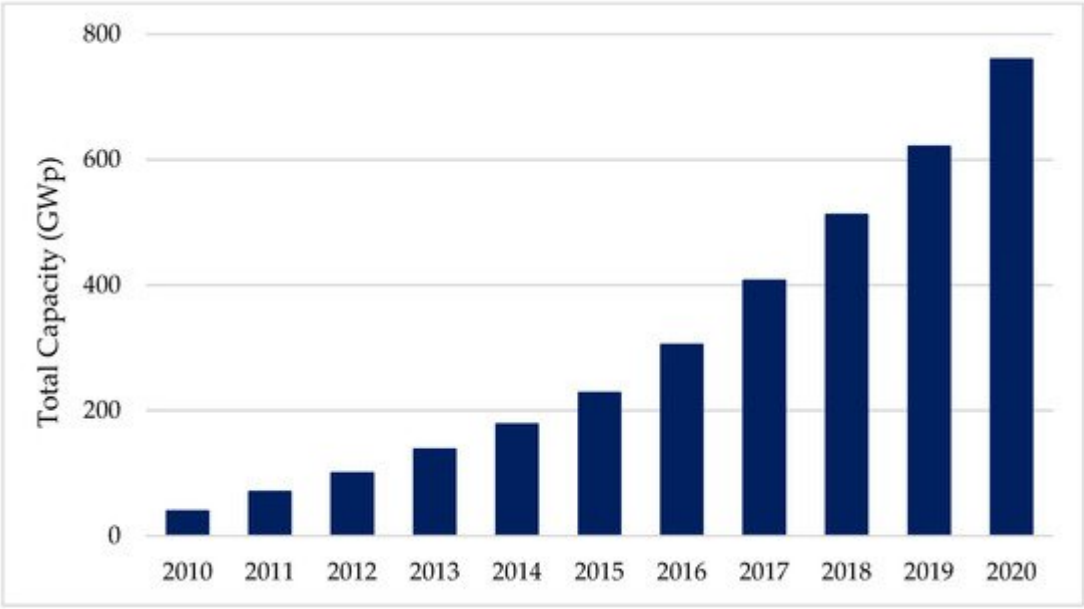

Figure 1. The total global installed capacity of solar PV in 2010–2020. (Adapted from Refs. [2][3]).

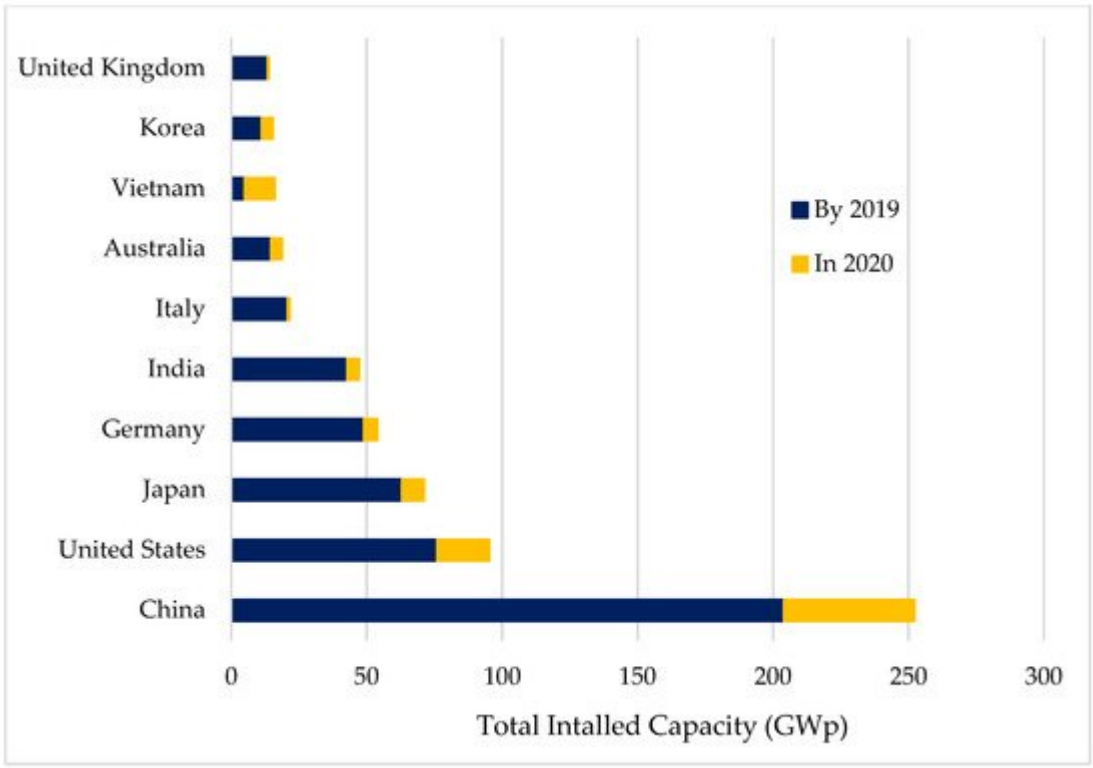

Figure 2. The total installed capacity of solar PV in top countries by 2020. (Adapted from Refs. [2][3][4]).

