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SUSTAINABLE DEVELOPMENT DEMANDS A RESILIENT POWER SYSTEM

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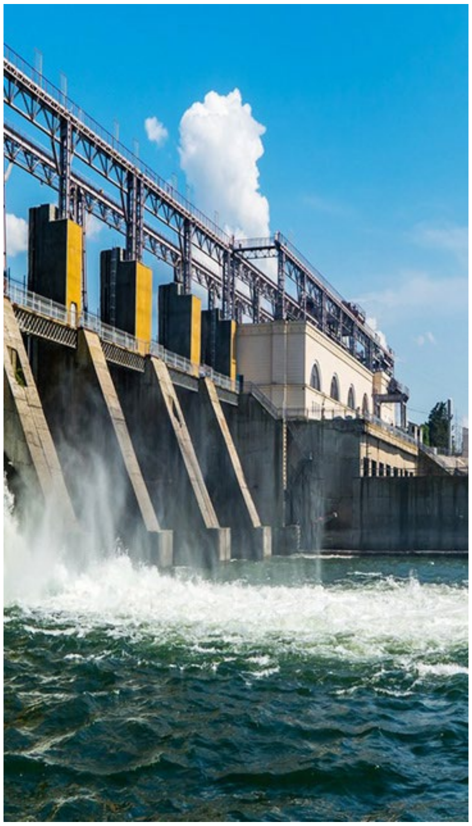
SUSTAINABLE DEVELOPMENT DEMANDS A RESILIENT POWER SYSTEM

The Philippines has the stated ambition of being a developed country by 2040. It appears to be on the way to being one and was considered an emerging economy prior to the pandemic. The country has registered consistent economic growth, a healthy balance of trade, sufficient forex reserves, a low level of borrowings, and a declining poverty level. However, the pandemic reversed all of these positive indicators.

Even prior to the pandemic and since its independence, the country's development was continually hampered by a poor-performing power sector. We have the infamous distinction of having one of the higher electricity rates in the world. On top of it, we have one of the lowest electricity consumption per capita in ASEAN. There is a direct correlation between the Human Development Index (HDI) and electricity consumption per capita. Thus, it is not surprising that the Philippines is near the bottom rung in HDI among ASEAN countries. How have we fallen so low? For several decades after World War II, the Philippines was touted as only second to Japan in Asia in terms of economic development. We were the hub of multinationals with respectable agricultural, industrial and financial sectors. Up to the mid-70s, we were the envy of our Asian neighbors. But Singapore, Thailand, Malaysia, Indonesia, and recently Vietnam had overtaken us. If we do not get our act together, especially in the power sector, it is quite conceivable that Cambodia, Laos, and Myanmar might eventually leap-frog over us.

The Philippines has good policies and objectives governing the energy sector provided in our constitution, energy laws, and environmental laws. The Philippines is also not risk averse to adapting new technologies. It was the leader in geothermal, solar, and wind power development in ASEAN. Up to now, the combined renewable energy (RE) share in the power mix is higher than our neighbors. However, the share keeps declining despite the passage of the RE Act of 2008. From 34% in 2008, RE share in terms of generation dropped to 21% in 2021. Geothermal and hydropower developments are minimal; solar, wind and biomass installations are lower than Thailand and Vietnam. In solar installations, for example, Vietnam has 16.45 GW; Thailand has 3.12 GW; while the Philippines has only 1.2 GW. We can no longer claim to be second to the United States of America in geothermal power. Indonesia has that honor now.



Taking off from the country's current power system status, its strengths in terms of available resources, challenges brought about by its archipelagic nature, vulnerability to calamities and climate change, innovative technologies, and regulations, this paper seeks to:

1. Analyze the weaknesses of the power sector, and then
2. Propose means on how these weaknesses could be addressed to enable a resilient and flexible power system at affordable electricity prices.

Current Status of the Power System in the Philippines

Given our country's archipelagic nature, the transition towards a more resilient, flexible, and distributed energy sector must be viewed from two perspectives: the main grid and off-grid areas. In this section, we will review the current situation from the perspectives of both areas.

Main Grid

The Philippines' main grid may be characterized as centralized with 58.4% of the power generation in GWh supplied by large coal-fired power plants. The power grid is dominated by baseload coal and gas power plants located in Batangas, Bataan, Quezon, and Pangasinan. Theoretically, a baseload power plant operates at a steady capacity which corresponds to the typical minimum system demand or base-load of the grid on a daily basis. In reality, data from the wholesale electricity spot market (WESM) show that there is no coal or natural gas power plant operating strictly as a baseload (see Figure 1).

FEATURES

ON THE COVER

Cover, title page, contents page, and page 3: en.wikipedia.org/wiki/Bangui_Wind_Farm; goodnewspilipinas.com/new-romblon-solar-power-plant-to-provide-electricity-for-thousands-of-households-by-september; powerphilippines.com/meralco-redc-construction-bukidnon-hydropower-plant; energy.com.ph/2020/11/03/edc-4th-automated-native-species-nursery-mindanao-geothermal-power-plan; scatec.com/stories/enters-nepal-and-acquires-magat-in-the-philippines; and powerphilippines.com/world-banks-ifc-to-build-biomass-plant-in-negros-occidental

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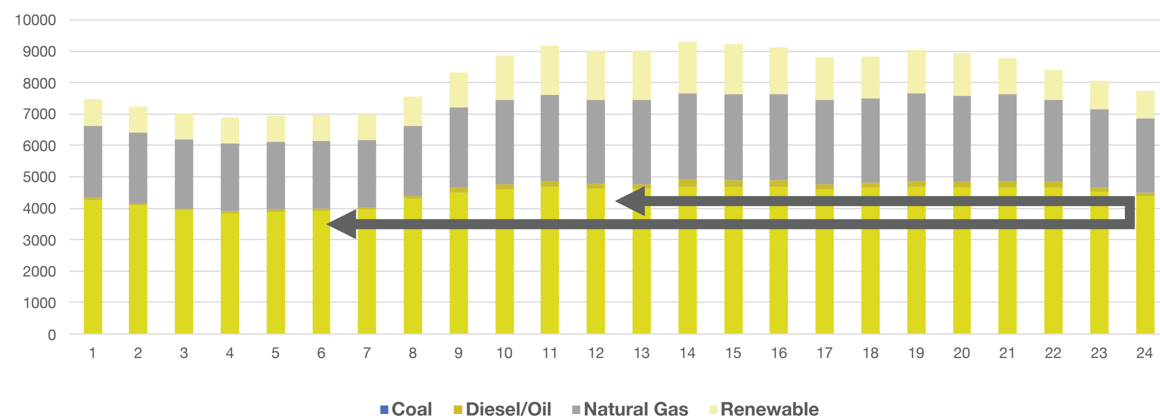
Average Hourly Energy Mix in 2019

