ATENEO DE MANILA UNIVERSITY
Department of Economics
ATENEO CENTER FOR ECONOMIC RESEARCH AND DEVELOPMENT

COVID-19, Coal, and the Energy Transition in the Philippines

BY

Majah-Leah V. Ravago and James A. Roumasset

Working Paper No.2020-09

June 23, 2020

Rm. 409 4/F, Dr. Ricardo & Rosita Leong Hall,
Ateneo de Manila University
Loyola Heights, Quezon City 1108, Philippines
Telephone: (632) 8426 6001 Local 5221 or 5222
Telefax: (632) 8426 5661

COVID-19, Coal, and the Energy Transition in the Philippines [*]

Majah-Leah V. Ravago, *Economics Department, Ateneo de Manila University*
James A. Roumasset, *Economics Department and UHERO, University of Hawaii*

Abstract

June 2020

The lockdown associated with COVID-19 caused a sizeable downward shock to electricity demand in the Philippines. Although coal is usually classified as a "baseload" fuel, it ironically bore the brunt of adjustment in the generation mix. The resulting upward pressure on retail prices was offset by *force majeure* contract provisions that allowed distribution utilities to pay lower fixed charges on their power purchase agreements. Coal generators thus suffered the double whammy of lower sales at lower rates. While existing coal plants will contribute to affordability during the recovery, plants in the planning stage may be reevaluated in light of the falling cost of wind and solar power and the low costs of dealing with intermittency when the percentage of intermittent generation is low. The Department of Energy's "technology neutral" policy towards the generation mix is sound so long as least cost is interpreted to include the social costs of pollution. Some changes in renewable energy policy are indicated.

JEL: Q4, Q2, O1
Keywords: COVID-19, Electricity industry, Energy transition, Philippines

[*] This paper elaborates on our commentary, "Can COVID-19 spark an energy transition in the Philippines?," published in the *East Asia Forum*. MVRavago (mravago@ateneo.edu) is Associate Professor at the Ateneo de Manila University and JARoumasset (jimr@hawaii.edu) is Visiting Professor, Hiroshima University and Professor Emeritus, Economics Department and UHERO at University of Hawaii.

Covid-19, Coal, and the Energy Transition in the Philippines

Majah-Leah V. Ravago, *Ateneo de Manila University Economics Department*
James A. Roumasset, *University of Hawaii Economics Department*

The Philippines Medium-Term Development Plan of 2017-2022 is anchored on *Ambisyon Natin 2040* (Clarete, Esguerra, and Hill, 2018; President of the Philippines, 2016), which targets attaining high-income status by 2040. From 2010-2019, the economy was nearly on track with this ambition, growing at an average rate of 6.3 percent, having apparently conquered boom-and-bust cycles characterizing economic development in the Philippines previously (Balboa 2019; Balisacan 2018).

In line with these rosy forecasts, electricity consumption was expected to grow to nearly four times its 2018 level by 2040, prompting concerns about attracting generation investments (Rivera 2019) to meet the growing demand. Enter the COVID-19 pandemic, and these concerns have evaporated. Since the first cluster of COVID-19 patients first erupted in Wuhan, China in December, the pandemic has affected 140 countries, including the Philippines. In mid-March 2020, President Duterte, along with local government officials, placed Metro Manila and the surrounding provinces under a hard lockdown (President of the Philippines 2020) known as "enhanced community quarantine" (ECQ). As operations of industrial facilities and commercial establishments slowed, especially in lockdown areas, electricity generation dropped by 20% in April and by 15% in May. From the perspective of energy economics, how would we expect a downward demand shock to affect the energy mix. For this we begin with a brief review of the simple economics of generation mix.

It is commonly believed that, due to its low fuel cost, high plant cost and high ramping inefficiencies that the least-cost generation mix involves using coal as the "baseload" fuel, meaning that it has a comparative advantage in serving the minimum load over a typical 24 hour period such that it can run at a nearly constant rate, at or near maximum capacity. In contrast, the low plant costs and greater ramping flexibility of open-cycle gas turbine plants (OCGT) makes them suitable as "peaker plants," i.e. with a comparative advantage in serving peak demands. The higher plant costs but greater energy efficiency of combined cycle gas turbines (CCGT) makes them the least cost choice hours of intermediate demand. (By running longer hours than peaker plants, the fixed cost is spread out over more hours.)