Vietnam is an emerging country for solar PV installation, but it made a spectacular breakthrough in 2019 with a growth jump of 45 times compared to the total installed capacity in 2018, and by 2.3 times in 2020 [3][4]. Similar to other countries, Vietnam is interested in solar PV mainly to meet the current increased electricity demand of up to 10% per year, as well as to ensure energy security and meet the criteria of reducing emissions.

Promoting the development of RES, including solar PV, is necessary for the current context of severe global climate change and the requirement for energy security and sustainable development [5]. This is also in line with the spirit of the Kyoto Protocol in 1997, which is to limit or reduce greenhouse gas (GHG) emissions in human activities of production, transportation, and consumption of energy [6]. Accordingly, the issues of improving energy efficiency and promoting and increasing the use of RES were mentioned. Limiting and reducing emissions in energy production, transportation, and distribution is also an important element in the Kyoto Protocol. In addition, the shift from fossil fuels to RES to cut indirect emissions is also well suited to the targets negotiated in the United Nations Framework Convention on Climate Change at the 21st meeting of the Conference of the Parties (COP21) and the 26th meeting of the Conference of the Parties (COP26) [7][8].

Furthermore, the competitiveness of solar PV in terms of Levelized Cost of Electricity (LCOE) is also a driving force behind investment in plants installations. In 2020, the LCOE of solar PV fell the most among RES; see **Figure 3** [9][10]. Specifically, the global weighted-average LCOE of solar PV in 2020 had decreased by 85% compared to 2010 and by 7% compared to 2019. The country-level weighted-average LCOE of utility-scale solar PV declined between 72% and 87% between 2010 and 2020, depending on the country. In Vietnam, the world's third-largest market for solar PV, this weighted-average LCOE declined by 58% between 2016 and 2020.

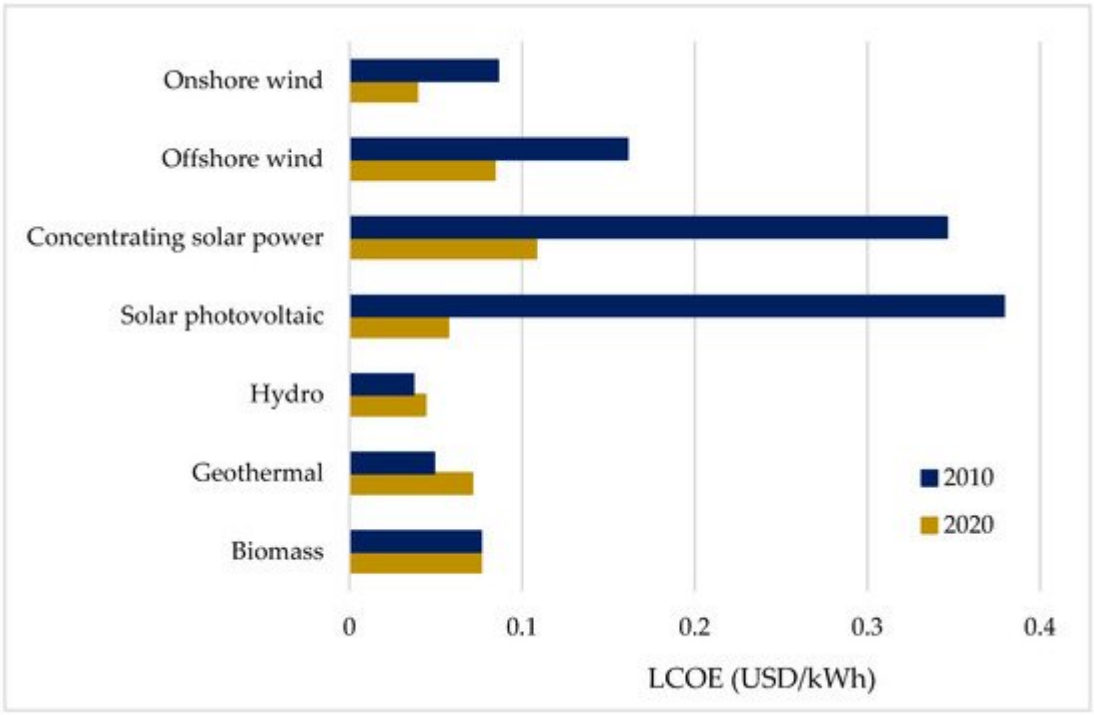

Figure 3. Global weighted-average LCOE of solar PV in 2010 and 2020. (Adapted from Refs. [9][10]).

The costs of solar PV modules and their associated installation have been significantly reduced, along with the increase of capacity factors year on year; see **Figure 4** [9][10]. Specifically, the global weighted-average total installed costs decreased by nearly 81% between 2010 and 2020, while the global weighted-average capacity factors for solar PV increased from 14% in 2010 to 16% in 2020. Total installation costs have fallen significantly across all major markets between 2010 and 2020, to only 596 USD/kW in China (reduced by 84%), 781 USD/kW in Italy (reduced by 85%), 1101 USD/kW in the United States (reduced by 77%) and 700 USD/kW in Germany (reduced by 81%). In Vietnam, the weighted-average total installation cost has reached 949 USD/kW, reduced by 58% between 2016 and 2020.