Figure 1

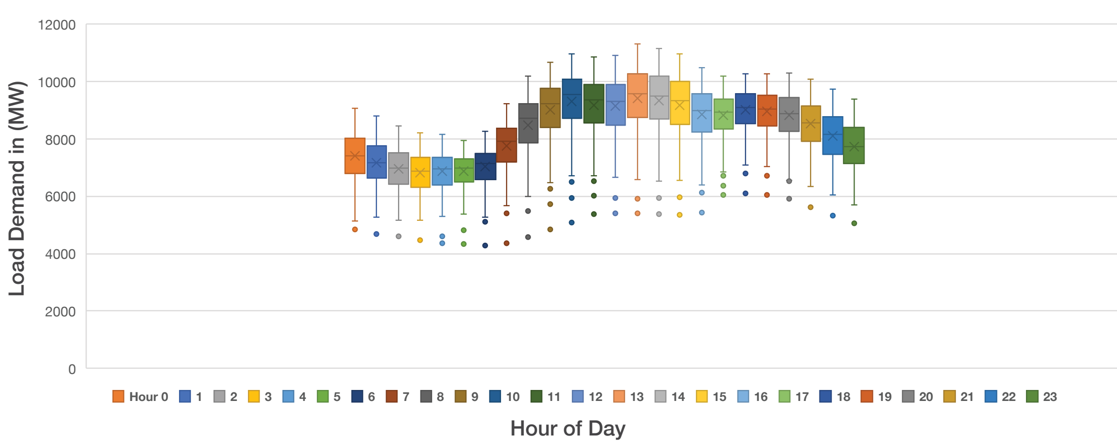


Source: CASE PH based on WESM 2019 data

All coal and gas power plants operate under a daily cycling condition – they ramp up and down to match the normal variations of demand during the day. This variability of demand of our local power grid is a characteristic that is not widely known. Demand changes throughout the time of day, day of the week, and season of the year. In Figure 2, the body of the boxplot in Hour 13 shows the data points from the 1st quartile to the 3rd quartile vary by about 1,500 MW. This capacity is more than twice that of our largest coal power plants, indicating a constantly changing load demand requirement in the Luzon grid. If more baseload coal power plants are constructed to meet this highly variable load demand, then the additional plants will likely also operate in cycling condition.

Electricity Hourly Load Profile in Luzon in 2019

Figure 2



Source: CASE PH based on WESM 2019 data

Unfortunately, the cycling operation is detrimental to the reliability of coal power plants. With frequent cycling, studies show that plants experience increased wear and tear of equipment, shortened equipment lifespan from thermal fatigue, thermal expansion, increased corrosion, and increased cost of start-up fuel. Thus, frequent cycling has negative impacts on the reliability and operating cost of power plants.[1]

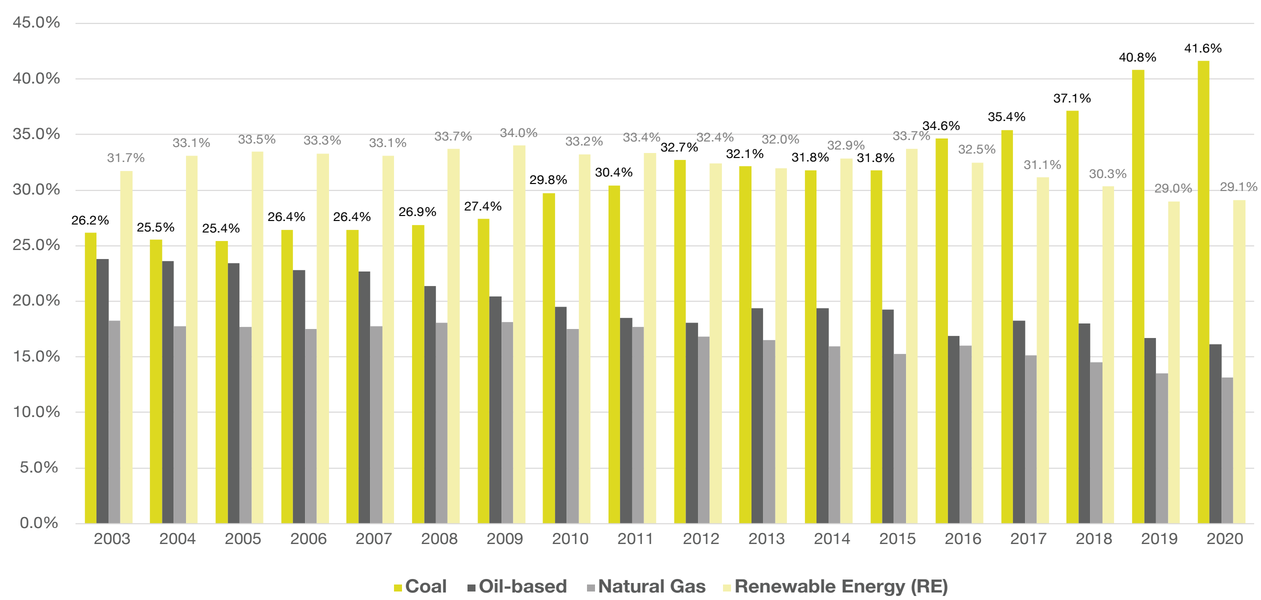
The decreased reliability caused by this cycling operation of coal power plants was established in the Towards an Affordable and Reliable Grid with Energy Transition (TARGET) study by CASE Philippines.[2] More recently, ICSC also looked at the period between June 26, 2021 and June 25, 2022, or the first year in operation of the enhanced WESM design. ICSC found out that coal power plants registered an average of over 80 outage days; this is equivalent to being non-operational for more than 20% of the time. Based on the relevant standards and regulations by the government, this average outage level far exceeds the ERC-mandated outage limit[3] and does not comply with the scheduled outages indicated in the DOE-approved Grid Operations and Maintenance Program (GOMP). The prolonged outages resulted in frequent grid alert levels, oftentimes leading to rotating blackouts in selected areas of the grid.

The recurring extended and unplanned outages of several coal power plants have a direct cost implication to the consumers. The TARGET report shows significant cost increases in the WESM, whenever the large baseload coal power plants become unavailable, especially during times of high demand. There were instances when the price of electricity more than doubled; consumers suffer paying a hefty price because of the unreliability of these plants. On average, WESM prices during coal plant outages reached over Php8 per kilowatt-hour.

In 2008 when the Renewable Energy Act was signed, the general expectation was that renewables share in the power mix will grow at an accelerated rate. From 2003 to 2007, the share of renewable energy (RE) in terms of both installed capacity and energy generated exceeds that of coal. However, from 2008 when RE supply accounted for 34% of both capacity and generation, the

Annual Percent Share in Installed Capacity of Power Generators by Resource Type

Figure 3A



Source: DOE, 2021

renewables share dropped sharply to 29% of capacity and less than 21% of generation by 2020. In contrast, coal share in capacity and energy zoomed up from 27% to 42% of capacity, and 57% of generation during this period.