Joskow (2006) proposed using *screening curves* to determine the least-cost mix of thermal generation fuels. Screening curves plot average cost as the linear function, annualized fixed-cost plus variable cost/hour times the number of hours used. Since minimizing cost implies choosing the fuel for each load-duration hour that has the least average cost, this method determines at

what load/hour, the baseload generation begins to be supplemented by the intermediate fuel type, and when those two types of generation are further supplemented by the peaking fuel-type.[2]

Applying this analysis to Luzon (main island of the Philippines), projecting demand to 2025, and including pollution costs, we find that, starting from scratch, coal is the least-cost generating fuel for the low-demand hours of 11pm to 8am. This means that CCGT should be running during the other hours. A very small supplementary capacity of OCGT is needed during the 1 and 2pm peak hours (Jandoc et al. 2018).

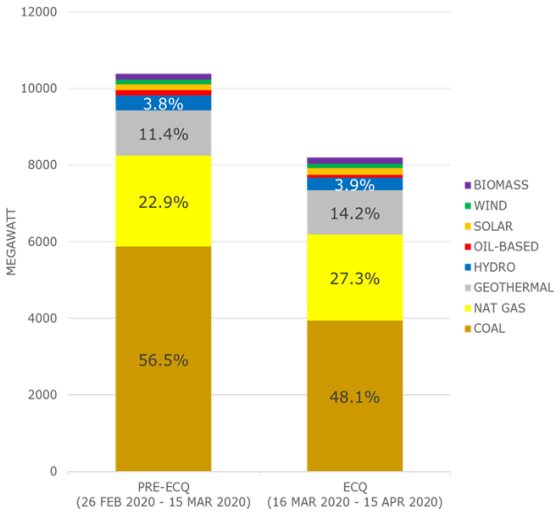
When demand falls, however, there is excess capacity. The problem becomes choosing which plants to use and which leave idle. From the forgoing, we know that coal generation has the least variable cost, primarily because of the relatively cheap fuel, even after adding pollution costs. In effect the screening curves shift down since we are no longer adding fixed costs. This analysis suggests that coal would be the sole generating source for more hours of the day than before and the burden of adjustment would fall on other plant types.

In reality, just the opposite happened. As shown in Figure 1, coal generation fell dramatically from 56% to 48%, a smaller share of a 20% smaller load (WESM-IEMOP April 23, 2020). Generation with natural gas decreased by 6 per cent, but as a share of total generation actually increased from 23 to 27 per cent. Other sources stayed about the same, with solar and biomass generation increasing slightly, reflecting new generation capacity.

The reason for this paradoxical result lies in inflexibilities in legal rules and contracts. Since renewables are assured "must-dispatch" status as per the Renewable Energy Act (Congress of the Philippines 2008), the system operator is required to accept whatever is generated. And while generation by natural gas is usually assumed to easily adjust to varying demands, what is not flexible is the supply of gas arriving by pipeline. The take-or-pay bilateral contracts with Meralco assure that minimum purchases of natural-gas generation reflect this inflexibility in gas delivery (and the very limited gas storage capacities). This leaves the burden of adjustment falling on coal plants, a number of which have had to temporarily shut down production.

[2] See van Kooten et al. (2016) for an instructive application of the screening-curve methodology. Joskow (2006) notes that the method is not applicable to intermittent renewable sources, however. Jandoc et al. (2018) adapt screening curves methodology to the Philippine case by subtracting projected renewable generation from projected load and applying the method to residual demand. An alternative method would be to remove the intermittency by adding storage cost *ala* Heal (2016, 2017).

