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Promoting Renewable Energy: How Fares the Philippines?

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Abstract

Sustainability is a key component of energy security. To help achieve the global long-term goal of zero-carbon emissions by 2050, the Philippine government has implemented laws, policies, and programs to increase the share of renewable energy (RE). An important example is the feed-in-tariff (FiT) scheme. The share of RE in electricity generation, however, has fallen from 45.4% in 1990 to 21% in 2019, a clear indication that the interventions have not been effective. Main constraints to the expansion of RE are formidable, which include market-based factors, technology inertia, market failure, and political economy issues. Even if policies are designed to overcome these constraints, there has been a delay in the implementation of some of them; but more importantly, many of the interventions do not adhere to the principles underlying sound industrial policy. In particular, policies should abide by the principle of embeddedness, which refers to the coordination between the public sector and private firms that allows the former to be aware of the constraints and opportunities of the latter. To address this problem, policymakers must incorporate said principles and streamline future interventions by anchoring them to three aspects: the moratorium on greenfield coal plants, the study on Competitive Renewable Energy Zones (CREZ), and the serious consideration of incorporating nuclear power in the energy mix. Meanwhile, the COVID-19 pandemic has provided an opportunity to "build back better". Studies have shown that some "green" fiscal recovery measures have strong multiplier effects and, at the same time, promote sustainability. An example is retrofitting buildings to enhance energy efficiency. The experience of other Southeast Asian countries in designing interventions can be useful but policymakers should acknowledge that one size does not fit all.

Key words: renewable energy, sustainability, political economy, energy efficiency

JEL Classification: Q4, P48, Q56

1. Introduction

Energy security remains a major concern among many developing countries. The International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price. Energy security has many aspects: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs. On the other hand, short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance."[1]

Interpreted broadly, energy security is a key component of sustainable economic development. A major implication is that the environmental impact of energy plans and policies has to be taken into account. The overall goal is for the world to achieve net-zero carbon emissions by 2050. Net zero means that, on balance, no more carbon is deposited into the atmosphere than is taken out. All economies, including those in Southeast Asia (SEA), have an important role in reducing reliance on fossil fuel—oil, gas, and coal—for their energy requirements.

SEA has set a target share of 23% for renewables of the region's primary energy consumption by 2025, a major increase from only 9.4% in 2014 (Peimani and Taghizadeh-Hesary 2019). However, according to the International Renewable Energy Agency (IRENA), the "current policies—including those still under consideration—only suffice to reach just under 17% renewables. This leaves a crucial six-percentage-point gap" (IRENA 2016, p. 10). A more detailed comparison of the goals of SEA countries is presented in Erdiwansyah et al. (2019). In the Philippines, the goal expressed in the latest Philippine Energy Plan is to increase installed RE capacity to at least 20,000 megawatts (MW) by 2040 (DOE 2020b). As of 2018, 148 RE facilities are currently providing 7,226.4 MW capacity.

The Philippines has committed to increase the share of renewable energy (RE) in its energy mix. However, the share of RE in electricity generation has remained stagnant over the past two decades. In 1990, the share of RE was 45.4% (Verzola et al. 2018), and this fell steadily in the succeeding years, reaching 42.8% in 2000, 26% in 2010, and 21% in 2019

[1] https://www.iea.org/topics/energysecurity/ (accessed on 26 November 2019).

(Table 1).[2] This paper assesses the progress of the Philippines in promoting energy security but with a focus on sustainability. The next section looks at the major obstacles to the development of RE, particularly in developing economies. Section 3 explores the responses of the government to these challenges. Data and other evidence presented in Section 4 provide a basis for assessing the progress. The policies and programs of the government are also juxtaposed against acceptable criteria for industrial policy. Meanwhile, Section 5 provides a cross-country comparison with a discussion on the importance of regional cooperation to enhance sustainability. The penultimate section deals with the possible impact of the coronavirus disease 2019 (COVID-19) pandemic on the prospects of RE. Proposed "green" fiscal recovery measures should be aligned to a medium-term program to expand the share of RE. The latter is presented in the last section.

2. Major Constraints to RE Development

Market- and technology-related factors

There are four major categories of constraints to RE development: market-related factors, technology-related factors, market failure, and political economy. Yap et al. (2020) discuss market failure and political economy factors in the energy sector in the Philippines. Meanwhile, market factors and technology-related factors can be consolidated. These consist of (a) technology inertia, which is driven largely by the need to recover investments in fossil-fuel infrastructure and the costliness of incorporating variable RE (VRE) into the grid; (b) availability and cost of energy supplies and the relation to the need to import; (c) technology ease and low cost of production of biomass relative to VRE; and (d) financing constraints.

Market and technology factors are more difficult to overcome because they have evolved over time and provided strong incentives for players in the energy market. Accessibility and affordability of energy supplies are some of the main considerations. The Philippine energy mix, therefore, is dominated by fossil fuels, with the power sector relying on imported coal to power its baseload generation capacity. Even if the cost of VRE has been falling, "technologies remain expensive and are not affordable for many SEA countries" (Peimani and Taghizadeh-Hesary 2019).

[2] https://www.doe.gov.ph/sites/default/files/pdf/energy_statistics/power_statistics_2015_summary.pdf (accessed on 22 November 2020) for the year 2000; Table 1 for 2010 and 2019.

Not being available all the time, VRE (e.g., wind and sunshine) is an intermittent source of energy. Hence, the concept of system effects, which are driven by this attribute, has to be considered (World Nuclear Association 2020). These are often divided into the following four broadly defined categories: profile costs (also referred to as utilization costs or backup costs by some researchers), balancing costs, grid costs, and connection costs to the grid (sometimes included in the levelized cost of electricity or LCOE).

A 2019 OECD Nuclear Energy Agency study states: "Profile costs (or utilization costs) refer to the increase in the generation cost of the overall electricity system in response to the variability of VRE output. They are thus at the heart of the notion of system effects. They capture, in particular, the fact that in most of the cases, it is more expensive to provide the residual load in a system with VRE than in an equivalent system where VRE are replaced by dispatchable plants." [3]

Even if the status quo is maintained—implying that technology inertia prevails—the Philippines remains vulnerable to price volatility and supply disruptions. Other issues to consider are resource depletion—highlighted by the Malampaya gas field—and carbon dioxide (CO_2) emissions. These risks can be weighed against the returns from maintaining the status quo. This is tantamount to dealing with the challenges of energy security and environmental sustainability from a balanced perspective. Section 3 looks at various policies, many of which have the objective of utilizing renewable resources.

Market Failure in Renewable Energy[4]

Market failure occurs when a service or commodity is not produced at a socially optimal level. In this context, the supply of RE is inadequate because the positive externalities from its use are not taken into consideration by the potential suppliers.

Market failures in the area of renewable energy can be defined as either atemporal or intertemporal. Atemporal deviations are those for which the externality consequences are based primarily on the rate of flow of the externality. For example, an externality associated

[3] https://www.world-nuclear.org/information-library/energy-and-the-environment/renewable-energy-and-electricity.aspx (accessed on August 15, 2020).
[4] This section is largely based on Gillingham and Sweeney (2010) as cited in Yap et al. (2020).

with air emissions may depend primarily on the rate at which the emissions are released into the atmosphere over a period of hours, days, weeks, or months. Such externalities can be described statically. They may change over time, but the deviation has economic consequences that depend primarily on the amount of emissions released over a short period. These may have immediate consequences or consequences that are felt over very long periods.

Intertemporal deviations are those for which the externality consequences are based primarily on a stock that changes over time based on the flow of the externality. The flows lead to a change in the stock over a relatively long period, typically measured in years, decades, or centuries. The stock can be of a pollutant (e.g., carbon dioxide) or of something economic (e.g., the stock of knowledge or the stock of photovoltaics installed in buildings). If the flow of the externality is larger (smaller) than the natural decline rate of the stock, the stock increases (decreases) over time. Intertemporal externalities can be best described dynamically, for it is the stock (e.g., carbon dioxide), rather than the flow, that leads to the consequences (e.g., global climate change).