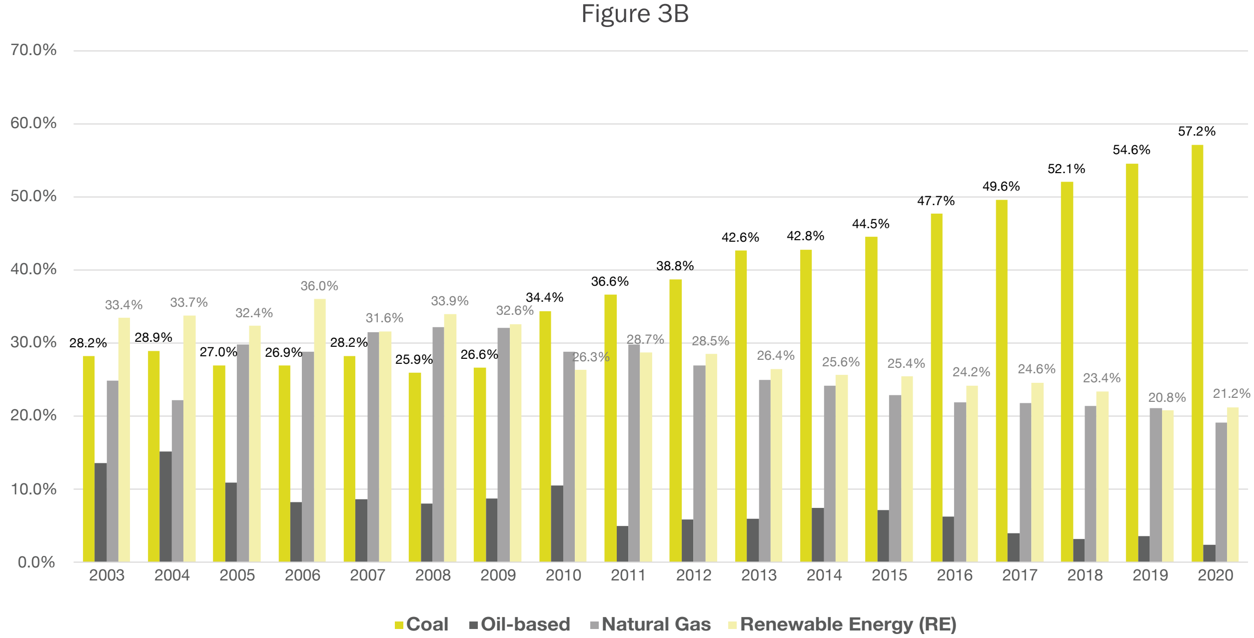
The bias towards more coal power by power producers and utilities has clearly not worked well for the country. Due to outages of coal plants, our power system remains unreliable despite the excess of base-load supply over peak demand. Our electricity rate, which is already one of the highest in the world, registers spikes whenever there are outages. To compound the problem, the Philippines does not only have power plant reliability issues, but also coal supply issues.

According to the Department of Energy, the Philippines imported 97.48% of its coal requirements from Indonesia in 2021.[4] The almost 100% dependence to a single country for coal supply is a threat to energy security, more so as Indonesia had recently banned coal exports. At the start of 2022, Indonesia announced that it was suspending all exports of thermal coal citing a domestic shortage.[5] The Indonesian Ministry of Energy and Mineral Resources said that coal inventories at 20 state-owned and private power plants were running low, raising the possibility of blackouts for up to 10 million customers. The Indonesian government tightly regulates the quantity and price of its coal exports. Export prohibition may be imposed on firms that do not follow the rules. Last August, for the second time in 2022, Indonesia banned the export of coal saying it was falling short of its domestic targets. While the current move is only a partial ban against some miners, it nonetheless comes at a difficult time.[6]

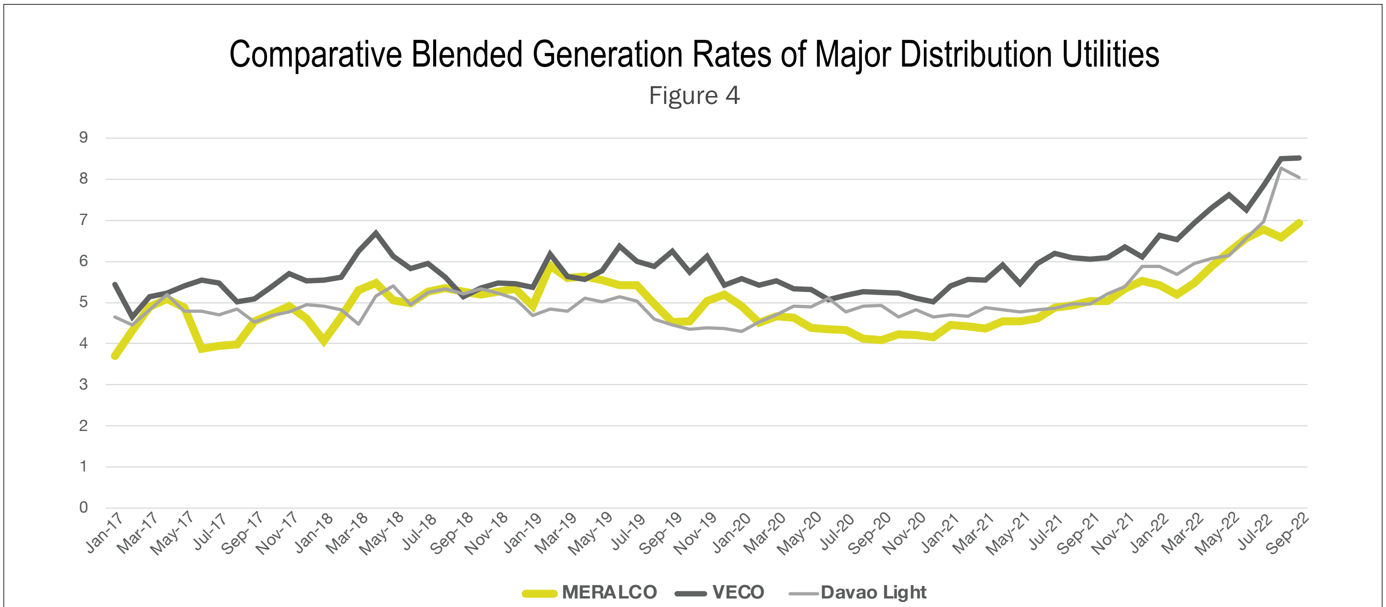
Coal supply is tightening, and coal prices have become much more expensive, further aggravated by the conflict between Russia and Ukraine. The following graph shows the coal generation costs (given the higher fuel prices) of the three major electric distribution utilities: MERALCO, VECO, and Davao Light. Current coal generation costs are at least double their normal levels, within the range of Php8 to 12 per kWh. Smaller electric distribution utilities will likely have higher prices than their larger counterparts, given their constraints in power procurement.

Annual Percent Share in Energy Generated of Power Generators by Resource Type

Figure 3B



Source: DOE, 2021



Source: MERALCO, VECO, Davao Light

Off-grid

Another component of the Philippine energy sector is the off-grid areas comprising of small island and isolated groups (SIIGs). Electricity for SIIG areas is largely served by the National Power Corporation (Napocor), since private power producers do not find the areas attractive for conventionally plants due to their lower energy demands. For this reason, SIIGs' total 623 MW capacity as of 2020 is 91% fueled by oil, primarily for diesel gensets.[7]

The electricity prices for these areas are subsidized by consumers from the main grid; they pay the Universal Charge for Missionary Electrification (UCME) included in their electricity bills for the imported fuels used by these off-grid generators. As fuel costs are currently at an all-time high in the world market, the UCME required by off-grid areas have likewise reached record highs. The energy reliability, affordability, and security aspects affected by high dependence on fossil fuels could trigger power crises in off-grid areas. For example, the outstanding Php1.3-billion debt on diesel supply in Basilan Island if unpaid, would leave the people of this island without power indefinitely.[8] Off-grid areas also experienced additional supply complications because of current regulatory provisions on contracting; provinces like Occidental and Oriental Mindoro experienced rotational outages due to contractual problems.[9]

There is still no certainty when oil and coal prices would go down, or how the global supply chain would continue to be affected by international events. With these looming uncertainties, there is an urgent need to address the reliability, affordability, and security of the power system by replacing imported fossil fuels with indigenous sources.