Figure 1. Generation Mix Before and After Enhanced Community Quarantine

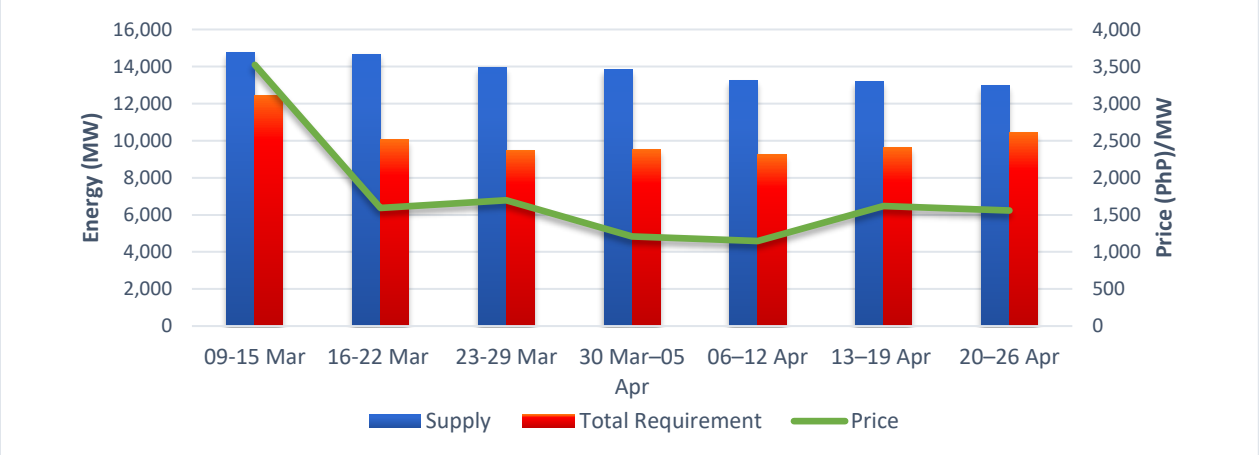


WESM Generation Mix (Actual Generation)				
Pre-ECQ		Fuel Type	ECQ	
Hourly Average, MW	%Share of Total		%Share of Total	Hourly Average, MW
5,870	56.5%	Coal	48.1%	3,946
2,379	22.9%	Nat Gas	27.3%	2,241
1,180	11.4%	Geo	14.2%	1,161
396	3.8%	Hydro	3.9%	320
130	1.2%	Oil	1.0%	78
160	1.5%	Solar	2.2%	177
122	1.2%	Wind	1.4%	117
154	1.5%	Biomass	1.9%	158

Image Source: Wholesale Electricity Spot Market (WESM) - Independent Electricity Market Operator of the Philippines (IEMOP) 2020.

Turning to the effect of the lockdown on electricity prices, average wholesale rates on the spot market fell by 55% during the lockdown period (Figure 2). Moreover, while wholesale prices used to peak around 2pm, they now peak in the early evening, reflecting the shifting demand from commercial and industrial to residential consumers. The typically higher percentage of solar generation during the early afternoon hours also contributed to this pattern.

Figure 2. Average Supply and Total System Requirement (Energy + Reserve)



Source of basic data: WESM - IEMOP (2020).

As for retail prices, the rates of Meralco, the country's largest distributor, increased from ₱8.90 per kWh in March to ₱9.00 per kWh in April. The increase appears paradoxical in light of the lower WESM prices. Appearances can be deceiving, however. WESM primarily serves as a residual market for generation excesses and unexpected demand. Most generation is covered by prices set according to previously negotiated bilateral contracts. Since prices on coal contracts are typically lower than prices for natural gas and renewable sources, the shift away from coal implies that average costs to distribution utilities such as Meralco have increased. In addition, the April increase reflected the Universal Charge returning to its normal level following a one-time refund of P0.1453.

In May and June, Meralco rates declined to ₱8.75 and ₱8.72 per kWh, respectively in Metro Manila and its other service areas (Meralco n.d.; CNN Philippines Staff 2020a and 2020b). These decreases were due to the lower costs that Meralco paid to its suppliers. Power supply agreements (PSAs) are bilateral contracts specifying the terms on which power is supplied to the distribution utilities. The typical consist of a fixed charge to be paid monthly and a price per kWh. Since April, Meralco has availed of *force majeure* provisions in their PSAs allowing them to pay a lower fixed charge and to suspend most of their mid-merit supply contracts. [3] In April, ERC also suspended Feed-In-Tariff Allowance component of customer bills in light of the CoVid-19 situation (ERC 2020a).

While these provisions avoided increases in retail rates, they imposed a double whammy on coal generators—lower sales and worse terms of sale. As recovery continues, it is unclear whether retail rates will increase, decrease, or return to previous levels. On the one hand, WESM prices will increase and the cost relief measures associated with *force majeure* will also come to an end. On the other hand, average generation costs will decrease as coal-fired generation comes back online.

Outside of Metro Manila, most electric cooperatives and private distribution utilities are struggling with collections since meter-reading is manual and prevented by the lockdown. Power outages continue to plague parts of Mindanao. When a cooperative in Zamboanga City finally billed their customers, complaints ensued due to large price increases (Jacinto 2020).