Atemporal Environmental Externalities

Environmental externalities are the underlying motivation for much of the interest in renewable energy. Combustion of fossil fuels emits a variety of air pollutants that are not priced without a policy intervention. Air pollutants from fossil fuel combustion include nitrogen oxides, sulfur dioxides, particulates, and carbon dioxide. Some of these pollutants present a health hazard, either directly as in the case of particulates, or indirectly as in the case of ground-level ozone formed from high levels of nitrogen oxides and other chemicals.

When harmful fossil fuel emissions are not priced, the unregulated market will overuse fossil fuels and underuse substitutes, such as renewable energy resources. Similarly, if the emissions are not priced, there will be no incentive for firms to find technologies or processes to reduce the emissions or mitigate the external costs. The evidence for environmental externalities from fossil fuel emissions is strong, even if estimating the precise magnitude of the externality for any given pollutant may not be trivial.

Information Market Failures (Atemporal)

Information market failures relate most directly to the adoption of distributed generation of renewable energy by households, such as solar PV or microgeneration wind turbines. If households have limited information about the effectiveness and benefits of distributed generation renewable energy, there may be an information market failure. In a perfectly functioning market, one would expect profit-maximizing firms to undertake marketing campaigns to inform potential customers. However, for technologies that are just beginning to diffuse into the market, economic theory suggests that additional information can play an important role. Information market failures are closely related to behavioral failures. Reducing information market failures would also be expected to reduce behavioral failures associated with heuristic decisionmaking.

Apart from these considerations, imperfect information also arises from uncertainties in the (1) the short- and long-term price of petroleum or carbon-based fuels and other substitutes; (2) price of RE technologies, which depends on the speed and type of technological innovation and how they are produced to scale; and (3) energy demand forecasting (national and local). These may have an impact on the cost-benefit calculus of firms concerning investment decisions and consumers and explain deviations from what is socially optimal.

Imperfect information also leads to coordination failures, specifically investment decisions between generation and transmission. RE, specifically VRE such as wind and solar, are location-specific. However, transmission companies are driven by prudent investment decisions as they are regulated by the Energy Regulatory Commission (ERC). Increasing reliance on VRE may mean adopting changes in evaluating its feasibility.

Economies of Scale (Atemporal)

Economies of scale, particularly increasing returns to scale, refer to situations where the average cost of producing a unit decreases as the rate of output at any given time increases, resulting from a non-convexity in the production function due to any number of reasons, including fixed costs. This issue may inefficiently result in a zero-output equilibrium only under the following conditions: (a) "market-scale increasing returns", (b) when the slope of the average cost function is more negative than the slope of the demand function, and (c) the firm cannot overcome the nonconvexity on its own.

Market-scale increasing returns refer to a non-convex production function at output levels comparable with market demand. Figure 2 graphically illustrates the second condition. If the quantity produced is small (e.g., quantity "a") then no profit-seeking firm would be willing to produce the product, but if production could be increased to the right of the crossing point level (e.g., at quantity "b"), then it would be profitable for the firm to produce: price would exceed average cost.

The role of policy would be to encourage production in order for the market to be at "b". The policy can take the form of a subsidy or even a renewable portfolio standard.

Market Power (Atemporal)

Uncompetitive behavior may influence the adoption of renewable energy technologies in several ways. First, market power in substitutes for renewable energy can influence the provision of renewable energy through several channels. Firms effectively exercising market power in substitutes for renewable energy (e.g., at times the Organization of the Petroleum Exporting Countries (OPEC) cartel would raise the price of energy above the economically efficient level), making investment in renewable energy more profitable, which can lead to an overinvestment in renewable energy. The converse can also be true. Predatory pricing can also be an outcome wherein firms exercising market power in RE substitutes can discourage the development of RE by driving down prices.

Meanwhile, firms that have market power in substitutes for renewable energy may have an incentive to buy out fledgling renewable energy technologies to reduce competitive pressures—leading to a possible underprovision of renewable energy resources if that purchasing firm "buries" the renewable technology. However, the prospect of being bought by a competitor could provide a strong incentive for a new firm to be created with the explicit intention of selling itself to a larger company. Which effect dominates and whether there is market power in substitutes for renewable energy can only be determined empirically.

Market power may also influence the adoption of renewable energy resources by influencing the rate and direction of technological change. If there is less competition in a market, firms are more likely to be able to fully capture the benefits of their innovations, so that incentives to innovate are higher. Conversely, if there is more competition, firms may have an incentive to try to "escape" competition by investing in innovations that allow them to differentiate their product or finding a patentable product. Some evidence suggest that the relationship between competition and innovation may be an inverted U-shaped curve, with a positive relationship at lower levels of competition and a negative relationship at higher levels of competition.

Intertemporal Environmental Externalities

Particularly relevant to renewable energy supplies are carbon dioxide (CO_2) and other greenhouse gases. For CO_2, every additional ton emitted remains in the stock for over a century. Thus, emitting a ton today would have roughly the same cumulative impacts as emitting a ton in 20 years. This implies that—absent changes in the regulatory environment—the magnitude of the deviation for emissions now will be the same as the magnitude of the deviation for emissions 20 years from now. Economic efficiency implies that a society should be almost indifferent between emitting a ton of CO_2 now, 20 years from now, or any year in between. It is this relationship that imposes a structure on the time pattern of efficient policy responses.

Imperfect Capture of Future Payoffs from Current Actions: Network Externalities

Network externalities occur when the utility an individual user derives from a product increases with the number of other users of that product. The externality stems from the spillover from one user's consumption of the product has on others, so that the magnitude of the externality is a function of the total number of adoptions of the product. Often quoted examples of network externalities include the introduction of the QWERTY typewriter keyboard, the telephone, and later, the fax machine. An important caveat about network externalities is that the externality may already be internalized. For example, the owner of the network may recognize the network effects and take them into account in their decision-making. When the externality is already internalized, network externalities are more appropriately titled "network effects" or "peer effects", and do not lead to market failures in network industries characterized by demand-side increasing returns to scale. Competition is heavily influenced by positive feedback in that each consumer's adoption of a product increases the likelihood of future adoptions.

Political Economy

Even if policies that improve social welfare are clearly defined based on economic theory, their adoption and implementation are not assured. A political economy framework is presented wherein the policies that will emerge are those that best fulfill the objectives of those actors that have the greatest influence in policy-making (Jakob et al. 2019). The general structure is presented and discussed in Yap et al. (2020).

Different actors with different or opposing interests would try to influence the crafting of policy or program outcomes in their favor. However, their incentives are not only shaped by pecuniary and non-pecuniary benefits but also by the transaction costs and other costs associated with lobbying or organizing forms of collective action (Coase 1960; Williamson 1979). This may depend on a number of factors such as the group size.

The major contending forces affecting the transition to a lower-carbon scenario in the Philippines are the fossil fuel interests, climate change mitigation and adaptation proponents, and the affected stakeholders (Verzola et al. 2018). To meet the goals of a stable, affordable, and secure power supply, the conflicts between the privatized electricity sector and government regulatory bodies must be resolved. One possible course of action is the principle of "embeddedness", which will be discussed in the next section.

Another source of conflict is the divergence in approach among government agencies. A clear example is the case of the National Determined Contributions (NDC), which is part of the Paris Agreement. The Philippines submitted an ambitious NDC with a conditional greenhouse gas (GHG) reduction target of 70% below business-as-usual levels by 2030. This is fully supported by the Climate Change Commission. Meanwhile, Department of Energy (DOE) Secretary Alfonso Cusi has declared that he will not support any measure that tends to increase electricity prices or impedes industrialization and economic growth.

Meanwhile, the technology-neutral policy of the DOE—which is its official position—may be inconsistent with the objective of increasing the share of RE. Some experts argue that a shift in the trajectory of the energy mix requires a bias towards clean energy technology. Neutrality will allow the market to dictate outcomes, leading to the continued stagnation of RE.