What is the Best Way Forward to a Resilient Energy Sector?

Given the country's geography and minimal domestic fossil fuel sources, the Philippines' way forward to a more resilient energy sector is to tap technological innovation brought about by flexible and distributed generation and renewable energy development. The reliability, affordability, and security concerns affecting coal and gas plants could be addressed by shifting toward a flexible and distributed generation anchored on renewable energy.

The Philippines is fossil-fuel poor, but renewable energy-rich. The abundance of RE sources in various regions of the Philippines could pave the way for a more distributed energy system. The characteristics of a distributed generation are advisable for an archipelagic country like ours; a robust network of interconnected self-sustaining sub-grids and micro-grids will be highly resilient and affordable.

While WESM data showed the unreliability of coal power plants, it highlighted the predictability of solar and wind power plants. In the monthly reports by IEMOP on the performance of must-dispatch resources, the aggregated performance of variable RE sources outperformed the standard forecasting accuracy required by the grid regulator.[10] This indicates a highly predictable system, which will further improve due to advances in forecasting and RE technologies.

Data also indicate that the supplies from variable RE sources, such as solar and wind, address the peak demand of the grid. While solar generation profile peaks at around noon, wind generation supply is mainly during the afternoon towards the evening, as indicated in Figure 5. Their combination can therefore address the peak demand that occurs during these periods.

Solar and wind power projects have the added advantage of quicker implementation over other supply options. The average construction lead time for a utility-scale solar power plant is around 1.5 years, while for a wind power plant is 2 years[11] – both significantly faster than other types of power plants. The faster deployment will reduce our dependence on imported and highly volatile resources, thus accelerating the energy transition.

The big question is: will solar and wind be enough to support a resilient energy sector? Maybe not. However, there are additional capacities that may be tapped from other renewable energy sources such as hydro (12,113 MW), geothermal (883 MW), and biomass (219 MW) based on DOE's latest summary of projects.[12] As an indigenous resource, they would not be affected by fuel price volatility in the global market. Moreover, these RE generation sources will be competitive considering the current and prospective high prices of fossil fuels.

Furthermore, the government plans to conduct more green energy auctions following the fairly successful first round last June when nearly 2,000 MW of solar, wind, hydro, and biomass capacities were awarded at prices way below current costs of coal generation.[13] The Green Energy Auction Program together with the Competitive Renewable Energy Zones will help achieve the targets of 35% RE share by 2030 and 50% share by 2040.

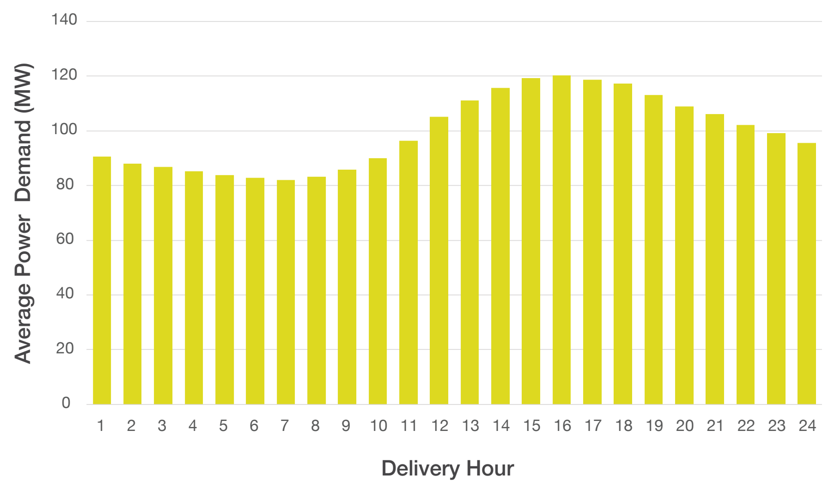
Average Solar Power Demand in 2020 Data

Figure 5

Source: ???

Average Wind Power Demand in 2020 Data

Figure 5



Source: ???

Support of Market Forces Towards a More Resilient Energy System

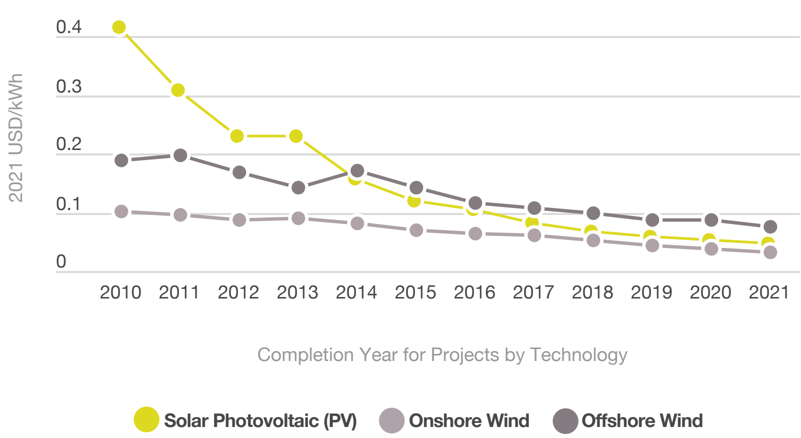
Aside from the energy reliability, affordability, and security concerns in the centralized power system and baseload power generators, economic market forces also support the need for a rapid shift to distributed generation:

a. Deflationary costs of RE, storage and other technologies

As indicated in the report by IRENA, the past decade has shown a seismic improvement in the competitiveness of renewable energy resources.[14] The global weighted average levelized cost of electricity (LCOE) of newly commissioned utility-scale solar PV projects declined by 88% between 2010 and 2021, while LCOE of onshore wind fell by 68% and offshore wind by 60%, as indicated in Figure 6. Since the Philippines imports most of its fossil fuels, the continual decline in the prices of RE technologies would make renewables even more competitive against fossil fuels.

Deflationary Cost of Renewable Energy Sources Over the Past Decade

Figure 6



Source: IRENA

In the Philippine context, all prices awarded in the recent green energy auction were below Php6 per kilowatt-hour versus actual coal generation costs ranging from Php8 to 12 per kilowatt-hour.