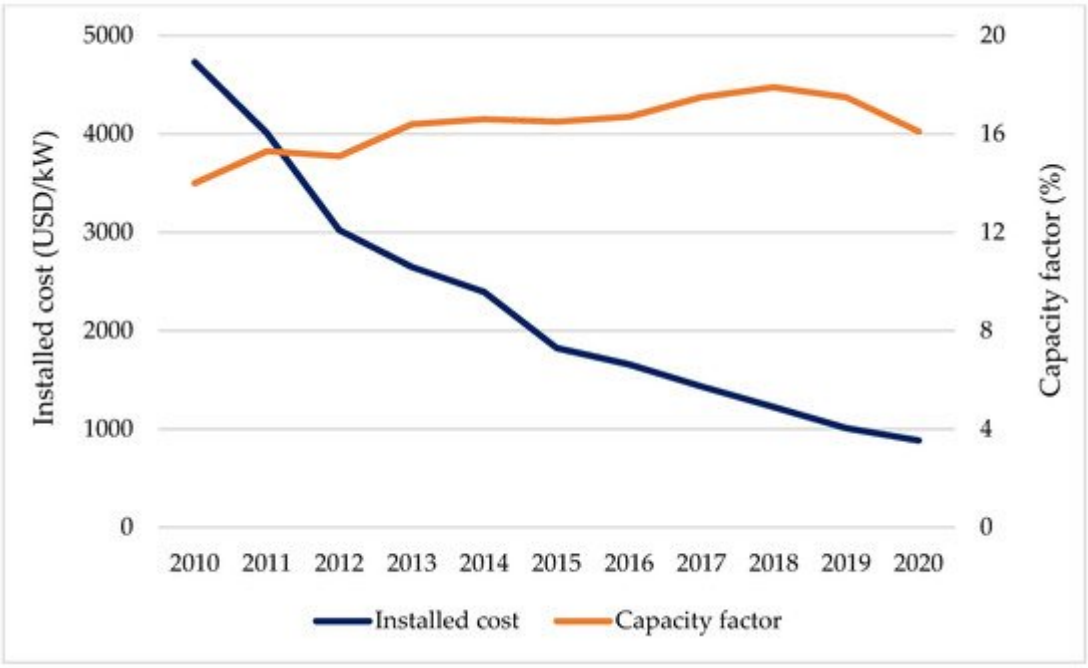

Figure 4. Global weighted-average installed costs and capacity factors of Solar PV in 2010–2020. (Adapted from Refs. [9][10]).

The total installed cost for solar PV relates to various factors, including costs of PV modules and Balance of System (BoS) [10][11]. By 2020, the global weighted-average cost of solar PV modules had declined by around 91% compared to 2010, while the BoS costs are different for each country [9][10]. These BoS costs are particularly tied to the support policy in each country, including limiting administrative barriers of licensing or connectivity or minimizing individual costs.

Today, with a sharp reduction in the cost of power generation from RES, especially utility-scale solar PV, new renewable plants can fully compete with conventional power plants [11][12]. Furthermore, the issues of reducing air pollution, limiting carbon emissions, and contributing to climate change mitigation are also advantages of RES power plants [13]. However, in the early stages of RES development, the difference in economic and technical conditions between RES and conventional fuels in the host countries is often quite large [4][14][15][16][17]. Therefore, it is not easy for RES to replace current conventional fuel sources.

In such a context, the role of governments has been very important in bridging the gap between conventional fuels and RES through supporting policies and related financial tools. Many incentive policies have been introduced, but currently, the most prominent mechanism is still the feed-in tariff (FIT) [2][3][18][19]. The FIT is an effective mechanism to encourage the development of RES and increase their competitiveness with fossil fuels [20][21]. This mechanism obliges electricity utilities to purchase electricity generated from RES in their service area at a tariff determined by the public authority and guaranteed for a specified period. These tariffs vary between RESs and between countries depending on available public resources and socio-economic conditions. The documents [22][23][24] have shown that different FIT structures greatly influence the development of RES and underline the important role of government in setting goals and foundations for RES deployment.

FIT mechanisms were also the most popular mechanism contributing to the large growth of solar PV in Europe during 2008–2012 [16], China during 2011–2016 [17], Japan during 2012–2017 [25][26], and Vietnam in 2019–2020 [4]. Over time, these mechanisms increase the reliability of investments and help to find a stable foothold for solar PV in particular and RES in general.

In Germany, one of the top countries of solar PV, the first law of the Electricity Feed-in Act for green electricity entered into force in 1991 [2][27]. The law required grid companies to connect all renewable power plants and give them a guaranteed FIT for 20 years. However, it was not until 2000, when the FIT price was concretized and no longer tied to the current electricity price [28], that solar power really prospered [27][28][29]. The 100,000-roofs scheme under the new act was also deployed with low-interest loans in 2001–2003. The success of the scheme plus the adjusted FIT prices led to the rapid development of solar PV in Germany during the 2000s.

