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Potential, Policies, and Issues for the Renewable Electricity Purchase Price: The Cases of Indonesia, Viet Nam, and the Philippines

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Abstract

Association of Southeast Asian Nations (ASEAN) Member States are engaged in global objectives to mitigate climate change. A high share of renewable electricity in the total generated power is amongst the main goal indicator to achieve. The Southeast Asia region has a huge potential for renewable resources, and in recent years, the region has also been experiencing a significant decrease in investment costs and the levelised cost of electricity generated by its renewable sources. This paper analyses the cases of three different ASEAN Member States, i.e. Viet Nam, the Philippines, and Indonesia, in implementing renewable electricity purchase pricing mechanisms to boost the renewable electricity share in the total generated power. The analysis has been performed with a focus given to the offered purchase price level, the structure and mechanism of the pricing, and the effects of the mechanism on the generated renewable electricity share. The main outcome of this paper is a set of six principles to be used in designing and implementing policies related to renewable electricity pricing that are applicable in developing and emerging economies in ASEAN and other regions.

Introduction

Association of Southeast Asian Nations (ASEAN) Member States are engaged in global objectives to mitigate climate change. The Paris Agreement, adopted in December 2015, urged ASEAN Member States to take individual actions to address climate change issues as stated in their intended nationally determined contributions. Individual measures range from improved energy efficiency to the increased use of renewable energy in energy-consumption-intensive sectors. Furthermore, following the United Nations Climate Change Conference in Glasgow in November 2021, COP26, some of the ASEAN Member States have also declared their net-zero emissions, or carbon neutrality targets, to be achieved by around mid-century. Decarbonising power generation sectors, as represented by targets for the share of electric power generated by renewable sources, is one of the most important indicators or milestones of climate change mitigation engagement.

From the economic perspective, the total gross domestic product of the 10 ASEAN Member States will rise from around US$3.1 trillion in 2017 to around US$12.25 trillion in 2050, an average yearly growth of around 4.3%. At the same time, the total ASEAN population will increase from around 636 million inhabitants in 2017 to around 810 million inhabitants in 2050, an average growth rate of 0.7% per year.

Under the Business-as-Usual (BAU) scenario of the Economic Research Institute for ASEAN and East Asia's (ERIA) Energy Outlook (Purwanto, 2021), generated electricity is expected to grow at 3.8 % annually to reach around 3,440 terawatt-hours (TWh) by 2050, whilst the share of renewable electricity in the scenario is estimated to go down from 22% in 2020 to 18% in 2050.

Under the Alternative Policy Scenario (APS), where improved efficiency of final energy consumption in the end-use sectors, more efficient thermal power generation, and a higher contribution of renewable energy to the total electricity supply are assumed, generated electricity is estimated to reach 2,900 TWh by 2050, with the share of renewable electricity reaching 27% by the same year.

Kimura et al. (2022) elaborate on an ASEAN scenario called CN2050/2060 that reflects nationally declared carbon-neutral target years and considers carbon sinks in Indonesia, Malaysia, Myanmar, Thailand, and Viet Nam. In the scenario, renewable energy is a major power source, accounting for 56% of total power generation in 2060 with solar PV power generation composing more than half of that renewable electricity share. ASEAN countries, therefore, need to more than double their renewable electricity share targets, to reach carbon neutrality by mid-century.

These estimated penetration rates of renewable electricity in the region contrast with the region's rich renewable energy resources. According to IRENA (2018), the largely untapped resources range from hydropower potential in Indonesia, Myanmar, the Lao PDR, and other lower Mekong countries, very strong horizontal irradiation suitable for photovoltaic (PV) installations, modest wind resource potential in areas of Indonesia, the Philippines, Thailand and Viet Nam, and significant geothermal potential in Indonesia and the Philippines, to the substantial potential for ocean energy, especially in the archipelago nations, and significant supply potential for bioenergy in the entire region.

For ASEAN countries in general, leapfrogging from large-scale fossil fuels in the short term is an important challenge, given their heavy dependencies on these affordable fuels and the development imperatives associated with them. At the same time, as in most developing and emerging economies, the adoption of modern renewable energy sources and other low-carbon energy technologies is generally slow, marked by a lack of investment, public budgetary limitations, and investors' high-risk perceptions (Pigato et al., 2020; IRENA, 2021).

Support mechanisms are important in increasing the share of renewable energy resources used to generate electricity. Amongst the mechanisms is the purchase of renewable-based electricity by the government or its representatives, such as state-owned-companies, utilities, or independent power producers, at prices higher than conventional alternatives.

According to Nguyen (2021), by 2020, the total installed capacity of solar power in Viet Nam reached 16,261 megawatts (MW) and continued to increase to reach 16,504 MW in 2021. According to Viet Nam Electricity (EVN) quoted by VN Express (2022), this was beyond the initial set target of 850 MW by 2020 (EVN, 2016). The Government of Viet Nam's policy to set feed-in tariffs (FITs) for solar power (Decision 13/2020/QD-TTg) has been one of the keys to the strong penetration of solar-based electricity (Massmann, 2020).

The Philippines began using FITs in 2012 and saw some growth in solar, wind, and biomass gasification from 2013 to 2017. The total installed capacity of biomass, solar, and wind power in the Philippines grew from just below 200 MW in 2013 to nearly 1,600 MW in 2017 (Guild, 2019).

Indonesia adopted FITs to increase its renewable electricity share in 2013 but cancelled them in 2017. Between 2017 and mid-September 2022, Indonesia set the maximum renewable electricity purchase price based on the average of the previous year's generation production costs for the region, which had no significant effect on the share of renewable electricity installed or capacity and generation (ADB, 2020). Indonesian Presidential Decree 112 of the year 2022, signed on 13 September 2022, set again the maximum renewable electricity purchase prices, this time in a set of defined fixed values that vary in function by location factors that represent basically nine power grid networks in the country.

This short paper compares the design and implementation of renewable-based electricity pricing in Viet Nam, the Philippines, and Indonesia and the impacts and effectiveness of those policy tools in the growth of solar power-based electricity generation in each of the countries. Analysis was performed and focus was given to the offered purchase price level, the structure and mechanism of the pricing, and the effect of the mechanism on the renewable electricity share.