3. Responding to RE Challenges

This section looks at policies that are intended to overcome market forces, technology inertia, and market failures with the objective of increasing the share of RE. In certain cases, two or three of these features are addressed by a particular policy. The theoretical considerations are first presented under a general discussion of industrial policy. This is followed by an inventory of laws, policies, and programs in the Philippines.

Green Industrial Policy

Many of the laws, policies, and programs to encourage RE and reduce GHG fall under the rubric of industrial policy. These measures are designed to address market failures and overcome the inertia produced by market-based and technology-related factors. In other words, the goal is structural change in the energy sector. Modern industrial policy concerns anticipating change and facilitating it by removing obstacles and correcting market failures (Syrquin 2008 as cited in Felipe 2015). Industrial policies contribute to structural transformation by facilitating the transfer of resources to preferred sectors of the economy, which are usually the more dynamic ones.

Rodrik (2014) dovetails his earlier work to describe the contours of "green industrial policy" (see for example Rodrik 2008). He argues that industrial policies must be built on three key ideas. First, the requisite knowledge on the existence and location of technological spillovers, market failures, and constraints that impede green investments is diffused widely within society across businesses, entrepreneurs, and scientific communities. Second, private investors and other beneficiaries of public support have strong incentives to 'game' the government by bending the rules to their advantage through their informational advantage and political muscle. Third, the intended beneficiary of industrial policies is neither bureaucrats nor business, but society at large.

Largely based on these three key ideas, Box 1 presents a set of principles that can guide industrial policy. This list can be used as a benchmark to evaluate the programs and policies implemented in the Philippines. Rodrik (2014) discusses a more succinct approach to evaluating industrial policy. The various principles can be incorporated in either (i) embeddedness, (ii) discipline, or (iii) accountability.

Embeddedness refers to the coordination between the public sector and private firms that allows the former to be aware of the constraints and opportunities of the latter. It was used first in the industrial-policy context by Evans (1995), who described South Korea's developmental state as one in which the bureaucracy exhibited 'embedded autonomy'. The South Korean bureaucracy, he argued, operated along Weberian, meritocratic lines but it was not insulated from the private sector. Quite to the contrary, it was 'embedded in a concrete set of social ties that binds the state to society and provides institutionalized channels for the continual negotiation and renegotiation of goals and policies'. Embeddedness can address some of the political economy problems described in Section 2.

The embedded nature of industrial policy makes the need for disciplining devices against abuse necessary. Firms and industries that receive assistance from the government must be aware that they cannot game the system, and that underperformance will result in the removal of assistance. Carrots must be matched by sticks.

Embeddedness and discipline are two sides of the same coin, establishing the acceptable boundaries of the relationship between public agencies and the private sector. They facilitate communication and collaboration between the two while ensuring that public officials retain sufficient autonomy and have the ability to deploy a stick when needed. However, the purpose of green industrial policy is to further the public good at large, not the interests of the two parties in this relationship, bureaucrats, and private firms. Therefore, the third element of the institutional architecture must be public accountability. Public agencies must explain what they are doing and how they are doing it. They must be as transparent about their failures as their successes. Accountability not only keeps public agencies honest, but it also helps legitimize their activities.

Box 1: How to Design Industrial Policy*

Economists and policymakers are looking at industrial policy for the important role that it can play in addressing market failures. This is especially so for failures related to information and coordination externalities, which are particularly pervasive in the development or adoption of new technologies, products, and markets. While the industrial policy debate is likely to continue, its focus is shifting from whether it is needed to how it should be designed and implemented.

Rodrik (2008) argues that industrial policy is not about subsidies, but about public-private collaboration to address market failures and providing the missing public inputs that the private sector needs to function effectively. For Rodrik, a change in the framework for formulating industrial policy is needed to 'maximize its potential to contribute to economic growth while minimizing the risks that it will generate waste and rent-seeking'.

The emphasis should be on self-discovery of the potential to enter into high-technology and higher-value industries and on assisting in addressing coordination failures inherent in structural transformation. Rodrik (2008) argues that the standard instruments of industrial policy—credit and fiscal support and infrastructure provision, among others—can be improved if they are deployed in a more productive manner. To do this, he proposes the following ten design principles for industrial policy:

- incentives provided only to 'new' activities
- clear benchmarks and criteria for success and failure
- built-in sunset clauses
- public support that targets activities and not sectors
- activities that are subsidized have clear potential for spillover and demonstration effects
- the authority for carrying out industrial policy is vested in agencies with demonstrated competence
- implementing agencies are monitored closely by a principal with a clear stake in the outcome and who holds political authority at the highest level
- the agencies carrying out promotions maintain channels of communication with the private sector

● the objective should not be to minimize the chances that mistakes will occur—which would result in no self-discovery at all—but to minimize the costs of the mistakes when they do occur

● promotion needs to be renewable so the cycle of discovery continues

While these provide broad principles to guide the implementation of industrial policy, the right policy mix will differ by circumstance and country. Any effective strategy is likely to be country-specific, as there is no one-size-fits-all solution.

*Lifted from page 18 of Zhuang, J., P. Vandenberg, and Y. Huang (eds), *Managing the Middle-Income Transition: Challenges Facing the People's Republic of China*. Massachusetts, USA: Edward Elgar Publishing Inc.

The next two sections deal with policies and programs in the Philippines. These are summarized in Table 2. The policies and programs will be evaluated vis-à-vis the principles listed in Box 1 and the general categories of (i) embeddedness, (ii) discipline, and (iii) accountability.

Laws and Policies in the Philippines

In the Philippines, the Electric Power Industry Reform Act (EPIRA) of 2001 or Republic Act (RA) 9136 embodied pro-market reforms intended to restructure the Philippine energy landscape and address the growing demand of Filipinos for reliable and competitively priced source of electricity. In addition to EPIRA, the Renewable Energy (RE) Act of 2008 or RA 9513 also shaped the industry by promoting the exploration, development, and use of the country's renewable energy sources such as solar, wind, biomass, hydro, and geothermal.

The RE Act of 2008, together with the Biofuels Act of 2006, aims to address the country's continuous dependence on imported fossil fuels by promoting the exploration, development, and use of the country's renewable energy sources such as solar, wind, biomass, hydro, and geothermal. The enactment of the RE Law is also vital for the low-carbon emission development strategy of the Philippines and in addressing the challenges of energy security and threats of climate change.

Among the mandates of the RE Law is the provision of fiscal and nonfiscal incentives to private sector investors to accelerate investment in renewable energy. Fiscal incentives include income tax holiday, duty-free importation, value added tax-free importation, and cash incentives. Meanwhile, nonfiscal incentives include net metering, green energy option, feed-in-tariff (FiT), and renewable portfolio standards (RPS).

The FiT was a landmark policy pushed by the DOE to accelerate the development of RE in the country. The FiT rates covered solar, wind, hydro, and biomass. Solar PV received the highest FiT price at PhP 9.68/kilowatt-hour (kWh) with 50 MW of installed capacity followed by wind with an approved rate of PhP 8.53/kWh and a target capacity of 250 MW. Run-of-river hydro and biomass FiT rates were at PhP 6.63/kWh and PhP 5.90/kWh, respectively. Installation target for both was capped at 250 MW. A second round of FiT rates were released in 2015 to change the installation target FiT price of wind and solar. On 24 February 2018, the DOE endorsed the extension of the biomass and run-of-river hydropower installation targets eligibility until 31 December 2019, or upon successful commissioning of the run-of-river hydro and biomass power projects. The extension covers the remaining balance of the respective initial installation targets.