In Italy, the FIT mechanism was changed five times between 2005 and 2012 under the name “Conto Energia”, before being decommissioned in 2013 [30]. The first FIT mechanism was issued in 2005, but it was not until 2007, under the second FIT mechanism, that solar PV plants really exploded, especially at the end of 2010. The incentives for solar PV plants increasing while the cost of solar power plummeted was one of the main drivers of this boom. However, weak management and confusion in the transition between the second FIT and the third FIT led to great chaos in solar PV deployment in 2010–2011 and affected support policies of solar PV later in Italy. It can be said that the Italian government has not succeeded in establishing a control system for the FIT mechanisms for solar PV, and thus caused troubles for the solar PV market in 2006–2013.

In Japan, by 2011, electricity from solar PV was negligible, at below 1% of the total electricity production [25]. The Japanese government did not really pay attention to RES development until the Fukushima nuclear plant disaster in March 2011. By the end of 2011, the Japanese government introduced the Innovative Energy Environment Strategy [31] with the goal of increasing the contribution of renewable sources, and the Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities [25][32] with a FIT scheme for renewable electricity. In 2012, the first tariff for solar PV was 53 UScents/kWh, more than double the price offered in Germany at the same time. As a result, solar PV in Japan has increased at a galloping pace. By 2017, the total installed capacity of solar PV in Japan reached 49 GW, fulfilling the expected target until 2030 [26].

In Vietnam, the world’s third-largest market for solar PV today, solar PV was just 100 MWp of the total installed capacity and less than 1% of total electricity production in 2018 [33][34][35]. The FIT mechanism for solar PV in Vietnam started in 2017 and was continuously adjusted in the years 2019–2020 [36][37][38]. The promulgation of FIT mechanisms over time helped solar PV grow strongly in 2019 and 2020 [3][4]. Nevertheless, Vietnam has also encountered problems similar to Italy in controlling FIT mechanisms and confusion in the transition between FIT mechanisms [39][40][41][42]. This has led to uneven and unsustainable development of solar PV applications across the country [4][42][43][44].

In summary, the role of host governments in promoting renewable electricity development is really important through setting goals and mechanisms for RES in general and solar PV in particular. Therefore, studying the

impacts of policies for solar PV at this time is necessary for the sustainable development of solar PV in the long term in Vietnam.

2. Policies for Solar PV in Vietnam

In Vietnam, the solar potential is up to 300 GW, even higher than that in Germany and Japan [45][46]. However, in 2018, the total installed capacity of solar PV was extremely low compared to its potential, with only 100 MWp and electrical generation from solar PV accounting for less than 1% of total electricity production; see **Figure 5** [33][34][35]. The main energy sources for electricity generation came from coal, oil, and hydropower. However, these energy sources are forecasted to be exhausted in the next 10 years, having limited exploitation capacity or being almost fully exploited [34][47].

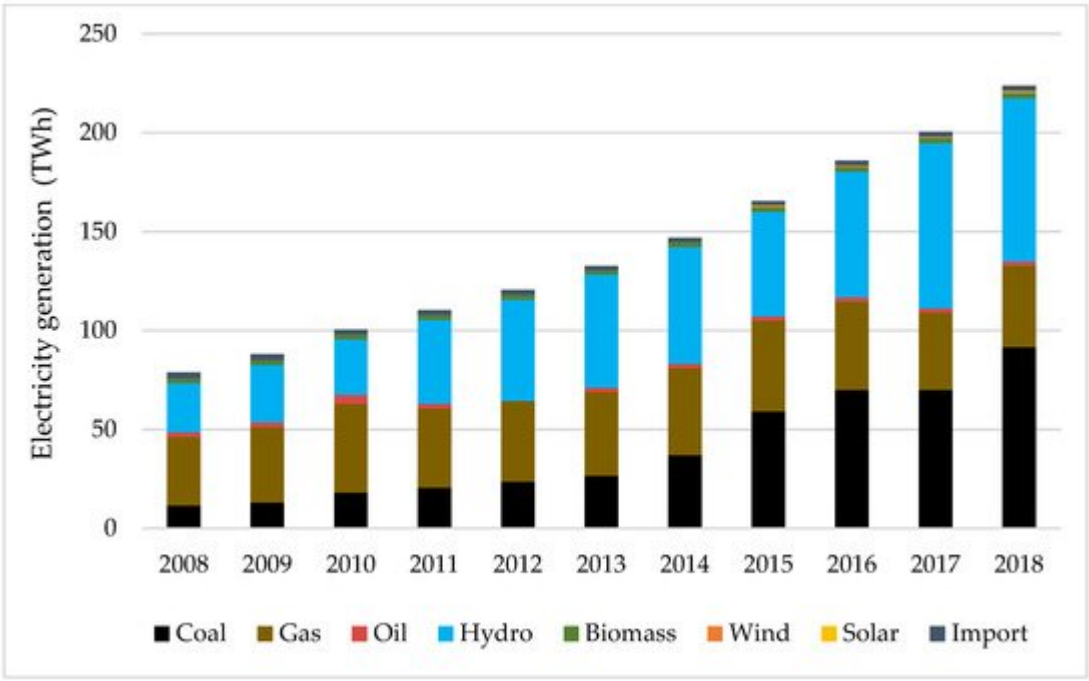

Figure 5. Types of electricity generation in Vietnam in 2018. (Adapted from Refs. [33][34][35]).

In 2007, the Vietnamese government enacted the first development strategy for RES, including solar PV, but there are no specific targets for each renewable energy source in this document [48][49][50][51]. Therefore, it was not attractive enough for local and international investors.