Since ECQ was extended to May 15, Meralco invoked the previous 3 months average rule[4] of Energy Regulatory Commission (ERC) to bill customers, resulting in widespread confusion and complaints. The average consumption from December, January, and February was used to bill customers in the summer months of March and April (Reyes 2020; Oplas 2020), even though consumption in summer is typically higher as shown in Table 1. In May, adjustments were made to reflect actual consumption, resulting in a bill shock for residential consumers. This prompted a Senate investigation (Ramos 2020) and a subsequent order from the sector regulator directing

[3] As approved by the ERC.

[4] The 3-month average rule is provided in Section 3.5.4 of the Distribution Services and Open Access Rules or DSOAR (ERC Case No. 2005-10RM). ERC is yet to determine if Meralco's computation has indeed complied with the relevant rules issued by the regulator (ERC 2020b).

the staggered collection of payments to cushion the impact of the lockdown (ERC 2020b; Flores 2020).

Table 1. NGCP's Billing Determinant Energy (BDE) from Distribution Utilities, in GWh.

	2019				2020			
	Philippines	**Luzon**	**Visayas**	**Mindanao**	**Philippines**	**Luzon**	**Visayas**	**Mindanao**
January	6,098	4,535	765	798	6,482	4,805	833	844
February	6,183	4,641	770	773	6,611	4,886	861	863
March	6,095	4,621	740	734	6,341	4,698	831	812
April	7,169	5,477	848	844	5,888	4,341	782	766
May	7,303	5,555	904	845				
June	7,590	5,800	932	859				
July	6,983	5,309	863	811				
August	6,997	5,264	888	846				
September	7,026	5,225	907	894				
October	7,094	5,332	896	867				
November	7,030	5,284	888	858				
December	6,480	4,818	835	827				

Source: National Grid Corporation of the Philippines (NGCP), BDE by customer type.

Pursuant to the Machiavellian credo to "never let a crisis go to waste,"[5] some observers have advocated government measures to accelerate the transition away from coal towards renewable source of generation (EcoBusiness 2020). The implementing rules covering the Renewable Energy Act of 2008 specify an "aspirational target" of 35% renewable by 2030, "subject to regular review and assessment by the DOE" (Department of Energy 2018).

The share of renewables in dependable capacity is already 31% (Table 2), suggesting that the target of 35% would be achieved much earlier than 2030. However, DOE rules (DOE 2017 and 2018) specify that the renewable portfolio standard (RPS) of 35% should be attained in terms of generation, not capacity. This is somewhat more difficult since the share of renewable in generation during 2018 was only 23.4% as shown in Table 3.

Despite the modestly higher gap to be filled, doing so does not make subsidies necessary. The Lazard levelized costs of electricity for wind and solar for the U.S. are already below those of coal and natural gas (e.g. Marachi 2020). Even though wind and photovoltaic power are intermittent resources, the costs of intermittency are quite modest, given the abundant

[5] The statement is commonly attributed to former Chicago Mayor Rahm Emanuel, but the original idea can be traced to Machiavelli.

opportunities for diversification, the falling costs of battery storage, and possibilities for demand management (Heal 2017).

Table 2. Total Installed and Dependable Capacity per Technology, in MW.

	Installed				Dependable			
	2017	**Share**	**2018**	**Share**	**2017**	**Share**	**2018**	**Share**
Coal	8,049	35%	8,844	37%	7,674	37%	8,368	39%
Oil based	4,154	18%	4,292	18%	3,287	16%	2,995	14%
Natural gas	3,447	15%	3,453	14%	3,291	16%	3,286	15%
Renewable Energy	7,080	31%	7,226	30%	6,263	31%	6,592	31%
Geothermal	1,916	8%	1,944	8%	1,752	9%	1,770	8%
Hydro	3,627	16%	3,701	16%	3,268	16%	3,473	16%
Biomass	224	1%	258	1%	160	1%	182	1%
Solar	886	4%	896	4%	700	3%	740	3%
Wind	427	2%	427	2%	383	2%	427	2%
Total	22,730	100%	23,815	100%	20,515	100%	21,241	100%

Source: DOE-EPIMB (2018), Power Demand and Supply Highlights.

Table 3. Generation Mix, in GWh.