Despite the rising materials and equipment costs in 2021, the global weighted average cost of newly commissioned solar photovoltaic (PV), onshore and offshore wind power projects still fell in 2021. The rapid decline in costs of renewable energy power generating technologies is also exhibited by battery storage and other technologies.[15]

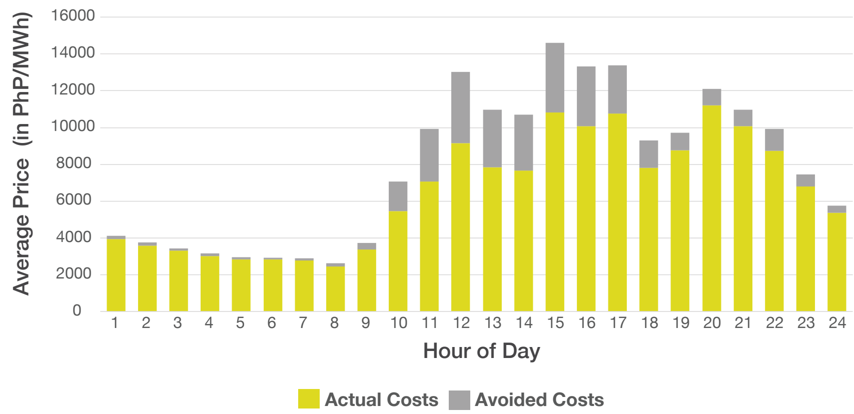
b. Reduction of electricity prices due to availability of RE resources

All data and previous studies of the Philippine Electric Market Corporation (PEMC) show that renewables are not subsidized, as the increasing penetration level of vRE resources promotes lower market prices.[16] Contrary to claims that Feed-in Tariff (FIT) increased electricity rates, the study proved that FIT actually

“The Philippines is still supply-deficient and needs to build more power plants to meet its rapidly growing energy demand. Assuming that the target installed capacities in the Power Development Plan and the National Renewable Energy Program are attained, the additional supply will just cover the projected demand.”

Actual Settlement Price of Electricity vs. Avoided Cost Due to RE in 2019

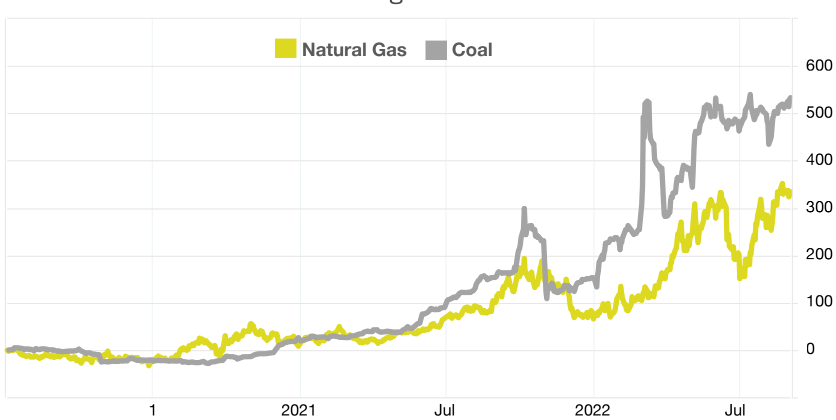
Figure 7



Source: CASE PH

Percent Change of Prices of Natural Gas and Coal in the World Markets from January 2020 to August 2022

Figure 8



Source: Trading Economics

redounded to billions of pesos in savings to consumers due to the merit-order effect.

The CASE PH in its TARGET report yielded similar results. In their study, a scenario was simulated where these vRE plants were not installed in the grid and were compared with the actual scenario. Results show that with a minuscule share of under 3% in the energy mix, vREs have effectively reduced the WESM market prices by 28% during peak hours. The simple explanation for the savings is that renewables being available at the right time displace very expensive oil-based generation in the merit-order dispatch. Thus, vREs reduce the WESM market prices whenever they are available.

There is certainly a large potential to further reduce electricity prices with higher RE penetration in the energy mix.

c. Rising fossil fuel prices in the global markets

Recently, the prices of coal and LNG in the global markets have increased by three to five-fold, as shown in Figure 8. Relating back to Figure 4 which shows the blended generation rates in major distribution utilities, these increases in fossil fuel prices are totally borne by the consumers.

Note that fossil fuel-based power generation is highly dependent on fuel costs, and fuel typically accounts for about half of the total cost. The regulatory practice of automatic fuel price pass-through or pasaload resulted in the volatile prices shown in Figure 4. Pasaload is considered highly disadvantageous to consumers because they bear all fuel risks while being the least capable of mitigating such risks. This highlights the longstanding calls to abolish the pasaload to ensure a competitive electricity market.

d. Preferential dispatch of all RE plants in the WESM

DOE is considering preferential dispatch of all renewables at the WESM[17] in recognition of the "zero marginal cost" and indigenous supply of renewables that directly address cost, security, and resiliency concerns. Currently, only solar, wind and run-of-river hydroelectric power plants receive preferential dispatch in the spot market. With the proposed policy by the DOE, other renewable energy technologies such as geothermal, biomass, and impounding hydroelectric power plants would also be given preferential dispatch.

The passage of this policy is expected to reduce settlement prices, increase the utilization of power plants that utilize indigenous resources, and reduce dependency on imported energy commodities. The policy will make the country's supply and delivery of electric power more stable and secure from international market volatility. Moreover, this policy would hopefully encourage renewable energy power producers and funders to build merchant plants.

Policy And Regulatory Reforms for a More Efficient Power Sector

The previous discussions established that the Philippine energy sector is experiencing a rapid and inevitable shift to distributed generation fueled by the following factors:

a. Recurring forced and unplanned outage of existing baseload generation
b. Continual decline in the costs of RE, storage, and sector coupling technologies;
c. Rising fossil fuel prices;
d. Global supply chains problems caused by the Covid-19 pandemic and the Ukraine invasion; and
e. Reduction of GHG emissions to mitigate global warming;

The paradigm shift in the power sector necessitates a similar shift in the policy and regulatory regime. The mechanisms and incentives under EPIRA, RE Act, Energy Efficiency Act, and environmental laws which promote free market competition and flexible generation must be strengthened and fully implemented. To equalize competition among technologies, regulations that unduly favor fossil fuel power plants for several decades should be abolished.

The three attributes of the power system of resiliency, flexibility, and connectivity proposed by the Electric Power Research Institute (ERPI) could not be achieved without major changes in energy policies and regulations.

- "Resiliency refers to the ability to harden the system against and quickly recover from high-impact, low-frequency events. Resiliency is vital to the Philippines; more so since it is subjected not only to high impact low-frequency events, but frequent extreme weather events. Power outages, which unfortunately still burden our people, cause billions of pesos in losses to all end-users per occurrence. The digitalization of society and the prolonged lockdowns during the pandemic increase consumer reliance on electricity; these impose pressure on utilities to enhance system resiliency.

- Connectivity refers to the rapid widespread deployment of advanced information technology equipment that can help decisions and behaviors along the value chain. Factors driving connectivity are intelligent and connected two-way flow of power and information; grid modernization technologies that depend on and build on increased connectivity; connection of advanced sensors across the network to improve decision making; and pervasive interconnected mobile devices across all industry and consumer classes.