In 2011, specific targets for installed capacity and power output of solar PV were first outlined in the Seventh Power Development Plan (PDP7) [49] and then amended in 2016 under the revised PDP7 [52]; see **Figure 6**. Accordingly, the total capacity of solar PV is expected to reach 850 MWp, 4000 MWp, and 12,000 MWp in 2020, 2025, and 2030, respectively accounting for 0.5%, 1.6%, and 3.3% of the total electricity output.

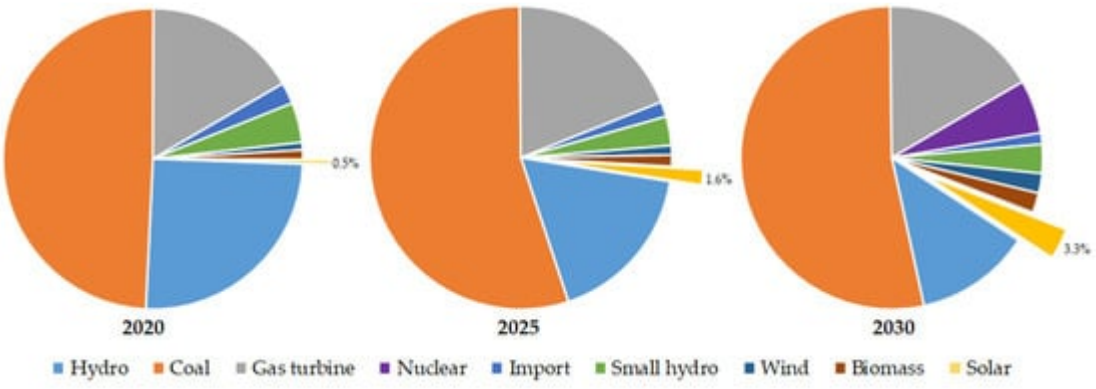

Figure 6. Targets for electricity output by fuels under revised PDP7. (Adapted with Refs. [49][52]).

In 2015, the first government-level document on a development strategy specifically for renewable energy (REDS) was issued [51]; see **Figure 7**. In REDS, the specific targets for electricity production from solar PV were planned to be up to 1.4 billion kWh, 35.4 billion kWh, and 210 billion kWh, accounting for 0.5%, 6%, and 20% in 2020, 2030, and 2050, respectively. In addition, other measures proposed in REDS to implement the objectives of the strategy include credits for RES; exemptions on import duties on certain equipment, materials, and products that cannot be produced locally; exemptions and reductions of corporate income tax and/or land-use costs.

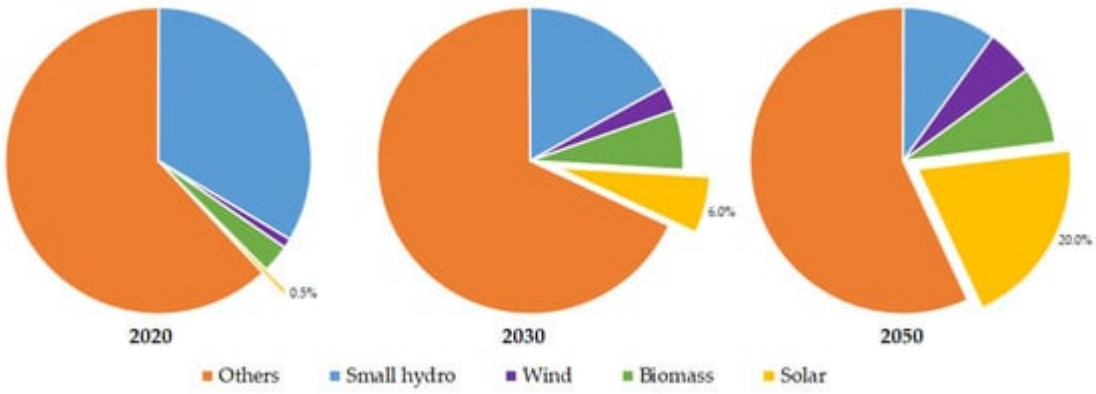

Figure 7. Targets for electricity production by renewables under REDS in Vietnam. (Adapted from Ref. [51]).

The FIT in Vietnam was first introduced in June 2011, but it was only for wind power, not solar power [53]. Six years later, mechanisms for solar PV were first officially enacted; they were enacted in 2017, 2019, and 2020; see **Table 1** [36][37][38]. Accordingly, in 2017, this mechanism imposed an obligation for the grid operators, herein Vietnam Electricity (EVN) Group, to purchase electricity generated from solar power plants (SPP) at the FIT of 9.35 UScents/kWh for the next 20 years. In 2019, the FIT price for RTS systems continued to be supplemented and amended with the same promotion of SPP. In early 2020, the latest FITs for grid-connected solar PV applications were issued with more options, including a floating SPP, a ground SPP, and an RTS in a range from 7 UScents/kWh to 8.4 UScents/kWh. For Ninh Thuan province only, the grid-connected solar PV projects below 2000 MWp included in the development plan could enjoy a FIT of 9.35 UScents/kWh for all levels.

Table 1. The FIT for grid-connected solar PV in 2017–2020. (Adapted from Refs. [36][37][38]).