	2017	**Share**	**2018**	**Share**
Coal	46,847	49.6%	51,978	52.1%
Oil based	3,787	4.0%	3,192	3.2%
Natural gas	20,547	21.8%	21,350	21.4%
Renewable Energy	23,189	24.6%	23,345	23.4%
Geothermal	10,270	10.9%	10,420	10.4%
Hydro	9,611	10.2%	9,406	9.4%
Biomass	1,013	1.1%	1,101	1.1%
Solar	1,201	1.3%	1,255	1.3%
Wind	1,094	1.2%	1,174	1.2%
Total	94,370	100%	99,765	100%

Source of basic data: DOE-EPIMB (2018), Power Demand and Supply Highlights.

Note: Numbers may not add up due to rounding.

Many "clean energy" and "sustainability" devotees decry the pre-lockdown decline in the share of renewables and favor an accelerated transition to renewable energy (Business Mirror 2020; EcoBusiness 2020, La Viña 2020). However, greater renewable mandates and subsidies would compromise the objectives of affordability, reliability, and security as required by the Electric Power Industry Reform Act of 2001 (EPIRA) and the tax reform act of 2000 (Congress of

the Philippines 2000).[6] Mandates and subsidies also put the renewability advocates at loggerheads with the DOE's declared "technology neutral" policy whereby the generation mix should satisfy the criterion of least cost (Inquirer.net 2017).

Economics provides a clear resolution of this apparent impasse. DOE needs only to interpret least cost to include the social cost of pollution. Given the rapid reduction in the cost of renewable energy, especially solar, and improvements in storage technology, the need is to facilitate an efficient energy transition, not to force it prematurely with costly subsidies.

Projecting the efficient (least social-cost) energy transition should take into account the declining costs of wind and solar power and the low costs of managing intermittency at levels needed to meet the RPS for 2030 (Heal, 2017). In order for the decisions of private investors to be consistent with least social costs, taxes should reflect the marginal damage costs of pollution, especially from generation with coal. The Philippines has included coal and petroleum excise taxes as part of the 2017 tax reform (Congress of the Philippines, 2017). The Renewable Energy (RE) Act of 2008 has put in place several programs and policy instruments that aim to accelerate the development of renewable energy (Congress of the Philippines, 2008). Replacing these with pollution taxes can harmonize the quest for renewability with affordability and other objectives of EPIRA.

The social cost of pollution includes both the domestic cost from carbon emissions and the costs of local pollutants (SO_2, nitrous oxides, and particulate matter) that impinge on health. The pollution cost of generation by coal are more than four times that for OCGT and 20 times that for CCGT (Jandoc et. al, 2018). These numbers highlight the environmental benefits of transitioning away from coal towards generation by natural gas (LNG, as the Malampaya gas fields are depleted) and by renewable sources.

Existing subsidies should be phased out in accordance with competitive costs wind and solar power. Inasmuch as current feed-in-tariff (FIT) rules involve several bureaucratic hurdles and *de facto* quotas, they may actually retard the energy transition. Moreover, the administration of quotas may impart market power, further inflating the cost to consumers.

In addition to pollution taxes, other policies can complement the ability of the market system to deliver energy efficiently. One of these is safeguarding competition by free entry into generation and retailing. Another is to plan investment in transmission in accordance with generation investments that minimize social cost.[7] Finally, aligning retail rates more closely with marginal costs, including real time pricing (Joskow and Wolfram 2012), can lower the costs on intermittency, lower rates, and deliver greater benefits from the power system.

[6] For a discussion of the potentially high *excess burden* cost of renewable mandates and subsidies, see Ravago and Roumasset (2018) and Roumasset et al. (2018).

[7] The ability of the NGCP to achieve this coordination has been frustrated in the past by renewable subsidies that inefficiently locate generation to surplus areas thereby bringing pressure to rationalize those investments with additional transmission capacity (see also Ravago and Roumasset 2018).

The hard lockdown was lifted on May 31 in Metro Manila. During the month of June, the lockdown is being gradually relaxed, and the economy is moving towards a "new normal" in anticipation of therapies and vaccines being developed. While resilience and disaster management were incorporated in economic planning for the energy sector under *Ambisyon Natin 2040,* the current slowdown was far greater than the effects of natural disasters. After a decade of rapid growth, GDP is expected to decline in 2020.[8] The nature of the rebound of the economy by 2021 (NEDA 2020; ABS-CBN News 2020) remains highly uncertain, lacking knowledge of the kind of recovery that will occur (Sheiner and Yilla 2020).