The DOE, as the lead implementor of the RE Act of 2008 formulated the National Renewable Energy Program (NREP), which serves as a roadmap for a countrywide approach in fostering the development of renewable energy in the Philippines. Figure 1 presents the revised RE roadmap, which outlines the medium- and long-term goals from 2019 – 2040 that will help in increasing RE installed capacity of at least 20,000 MW. This is set to improve energy security and mitigate the effects of climate change and help in rural development. The roadmap outlines five key strategies that direct policy directions and programs. These strategies include (1) acceleration of RE positioning, (2) creation of conducive business environment, (3) reliable and efficient infrastructure, (4) promotion and enhancement of research design and development agenda, and (5) other activities.

A key feature of the NREP is the establishment of an RPS, a market-based policy that requires power distribution utilities, electric cooperatives, and retail electricity suppliers (RES) to source an agreed portion of their energy supply from eligible RE facilities. Per the RPS rules released in December 2017, the renewable energy market (REM) operations must commence in December 2018. The REM rules must also be promulgated by mid-2018; draft rules were released in January 2018. The year 2019 is expected to be the transition year when mandated participants can make their preparations for the mandatory RPS compliance, which will commence in 2020.

The REM serves as the platform for trading Renewable Energy Certificates (RECs), which is equivalent to an amount of power generated from RE sources. It is the intended facility for participants to comply with their RPS obligations. The REM aims to (1) create a fair and transparent market for trading RECs, (2) ensure that REC prices are governed by the laws of supply and demand, and (3) make certain that prices reflect benefits of the additional megawatt-hour (MWh) of electricity generated from RE. REM participants include distribution utilities, electric cooperatives, retail electricity suppliers, and off-grid mandated participants.

Under the REM, the RE Registrar issues every mandated participant with one REC for every MWh of actual generation. If mandated participants surrender the RECs for compliance with their RPS obligations, then the RECs will be retired and cannot be traded to another participant. A trading participant may also transfer REC to another REM trading participant, but disclosure of price and volume of each REC transfer is required.

An interesting piece of legislation is RA 11357, which is "An Act Granting Solar Para sa Bayan Corporation a Franchise to Construct, Install, Establish, Operate, and Maintain Distributed Energy Resources and Microgrids in the Remote and Unviable, or Unserved or Underserved Areas in Selected Provinces of the Philippines to Improve Access to Sustainable Energy". This law provides a private firm a unique advantage over its competitors, violating the principle of embedded autonomy.

The passage of RA 11032 or the Ease of Doing Business and Efficient Government Service Delivery (EODB) Act, a landmark legislation which aims to facilitate prompt actions or resolution of all government transactions with efficiency across all government offices and agencies in the Executive Department, is vital in improving the transparency as well as efficiency of DOE in its issuance of RE service contracts and permits, improving the permitting process from 45 to 25 working days.

RA11234 or the Energy Virtual One-Stop Shop (EVOSS) Act aims to provide an electronic application and processing system, which provides users with information necessary for applications for new power generation, transmission, and distribution projects and allow them to submit and monitor their application. EVOSS eliminates duplication of documentary submission and processes and ensures timely completion of power generation, transmission, and distribution projects.

RA 11285 or the Energy Efficiency and Conservation Act was signed into law on 12 April 2019. The law would "institutionalize energy efficiency and conservation as a national way of life geared towards the efficient and judicious utilization of energy by formulating, developing, and implementing energy efficiency and conservation plans and programs to secure sufficiency and stability of energy supply in the country". The law also encouraged "the development and utilization of efficient renewable energy technologies and systems to ensure optimal use and sustainability of the country's energy resources". Meanwhile, an Inter-Agency Energy Efficiency and Conservation Committee was created "to evaluate and approve government energy efficiency projects".

In October 2020, the DOE declared a moratorium on new applications for greenfield coal power plants. This policy aims to accelerate the development of indigenous energy sources and the transition to cleaner energy sources to ensure sustainability. The new government policy does not cover coal plants that have been endorsed and have already secured permits. In addition, the DOE announced that 100% foreign ownership in large-scale geothermal energy exploration and development has been allowed.

Institution Building

The passage of the RE Law expanded the role of the DOE and mandated the agency to be the lead implementor of the RE Law. In addition, the agency was mandated to create the National Renewable Energy Board (NREB) and the Renewable Energy Management Bureau to help in its thrust to develop renewable energy in the Philippines.

Section 27 of the RE Law authorizes NREB to provide policy recommendations and serve as a monitoring body for the implementation of the RE Law. The board is composed of a (1) Chairman; (2)one representative each from DOE, Department of Trade and Industry, Department of Finance, Department of Environment and Natural Resources, National Power Corporation, National Transmission Corporation, Philippine National Oil Company, and Philippine Electricity Market Corporation; and (3) endorsed representatives from RE developers, government financial institutions, private distribution utilities, electric cooperatives, electricity suppliers, and nongovernmental organization. Among the functions of NREB are to (1) recommend policies and actions to facilitate the implementation of NREP to be executed by the DOE, (2) monitor and review the implementation of NREP, (3) evaluate and recommend to the DOE the mandated RPS and minimum RE generation capacities in off-grid areas, and (4) oversee and monitor the utilization of the Renewable Energy Trust Fund.

The creation of the REMB replaced the former Renewable Energy Management Division. Under Section 32 of the RE Law, the REMB was established to effectively implement the provisions of the Act and facilitate and accelerate renewable energy development, utilization, and commercialization. The following are its primary functions: (1) Implement policies and plans and programs related to the accelerated development, transformation, utilization, and commercialization of RE resources and technologies; (2) Develop and maintain a centralized, comprehensive, and unified data and information base on RE resources to ensure the efficient evaluation, analysis, and dissemination; (3) Promote the commercialization/application of RE resources including new and emerging technologies; (4) Conduct technical research, socio-economic and environmental impact studies of RE projects; and (5) Supervise and monitor activities of government and private companies and entities on RE resources and development. The REMB is composed of five divisions namely: biomass, geothermal, ocean and hydropower, solar and wind, and the NREB Technical Secretariat.

Private Sector Perspective

A succinct perspective of the private sector can be gleaned from a presentation of Reynaldo T. Casas during the Future Energy Show 2020 on November 16, 2020.[5] He represented the Confederation of Solar Developers of the Philippines (CSDP) at the forum. Casas expressed concern on the share of coal in total installed generating capacity, which is

[5] Available on https://www.youtube.com/watch?v=Q2p748fUvYE&feature=youtu.be (accessed on 19 November 2020).

forecast by the DOE to be 56% in 2040 from its current share of 39%. This implies that the current interventions to expand RE (e.g., the Renewable Energy Act) are not working or not adequate.

One reason for the stagnant share of RE may be the absence of a comprehensive approach by the government in managing the energy sector. For example, the current version of the Philippine Energy Plan (2018–2040) does not propose any improvements in the net-metering scheme for consumers who installed solar panels. There has been no acknowledgment of the analysis emanating from the study on Competitive Renewable Energy Zones (CREZ) and no consideration of the possible impact of advancements in the area of battery storage.

Meanwhile, Mr. Casas highlighted the lack of financing for RE projects, a factor listed under market-based constraints earlier in this paper. Proposals from CSDP include acquiring funding from the government in collaboration with the finance industry, improving the bankability of RE providers through the FiT, and establishing an insurance scheme for RE providers as a contingency in case their off-takers are not able to comply with their commitments to purchase electricity from them.

The CSDP applauds the efforts of the government to streamline the processing of investment projects through RA 11032 and RA 11234 and the EODB act and EVOSS act, respectively. Mr. Casas also mentioned the Anti-Red Tape Authority which was established through the EODB act. While these efforts are laudable, the problem of bureaucratic inefficiency has been the target of major reforms in the Philippines for at least three decades. The latest foray may only be an extension of past efforts and only time will determine if these will yield significant results.

CSDP considers the experience of Singapore with regard to solar rooftops and Viet Nam with regard to the implementation of the FiT as models for the Philippines to emulate. However, caution has to be applied primarily because no one size fits all. Singapore is a city-state and Viet Nam's government structure facilitates quick adjustments when policies do not have the desired effects. Moreover, solar rooftops have unintended consequences as the decline in sales of the distribution utility will compel the latter to spread its fixed cost to the remaining customers. In one context, the policy of promoting solar rooftops is anti-poor since only members of the upper-income bracket can afford this technology. This means the residual customers, whose share of the fixed cost will rise, are in the lower-income brackets.