The main outcome of the paper consists of some principles to be used as a framework in designing and implementing policies related to renewable electricity pricing, which can be applicable in developing and emerging economies using the three AMS cases. At least two previous research works have proposed frameworks for the same purpose.

First, DeShazo and Matulka (2009) pointed out the importance of the cost-effectiveness of a FIT programme, which should consist of a programme cap, capacity allocation, the allocation of utility-side network upgrade costs, and the allocation of participant risk through specific contractual features. They also emphasised the importance of application requirements based on capacity, project selection criteria, participant pre-qualifications, and any other fees and deposits that must aim at encouraging inclusiveness and diverse participation.

Second, Cox and Esterly (2016) suggested a framework that consists of the payment level setting that considers the levelised cost of renewable electricity generation, the utility's avoided cost of generation added to the ancillary grid benefits, resource quality that relates to generation costs at specific sites, and auction-based procurement through tender mechanisms. They also proposed that the mechanism includes containment costs and long-term contracts and considers guaranteeing grid access, streamlining approvals and administration issues, linkages with other support policies, linking FITs to wholesale market prices to increase the efficiency of policy outcomes and decrease costs, and ensuring the payment's transparency and predictability.

The principles of the framework to be proposed in this paper concentrate on six aspects that are found at the same level of implementation as Cox and Esterly (2016). The first one is the level of the offered purchase prices and the pricing level of segmentation to capture the differences in locations, technologies, and other local specificities. The other six aspects concern the role of the levelised costs of renewable electricity, the consideration of the electricity tariffs paid by end users, stability and certitude of the implemented regulations, the need to have a set of accompanying measures to restrain the growth of fossil fuels-based electricity, and the importance of the inverse auction mechanism.

The set of six principles should be usable as a basic framework to elaborate a sustainable and effective mechanism of renewable electricity purchase pricing in developing ASEAN countries as well as developing countries in other world regions.

1 Renewable electricity pricing policy development

1.1 Viet Nam

According to the MOIT (2016), Viet Nam has a solar power potential of 130 GW and a wind power potential of 27 GW.

On 25 November 2015, the Government of Viet Nam issued Decision No. 2068/QĐ-TTg on the National Strategy of Renewable Energy Development by 2030 and Vision to 2050 with the goal of reducing the country's dependency on fossil fuels, maintaining national energy security, and contributing to global climate change mitigation. The Strategy included the objective to raise the share of electricity generation from renewable energy from 35% of total national electricity production in 2015, to 38% by 2020 and to 43% by 2050. According to this National Strategy, focus shall be given to proven technologies in the renewable energy field, including hydropower, wind power, solar power, biomass energy, and biogas, with a view to using various renewable energy sources for efficient power supply to the national electricity system and thermal energy for heating needs in production and residential activities.

Viet Nam's 'Revision of National Power Development Plan' (Decision No. 455/QD-TTg dated 18 March 2016) details its plans to increase wind power from 140 MW in 2015 to 800 MW in 2020, 2,000 MW in 2025, and 6,000 MW in 2030. The Decision also targeted an increase in solar power capacity from a negligible rate in 2015/2016 to around 850 MW in 2020, around 4,000 MW in 2025, and around 12,000 MW by 2030. The expected share of electricity generated from solar energy is around 0.5% in 2020, around 1.6% in 2025, and around 3.3% in 2030 (Vietnam Electricity, 2016).

Furthermore, Prime Minister Phuc said in June 2018 that Viet Nam will increase the electricity output produced from renewable sources from approximately 58 TWh in 2015 to 101 TWh by 2020 and 186 TWh by 2030 (Pearson and Vu, 2018).

According to Massmann (2020), the Government of Viet Nam also promulgated several policies to set FITs for solar power (Decision 13/2020/QD-TTg), wind power (Circular 02/2019/TT-BCT), and bioenergy, i.e. solid waste (Decision 31/2014/QD-TTg).

According to Nguyen (2021), Viet Nam's total solar power installed capacity in 2020 of 16,261 MW, beyond the 2020 target of merely 850 kW. This solar power installed capacity continued to increase to reach 16,504 MW in 2021, according to the Viet Nam Electricity (EVN) quoting VN Express (2022). Nevertheless, most of the deployment of solar PV applications in Viet Nam was concentrated in the southern and central regions, which can be understood as the northern region has the lowest solar potential in Viet Nam and at the same time the highest average solar PV levelised cost of electricity (LCOE).

FIT mechanisms for solar PV in Viet Nam were enacted in 2017, 2019, and 2020. Le et al. (2022) recorded that in 2017, the mechanism imposed an obligation for the Vietnam Electricity (EVN) Group to purchase electricity generated from solar power plants (SPP) at the FIT of US$0.0935/kWh for the next 20 years. In 2019, the FIT mechanism was expanded to include rooftop solar (RTS) systems for the same price as SPPs, i.e., US$0.0935/kWh. In 2020, solar PV applications were given more options, including a floating SPP, a ground SPP and an RTS in the range from US$0.07/kWh to US$0.084/kWh.[1]

Still, according to Le et al. (2022), the first FIT mechanism issued in 2017 did not give the expected impact as the LCOE was three times higher than the offered FIT price. The FIT prices in 2019 were slightly higher than the weighted average solar LCOE and the average electricity price in Viet Nam, whilst in 2020, the three average prices became more converged. During 2019, almost 5 Gigawatt peak (GWp) of grid-tied capacity of solar PV was installed, of which 92% was SPP and the remaining 8% was RTS. In 2020 it was the contrary: around 84% (9.3 GWp) of the newly installed capacity was RTS whilst around 16% (1.8 GWp) was SPP. The difference in the FIT support mechanism between 2019 and 2020 is believed to have affected the deployment of these types of solar power applications.

Similar to Nguyen (2021), Le et al. (2022) also indicated a too simplistic mechanism of Vietnamese FIT that led to out-of-control growth in the southern-central and the southern regions considered to be solar high potential regions, due to the successive explosion of solar power plants and RTS in 2019 and 2020. Le et al. (2022) suggested that this has caused instability and uncertainty in the solar PV market in Viet Nam that might persist in the future. Doanh Nghiep (2020) reported the overloaded grid happened as the Power Development Plan VII did not fully anticipate such rapid growth in renewable energy, i.e. the asynchronous development of transmission infrastructures caused solar power projects in Viet Nam to operate without releasing their full capacity.