- Flexibility is the system's ability to adapt to changing conditions while providing electricity safely, reliably, and affordably. The main factors driving flexibility in both supply and demand, are uncertain fuel prices, power market prices and incentives, variable generation, regulation and policy, and consumer behavior."[18]

To achieve these attributes, especially the flexibility of the power system, all present and future resources must be on a level playing field. The MIT Energy Initiative: Utility of the Future paper recommended: "cost-reflective electricity prices and regulated charges based on what is metered at the point of connection and not behind the meter. Flat volumetric tariffs should be replaced by cost-reflective prices and regulated charges, which are symmetrical with the injection at a given time and place, i.e., compensated at the same rate that is charged for withdrawal. Regulators can cope with the evolving and uncertain energy landscape through incentive-compatible contracts, automatic adjustment factors to account for forecast errors, and outcome-based performance rewards for enhanced resiliency, reduced distribution losses, and improved interconnection times. The wholesale market transactions should be as near as possible to real time to reward flexible resources and better forecasting. More efficient pricing of reserves can improve price signals and strengthen the link between energy and operating reserves. For transparency, monitoring and connectivity, a data hub secure from cybersecurity threats is necessary for storing metered data on customer usage, telemetry data on network operations, and other relevant information. It is important that non-discriminatory access must be provided to all registered participants."[19]

Rate design is very important in encouraging flexible generation; the design must address both demand on the part of power producers and demand-side management of the part of end-users. Below are the rate design options for electricity pricing available to regulators:

The regulators can utilize Auctions as well as Corporate Virtual Power Purchase Agreements to accelerate the deployment of distributed energy resources. The terms and conditions must be fair and attractive enough to attract a sufficient number of participants.[20]

New Technologies and Mechanisms

The Philippines is still supply-deficient and needs to build more power plants to meet its rapidly growing energy demand. Assuming that the target installed capacities in the Power Development Plan and the National Renewable Energy Program are attained, the additional supply will just cover the projected demand. Moreover, the continual decline in RE costs together with higher generation efficiencies could encourage the heavy influx of a large number of prosumers in the energy mix. In many countries in Europe, they already have to contend with excess power supply from RE sources on a regular basis. How could the excess power be saved and then utilized for future use? How could regulations encourage end-users to either consume, save, or convert the surplus supply? These are the technologies and mechanisms already being

Rate Design Options for Electricity Pricing

Table 1

Traditional Rates		Smart Rates	
Rate Design Option	**Definition**	**Rate Design Option**	**Definition**
Volume rate	Payment per kWh consumed	Time-of-Use	A form of time-varying rate, where the cost of electricity varies based on the time of day it is consumed
Fixed rate	Payment per kW/month	Critical Peak Pricing	Pricing scheme where rates are low in off-peak times but increase substantially when costs spike
Minimum bills	Per kWh rate that does not apply unless a customer uses less than a certain amount of power each month	Real-Time Pricing	Pricing scheme where customer pay a rate that is directly linked to the hourly market prices. Generally, in use for large consumers (industry, commercial users)
Demand Charges	Customers are charged based on their peak consumption, which can be determined either ex-ante or ex-post	Locational Pricing	Geographically differentiated price signals that reflect the specific costs to transmit electricity from generation to load

Source: RENAC

relied upon by other countries to cope with excess supply from RE sources.

Sector Coupling

"Sector coupling is the use of electricity to provide heating, cooling, mobility, and energy for industrial applications in direct or indirect form. It provides a solution for decarbonization by providing an alternative to fossil fuels for many applications.

Electricity is often times used directly as a final energy source, for example, to power a battery electric vehicle (BEV) or to operate a heat pump. However, electricity can also be used indirectly where it is converted to a different energy carrier first. The main disadvantage to converting electricity for indirect use of electricity is a loss in efficiency corresponding to higher total costs.

In the transport sector, BEVs already offer a suitable technology for passenger cars and commercial transport. For large heavy-duty transports, the high energy densities required cannot yet be provided by current battery technology. The use of overhead line systems and gaseous or liquified synthetic fuels are possible options. For EVs, a promising flexible strategy is to shift load from EVs to nighttime when demand is low or during times of high RE feed-in.

Regulatory Framework

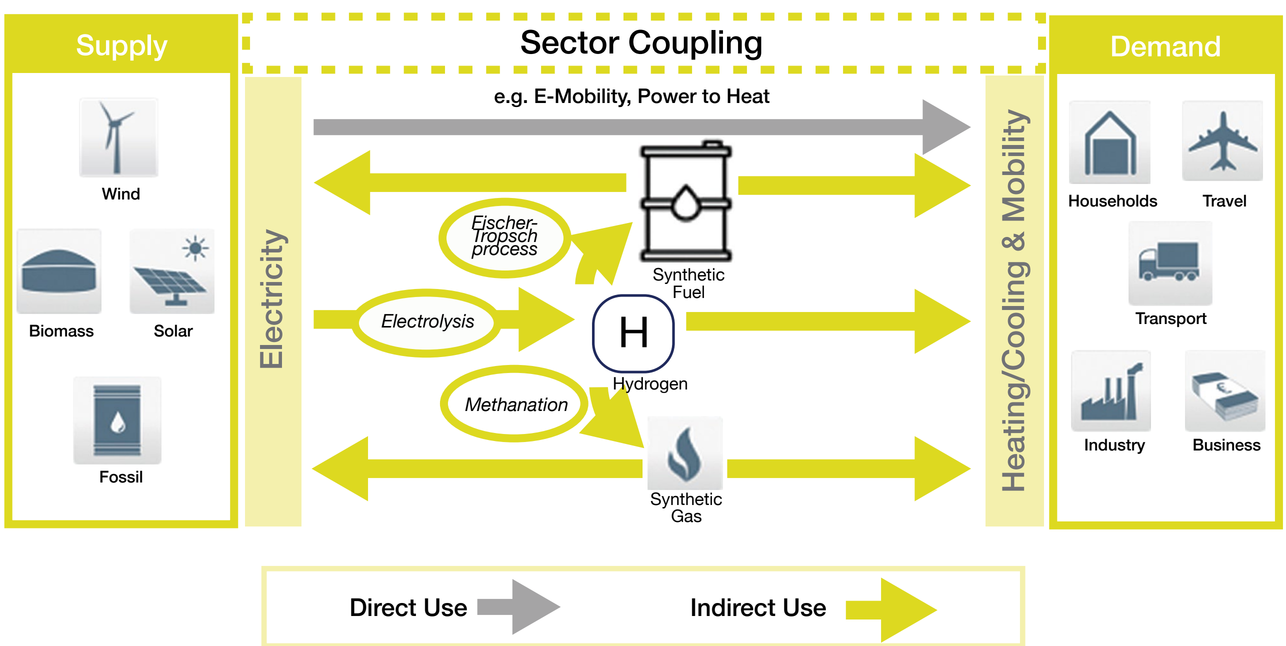
A barrier to the increased application of sector coupling is the high electricity prices that may be passed on to consumers. A supporting regulatory framework that minimizes price distortions between electricity prices and fossil fuels must be established. This could be achieved partly through consistent pricing and/or taxation of the CO2 emissions from the different energy carriers.

Digitalization

The power sector is highly affected by digitalization, due to the exponential growth in the amount of data of the sector. Per Reinsel, Gantz and Rydning

Concept of Sector Coupling

Figure 9



Source: r2b energy consulting, 2019. Redrawn by RENAC as adapted by RENAC, the worldwide amount of data is projected to increase from 33 Zettabytes in 2018 to 175 Zettabytes by 2025. A zettabyte is equal to 270 bytes. The power sector must integrate digital systems into their business processes. The increasingly higher share of decentralized RE sources requires efficient digital systems. New products and services must be employed from generation to measurement and accounting.