Year	RTS (UScents/kWh)	SPP (UScents/kWh) Floating	Ground	Tariff Duration (Years)	Max. Cap (MWp)	Others
2017		9.35	9.35	20		
2019	9.35	9.35	9.35	20		
2020	8.38	7.69	7.09	20	<1 (RTS)	
	9.35	9.35	9.35	20	<2000	Ninh Thuan

Based on the promulgated supporting policies and instruments, schemes on grid development using RES have also been implemented. Specifically, the program to supply electricity to rural areas, mountainous areas, and islands in the period of 2013–2020 [50] focuses on low-income households in remote areas. It encourages the implementation of rural electricity investment projects from RES in cases where they cannot be connected to the grid. In fact, most projects under this program are non-profit and funded by governments or corporations [54].

Furthermore, the RTS promotion program was launched in 2019 by the Ministry of Industry and Trade (MoIT) [55]. Accordingly, 100,000 RTS systems (equivalent to 1000 MWp) would be installed and operated in the whole country until 2025 under the REDS. The development and completion of policies and regulations to support the development of rooftop solar PV is also another result of the program.

Finally, taxes on land use and leasing for solar PV projects would be waived or partially reduced depending on the project category [36][37][38][56][57][58]. Parts for solar PV power plants purchased from other countries would also be exempt from taxes on imported goods. Exemptions and reductions of corporate income tax are also implemented in accordance with the current law.

3. Conclusions and Recommendations

This paper reviewed the current status of solar PV with the respective adjustments of the FIT mechanism in Vietnam. The government has set a strategic target for developing renewable energy, with a solar PV output target of 1.4 billion kWh by 2020. The revised PDP7 also sets the total installed solar PV capacity by 2020 to be 850 MWp. However, until 2018, the total installed capacity of solar PV was only 106 MWp. This implies the need to set appropriate tariffs for future solar PV development.

The dependence on foreign organizations for technology, engineering, and project development capabilities has made the LCOE of solar PV in Vietnam always high compared to many other countries. Waiting for the global weighted-average LCOE index to decrease in order to achieve a similar explosive development of solar PV, such as what happened in 2019, is a passive and unsustainable way of developing the solar PV industry in Vietnam. Despite the government's subsequent policy adjustments, they are only short-term political interventions. In this regard, the deployment of large-scale projects often responds more quickly to changes in support policies. In the context of FIT policy changes, however, the number of new SPP projects in 2020 has decreased sharply compared

to 2019. Investors have focused on the development of small-scale RTS systems in order to more carefully consider the effects of the newly enacted policies and capital preservation.

In Vietnam, the FIT price is fixed and based on the global average LCOE of solar PV without taking into account the domestic LCOE situation. In addition, the modality of FIT pricing is limited, with no clear distinctions of the applied technology, capacity size, or project location. This has led to the unbalanced development of solar PV projects throughout the territory of Vietnam today. The out-of-control boom of SPP and RTS projects in the south-central and south regions has clearly reflected the impact of the FIT mechanism on the solar PV sector in Vietnam.

The electricity retail price is adjusted annually, but it has not truly been used to leverage the sustainable development of PV electricity in Vietnam. The regulated electricity price framework has not yet reflected the current penetration of solar PV as well as RES in Vietnam's power system. This competitive retail electricity market is still in the plan until 2024. The existing subsidy policy can be an effective tool but affects investments in solar PV as well as RES installations due to long payback times and costly government budgets.

In the future, the government should build a solar PV roadmap based on the cost trend of demand, technology type, installed capacity, and/or project location. The roadmap should provide vision, target identification, and identify specific actions, especially the stability of policy frameworks. Policy changes should be made in a deliberate and predictable manner. The process of developing and implementing a roadmap is also important and needs to involve stakeholders.

The availability of the power system for solar PV should also be considered in order to ensure the sustainability of future solar PV development. The government should have other support policies to ensure the injection of electricity from solar PV into the power system, including incentives and support for transmission line development and energy storage systems. These policies should be built on the basis of the exploitation potential of solar energy and the absorbance capacity of the grid for solar PV in each region.

Reducing investment risks appears to be important for solar PV deployment, as it provides a safe environment for investors and will allow for sustainable development of the solar PV industry in the future. Policymakers and regulators are responsible for identifying and implementing relevant regulations and market designs that are conducive to investment while maintaining efficiency by providing satisfying compensation for policy risk. For large-scale solar PV projects, it is possible to organize competitive auctions or offer premium FIT schemes for long-term power purchase agreements with time-based energy pricing.

Policymakers should ask for assistance from international organizations, especially in countries with developed solar industries, and international solar alliances, as well as banks and multilateral and bilateral development agencies.