Massmann (2022) remarked that the latest draft of the National Power Development Plan VIII was approved on 26 April 2022 by the Appraisal Council, and the Ministry of Industry and Trade (MOIT) should submit the final draft for the Prime Minister's approval in May 2022.

Concerning solar power development, the draft of the National Power Development Plan VIII[2] includes the plan to expand the total capacity of solar power sources to reach around 16,491 MW by 2025. This total capacity should remain unchanged until 2030 but then will be expanded to reach between 74,741 MW and 96,666 MW by 2045. In terms of proportion, the electricity produced from solar power is expected to reach a share of around 6.8%–7.0% by 2025, 4.5%–4.8% by 2030, and 11.1%–12.1% by 2045.

Finally, Do et al. (2021) remarked that Viet Nam had been relatively cautious in applying reverse auctions. They concluded that solar PV installations would not have undergone such strong growth if reverse auctions had been the only procurement mechanism as the government would

[1] In Ninh Thuan province, grid-connected solar PV projects below 2,000 Megawatt peak (MWp) included in the development plan could enjoy a FIT of US$0.0935/kWh for all levels

[2] Still in draft when this paper was written.

unlikely have procured such large quantities of new power generation capacity so quickly through auctions.

Vietnam Plus (2022) revealed that the Ministry of Industry and Trade of Vietnam (MOIT) has been proposing to start auctioning solar and wind energy projects in the country. The ministry has argued that renewable energy has become more affordable and supply competitive in recent years and suggested adopting a more market-oriented approach as they considered that the previously signed 20-year FIT contracts no longer had a suitable timeframe as renewable energy production costs have been steadily declining.

1.2 The Philippines

The Philippines started its effort to increase the share of renewable electricity by promulgating the Renewable Energy Act of 2008 Republic Act No. 9513, an act for promoting the development, utilisation, and commercialisation of renewable energy resources and for other purposes. To implement the act, the National Renewable Energy Program (NREP) was promulgated in 2011 where the Philippines government set an ambitious target to raise its renewable-based generation capacity to an estimated 15.3 GW by 2030.

According to Guild (2019), in May 2011, the National Renewable Energy Board proposed FIT rates that were eventually approved in 2012 by the Energy Regulatory Commission (ERC) of US$0.20/kWh (wind), US$0.16/kWh (biomass), US$0.23/kWh (solar), and US$0.14/kWh (hydro). The set installed capacity targets were 200 MW (wind), 250 MW (biomass), 50 MW (solar), and 250 MW (hydro). According to Lagac and Yap (2020), this mechanism guaranteed all eligible renewable energy plants three things: a purchase agreement for a period of 20 years, priority connection to the transmission or distribution system, and priority scheduling and dispatch in the spot market.

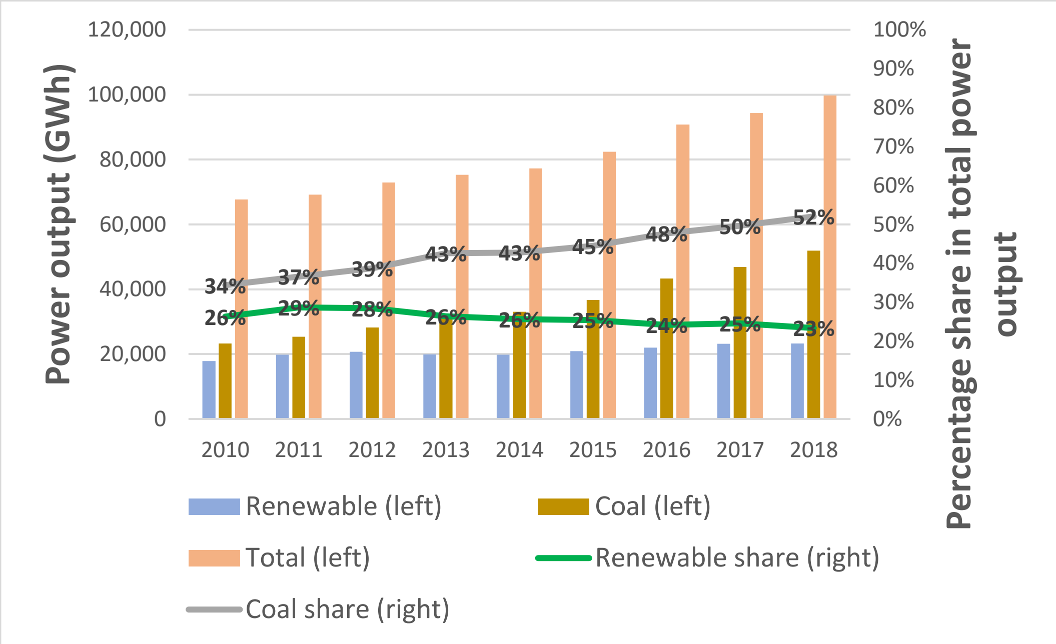
Apart from providing those FITs, the government also put in place several measures to support investors, including a 7-year income tax holiday, duty-free imports of equipment and materials used for renewable energy development, net operating loss carryover for 7 years, a 10% corporate discount instead of the typical rate of 30%, tax exemption on carbon credits, and a tax credit on domestic capital expenditures (Philippines Department of Energy, 2009).

Interest from solar power companies was so high that in 2015, the framework was adjusted. By 2015, the ERC released Resolution No. 06, where the tariff paid for solar was lowered from US$0.23/kWh to US$0.20/kWh, and the target for installed capacity was expanded by 450 MW to 500 MW.

According to Guild (2019), by 2013, the total national installed capacity of new renewable energy sources, i.e. biomass, solar, and wind power, reached 153 MW. By 2017, the total installed capacity had grown to 1,537 MW because of the introduced FIT scheme. The total installed renewable capacity by 2016 was 6.958 GW, almost even with the 7.419 GW sourced from coal-fired plants. The same research concluded that the Philippines' FIT costs were largely passed on to electricity consumers. The Philippines’ relatively expensive electricity tariffs for end users allowed the design of the FIT scheme to result in the accelerated growth of renewable energy from 2012 to 2017, particularly in biomass, solar, and wind power, which had a very small share prior to the enactment of the FITs.

Nevertheless, it is important to note that after the introduction of FITs in 2012, the growth of coal-based electricity was still stronger than that of renewables, and the effect of FITs on the total renewable share in the Philippines’ power generation is not significant.