The lower growth trajectory means that electricity demand targets can be reduced. On the other hand, investments already in the pipeline may be delayed and new projects may be put off. The outlook for new investments in generation, more so in coal-fired power plants, is especially bleak given the current excess capacity. If and when the economy picks-up, there may again be a concern with attracting sufficient investment in generation. Accordingly, there is a need to reevaluate demand forecasts and revise investment plans. For example, "the ABC's of post-COVID-19 economic recovery" (Sheiner and Villa 2020) could be adapted to the Philippine case and mapped into demand forecasts for the different scenarios.

While the average costs of power delivery have temporarily increased, there are opportunities for lowering costs and consumer rates in the near, medium, and longer terms. First, as existing coal-fired plants come back online in response to recovery, average costs to the distribution utilities and electricity cooperatives will decrease. Any attempt to prevent this by carrot or stick will only lead to higher rates for consumers. Second, postponed investments in coal plants may be scrapped altogether, in lieu of investments in LNG-fueled plants and falling costs of wind and solar power, especially when taxes on coal generation reflect the marginal damage costs of pollution. These are promising conditions for an energy transition that is a win-win for affordability and sustainability.

Given that utility-scale wind and solar projects are cost competitive with coal and natural gas, even after adding the cost of intermittency, an investigation is needed into the relatively small investments in those sources. It is possible that the bureaucratic requirements of FIT subsidies are actually retarding investment relative to free market levels. Using COVID-19 to justify further subsidies is likely to be counterproductive, in spite of recent proposals to extend the feed-in-tariffs.[9] A better approach is for government to facilitate faster approval of unsubsidized projects.

[8] World Bank Senior Economist Rong Qian predicts a 2020 GDP decline of 1.9% (Reuters, 2020).

[9] With the ending of FIT awarding in 2019, the Mindanao Development Authority recommended the extension of the FIT program for hydro and biomass in Mindanao (Mindanao Development Authority, n.d.).

References

[data] National Grid Corporation of the Philippines. (2020). Billing Determinant Energy. https://www.ngcp.ph/

ABS-CBN NEWS. (2020). Economy to shrink further on longer lockdown, rebound seen in 2021: BSP, *ABS-CBN News,* 04 May 2020. Retrieved from https://news.abs-cbn.com/business/05/04/20/philippines-gdp-economy-contraction-negative-growth-COVID-19-bangko-sentral-benjamin-diokno on 20 May 2020.

Balboa, J. (2019). The Philippine economy remains stable despite Duterte's instability, *East Asia Forum,* 15 July 2019. Retrieved from https://www.eastasiaforum.org/2019/07/15/the-philippine-economy-remains-stable-despite-dutertes-instability/ on 30 May 2020.

Balisacan, A. M. (2018). Foreword in Clarete, R. E. Esguerra, and H. Hill (eds), *The Philippine Economy: No Longer the East Asian Exception?* Singapore: Institute of Southeast Asian Studies. https://bookshop.iseas.edu.sg/publication/2342

Clarete, R. E. Esguerra, and H. Hill. (2018). *The Philippine Economy: No Longer the East Asian Exception?* Singapore: Institute of Southeast Asian Studies. https://bookshop.iseas.edu.sg/publication/2342

CNN Philippines Staff. (2020a). Meralco Rates Up Slightly in March, CNN Philippines, 6 March 2020. Retrieved from https://cnnphilippines.com/news/2020/3/6/Meralco-rate-slight-increase-March.html on 5 April 2020.

CNN Philippines Staff. (2020b). Meralco Rates Lower in May, CNN Philippines, 8 May 2020. Retrieved from https://cnnphilippines.com/news/2020/5/8/lower-meralco-rates-may-2020.html?fbclid=IwAR1kV9uWjCPgrwhHy9PxkDnyiaS4wiTDZ-RKnu28IZqUXZab87ngoMYb9k8 on 15 June 2020.

Congress of the Philippines. (2000). Republic Act No. 10963, Tax Reform for Acceleration and Inclusion (TRAIN). Retrieved from https://www.officialgazette.gov.ph/downloads/2017/12dec/20171219-RA-10963-RRD.pdf on 15 May 2020.

Congress of the Philippines. (2008). Republic Act No. 9513, An Act Promoting the Development, Utilization and Commercialization of Renewable Energy Resources. Retrieved from https://www.officialgazette.gov.ph/2008/12/16/republic-act-no-9513/ on 10 May 2020.

Congress of the Philippines. (2017). Republic Act No. 9136, An Act Ordaining Reforms in the Electric Power Industry. Retrieved from https://www.officialgazette.gov.ph/2001/06/08/republic-act-no-9136/ on 20 May 2020.

