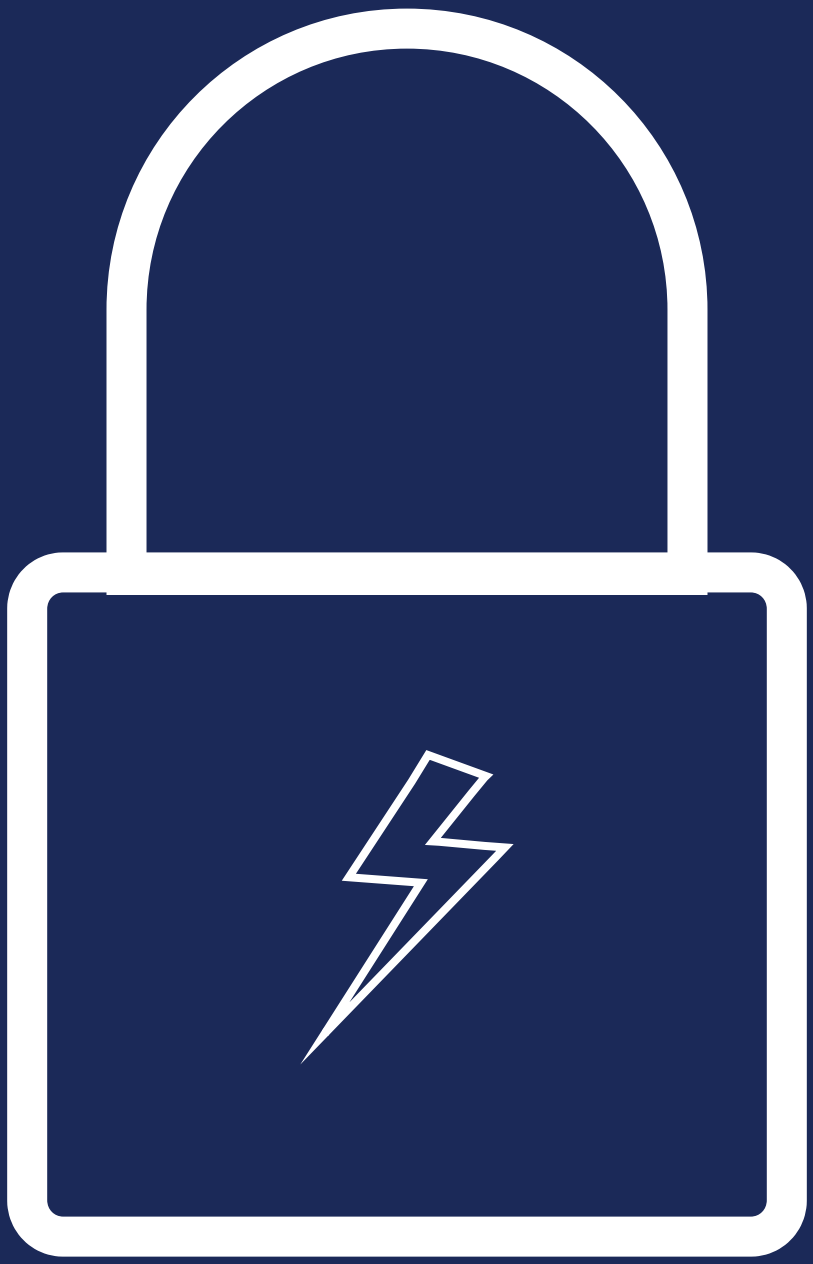


Energy security and the new role of renewable energy

Energy security is crucial to economic development. In the Philippines, increasing demand for electricity, frequent natural disasters, heavy reliance on foreign fuel imports and the country's archipelagic geography all make ensuring energy security particularly challenging. Renewable energy (RE) can help to ensure a reliable, resilient and cost-efficient energy supply – provided it is properly planned and implemented. Greater reliance on indigenous resources means that dependency on world markets can be reduced.