Figure 1: Electricity Output in the Philippines, 2010–2018



Source: Processed data from Lagac and Yap (2020).

Data from the National Transmission Corporation (Transco), as cited by Lagac and Yap (2020), show that the number of FIT-eligible renewable plants increased from 18 in 2014 to 68 in 2018, corresponding to increased installed capacity of 327.95 MW in 2014 to 1,232.5 MW in 2018. The electricity outputs of the eligible FIT plants increased from 1,215,528 MWh in 2015 to 2,710,903 MWh in 2018.

As shown in **Error! Reference source not found.**, the renewable power generated in the country increased from 19,903 GWh in 2013 to 23,326 GWh in 2018, but its share in the total generated power in the country decreased from 26.4% in 2013 to 23.4% in 2018. During the same period, the electricity generated from coal-fired power plants increased from 33,052 GWh to 51,932 GWh. Between 2013 and 2018, the power generated by renewable plants only increased by an annual average rate of 3.2%, significantly below that of coal (10.1%) and total generated power (5.8%).

To deal with the absence of a policy to restrain the growth of coal-based power generation, the Government of the Philippines started to implement a coal import excise duty that grew from US$0.20 per metric ton (MT) of coal in 2017 to US$1 per MT coal by 2018 and US$3 per MT coal by 2020 (Eco Business, 2018).

Lagac and Yap (2020) added that the investment in installing renewable electricity power plants increased from 2014 to 2019, and the costs were passed on to end users translated into increasing electricity tariffs, i.e. an additional short-term burden on them. In 2016, the Philippines had one of the highest retail electricity rates in Southeast Asia, with households paying US$0.17/kWh by 2018 (Eco Business, 2018).

The Philippines adopted an FIT mechanism and had never implemented a reverse auction mechanism. Guild (2019) suggested that auction mechanisms may not be as effective as FITs in the emerging and less-developed renewable energy markets where regulatory uncertainty is relatively important and the pools of competitive bidders are relatively small, such as in the Philippines and Indonesia.

1.3 Indonesia

Indonesia started to capitalise on its resource potential with the promulgation of the Ministry of Energy and Mineral Resources' (MEMR) Regulation 2/2006, which legally obligated the State Power Company or *Perusahaan Listrik Negara* in Indonesian language (abbreviated into PLN) to purchase power from renewable energy sources and was amended by Regulation 31/2009 that created a standardised FIT framework. Between 2009 and 2017, the different renewable energy resources, such as wind, biomass, solar, and hydropower, were governed by separate, distinct regulations that were superseded in series. Each regulation set a range of FIT rates for a particular renewable resource. The different rates within the defined range corresponded to the different parameters, such as voltage, location, and local content of the used solar PV modules.

Frequent change was amongst the main characteristics of the Indonesian policy framework on FIT during that period. For example, for solar PV, MEMR Regulation 17/2013, issued on 12 June 2013, was the first to govern the power purchase by PLN from solar PV generation companies. This regulation set the maximum purchase price of US$0.25/kWh for all solar PV generators without a limitation on installed capacity. The maximum purchase price was increased to US$0.30/kWh if the solar PV module's local content was at least 40%. These maximum prices were accompanied by a reverse auction mechanism that selected the provider based on their minimum bid prices to be valid in a 20-year period.

By 12 July 2016, MEMR Regulation 17/2013 was amended by a new regulation, MEMR 19/2016, that set the FIT prices for the different regions where the different minimum installed capacities were defined. The FIT prices were also calculated as a function of the local content percentage of the used PV module, i.e. a lower local content percentage led to a lower FIT price. The same kind of superseding regulations happened also in other renewable energy resources.

FIT mechanisms were implemented instead of a maximum purchase price for the other renewable resources, such as urban waste (starting with MEMR 19/2013); small, medium and excess biomass, biogas, and rural waste-based renewable electricity generation (starting with MEMR 4/2012); and geothermal (starting with MEMR 22/2012).

On 8 February 2018, the government promulgated Regulation 9/2018, which annulled the different regulations on FIT mechanisms on solar PV (MEMR 19.2016), biomass and biogas (MEMR No. 21/2016), and hydro (MEMR/2015) and therefore put an end to the different FIT mechanisms.

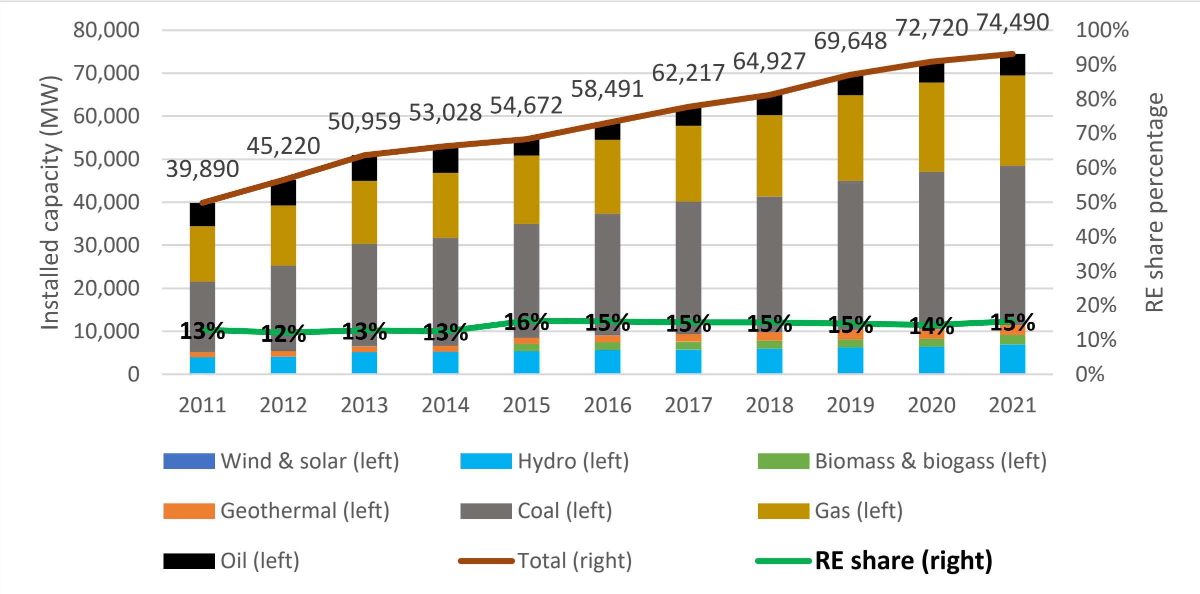
According to the Asian Development Bank (2020), the MEMR's policy objective since the start of 2017 has been to ensure the affordability of electricity whilst reducing subsidies to PLN and simultaneously maintaining PLN's health. Regulation MEMR 50/2017 on the Utilization of Renewable Energy Resources for Electricity Supply, amended twice by MEMR 53/2018 and then MEMR 4/2020, replaced the previous regulations on the pricing of renewable energy purchases by PLN by capping the price of most renewable technologies at some percentage of PLN's generation production cost, abbreviated in the Indonesian language as BPP.[3] In brief, BPP is the average accounting cost of electricity production for the past year for a particular grid or system. As such, PLN will not pay more to develop renewable projects than the average of the last year's generation production cost. Basically, if a region is mainly electrified by low-cost coal-fired plants, then PLN will only buy electricity at that price level instead of at a higher price relating to the average levelised cost of solar.