References

1. Jäger-Waldau, A. PV Status Report 2019; Publications Office of the European Union: Luxembourg, 2019; ISBN 978-92-76-12608-9.
2. REN21. Renewables 2020. Global Status Report; REN21 Secretariat: Paris, France, 2020; ISBN 978-3-9818911-7-1.
3. REN21. Renewables 2021. Global Status Report; REN21 Secretariat: Paris, France, 2021; ISBN 9783948393038.
4. Riva Sanseverino, E.; Le Thi Thuy, H.; Pham, M.-H.; Di Silvestre, M.L.; Nguyen Quang, N.; Favuzza, S. Review of Potential and Actual Penetration of Solar Power in Vietnam. Energies 2020, 13, 2529.
5. Tvaronaciene, M.; Slusarczyk, B. Energy Transformation towards Sustainability; Elsevier Inc.: Amsterdam, The Netherlands, 2019; ISBN 9780128176887.
6. UN. Report of the Conference of the Parties on its Third Session, Held at Kyoto from 1 to 11 December 1997; United Nations: Kyoto, Japan, 1998.
7. COP21. Paris Agreement under the United Nations Framework Convention on Climate Change; United Nations: Paris, France, 2015.
8. COP26. Glasgow Agreement under the United Nations Framework Convention on Climate Change; United Nations: Glasgow, Scotland, 2021.
9. IRENA. Renewable Power Generation Costs in 2020; International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2021; ISBN 978-92-9260-348-9.
10. IRENA. Renewable Power Generation Costs in 2019; International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2020; ISBN 9789292602444.
11. Taylor, B.Y.M. Energy Subsidies: Evolution in the Global Energy Transformation to 2050; International Renewable Energy Agency: Abu Dhabi, United Arab Emirates, 2020; ISBN 9789292601256.
12. Lazard Lazard’s Levelized Cost of Energy Analysis—Version 14.0. Available online: https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2020/ (accessed on 19 October 2020).
13. Gray, M.; Ljungwaldh, S.; Watson, L.; Kok, I. Powering Down Coal—Navigating the Economic and Financial Risks in the Last Years of Coal Power; Carbon Tracker Initiative: London, UK, 2018.
14. Perez-Arriaga, I.J.; Batlle, C. Impacts of Intermittent Renewables on Electricity Generation System Operation. Econ. Energy Environ. Policy 2012, 1, 3–18.
15. Hart, E.K.; Stoutenburg, E.D.; Jacobson, M.Z. The Potential of Intermittent Renewables to Meet Electric Power Demand: Current Methods and Emerging Analytical Techniques. Proc. IEEE 2012,

100, 322–334.

16. Milanés-Montero, P.; Arroyo-Farrona, A.; Pérez-Calderón, E. Assessment of the Influence of Feed-In Tariffs on the Profitability of European Photovoltaic Companies. Sustainability 2018, 10, 3427.
17. Ye, L.-C.; Rodrigues, J.F.D.; Lin, H.X. Analysis of feed-in tariff policies for solar photovoltaic in China 2011–2016. Appl. Energy 2017, 203, 496–505.
18. Dusonchet, L.; Telaretti, E. Economic analysis of different supporting policies for the production of electrical energy by solar photovoltaics in eastern European Union countries. Energy Policy 2010, 38, 4011–4020.
19. Dusonchet, L.; Telaretti, E. Economic analysis of different supporting policies for the production of electrical energy by solar photovoltaics in western European Union countries. Energy Policy 2010, 38, 3297–3308.
20. Abolhosseini, S.; Heshmati, A. The main support mechanisms to finance renewable energy development. Renew. Sustain. Energy Rev. 2014, 40, 876–885.
21. Johnstone, N.; Haščič, I.; Popp, D. Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts. Environ. Resour. Econ. 2010, 45, 133–155.
22. Haas, R.; Panzer, C.; Resch, G.; Ragwitz, M.; Reece, G.; Held, A. A historical review of promotion strategies for electricity from renewable energy sources in EU countries. Renew. Sustain. Energy Rev. 2011, 15, 1003–1034.
23. Lüthi, S.; Wüstenhagen, R. The price of policy risk—Empirical insights from choice experiments with European photovoltaic project developers. Energy Econ. 2012, 34, 1001–1011.
24. Couture, T.; Gagnon, Y. An analysis of feed-in tariff remuneration models: Implications for renewable energy investment. Energy Policy 2010, 38, 955–965.
25. Muhammad-Sukki, F.; Abu-Bakar, S.H.; Munir, A.B.; Mohd Yasin, S.H.; Ramirez-Iniguez, R.; McMeekin, S.G.; Stewart, B.G.; Sarmah, N.; Mallick, T.K.; Abdul Rahim, R.; et al. Feed-in tariff for solar photovoltaic: The rise of Japan. Renew. Energy 2014, 68, 636–643.
26. Arias, J. Solar Energy, Energy Storage and Virtual Power Plants in Japan—Potential Opportunities of Collaboration between Japanese and European Firms; EU-Japan Centre for Industrial Cooperation: Tokyo, Japan, 2018.
27. Lüthi, S. Effective deployment of photovoltaics in the Mediterranean countries: Balancing policy risk and return. Solar Energy 2010, 84, 1059–1071.
28. FMENCNS. Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act, Germany, 2000). Solar Energy 2001, 70, 489–504.