Energy Security

Energy security[1] means the uninterrupted availability of energy services of an appropriate quality and at an affordable price. Energy security can be jeopardized by political, technical or economic factors – the physical unavailability of energy resources or generators, for instance, or overly volatile fuel prices.[2] Filipino consumers will notice severe constraints on energy security if power black-outs or brown-outs occur on a regular basis or prices rise as a result of under-supply in the power market (WESM)[3], as was the case during the 'Malampaya turnaround' in 2013.[4]

In the short term, energy security requires a national energy system to be able to react promptly to sudden changes within the energy supply/demand balance. Disruptions may occur for various reasons, such as a malfunction of one or more power plants or grid components or a disruption in fuel supply. In the long term, energy security also means timely investment to secure supply for the long term, in line with growing needs for economic development and sustainability.[5]

Power outages – eating up the fruits of economic development?

During the 2014/15 El Niño period, a drought in Mindanao led to frequent power outages on the island as important hydropower plants had to run below capacity for an extended period. In Davao, these outages lasted up to five hours a day, resulting in estimated losses of about PHP 400 million a day.

On the off-grid island of Palawan, consumers have been struggling with an insecure power supply for years. During the first six months of 2017 alone, they suffered through an average of 13 brownout hours during 10 power interruptions per month. In northern Palawan, there are widespread fears that these blackouts will affect tourism, on which many rely for their income. [6]

Natural disasters pose many threats to the infrastructure of the Philippines – earthquakes and typhoons can have devastating effects on large areas, damaging generation, transmission and distribution facilities. In the future, typhoons are expected to occur more frequently and grow in strength because of climate change.[8] Decentralizing energy generation would make the Philippines less vulnerable to environmental hazards.

The country's reliance on foreign fuel imports can also endanger energy security if fuel supply or fuel markets are disrupted. The archipelagic geography of the Philippines means that many islands are not connected to the three central power grids, making them prone to black-outs or brown-outs in case of fuel supply shortages or imbalances in supply and demand.

Major natural disasters that have negatively affected the power system in recent years[7]

2011	Tropical Storm Sendong & Typhoon Pedring
2012	Typhoon Pablo
2013	Bohol Earthquake
2013	Super Typhoon Yolanda
2014	Typhoon Glenda
2014/15	El Niño
2016	Typhoon Lando

Decentralizing and diversifying energy generation will make the Philippines less vulnerable to environmental hazards and system failures.

'Distributed generation' is the use of multiple small-scale power generation technologies located close to the consumers (load) they serve. Decentralized power systems with variable RE[9] and energy storage facilities can be more resilient than a system with fewer large central power generators, especially where grids are not well interconnected. While shocks to a centralized system can threaten a large proportion of total supply and thus affect a substantial part of the population, a decentralized and diversified system is more resilient to shocks. Even if parts of the power generation system break down, others may continue to provide energy.

It is highly unlikely that all generation units in a distributed network will fail at the same time, and even if some units fail, the impact is still smaller than the failure of one large central power plant. Some technologies are also more resilient to shocks than others. In the aftermath of a storm, wind and solar generation can quickly resume even after a shutdown. Since they do not rely on fuel, disrupted or destroyed supply lines and roads do not pose a problem. Solar PV may also be less reliant on long-distance transmission lines. As long as the local grid remains unaffected and stable, distributed generation can continue to provide power even when long-distance transmission is disrupted.

Hurricane Maria in Puerto Rico

After Hurricane Maria hit Puerto Rico in September 2017, 100% of the power system run by the Puerto Rico Power Authority went offline. However, some businesses had previously invested in solar PV panels and were able to rely on their own electricity supply. These systems remained operational and continued to provide electricity, even though some of the panels were damaged by flying debris.

More renewable energy will make the power system more independent of imports, the overall geopolitical situation and external relations.

The Philippines imports most of its fossil fuel. It currently imports about 80% of its total requirements for coal, with Indonesia alone supplying 95% of that coal.[10] [11]The majority of all oil products are imported from Gulf States. This not only exposes consumers to considerable risk from international coal price and currency fluctuations; changes in geopolitical trends or other external factors can also quickly result in disruption of fuel supply.[12] The high reliance on imported coal may leave the Philippines open to coercion and threats from other countries. In 2016, Abu Sayyaf militants abducted a group of Indonesian sailors, prompting Indonesia to threaten a halt to coal exports to the Philippines. When coal prices plummeted in 2016, the Chinese government took action to reduce oversupply. The resulting sharp rise in thermal coal prices was felt around the globe. Utilities in the Philippines can directly pass on such prices changes to their customers, so Filipino consumers may feel the effects of events as far off as strikes by Indian miners or heavy rainfall in Indonesian mining regions.[13]