[3] Biaya Pokok Pembiayaan.

Regulation MEMR 50/2017 subsumed all renewable energy sources—geothermal, hydropower, solar, biomass, and wind—under a single regulatory framework where the tariffs would be benchmarked to PLN's average local and national costs of production (Wulandari, 2017).

According to MEMR (2022), as shown in **Error! Reference source not found.**, the total installed capacity of renewable electricity, including wind, solar, biomass, biogas, hydro, and geothermal, increased at an annual rate of 8.3% from 5,173 MW in 2011 to 11,488 MW in 2021. The biggest jump in renewable plants' installed capacity happened between 2015 and 2016 with the development of a total of 1.6 GW of off-grid biomass power plants by independent power producers (IPPs).

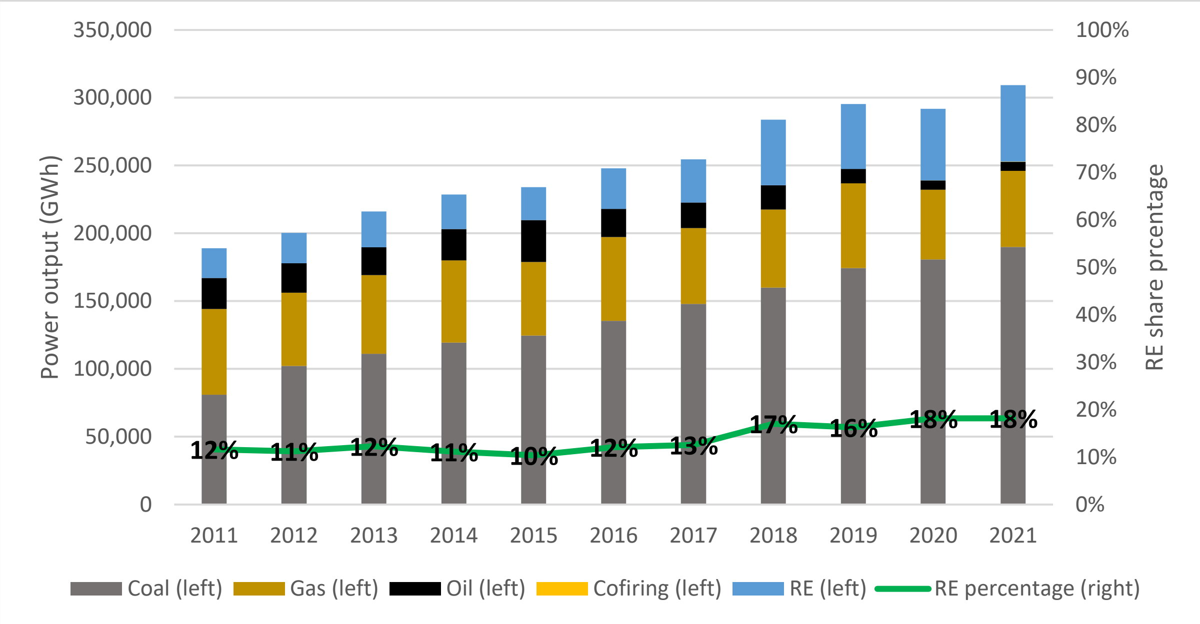
Figure 2: Electricity Generation Installed Capacity in Indonesia, 2011–2021



Source: Processed data from MEMR (2022).

As shown in **Error! Reference source not found.**, by 2021, the biggest share of renewable electricity was generated in hydro power plants (57.5%), followed by geothermal (19.9%), biomass and biogas (19.6%), and wind and solar (3.0%). The development of coal-fired power plants during the same period at 8.5% yearly was, nevertheless, faster than that of renewables.