4. Evidence and Assessment of Progress

Objectives and Results

Clearly, the government's intention has been to promote renewable energy, with an ambitious goal of at least 20,000 MW of installed RE capacity by 2040 and 35% of RPS by 2030. However, data show that there is a fairly wide gap between good intentions and actual results.

Table 1 presents power generation by source from 2010 to 2019. The data suggest that although the total gigawatt-hours (GWh) of electricity generated from RE is increasing, the share of RE to the total power generation mix is decreasing. On average, the share of coal is increasing by 5% while the share of RE is decreasing by 2% annually. The share of RE in 2019 was only 21%. This was 26% in 2010 and 42.8% in 2000.

Renewable energy plants constitute the second-largest share of both installed and dependable generation capacity from 2013 to 2019 as shown in Tables 3 and 4 while coal maintains the largest share in total capacity. Tables 1, 3, and 4 indicate that the concerns expressed by CSDP are valid.

The FiT and RPS were intended to be two of the principal policy mechanisms to realize the NREP targets. Table 5 presents the projected RE capacities and installation targets as a result of the FiT scheme. Among the four RE sources, biomass, solar, and wind have installed capacities above the mandated installation targets. Only hydropower is undersubscribed with 172.43 MW installed capacity compared to the 250 MW installation target. From the total number of additional RE plants from FiT, 61% of the new RE plants are located in Luzon while only 12% are located in Mindanao.

Assessment

An evaluation of the progress in expanding RE capacity in the Philippines can begin with the FiT program. From the data in Table 5, it seems the FiT scheme was successful in allowing VRE to establish presence in the Philippine energy market. However, this was not enough to overcome a stagnant RE sector. A closer evaluation revealed some flaws in the implementation of the FiT (Lagac and Yap 2020). The program started at a time when the cost of VRE was beginning to decline sharply, rendering the subsidies redundant. There are issues related to the phenomena of "missing money" and "curtailment risk and price dislocation". Generally, these issues refer to the reduced profitability of existing investment as a result of the expansion of RE in response to the FiT. The cost of reduced profitability has not been quantified but this will definitely add to the net social cost that Lagac and Yap estimated.

Meanwhile, FiT rates, which were recommended by the NREB and approved by the ERC, were designed to cover the cost of capital investment, connection to transmission or distribution network, and market-based return of capital. A host of other countries including Argentina, Canada, Mexico, Germany, and the People's Republic of China conducted auctions to bring new renewable energy capacity to the market. Unlike the design of the Philippines' FiT program where the NREB set a predefined FiT rate, renewable energy auctions allowed for greater price discovery and are considered both cost-efficient and transparent.

The experience with the FiT highlights one of the pitfalls with industrial policy. The correct way of thinking about industrial policy is "as a process of discovery, by the government no less than the private sector, instead of a list of specific policy instruments. This perspective focuses attention on learning where the constraints and opportunities lie and responding appropriately, rather than on whether the governments should employ tax breaks, R&D subsidies, credit incentives, loan guarantees, and so on. It is important, of course, to evaluate the effectiveness of these specific instruments. But the prior, meta-question on green industrial policy is whether a government has put in place the appropriate processes and institutions of engagement with the private sector" (Rodrik 2014, p. 485).

In other words, embeddedness, as defined earlier, has to be observed and it has to be in the form of embedded autonomy. The FiT was implemented with only a narrow set of targeted beneficiaries and, as described earlier, not all ramifications were considered. The period for the scheme was also set at 20 years, leaving little leeway to shift course. It was virtually impossible, therefore, to impose "discipline", which is another criterion for sound industrial policy.

Meanwhile, it is acknowledged that there was a delay in implementing the RPS along with its accompanying elements (e.g., REM). Nevertheless, the RPS is an example of a program where "the targets remain contingent on a combination of policy mechanisms, technological advancements, cost reductions, and resource development all being successful" (ADB 2018, p. 27). In other words, there are too many moving parts, making it difficult to ensure policy coherence.

5. Cross-country Comparison

Southeast Asian nations have an abundance of untapped RE potential, including ocean energy as well as a significant amount of geothermal potential in countries like Indonesia and Philippines (IRENA 2018). A more recent study provided high-quality data and spatial analysis of the cost of utility-scale wind and solar PV generation in select countries of Southeast Asia (Lee et al. 2019). The results of the analysis show abundant potential for utility-scale, land-based wind, and solar PV development in member-states of the Association of Southeast Asian Nations (ASEAN) at a range of generation costs. Meanwhile, the study by IRENA argues that furthering RE development in the region offers employment and welfare opportunities. In recent years, these countries have increasingly diversified their portfolio to include RE sources to achieve benefits in terms of environmental sustainability, energy access, and energy security.

Collectively, ASEAN had set a target of securing 23% of its primary energy source from RE by 2025. At the national level, countries have adopted policies to accelerate RE investments. To foster competition, countries like the Philippines and Thailand have liberalized their energy markets to create a competitive and dynamic energy sector to attract RE developers, particularly those in the private sector (IRENA 2018).

Thailand has recognized the importance of renewable energy and acknowledged the need for policies to support the deployment of RE projects. it has adopted a variety of support schemes such as tax exemptions, Feed-in Premiums (FiP), FiT, and competitive bidding to support the early stages of RE development. The implementation of the FiP, also known as the Adder Program, in 2007 allowed for premium rates to be added to the wholesale price of RE sources such as solar, wind, biomass, hydro, and biogas. However, the program was effectively replaced by FiT in 2010 to address the issues of uncertainty in long-term tariffs as well as its failure to accurately reflect levelized cost of energy (IRENA 2017a).

The passage of the Renewable Energy Act in Malaysia in 2011 introduced the FiT scheme to increase generation from renewable energy resources such as biogas, biomass, small hydropower, solar PV, and geothermal. The government of Malaysia also introduced net metering in 2016 to allow consumers to generate electricity by installing more solar PV units and selling the resultant power to utilities. Malaysia's National Renewable Energy Policy and Action Plan also supported innovation in RE through investments in human capital to build local expertise and provide subsidies to individuals finishing renewable energy courses.

Indonesia's renewable energy policies are guided by two regulations: (1) Renewable energy should contribute 23% of total energy use by 2025 and (2) reduce GHG emissions by 26% by 2020 from the baseline level. To achieve these goals and accelerate renewable energy deployment, Indonesia adopted the FiT system for a range of renewable energy sources such as geothermal, mini- and micro-hydro biomass, non-biogas, landfill gas, and solar. The FiT rates applied were adjusted depending on location, and higher FiT rates were paid to projects to account for higher transmission losses due to lower voltage network (IRENA 2017b).

In 2013, Cambodia established the Renewable Energy Action Plan which aims to support rural development in the country by providing reliable renewable energy systems and achieve 70% electrification rate by 2030.

While there is no established policy on renewable energy regulation, Singapore is focused on conducting research on renewable energy potential (Erdiwansyah et al. 2019). In an earlier section of this paper, Singapore was identified as a paragon of rooftop solar RE.

Vietnam adopted the Renewable Energy Development Strategy to increase the share of renewable energy in its energy mix and address problems of energy security as well as environmental sustainability. By 2030, the country aims to reduce its GHG emissions by 8%. Renewable energy policies such as investment protection policy as well as FiT were adopted to accelerate the development of RE (Erdiwansyah et al. 2019).

As argued earlier, emulating country experiences would be difficult because one size does not fit all. Nevertheless, some elements can be considered universal. Policymakers just have to be judicious in determining the successful cases that can be transplanted to their countries.