Sources of coal in 2016

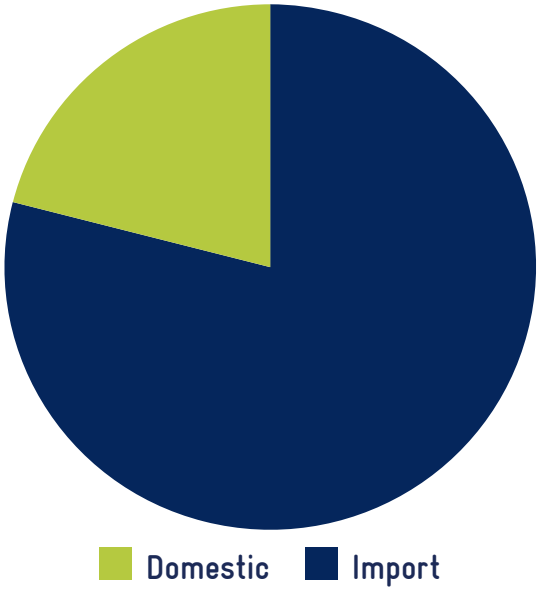


Figure 1. Sources of coal in 2016. In the last 13 years, only about a quarter of domestic coal consumption was met by domestic coal. Although domestic coal production has grown in recent years, most is exported, while higher quality Indonesian coal is used to run coal-fired power plants in the Philippines.

Total coal imports by the Philippines in 2016

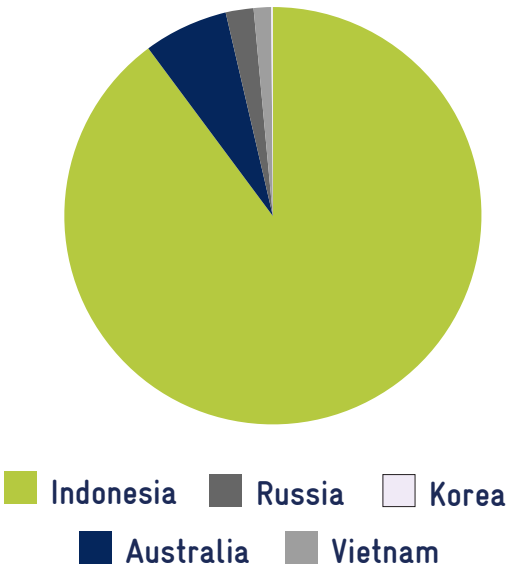


Figure 2. Total coal imports by country in 2016. The Philippines imports most of its coal from Indonesia. Source: DOE.

Gross electricity production by plant type in 2016

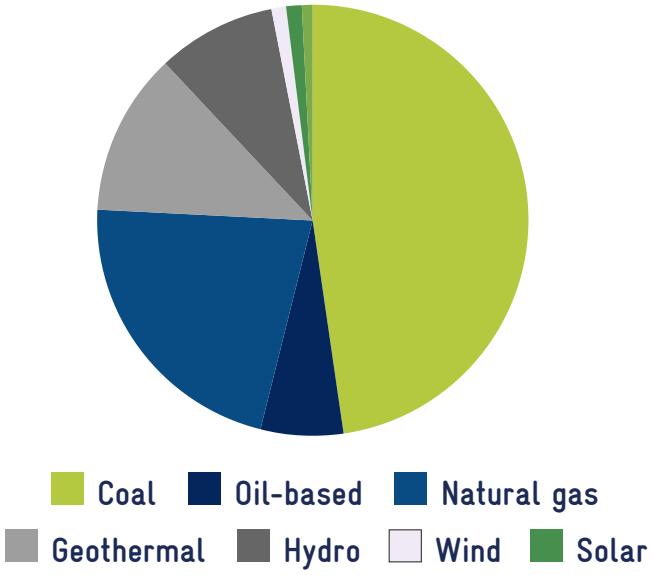
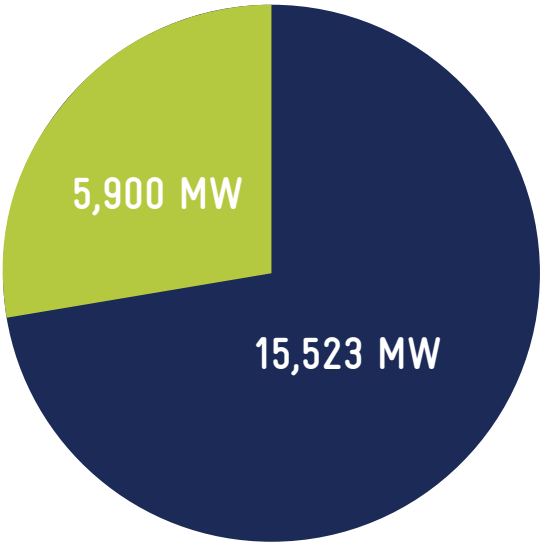