29. Grau, T. Responsive feed-in tariff adjustment to dynamic technology development. Energy Econ. 2014, 44, 36–46.
30. Di Dio, V.; Favuzza, S.; La Cascia, D.; Massaro, F.; Zizzo, G. Critical assessment of support for the evolution of photovoltaics and feed-in tariff(s) in Italy. Sustain. Energy Technol. Assess. 2015, 9, 95–104.
31. Homma, T.; Akimoto, K. Analysis of Japan's energy and environment strategy after the Fukushima nuclear plant accident. Energy Policy 2013, 62, 1216–1225.
32. METI. Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities; Japan Ministry of Economy Trade and Industry: Tokyo, Japan, 2011.
33. CEERP. BP Statistical Review of World Energy 2019; BP International Limited: London, UK, 2019.
34. EREA&DEA. Vietnam Energy Outlook Report 2019; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2019.
35. Zissler, R. Renewable Energy to Replace Coal Power in Southeast Asia. Pragmatism to Deliver a Sustainable Bright Future; Renewable Energy Institute: Tokyo, Japan, 2019.
36. Prime Minister. Decision 02/2019/QD-TTg on Amendments and Supplements to Certain Articles of Decision No. 11/2017/QD-TTG on the Mechanism for Encouragement of Development of Solar Power in Vietnam; Vietnam Government: Hanoi, Vietnam, 2019.
37. Prime Minister. Decision 11/2017/QD-TTg on Mechanism for Encouragement of the Development of Solar Power Projects in Vietnam; Vietnam Government: Hanoi, Vietnam, 2017.
38. Prime Minister. Decision 13/2020/QD-TTg on Mechanism for Encouragement of the Development of Solar Power in Vietnam; Vietnam Government: Hanoi, Vietnam, 2020.
39. VGO. Notice 402/TB-VPCP of Prime Minister's Conclusions on the Draft of Solar Power Promotion Mechanism in Vietnam, Applied from July 1, 2019, Following Decision 11/2017/QD-TTg; Vietnam Goverment Office: Hanoi, Vietnam, 2019.
40. MoIT. Dispatch 9608/BCT-DL on Suspension of Proposal and Agreement for Solar Power Projects under FIT Price Mechanism; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2019.
41. MoIT. Dispatch 89/BCT-DL on on Implementation of Agreements with Rooftop Solar Power; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2020.
42. MoIT. Proposal 10170/TTr-BCT of a New Draft Decision on the Mechanism for Developing Solar Power Projects in Vietnam; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2019.
43. VEPG. Vietnam Factsheet on Rooftop Solar Development 2019; Viet Nam Energy Partnership Group: Hanoi, Vietnam, 2019.

44. EVN. Press Release on Capacity Release of Renewable Energy Sources of Vietnam Electricity. Available online: https://www.evn.com.vn/d6/news/Den-3062019-Tren-4460-MW-dien-mat-troi-da-hoa-luoi-6-12-23925.aspx (accessed on 10 September 2020).
45. MoIT&DEA. Vietnam Energy Outlook 2017; Danish Energy Agency: Hanoi, Vietnam, 2017.
46. WB Group. Solar Resource Maps for More Than 200 Countries on the World. Available online: https://solargis.com/maps-and-gis-data/download (accessed on 8 May 2021).
47. IEA. Southeast Asia Energy Outlook 2017; OECD: Bangkok, Thailand, 2017; ISBN 9789264285576.
48. Prime Minister. Decision 1855/QD-TTg of Approving Vietnam's National Energy Development Strategy up to 2020, with Vision to 2050; Vietnam Government: Hanoi, Vietnam, 2007.
49. Prime Minister. Decision 1208/QD-TTg Dated 21 July 2011 of Approving the National Master Plan for Power Development in the 2011–2020 Period, with Considerations to 2030; Vietnam Government: Hanoi, Vietnam, 2011.
50. Prime Minister. Decision 2081/QD-TTg of Approving the Program on Electricity Supply in Rural, Mountainous and Island Areas in Period of 2013–2020; Vietnam Government: Hanoi, Vietnam, 2013.
51. Prime Minister. Decision 2068/QD-TTg of Approving the Viet Nam's Renewable Energy Development Strategy up to 2030 with an Outlook to 2050; Vietnam Government: Hanoi, Vietnam, 2015.
52. Prime Minister. Decision 428/QD-TTg of Approval of the Revised National Power Development Master Plan for the 2011–2020 Period with the vision to 2030; Vietnam Government: Hanoi, Vietnam, 2016.
53. Prime Minister. Decision 37/2011/QD-TTg on the Mechanism Supporting the Development of wind Power Project in Vietnam; Vietnam Government: Hanoi, Vietnam, 2011.
54. Sinh, T.D.; Long, N.H.; Dung, N.T.M. Report on Rural Electrification Policies and Supporting Mechanisms for Off-Grid Community; Green Innovation and Development Centre: Hanoi, Vietnam, 2017.
55. MoIT. Decision 2023/QD-BCT of Approving the Program to Promote the Development of Rooftop Solar Power in Vietnam in Period of 2019–2025; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2019.
56. MoIT. Circular 16/2017/TT-BCT on Project Development and Model Power Purchase Agreements Applied to Solar Power Projects; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2017.
57. MoIT. Circular 18/2020/TT-BCT on Project Development and Model Power Purchase Agreements Applied to Solar Power Projects; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2020.

58. MoIT. Circular 05/2019/TT-BCT of Amendments to Circular 16/2017/TT-BCT on Development of Solar Power Projects and Standard form Power Purchase Agreement; Vietnam Ministry of Industry and Trade: Hanoi, Vietnam, 2019.