6. Impact of Pandemic on Prospects for RE

The world continues to reel from the adverse impacts of the pandemic wrought by COVID-19. In the economic sphere, a triple whammy is possible. Lockdowns have caused massive unemployment and a sharp reduction in the purchases of nonessential goods, leading to a demand shock. There has also been a supply shock because supply chains have been disrupted as several small and medium enterprises have been forced to shut down and transportation systems are severely limited. Meanwhile, a potential financial shock also looms as many loans have been left unpaid due to the aforementioned demand and supply shocks, thereby putting stress on some banks and other financial institutions.

Similar shocks have buffeted the energy sector in the Philippines. Power consumption is expected to decline by 5.9% in 2020, mirroring the forecast 9.1% contraction in GDP.[6] During the period of enhanced community quarantine, electricity consumption dropped and shifted largely to the residential sector. Decreasing demand and shifting load curves have likely led to a decline in the profitability of the power sector across its entire value chain. Meanwhile, the pandemic has also reduced construction activities and caused supply chain disruptions, affecting all power generation technologies as well as transmission and distribution. As the International Energy Agency (2020) succinctly describes it: “The crisis

[6] https://asian-power.com/regulation/news/philippines-power-consumption-contract-59-end-2020 (accessed 21 November 2020).

has curbed investments in the energy sector and threatened to slow the expansion of clean energy technologies."[7]

Many governments have responded appropriately by approaching the problem as a public health crisis. Measures to mitigate the adverse effects of the pandemic were analogous to disaster relief. These fiscal rescue measures were intended to offset income losses and address immediate human welfare concerns during lockdown periods, including the provision of basic necessities, curtailment of the spread of the virus, and coverage of additional medical costs. Broader aspects included protection of balance sheets of businesses, minimizing bankruptcies, and maintaining employment levels to the largest extent possible.

When the spread of the virus was controlled, governments shifted to stimulus packages or fiscal recovery measures. In the context of the energy sector, these recovery packages could be 'brown', reinforcing the links between economic growth and fossil fuels or 'green', decoupling emissions from economic activity or 'neutral'. A silver lining during the pandemic was the sharp decline in GHG emissions. It is estimated that globally, GHG emissions might fall by 8% or 2.6 gigatonnes of CO_2 in 2020 (IEA 2020 as cited in Hepburn et al. 2020). This is more in absolute terms than in any other year on record.

The challenge is to encourage governments to sustain this momentum by adopting "green" fiscal recovery measures. It should be noted that the pandemic occurred at a time when renewable energy costs were declining, oil prices were persistently low, debt in the fossil fuel sector was rising, and investor concerns about the impact of fossil fuels on carbon emissions and environmental regulations were already lowering capital investment in the fossil fuel industry while making renewable energy one of the fastest-growing industries (Khanna 2020). A distinct opportunity, therefore, exists to harness this earlier momentum and build on the desire segments of society to "build back better" after experiencing a cleaner environment during lockdowns. This renewed thrust can be channeled to the recovery efforts with a parallel objective of expanding the use of RE and low-carbon infrastructure.

A recent global survey of economic experts indicates that there are fiscal recovery measures that are ranked favorably because of their relatively high multiplier effects but can

[7] https://www.iea.org/articles/the-impact-of-the-covid-19-crisis-on-clean-energy-progress (accessed 02 July 2020).

be classified as “green” at the same time. (Hepburn et al. 2020). These are clean physical infrastructure, building efficiency retrofits, investment in education and training, natural capital investment, and clean R&D. The extent to which these measures will be implemented largely depends on the priorities of policymakers.

Examples of clean energy infrastructure are solar panels, wind turbines, energy storage, grid modernization, and carbon capture technology. A lesson from the 2008 Global Financial and Economic Crisis is that green recovery measures often have advantages over traditional fiscal stimulus. For instance, renewable energy investment is attractive in both the short and the long run. Renewable energy generates more jobs in the short run when employment opportunities are scarce in the middle of a recession. In the long run, renewable energy conveniently requires less labor for operation and maintenance. This frees up labor as the economy returns to capacity.

Meanwhile, fast-acting green recovery measures include residential and commercial energy efficiency retrofits as well as natural capital spending, e.g., afforestation, parkland expansion, enhancement of rural ecosystems. In the Philippines, rehabilitating mangrove forests falls in this category. Natural capital spending is fast acting because worker training requirements are low, many projects have minimal planning and procurement requirements, and most facets of the work meet social distancing protocols. A report published by IEA (2020) corroborates the effectiveness of these measures. For investment measures, energy efficiency in buildings and industry together with solar PV creates the most jobs per million dollars of investment: on average, these three measures create between 10and 15 jobs for every million dollars. Energy efficiency measures tend to be labor-intensive, and the jobs involved tend to pay relatively low average wages, while the rapid cost reductions in solar PV in recent years mean that labor now represents a much larger portion of total costs than was the case in the past.

These investment decisions need to be accompanied by appropriate policy incentives that are technology-neutral, performance-based, and market-based. Additionally, in designing policies to stimulate investments in RE, it will be important to consider various issues, including the intermittency of renewable energy and its integration in the grid, the welfare economic costs, and the distribution of those costs among consumers and producers of energy. In other words, the issues that were discussed earlier—factors that constrain RE and the criteria that lead to sound industrial policy —have to be considered.

7. The Way Forward

Quite clearly, the goal of increasing the share of RE in the energy sector has been derailed. This is not because of laws, programs, and policies that need to be implemented to support this goal are lacking. However, it would be inefficient for this paper to evaluate each of them individually. One hurdle would be the attribution problem, i.e., which particular law, policy, or program was faulty and to what extent it contributed to the stagnation of RE. Instead, the shortcomings of the FiT program and RPS provide a useful framework to craft a holistic RE policy. This process can benefit by using criteria for an effective industrial policy as guidelines.

In the short run, policymakers can explore "green" fiscal recovery measures, but these should be aligned with a medium-term policy aimed at correcting the pre-pandemic trajectory. This paper proposes a streamlined policy structure aimed at increasing the share of RE with focus on three elements. The first is the moratorium on new applications for greenfield coal power plants. By effectively narrowing the options for energy firms in terms of future expansion, resources will be diverted to other sectors like RE. This is industrial policy in its purest form.

For an effective, smooth, and just transition to a lower carbon emission scenario, the private sector and the government must cooperate in a constructive manner. The latter must work to reduce the economic uncertainty that will be generated by the moratorium. This can be achieved by consolidating the various programs and policies and anchor them to the CREZ (Lee et al. 2020), which is the second element of the simplified structure.

A CREZ is a geographic area with high concentrations of cost-effective RE and strong developer interest. A recently completed study by Lee et al. (2020) identified 25 individual CREZ across the Philippines with high-quality RE resources, limited development constraints, and strong private developer interest. The resource capacity in these zones exceeds the Philippines' Renewable Energy Roadmap goal of at least 20 GW of renewable power on the grid by 2040, offering plenty of flexibility in finding the most cost-effective transmission build-out scenarios (Lee et al. 2020).

Because a significant amount of data and information has already been generated by this study, technical feasibility has been enhanced significantly. For example, high spatial and temporal resolution wind and solar resource data for the meteorological year 2017 are publicly available. This is intended to support transparent, data-driven decisionmaking.

Another important feature of CREZ is the involvement of the National Grid Corporation of the Philippines and the DOE in the project. Their collaboration led to the formulation of transmission expansion options that incorporated the identified CREZ. As a result, two important constraints to the deployment of RE—and it should be noted, other energy sources—were mitigated. The first is timescale misalignment. Traditional transmission planning approaches are often misaligned with RE scale up. Deployment of large-scale wind and solar generation may only require a year or less, while transmission planning and development may take 10 or more years. The second is the circular dilemma which was described as an example of coordination failure in Section 2. RE generator development requires financing, but remote wind or solar resources cannot be financed until transmission access is available; however, transmission lines cannot be built without cost recovery certainty or demonstrated need from wind or solar generation (Lee et al. 2020).