Figure 3: Electricity Output in Indonesia, 2011–2021

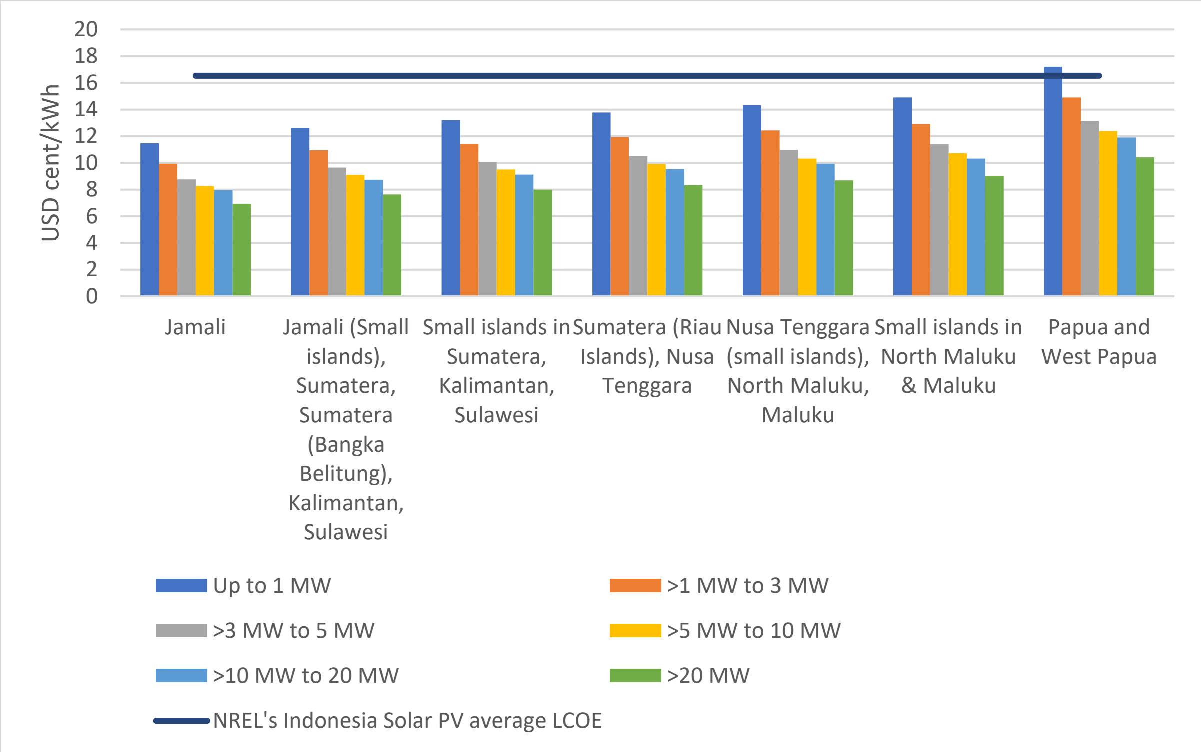


Source: Processed data from MEMR (2022).

Finally, Presidential Decree 112/2022, signed on 13 September 2022, was the ultimate promulgated regulation on the renewable electricity purchase price. It basically set the maximum purchase price of renewable electricity that can be bought by PLN as a function of the different renewable resources and power plant type, installed capacity, and the nine principal grids in Indonesia and their sub-networks.

As shown in Figure 4, for solar PV for example, the highest purchase prices are for plants with installed capacity of up to 1 MW, and the values range from US$0.1147/kWh in the Jawa-Madura-Bali grid to US$0.172/kWh in the Papua and West Papua grids. For wind power (Figure 5), the highest purchase prices are for plants with installed capacity of up to 5 MW, and the values range from US$0.1122/kWh in the Jawa-Madura-Bali grid to US$0.1683/kWh the in Papua and West Papua grids.

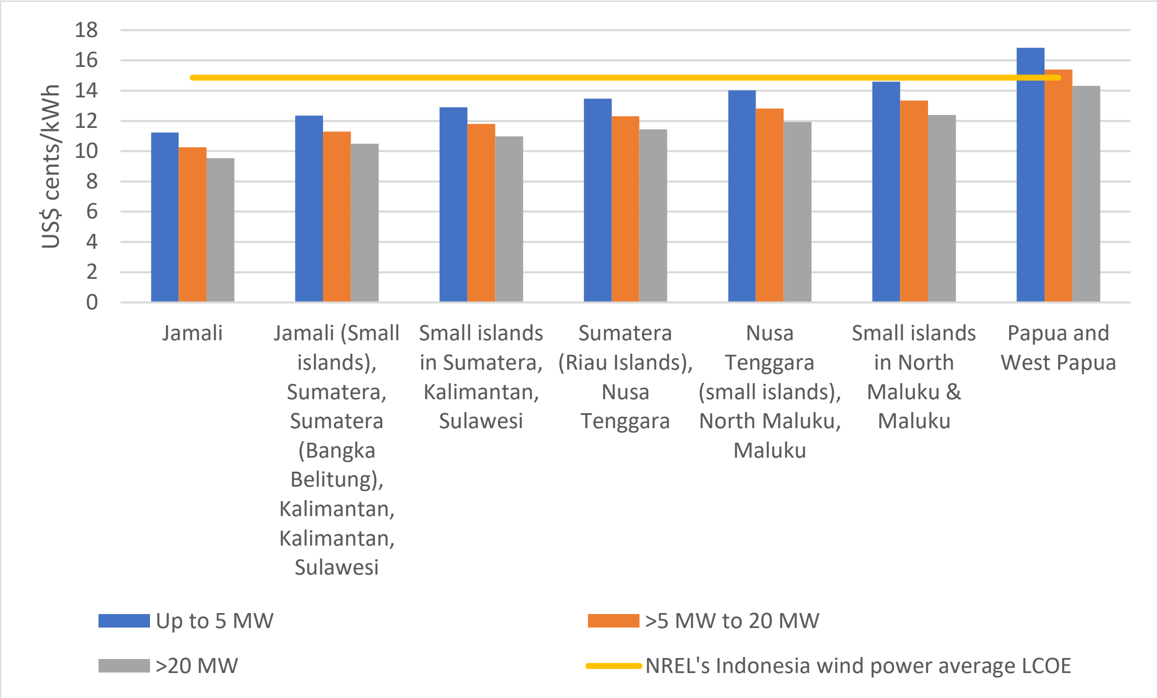
Figure 4: Maximum Solar PV Electricity Purchase Prices (1st to 10th Years) by Installed Capacity and Region in Presidential Decree 112/2022



Source: Author's elaboration based on Presidential Decree 112/2022 and Leet et al., 2019

Considering the current average LCOE of solar and wind in Indonesia of around US$0.1653/kWh (Figure 4) and US$0.1486/kWh (Figure 5), respectively (Lee et al., 2019), it is probable that the maximum purchase prices set by Presidential Decree 112/2022 will not do much to attract private investment in renewable electricity.

Figure 5: Maximum Wind Electricity Purchase Prices (1st to 10th Years) by Installed Capacity and Region in Presidential Decree 112/2022



Source: Author's elaboration based on Presidential Decree 112/2022 and Leet et al., 2019

Calculations using data from MEMR (2022) and PLN (2022) reveal that the yearly growth rate of installed renewable electricity capacity owned by PLN between 2013 and 2021 was only around 1% per year, whilst that of IPPs was around 20%. The share of installed renewable electricity capacity of PLN decreased from around 58% in 2013 to around 36% in 2021. These historical data show that the role of IPPs in developing renewable electricity has been increasing. The current policy in maximum purchase price capping however might not be encouraging for IPPs to keep investing in building renewable sources-based power plants in Indonesia.

Two different mechanisms were put in place between 2012 and 2017. First was the combination of the maximum purchase price of renewable electricity and reverse auction (for solar) and the second was the FIT (for geothermal, biomass, biogas, waste, etc.).