Department of Energy. (2017). Department Circular 2017-12-0015, Promulgating the Rules and Guidelines Governing the Establishment of the Renewable Portfolio Standards for On-grid Areas. Retrieved from https://www.wesm.ph/market-development/re-market/renewable-portfolio-standards on 30 April 2020.

Department of Energy. (2018). Department Circular 2018-08-0024, Promulgating the Rules and Guidelines Governing the Establishment of the Renewable Portfolio Standards for Off-grid Areas. Retrieved from https://www.wesm.ph/market-development/re-market/renewable-portfolio-standards on 30 April 2020.

Department of Energy - EPIMB. (2018). Power Demand and Supply Highlights. Retrieved from https://www.doe.gov.ph/sites/default/files/pdf/electric_power/2018_power_situation_report.pdf on 14 June 2020.

EcoBusiness. (2020). Coalition celebrates leadership and cooperation in Philippine energy transition amid COVID recovery. Retrieved from https://www.eco-business.com/press-releases/coalition-celebrates-leadership-and-cooperation-in-philippine-energy-transition-amid-COVID-recovery/ on 15 June 2010.

Energy Regulatory Commission (ERC). (2020a). ERC Suspends FIT-All Collection to Lower Electricity Rates, 18 March 2020. Retrieved from https://www.erc.gov.ph/ContentPage/61946 on 18 June 2020.

Energy Regulatory Commission (ERC). (2020b). ERC Requires Meralco to Explain Consumers' Billings, 15 May 2020. Retrieved from https://www.erc.gov.ph/ContentPage/61974 on 2 June 2020.

Flores, A.M.E. (2020). ERC approves staggered payment of Meralco bills in four months, *ManilaStandard.Net*, 16 April 2020. Retrieved from https://www.manilastandard.net/business/power-technology/321702/erc-approves-staggered-payment-of-meralco-bills-in-four-months.html on 16 June 2020.

Heal, G. (2017). Reflections—What Would It Take to Reduce U.S. Greenhouse Gas Emissions 80 Percent by 2050?, *Review of Environmental Economics and Policy*, 11(2: 319-335, https://doi.org/10.1093/reep/rex014.

Inquirer.net. (2017). PH goes 'tech neutral' in new energy projects, *Inquirer.net,* 03 May 2017. Retrieved from https://newsinfo.inquirer.net/893737/ph-goes-tech-neutral-in-new-energy-projects on 10 May 2020.

Jacinto. A. (2020). Zamboanga power rates soar, *Manila Times, 2 May 2020.* Retrieved from https://www.manilatimes.net/2020/05/02/news/regions/zamboanga-power-rates-soar/721486/ on 20 May 2020.

Jandoc, K., J. Roumasset, M.V. Ravago, K. Espinoza. (2018). "The Simple Economics of Optimal Generation, Transmission, and Electricity Use" in M.V Ravago, J. Roumasset, and R. Danao

(eds.), *Powering the Philippine Economy: Electricity Economics and Policy.* Quezon City: University of the Philippines Press.

Joskow, P. (2006). Competitive Electricity Markets and Investment in New Generating Capacity. SSRN Electronic Journal. 10.2139/ssrn.902005.

Joskow, P. and C. Wolfram. (2012). "Dynamic Pricing of Electricity," *American Economic Review,* 102 (3): 381-85, https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.102.3.381

La Viña, T. (2020). A Crossroads for Meralco, *Rappler*, 23 May 2020. Retrieved from https://www.rappler.com/thought-leaders/261783-opinion-crossroads-meralco-bill on 15 June 2020.

Marachi, S. (2020). Renewable Energy Prices Hit Record Lows: How Can Utilities Benefit from Unstoppable Solar and Wind? Retrieved from https://www.forbes.com/sites/energyinnovation/2020/01/21/renewable-energy-prices-hit-record-lows-how-can-utilities-benefit-from-unstoppable-solar-and-wind/#294c5c722c84 on June 12, 2020.

Meralco. (n.d.). Rates Archives, Retrieved from https://company.meralco.com.ph/news-and-advisories/rates-archives on 17 June 2020.

Mindanao Development Authority. (n.d.). MinDA renews call for extension of feed-in-tariff in Mindanao. Retrieved from http://minda.gov.ph/news/241-minda-renews-call-for-extension-of-feed-in-tariff-in-mindanao on 18 June 2020.