Figure 3. Gross electricity production by plant type in 2016. Over 50% of gross electricity production is from imported fuels. Source: DOE.

Installed generation capacities in 2016



TOTAL INSTALLED CAPACITY IN 2016

21,423 MW

RE Capacity

Conventional generation

Figure 4. Installed generation capacities in 2016 depicting Conventional Generation (15523 MW) and RE capacity (5900 MW)

Estimated potential for different RE sources in the Philippines

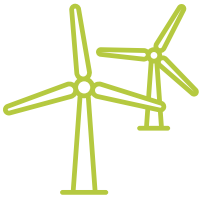
HYDRO

13,097 MW

GEOTHERMAL

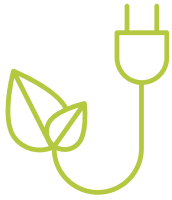
2,600 MW

WIND



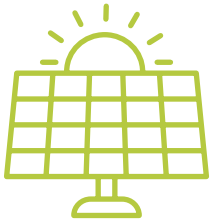
76,600 MW

BIOMASS



4,450 MW

SOLAR



5kWh/m2/day

Because of their decentralized nature, RE technologies can provide more reliable and cost-efficient power to island communities than traditional diesel generation.

Yet the Philippines have a high technical potential[14] for RE sources. The DOE estimates untapped potential of as much as 2,600 MW for geothermal energy, with projects totaling 1,165 MW identified in the Philippine Energy Plan (2012-2030). The potential for large hydropower schemes may be as great as 11,223 MW, while a further 1,875 MW could be provided by mini- and micro-hydropower schemes in about 900 locations. Based on an NREL study, the average potential for solar power is 5.1 kWh per m^2 per day. While some areas, like the north-western parts of Luzon, have an even higher potential, the resource is distributed fairly evenly across the country, with variations of less than 10% to 20% in any given month. This potential includes not only rural areas but also urban industrial and commercial areas, where solar PV modules can be installed on rooftops. Solar PV is therefore much larger in terms of MWp than any of the other energy sources listed here. The technical potential for wind energy is estimated to be higher than 76,000 MW of installed capacity, especially in the northern and central parts of Luzon. Agricultural residues, such as rice husk and straw, coconut shells and sugarcane bagasse, are all suitable as the basis for biofuels or as feedstock for biomass plants. Forest residue, municipal solid wastes and animal manure can also serve as biomass feedstock. An investigation by USAID's Climate Change and Clean Energy (CEnergy) project in 2013 estimated 4,450 MW available capacity (net of competing uses) for power generation from different types of biomass feedstock. Pending further technological advances and exploration of sites, marine energy could also contribute to energy production through wave energy and ocean thermal energy conversion.[15]

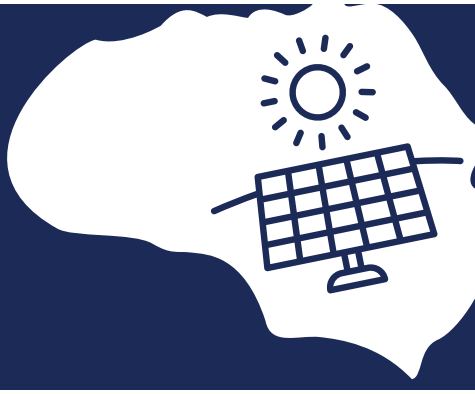
Variable renewable energy sources can improve access to energy in areas away from the main grids.