Between 2017 and 2022, the mainly used renewable electricity provider selection method was direct selection. According to the Asian Development Bank (2020), the process was only accessible to firms that registered in advance for the generic 'List of Selected Providers', which was opened only once every 3 years on a general basis where developers would typically undergo prequalification if they were interested in a specific project that was being offered. The Asian Development Bank (2020) and Febriza et al. (2019) pointed out that the direct selection step was followed by purchase price negotiation between the potential IPP and PLN.

The latest Presidential Decree 112/2022 defines two methods, the direct appointment and direct selection methods.

The direct appointment method is implemented for purchasing power from hydro power plants that use waterpower from dams or irrigation canals that belong to the state and are managed by state agencies that deal with water resources, geothermal plants, additional or expanded capacity from geothermal, hydro, solar PV, wind, biomass and biogas, excess power from geothermal, hydro, biomass, and biogas. Direct selection is implemented for electricity purchasing from the rest of the hydropower plants, solar PV and wind power plants, biomass and biogas plants, hydro power plants as peakers, biofuel-based power plants, and ocean energy power plants.

Both methods are applied with any installed capacity limitation and are followed by a price negotiation process between PLN and the potential providers.

2 Opportunities and challenges in implementing pricing policies

Three kinds of opportunity are identified based on the analysis of the three cases above: the need to boost the share of renewable electricity, the decreasing investment and levelised cost of renewable electricity, and the huge renewable potential of the region.

The first and main opportunity in implementing pricing policies for renewable electricity is the need for ASEAN countries to boost the share of generated renewable electricity in their total power generation. The International Energy Agency (2022) pointed out that achieving the current ASEAN countries' objectives in accordance with their National Determined Contributions (NDCs), such as Indonesia's target to reach a 23% share of renewable energy in its primary energy supply by 2025 and 31% by 2050, will not be enough to reach the target of keeping the world temperature rise below 2 degrees Celsius. Much more ambitious targets, such as reaching a 56% renewable electricity share in ASEAN by 2060 (Kimura et al., 2022), need to be adopted in ASEAN Member States' energy policies.

The second opportunity is the decreasing investment and LCOE generated by renewable energy sources. IRENA (2018) reported that in Southeast Asia, the investment costs of renewable electricity experienced a significant reduction. For instance, solar PV saw a 45% decline from 2012 to 2016, wind saw a decrease of 11% from 2013 to 2016, whilst geothermal saw a stagnation in the investment cost during the same period. The same report also pointed out the slight 7% increase in the weighted average LCOE for geothermal projects between 2014 and 2016, a 4% decrease in hydro projects' LCOE during the same period, and a 39% decline in solar PV projects' LCOE between 2012 and 2016.

However, even though the investment costs and LCOE of renewable electricity projects decreased, the levels of those costs in Southeast Asia were relatively higher than in other parts of the world.

The last opportunity, as mentioned by IRENA (2018), is the huge potential of renewable sources in the region, which has remained untapped. For example, the total installed hydropower capacity of the region can still be doubled to reach around 79 GW by 2025. For geothermal, the Philippines has only made use of around 50% (2 GW) of its total potential, whilst Indonesia has only tapped 5% (around 2.2 GW) of its total geothermal potential to generate power.

Several challenges can also be identified based on the three cases previously presented and analysed. They consist of unsustainable pricing mechanisms, a relatively high LCOE of renewable sources, electricity tariff levels, policy inconsistency and incoherency, and the absence of a reverse auction mechanism in case FITs are not put in place.

An unsustainable pricing mechanism in the region is reflected by two main indicators: offered renewable electricity prices or FITs that are too low, and a pricing structure that is too simplified or too complex.

In Viet Nam, an unsustainable FIT mechanism occurred the first time the mechanism was introduced, in 2017, and the LCOE was around three times higher than the offered FIT (Le et al., 2022). In Indonesia, the offered maximum renewable purchase prices during the period 2017–2022 represented basically the average production prices of fossil-fuel-based electricity, i.e., coal-based electricity, which were significantly lower than the average LCOE of renewable electricity. The latest maximum purchase price in Indonesia put in place since September 2022 also risks having a weak positive impact on the growth of renewable electricity as most of the maximum purchase prices for renewable electricity are below Indonesia's average renewable LCOEs.

A too-simplified pricing structure was represented by the use of singular FIT values offered in Viet Nam and the Philippines. In Viet Nam, for instance, the FITs that were not segmented geographically have caused the underdevelopment of solar PV in the low-potential northern region and overdevelopment in the high-potential southern and central regions.

On the other hand, the implementation of the FIT mechanism in Indonesia during the period 2013–2017 was too segmented. The need to differentiate the FITs depending on the region, installed capacity, and local content of the power plant module was complicated and made it difficult for IPPs to estimate their returns and profits.

In terms of the LCOE level, Southeast Asian countries in general had a disadvantage concerning solar PV and wind power. The weighted average LCOE for solar PV projects in Southeast Asia was one of the most expensive in the world, whilst that of onshore wind was the second-highest in the world after Central America and the Caribbean (IRENA, 2018). Therefore, it was challenging for countries in the region to develop renewable electricity based on those two sources.

The LCOE can also differ significantly based on the geographical situation at a scale lower than the country level. In Viet Nam, for example, the country-level FIT for solar power had different impacts in the different regions. In the northern region, the high LCOE was an important barrier to the deployment of solar PV, whilst in southern and central regions, the same FIT succeeded to boost the development of solar power plants and rooftop solar panels.

The level of electricity tariffs appeared to be amongst the determining factors considered by policymakers in elaborating strategies for renewable electricity pricing. In cases where the FIT is financed by the end users, policymakers might face difficulties when the end users' electricity tariffs have already been high, as in the case of the Philippines. High electricity tariffs might attract investment in renewable electricity as the high tariffs mean a shorter period to get the return. On the other hand, in countries where the end users have benefited from relatively low electricity tariffs due to a subsidy, such as in Indonesia, raising the electricity tariffs (by reducing the subsidy) risks some resistance. Low electricity tariffs also mean a longer time to get an investment return.