National Economic Development Authority (NEDA). (2020). Addressing the Social and Economic Impact of the COVID-19 Pandemic. Retrieved from http://www.neda.gov.ph/addressing-the-social-economic-of-the-covid-19-pandemic/ on 20 May 2020.

Oplas, B.S. (2020). Meralco lockdown billings and coal contracts, *BusinessWorld,* 3 June 2020. Retrieved from https://www.bworldonline.com/meralco-lockdown-billings-and-coal-contracts/

President of the Philippines. (2016). Executive Order No. 5, s. 2016, Adopting the Twenty-five-year Long Term Vision Entitled Ambisyon Natin 2040. Retrieved from https://www.officialgazette.gov.ph/2016/10/11/executive-order-no-05-s-2016/ on 7 June 2020.

President of the Philippines. (2020). Proclamation No. 929, Declaring a State of Calamity Throughout the Philippines due to Corona Virus Disease 2019. Retrieved from https://www.officialgazette.gov.ph/downloads/2020/03mar/20200316-PROC-929-RRD.pdf on 7 May 2020.

Ramos, C.M. (2020). Gatchalian: Meralco to face scrutiny over 'confusing' high electricity bills, *Inquirer.net,* 19 May 2020. Retrieved from

https://newsinfo.inquirer.net/1277259/gatchalian-meralco-to-face-scrutiny-over-confusing-high-electricity-bills on 20 May 2020.

Ravago, M.V. and J. Roumasset. (2018). The Public Economics of Electricity Policy with Philippine Applications, in M.V Ravago, J. Roumasset, and R. Danao (eds.), *Powering the Philippine Economy: Electricity Economics and Policy.* Quezon City: University of the Philippines Press.

Ravago, M.V. and J.A. Roumasset. (2020). Can COVID-19 spark an energy transition in the Philippines?, *East Asia Forum*, 5 June 2020. Retrieved from https://www.eastasiaforum.org/2020/06/05/can-covid-19-spark-an-energy-transition-in-the-philippines/?fbclid=IwAR1cRjLFrt0OhiN32s7dwzB4FEGHbobYo_pwecDgwsMsAdAbtkg7Iktd18M 7 June 2020.

Reyes, M. A. L. (2020). Getting the Facts Straight, *PhilStar Global*, May 30 2020. Retrieved from https://www.philstar.com/business/2020/05/30/2017404/gettings-facts-straight on 15 June 2020.

Reuters. (2020). Philippine GDP to contract 1.9% in 2020: World Bank. Retrieved from https://www.reuters.com/article/philippines-economy-worldbank/philippine-gdp-to-contract-19-in-2020-world-bank-idUSP9N2C301B on June 17, 2020.

Rivera, D. (2019). Philippines needs more power plants to meet growing demand, *PhilStar,* Dec. 26, 2019. Retrieved from https://www.philstar.com/business/2019/12/26/1979748/philippines-needs-more-power-plants-meet-growing-demand on 5 May 2020.

Roumasset, J., M.V. Ravago, K. Jandoc, and C. Arellano. (2018). Environmental Resources, Shocks, and National Well-Being, in R. Clarete, E. Esguerra, and H. Hill, The Philippine Economy: No Longer the East Asian Exception? Singapore: ISEAS Institute.

Rudnick, H. and C. Velasquez. 2019. Learning from Developing Country Power Market Experiences: The Case of the Philippines, Policy Research Working Paper 8721. World Bank.

Sheiner, L. and K. Yilla. (2020). The ABCs of the post-COVID economic recovery, The Hutchins Center Explains Series, Brookings Institution. Retrieved from https://www.brookings.edu/blog/up-front/2020/05/04/the-abcs-of-the-post-covid-economic-recovery/ on 20 May 2020.

van Kooten, G. C., R. Lynch and J. Duan. (2016). "Carbon Taxes and Feed-in Tariffs: Using Screening Curves and Load Duration to Determine the Optimal Mix of Generation Assets," Working Papers 2016-02, University of Victoria, Department of Economics, Resource Economics and Policy Analysis Research Group. Retrieved from https://ideas.repec.org/p/rep/wpaper/2016-02.html on 28 April 2020.

WESM-IEMOP. (2020). IEMOP Powers Continuous Market Operations During the ECQ. Retrieved from http://www.iemop.ph/inner.php/news/news_and_events/629 on 20 May 2020.