Virtual Power Plants

Compared to conventional power plants, distributed RE generation has the following disadvantages: lower generation capacity, flexibility, and availability. However, digitalization enables the combination of the properties and outputs of many small RE generators into one virtual power plant (VPP). The VPP accumulates the installed generating capacities and load ramps of multiple sources. It can be managed like one large power plant with a certain capacity, flexibility, and availability.

Smart Storage

Storage is utilized to store the excess power. The three general categories of smart storage are:

- Electrical storage: Capacitors and coils, which store energy either in an electrical or a magnetic field.

- Electrochemical storage: Mainly batteries (including Redox flow batteries). Batteries have high energy densities and quick reaction times to store and deliver energy.

- Mechanical storage: Pumped hydro storage units that store energy as potential energy in water reservoirs. Flywheel, which stores energy as kinetic energy in a large spinning mass.

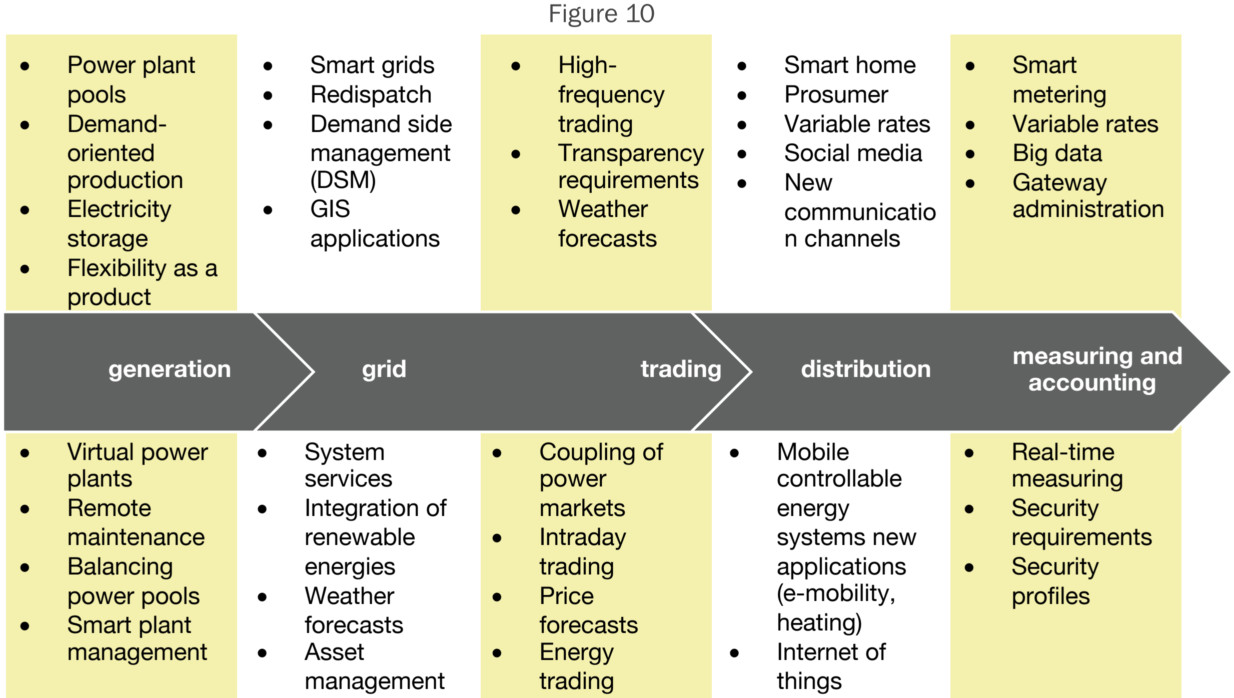
Smart storage units must be able to react quickly to changing power supply and demand. They need to be flexible and small enough to be built and operated in a distributed way.

Smart Grid

The traditional power grid is centralized and designed to transmit

Current Digitalization Trends in Power Economics in the Five Steps of the Value Chain of the Power Sector