Policy inconsistency puts IPPs in a difficult situation. In Indonesia, for example, apart from being too segmented and having too complex a mechanism, the scheme experienced frequent changes in its structure during the period 2013–2017, which created uncertainty for IPPs and discouraged them from investing. In Viet Nam, the change from the FIT mechanism put in place in mid-2019 by a new one issued in mid-2020 was considered too short, which also brought uncertainty to IPPs.

The growth of renewable electricity in the Philippines and Indonesia had been relatively slow as, during almost the same periods, coal-based power plants were developed at a higher pace. The absence of policy that restrained the development of coal and/or other fossil-fuel-based electricity turned out to be amongst the constraints for the real development of renewable electricity in those two countries.

Finally, since 2017, Indonesia has opted to implement maximum purchase prices that are accompanied by a purchase price negotiation process between the selected or appointed providers and the PLN instead of an inverse auction mechanism. ADB (2020) saw this as a way for the government to protect PLN's revenues and the affordability of electricity tariffs, which was counterproductive to attracting investment. ADB (2020) stated that the record-low prices for renewable energy achieved around the world through reverse auctions without subsequent negotiation demonstrate the effectiveness of reverse auctions.

3 Conclusions and the way forward

This paper has analysed three cases from three different ASEAN Member States on the implementation of a renewable electricity purchase pricing mechanism to boost the renewable electricity share in the total generated power in each of the countries. Different pricing mechanisms have been implemented in three different situations, which brought different results. Analysis has been performed and focus has been given to the offered purchase price level, the structure and mechanism of the pricing, and the effect of the mechanism on the renewable electricity share.

Six principles to be used in elaborating and implementing policies related to renewable electricity pricing that are applicable in developing and emerging economies in ASEAN and other world regions are given in the following paragraphs.

First, a sustainable pricing mechanism should consist of a set of reasonable offered purchase prices that are segmented in an optimised level of disaggregation. Reasonable purchase prices are a set of prices that are high enough to compensate for the production costs of renewable electricity. The setting of the offered purchase price level is amongst the most influential work in elaborating the mechanism. A level that is too low, as in the case of Indonesia between 2017 and 2022, and in Viet Nam during its initial years of FIT implementation, i.e. 2017–2018, resulted in negligible development of renewable power plants. An FIT level that is too high risks generating offers that are too high, which in turn are difficult to manage and caused grid instability in Viet Nam's case. An optimised level of price disaggregation is an easy-to-understand price segmentation structure that considers the different sub-markets formed by a combination of the different well-defined parameters, such as the type of plants, local/regional situation, and installed capacity, etc.

Second, the LCOE of renewable sources is a key parameter that can determine the effectiveness of the pricing mechanism. Apart from using it as a dependent variable in defining the correct level of the offered price or tariff, policymakers need to elaborate on a set of policy measures to reduce the LCOE of renewable resources. These policy measures should aim at increasing the domestic industry's capability to produce modules, panels, and other components of renewable-based power plants and at building the skills and capacity of domestic human resources—in other words, reducing countries' dependencies on foreign entities or organisations. Other measures to reduce the LCOE are equally important; for instance, those which enable or ease deployment policies or reduce non-technical costs, such as licensing, permitting, grid connection, and land acquisition, etc.

Third, compensating the production costs of the IPPs involved in generating renewable electricity requires financing. A widely used practice in financing renewable electricity purchase pricing is increasing the electricity tariffs paid by end users. Increasing end users' electricity tariffs has never been a simple policy measure. Countries with electricity tariffs that are already high will have less manoeuvring room, whilst countries with low electricity tariffs will experience resistance from end users.

Nevertheless, high electricity tariffs also mean a shorter capital recovery time, whilst low electricity prices leave consumers and investors with no incentive to invest in renewables since the capital recovery time would become too long.

Financing strategies, therefore, need to be elaborated carefully. Any consideration to pass the financial burden onto end users should be undertaken by seriously considering two different perspectives: first, from the end user's perspective, the affordability of the electricity tariffs, and second, from the investors' or IPPs' perspective, the duration to recover their capital.

Fourth, investors or IPPs need long-term regulatory stability and certainty to give them enough confidence to invest. Policy consistency significantly contributes to the effectiveness of the purchase pricing mechanism. Policy design needs to minimise the risk borne by investors, therefore also minimising the financial costs of renewable energy projects.

Fifth, accompanying measures implemented for other sources of energy, especially fossil fuels such as coal, to generate electricity are indispensable. There is a high probability that a renewable electricity purchase pricing policy and the continuous development of coal-fired power plants are two incompatible energy policies. From the investment and LCOE perspectives at least, the two types of energy sources are not found on a level playing field. Putting a renewable electricity purchase pricing policy in place whilst allowing the coal-fired-based electricity industry to continue to develop might not be enough to make the renewable energy sources competitive enough. Policymakers need to put in place a set of necessary regulations to slow down coal-based electricity development.

Six, in the absence of FITs, one of the most effective ways to reduce the levelised cost of renewable electricity is to introduce a reverse auction without further price negotiation. Viet Nam is considering replacing their FITs with an inverse auction, whilst the Philippines has just started auctioning their first green energy-based electricity (Department of Energy of the Philippines, 2022). However, Indonesia still equips its maximum purchase price setting with the selection or appointment process of providers followed by a final purchase price negotiation.

The set of six principles above can be used as a starting framework to elaborate a sustainable and effective mechanism for renewable electricity purchase pricing in developing ASEAN countries as well as in developing countries in other world regions.

More important details, however, remain to be elaborated. Those details might be addressed by the following research questions, amongst others: What would be reasonable levels for the offered renewable electricity purchase price? What would be the effective range of offered prices considering the investment costs and the LCOEs of the renewable electricity and end user electricity tariffs? How can easy-to-understand pricing mechanisms that have an optimised price segmentation and structure be set up? How can an effective financing strategy be set up? What will be the most effective measures to be implemented in fossil fuel-based electricity to increase the effectiveness of the renewable electricity purchase pricing mechanism policy?

These questions give several possible research axes, but answering the first two should be a priority of research to be done for the ASEAN Member States. Quantitative results that incorporate the development of investment costs and the LCOEs of the different sources in time series disaggregated into countries or smaller geographical regions can be obtained by performing a historical time-series analysis of policies, prices, costs, installed capacity, and the generated power.

The inclusion of more ASEAN Member States’ cases, data, and information will be indispensable, supported by more extensive literature studies on pricing mechanisms and FIT mechanisms from cases of developed countries.

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