By explicitly dealing with issues pertaining to the grid, the issue of system effects has also been effectively addressed. As mentioned earlier, these consist of profile costs, balancing costs, grid costs, and connection costs. The primary result of the CREZ study, therefore, has been to ensure technical feasibility. As the report states: “The CREZ process opens opportunities for private sector development and reduces investment barriers by directing transmission development and RE developers to the Philippines’ most promising RE opportunities” (Lee at al. 2020, p. 16). Nevertheless, financial viability remains to be a major concern of the private sector. There can be cooperation between the government and the private sector along the lines proposed by CSDP. However, the pitfalls of the FiT scheme and RPS have to be avoided. More importantly, since industrial policy is involved, the guidelines and criteria listed in Box 1 have to be adhered to as closely as possible.

The general contours of the public-private partnership can be laid out. Details are left to other studies. First and foremost, the government has to practice embedded autonomy. In practical terms, CREZ should be open to all energy providers, not only to those firms dedicated to RE. The announcement that 100% foreign ownership in large-scale geothermal energy exploration and development is allowed is a step in the right direction. Second, any subsidies provided by the government have to well-designed and calibrated. These should be subject to the principle of discipline and accountability. Lastly, technological developments, especially in the area of battery storage, have to be monitored closely. The government and the private sector have to be prepared to adopt a more aggressive posture in transitioning to VRE if technological trends provide a compelling basis for doing so.

The latest Philippine Energy Plan (2018 –2040) shows that the installed capacity in 2018 is 23,825 MW or 23.8 GW. The forecast capacity under a reference scenario or business as usual is 90,584 MW or 90.6 GW in 2040. According to Lee et al. (2020) the 25 individual zones across the Philippines have an estimated gross capacity of 152 GW of new wind and solar PV. The zones also include an estimated 365 MW of geothermal, 375 MW of biomass, and over 650 GW of hydropower capacity distributed across the Luzon, Visayas, and Mindanao systems. This brings the total capacity to 802.74 GW, but this does not take into account the relatively low capacity factors of RE (Table 6). However, if majority of the CREZ materialize, this is more than enough to cover the additional requirements in the next 20 years, even if capacity factors of solar, wind, and hydro do not improve significantly.

The last element of the simplified policy structure aimed at increasing the share of RE is revisiting the option of nuclear energy (e.g., Yap 2020). While it is not classified as RE, nuclear energy has contributed significantly to the reduction in GHG emissions. This option will be useful if capacity factors of solar, wind, and hydro are not expected to improve significantly beyond 2040, e.g., the cost of battery storage will not decline to profitable levels in the foreseeable future. Estimates show that when there is collaboration between nuclear and renewables, the cost of reaching a carbon-free grid could fall by as much as 62%.[8]

The most feasible nuclear option for developing countries is small modular reactors, which is an emerging technology in nuclear energy. SMRs are defined as nuclear reactors

[8] https://www.thirdway.org/blog/nuclear-renewables-the-ultimate-power-couple-we-think-so (accessed on 09 August 2020).

with an electrical capacity of less than 300 MW per module. They could be installed as single modules distributed throughout the grid, which may be attractive in countries or regions with less-developed networks, in remote regions, or as dedicated sources of electricity for industrial complexes. For example, this can be an option for large isolated islands like Masbate or Romblon. Estimates indicate that the LCOE of SMRs could be competitive with larger nuclear units and with other dispatchable generating technologies (IEA 2019). SMRs have not yet been mainstreamed in the global energy market. However, they are already on the radar of the DOE.[9]

[9] https://business.inquirer.net/285959/ph-eyes-use-of-small-nuclear-reactors-for-power-generation (accessed on 11 August 2020).

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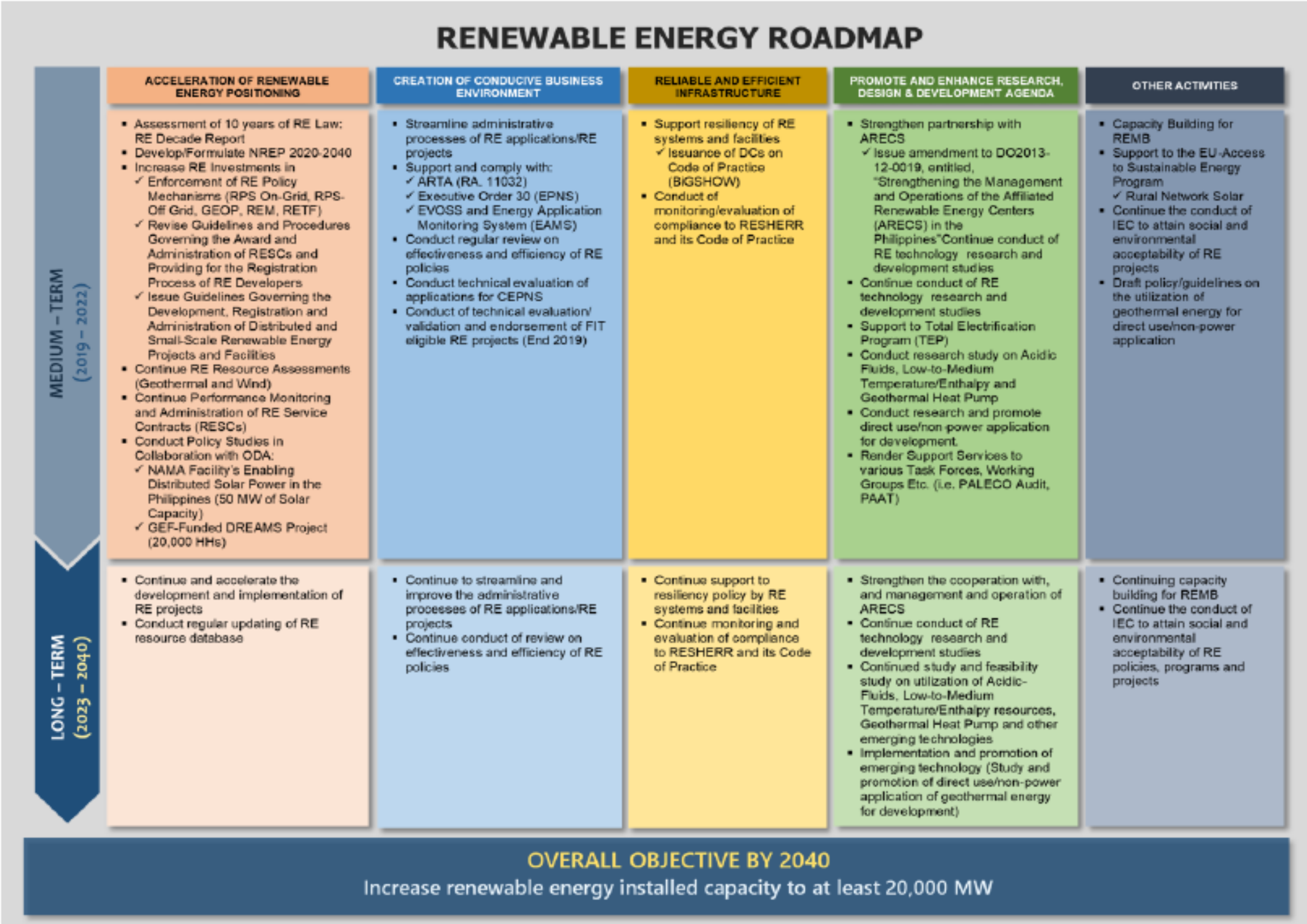
Figure 1: Philippine Energy Plan, Renewable Energy Roadmap



Source: Table 62, page 112 of Philippine Energy Plan 2018-2040, https://www.doe.gov.ph/sites/default/files/pdf/pep/pep-2018-2040-final.pdf

Figure 2: Economies of Scale: Slope of average cost function more negative than slope of demand function.