More than 1,000 islands in the Philippines are inhabited, but only about a dozen are connected to the main Luzon, Visayas and Mindanao grids. Extending the grid is often not economic, especially for small and remote islands. Many of these areas are currently supplied through the Small Power Utilities Group under the National Power Corporation (SPUG-NPC) or by New Power Producers (NPPs) through diesel generators, which generate power at high cost and with low reliability.[16] Such areas can profit from RE technology, which can be built quickly and on a scale appropriate to the islands' size. For solar energy, short lead times of less than one year from investment decision to power feed-in are now possible. Investment pathways can be designed to start small and then add more RE capacity or storage as demand grows. Solar and wind energy, hydropower and biomass plants rely on locally available sources, so RE can also serve to electrify very remote islands that are hard to reach through conventional fuel supply chains.

Existing diesel systems can be enhanced and strengthened through the addition of solar panels and, in some cases, small power storage units, a process called hybridization.[17] Adding solar panels means that diesel fuel consumption and costs can be reduced while energy availability increases. The storage units store excess solar power generated for evening use or even over the next few days. Energy security can be improved where energy supply relies on stored diesel fuel, since stored electricity can run out if an area is temporarily inaccessible following extreme weather events.[18] [19]Solar panels can also be combined with other power plants, such as hydropower, as demonstrated by a project in Mindanao.[20]

Cobrador Island (Romblom Province)

In 2016, the existing 15 kW diesel generator on Cobrador Island was supplemented with 30 kW solar PV capacity and a 180 kWh lithium ion battery. While the diesel generator had only been able to provide 110 households with 8 hours' electricity each day, this system ensures 24-hour electricity for all 244 households on the island. With the solar-diesel hybrid, the cost of electricity is now about PHP 42/kWh, down from PHP 60/kWh with the diesel generator.



In contrast to popular opinion, a greater contribution by variable RE, such as solar and wind, can easily be accommodated by the Philippine power grid without endangering overall system reliability.

Despite their rapid growth, wind and solar PV still make up only 5.6% of the installed capacity in the Philippines, representing less than 2.5% of total electricity generated in 2016.[21] However, as a vast array of recent studies has shown, having up to 30% of energy produced from variable RE does not pose any threat to grid stability in most countries and with current technology, and technical difficulties associated with RE integration can easily be resolved. This is important, as wind and solar energy vary on a sub-hourly scale, and many energy practitioners are therefore worried about the increased share of 'non- dispatchable' power. Indeed, a number of new technical challenges need to be considered once variable RE contributes more than 10%, to ensure smooth operation, avoid unnecessary transmission losses and reap optimal economic benefits at system and customer level. These include the need for more flexibility to balance the system, the need for additional transmission capacity if generation is added at a distance from load, grid and ancillary services (e.g. inertia response) from wind and solar or other equipment and, finally, the effects on cost recovery on the part of conventional generators that may result from changes to operation modes. However, these challenges are well understood and relatively easy to handle today, as many countries have already reached variable RE shares well above 20%. The significant increase of variable RE shares in the German power system over the last decade have not been accompanied by reduced system reliability: outage duration actually declined over the same period.