Figure 10

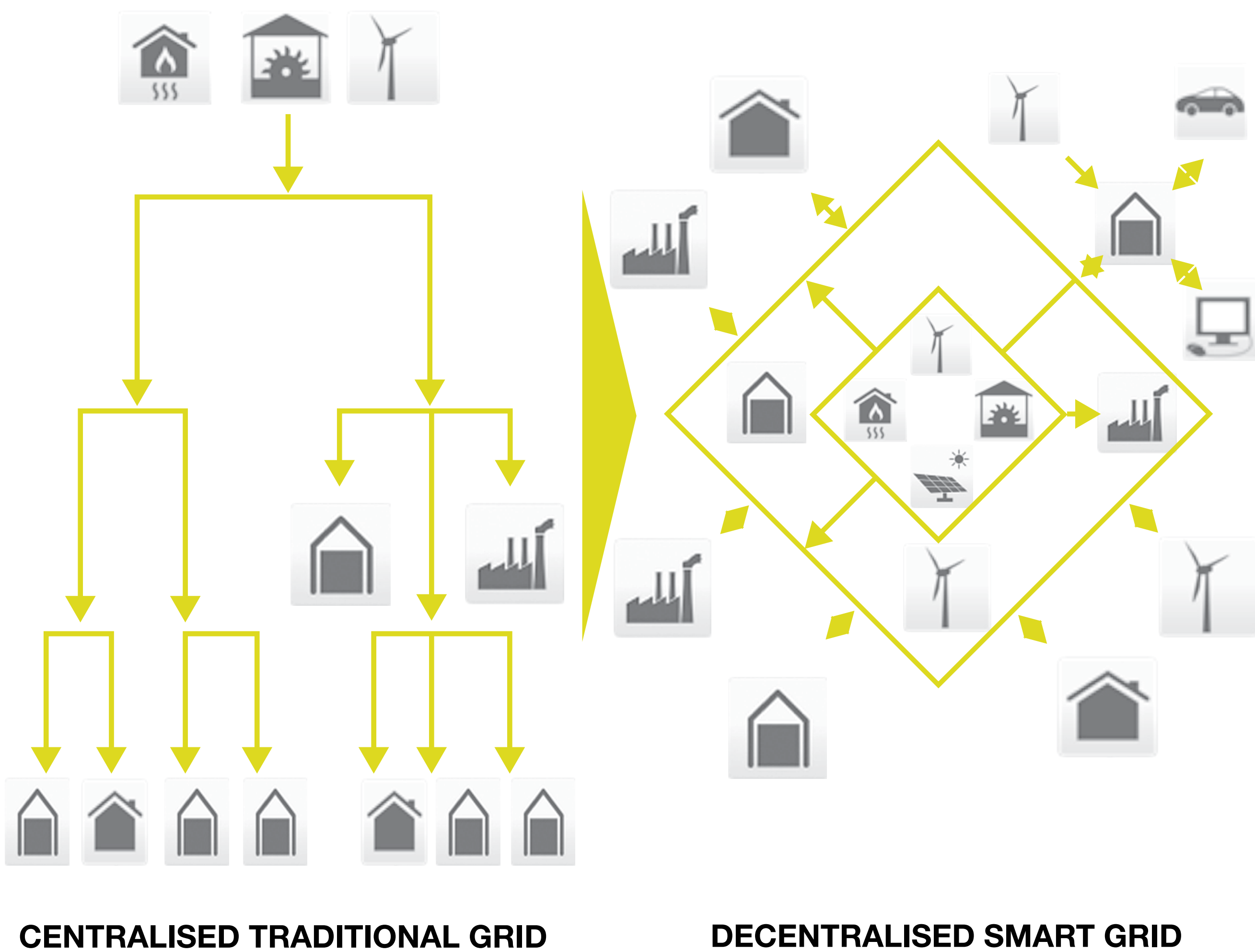


Source: RENAC based on Roth, 2018

electricity from a small number of large generators to many decentralized end-users via unidirectional power flows from high to low voltage levels. Considering the increasing share of RE sources, energy storage, and smart power management, generation has become decentralized. Power flow is no longer only unidirectional, but also bidirectional between units of the same voltage level as well as from low to a high voltage level. This change necessitates the use of more flexible controls, in the so-called smart grid. The technological basis for a smart grid is a digital communication infrastructure, which can help enable the transition towards a carbon-free economy."[21]

Comparison Between a Centralized and Decentralized Grid

Figure 11



In a traditional grid (left), load flows are unidirectional from the top (generation) to the bottom (consumption). In decentralized smart grids (right), power and information can flow in both directions

Source: RENAC, adapted from ABB, 2019

Conclusion

The transition towards a more resilient, flexible, and distributed energy sector is inevitable, for the following reasons:

The energy transition towards renewable energy: the only choice
The data presented in this paper show that an energy transition centered on flexible and distributed generation and renewable energy development is the only choice for the Philippines. The existing baseload-centric system has proven to be unsuitable as the global supply constraints highlighted the systemic issues of our overreliance on baseload generation. The outages attributable to baseload power plants and their continually increasing generations costs were shown as the major causes of the twin banes of unreliable supply and high power rates.

These issues can be addressed by instituting renewable energy as the foundation of a resilient power system. RE resources are established to be highly predictable and available during times of high demand – which make them the preferred energy resource to reduce the overall blended price of electricity in these periods. Being indigenous, they are mainly immune from the variability of global fuel prices, foreign exchange rates, and supply chain problems.

The reliable, affordable, secure, and resilient main grid
In the context of the main grid, the pivot towards a more flexible and distributed generation would pave the way for an energy sector that is less vulnerable to extreme weather events. Strong typhoons usually topple transmission towers and lines, which cause brownouts and lengthy as well as costly restorations. This also highlights the strategic role of the National Grid Corporation of the Philippines (NGCP) to establish a more resilient main grid – wherein the existing transmission infrastructure would transition from being the highway of baseload power towards being an interconnection between various distributed generation sub-grids.

Sustainability and self-sufficiency in small island grids
In the context of small island grids and microgrids, the pivot towards renewable energy as the main energy resource would require a more sustainable energy system. The sole dependence on diesel in these areas is highly inefficient, unreliable, expensive, and insecure – as evidenced by impending multiple occurrences of power crises in these island grids caused by high fuel costs.

Renewable energy should be prioritized in these areas. By doing so, these off-grid areas can develop community-based RE systems, that would pave the way for economic development and better quality of life in small island grids and remote areas.

Policy should adapt to emerging technologies
For a more resilient power system, a level playing field across all energy resources is imperative. Policies and regulations should address the requirements of a flexible and distributed generation. One key policy is the abolition of the automatic fuel cost pass-through clauses in power purchase agreements; the pasaload provides power producers with minimal risk investments while placing the onus of fossil price volatility on the consumers. Regulators must institute their firm mandate under the Constitution, EPIRA, and energy laws, which provides for preferential bias toward indigenous, clean and affordable energy resources. Innovative pricing and regulated charges to unlock flexible demand, distributed generation and energy efficiency must be developed and implemented.

Ultimately, our power supply can be founded on RE resources as long as appropriate policies and regulations are crafted for emerging technologies. For instance, the adoption of smart grids as the distribution backbone would allow for flexible, decentralized energy systems to work on a large-scale basis. Sector coupling, smart storage technologies, virtual power plants, and smart contracts would further ensure the optimal utilization of RE resources. Deployment of these technologies is not far-fetched for a developing country like the Philippines. In fact, the Philippines is one of the early adopters of digitalization in power trading through the Wholesale Electricity Spot Market in 2006. The WESM design was enhanced and has transitioned into a five-minute dispatch in June 2021, serving as a major enabler of flexible generation in the Philippines.

These new technologies in tandem with outcome-based performance incentives for enhanced resiliency, reduced distribution losses, and improved interconnection times would enable the achievement of a resilient energy system based on flexible and distributed generation.

endnotes

[1] U.S. National Association of Regulatory Utility Commissioners, January 2020

[2] Data from 2017- 2020 showed Circulating fluidized beds and pulverized subcritical coal plants to be unavailable about 20% of the time annually (CASE Philippines, 2021).

[3] The average Circulating Fluidized Beds (CFB) and Pulverized Subcritical Coal (PSC) coal plants have a combined planned and unplanned outage limits of 32.3 days and 44.7 days, respectively (ERC, 2020)

[4] 2021 Coal Statistics (DOE, 2021)

[5] Indonesia bans coal exports in January on domestic power worries (Reuters, 2022)

[6] Indonesia blocks exports from 48 coal miners as EU's Russian coal ban begins (Hellenic Shipping News, 2022)

[7] Philippine Energy Plan 2020-2040 (DOE, 2021)

[8] Government seeking funds to pay P1.26-B Napocor diesel debt, legislator says (Business World, 2022)

[9] Mindoro power woes continue (The Manila Times, 2022)

[10] 2019-2021 Monthly Report on the Monitoring of Forecast Accuracy Standards for Must Dispatch Generating Units (IEMOP, 2021)

[11] For a 150 MW solar photovoltaic plant, total lead time before commercial operations date is 18 months. For a 200 MW onshore wind plant, total lead time before commercial operations date is 21 months (EIA, 2020).

[12] Summary of Renewable Energy (RE) Projects under the RE Act of 2008 (DOE, 2021)

[13] DOE to re-evaluate volume for next round of RE auction (Manila Bulletin, 2022)

[14] Renewable Power Generation Costs in 2021 (IRENA, 2021)

[15] Grid scale battery costs have reached a tipping point (IEEFA, 2020)

[16] Increasing Penetration of vRE Resources and The Reserve Market (PEMC, 2018)

[17] DOE: Preference of RE plants in spot market to ramp up energy security (Philippine Star, 2022)

[18] Adapted from Electric Power System Resiliency: Challenges and Opportunities. Electric Power Research institute. February 2016

[19] Adapted from MIT Energy Initiative: Utility of the Future. MIT. December 2016

[20] Online Course. Policy frameworks for renewable energy generation, Renewables Academy (RENAC) AG, Berlin, 2019-06-28, p. 21

[21] Adapted from Online Course. Power-to-X: applications and cost developments, Renewables Academy (RENAC) AG, Berlin, 23 April 2021

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