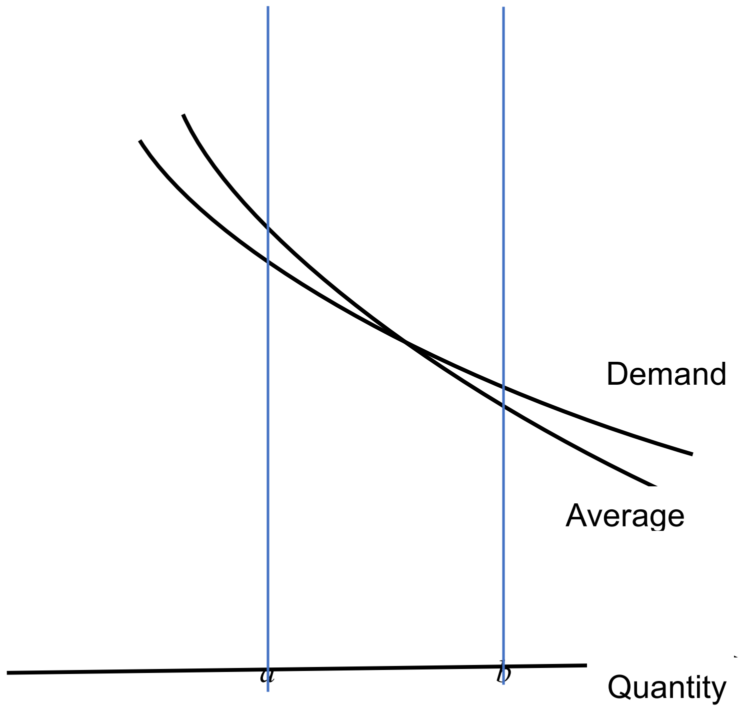


Table 1: Power Generation by Source (in GWh)

Technology	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1. Coal	23,301	25,342	28,265	32,081	33,054	36,686	43,303	46,847	51,932	57,890
2. Oil-Based	7,101	3,398	4,254	4,491	5,708	5,886	5,661	3,787	3,173	3,752
3. Combined Cycle	1,202	124	227	247	515	276	694	405	522	728
4. Diesel	4,532	2,762	3,332	3,805	4,730	5,521	4,722	3,100	2,505	2,8115
5. Gas Turbine	3	-	-	-	-	10	-	-	-	26
6. Oil Thermal	1,364	512	695	438	463	80	245	282	145	184
7. Natural Gas	19,518	20,591	19,642	18,791	18,690	18,878	19,854	20,547	21,334	22,354
8. Renewable Energy (RE)	17,823	19,845	20,762	19,903	19,810	20,963	21,979	23,189	23,326	22,044
a. Geothermal	9,929	9,942	10,250	9,605	10,308	11,044	11,070	10,270	10,435	10,691
b. Hydro	7,803	9,698	10,252	10,019	9,137	8,665	8,111	9,611	9,384	8,025
c. Biomass	27	115	183	212	196	367	726	1,013	1,105	1,040
d. Solar	1	1	1	1	17	139	1,097	1,201	1,249	1,246
e. Wind	62	88	75	66	152	748	975	1,094	1,153	1,042
TOTAL	**67,743**	**69,176**	**72,922**	**75,266**	**77,261**	**82,413**	**90,798**	**94,370**	**99,765**	**106,041**
Share of Coal (%)	34%	37%	39%	43%	43%	45%	48%	50%	52%	54%
Share of Renewable Energy (%)	26%	29%	28%	26%	26%	25%	24%	25%	23%	21%

Source: Department of Energy (DOE) Power Statistics

Table 2: Philippine Renewable Energy Policies

Philippine Renewable Energy Policies
Important Laws and Policies
EPIRA
Renewable Energy Act
Biofuels Act of 2006
Ease of Doing Business and Efficient Government Service Delivery Act
Energy Virtual One-Stop Shop (EVOSS) Act
Solar Para sa Bayan
Energy Efficiency and Conservation Act
Tools Used
7-Year Income Tax Holiday
Duty Free Importation
VAT Free Importation
Special Realty Tax Rate
Zero Percent VAT on RE Sales and Purchases
Cash Incentive = 50% of UC for Missionary Electrification
Tax Exemption on Carbon Credits
Renewable Portfolio Standards
Feed-In Tariff on Emerging Technologies
Green Energy Options
Net Metering
Renewable Energy Market and Certificates

Table 3: Total Installed Generating Capacity per Technology (in MW)

Technology	2013	2014	2015	2016	2017	2018	2019
Coal	5,568	5,708	5,963	7,419	8,049	8,844	10,417
Oil-Based	3,353	3,476	3,610	3,616	4,153	4,292	4,262
Natural Gas	2,862	2,862	2,862	3,431	3,447	3,453	3,453
Renewable Energy (RE)	**5,541**	**5,898**	**6,330**	**6,958**	**7,079**	**7,227**	**7,399**
Geothermal	1,868	1,918	1,917	1,916	1,916	1,944	1,928
Hydro	3,521	3,543	3,600	3,618	3,627	3,701	3,760
Biomass	119	131	221	233	224	258	363
Solar	1	23	165	765	885	896	921
Wind	33	283	427	427	427	427	427
Total	**17,325**	**17,944**	**18,765**	**21,423**	**22,728**	**22,815**	**25,531**

Source: Department of Energy (DOE)

Table 4: Total Dependable Generation Capacity per Technology (in MW)

Technology	2013	2014	2015	2016	2017	2018	2019
Coal	5,206	5,378	5,613	6,979	7,674	8,368	9,743
Oil Based	2,846	2,692	2,734	2,821	3,286	2,995	3,015
Natural Gas	2,760	2,760	2,759	3,291	3,291	3,286	3,286
Renewable Energy (RE)	4,559	4,789	5,325	6,005	6,264	6,592	6,691
Geothermal	1,482	1,607	1,601	1,689	1,752	1,770	1,792
Hydro	2,983	2,982	3,073	3,181	3,269	3,473	3,508
Biomass	76	81	146	157	160	182	227
Solar	0	17	125	594	700	740	737
Wind	103	379	383	383	427	427	427
TOTAL	**15,371**	**15,619**	**16,431**	**19,096**	**20,515**	**21,241**	**22,735**

Source: Department of Energy (DOE)

Table 5: Projected FiT Eligible RE Capacities and Installation Targets

	2019		2020		
Technology	**No. of Plants**	**Installed Capacity (MW)**	**No. of Plants**	**Installed Capacity (MW)**	**Installation Targets**
Biomass	**31**	**250.5**	**31**	**250.5**	**250**
Luzon	*16*	*114.21*	*16*	*114.21*	
Visayas	*11*	*115.45*	*11*	*115.45*	
Mindanao	*4*	*20.84*	*4*	*20.84*	
Hydropower	**20**	**172.43**	**20**	**172.43**	**250**
Luzon	*13*	*59.99*	*13*	*59.99*	
Visayas	*3*	*31.1*	*3*	*31.1*	
Mindanao	*4*	*81.34*	*4*	*81.34*	
Solar	**24**	**525.95**	**24**	**525.95**	**500**
Luzon	*16*	*283.73*	*16*	*283.73*	
Visayas	*6*	*225.5*	*6*	*225.5*	
Mindanao	*2*	*16.72*	*2*	*16.72*	
Wind	**7**	**426.9**	**7**	**426.9**	**400**
Luzon	*5*	*336.9*	*5*	*336.9*	
Visayas	*2*	*90*	*2*	*90*	
Mindanao					
Total	**82**	**1375.78**	**82**	**1375.78**	**1400**
Luzon	*50*	*794.83*	*50*	*794.83*	
Visayas	*22*	*462.05*	*22*	*462.05*	
Mindanao	*10*	*118.9*	*10*	*118.9*	

Source: Department of Energy (DOE)

Table 6: Capacity Factors of Energy Technologies

Source	**Capacity Factor (%)**
Nuclear	93.5
Natural gas	56.8
Coal	47.5
Hydropower	39.1
Wind	34.8
Solar	24.5

Source: https://www.energy.gov/ne/articles/nuclear-power-most-reliable-energy-source-and-its-not-even-close (accessed 11 August 2020)