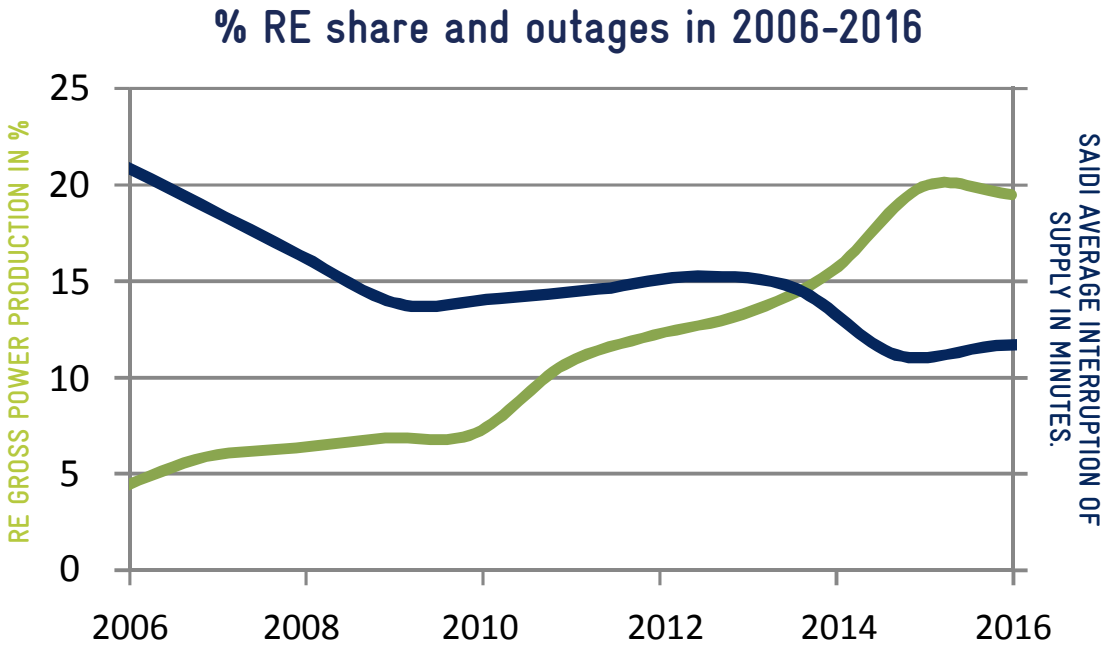


Figure 5. Share of variable RE production and reliability of power supply in Germany. The left side shows the development of the share of variable RE (solar, onshore wind, offshore wind) of gross power production in %. The right side shows the SAIDI (System Average Interruption Duration Index), measuring average interruption of supply per connected consumer in minutes Authors' own illustration based on data from BNetzA (2017) and BMWi (2017).[1]

Distributed generation is the use of multiple small-scale power generation technologies located close to the consumers (load) they serve. Decentralized power systems with variable RE and energy storage facilities can be more resilient than a system with fewer large central power generators, especially where grids are not well interconnected. While shocks to a centralized system can threaten a large proportion of total supply and thus affect a substantial part of the population, a decentralized and diversified system is more resilient to shocks. Even if parts of the power generation system break down, others may continue to provide energy.

While technological solutions exist for ensuring voltage control and frequency stability even for variable RE shares well above 30%, there may well be economic limits to adding ever more variable RE, even before technical limits are reached in practice. These limits, however, depend on individual systems (size, configuration, etc.) and may change over time as the cost of alternative technologies falls or carbon prices rise.[22]

A recent grid integration study conducted by NREL calculates that RE targets of 30% and 50% would be technically achievable in the Philippines under the present power system expansion scenario. The study found no binding technical limits to RE integration in the Philippines, even when most of the added capacity comes from variable RE sources such as wind and solar.[23] However, achieving these high RE targets will most likely require significant changes in power system operation: energy planning processes would have to adapt to the decentralised nature of RE and provide clear spatial guidance to the private sector to avoid unnecessary costs from grid congestion and balancing.[24]

This factsheet is part of a series on energy issues relevant to current policy discussions in the Philippines. The factsheets aim to provide policymakers and sector practitioners with a rapid overview of some of the most pressing issues in this dynamically evolving sector.

The factsheets were prepared under the 'Support to the Philippines in Shaping and Implementing the International Climate Change Regime' (SupportCCC II) Project implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

END NOTES AND RESOURCES

[1] In this factsheet, we concentrate mainly on the physical and technical aspects of energy security in the power sector; the economic aspects and the role of RE will be addressed in more depth in a separate factsheet.

[2] IEA (2014). What is Energy Security? Retrieved from: https://www.iea.org/topics/energysecurity/subtopics/ whatisenergysecurity/

[3] The Wholesale Electricity Spot Market (WESM) is the centralised forum for trading electricity as a commodity in the Philippines. See http://www.wesm.ph/ for more information.

[4] During this controversial incident in 2013, average prices on the WESM rose from PHP 13.74 /kWh in October to PHP 33.216/ kWh in November and PHP 36.08/kWh in December. DOE (2017a). Power Development Plan 2016-2040 Retrieved from: https:// www.doe.gov.ph/electric-power/power-development-plan-2016-2040. This would have resulted in a PHP 415 rise in monthly household bills for every 100 kWh consumed, leading to much controversy and an intervention by the Supreme Court. Philippine Daily Inquirer (2016). What went before power rates. Retrieved from: http://newsinfo.inquirer.net/798092/what-went-before-power-rates.

[5] IEA (2014). What is Energy Security? Retrieved from: https://www.iea.org/topics/energysecurity/subtopics/ whatisenergysecurity/

[6] The Inquirer (2016). Brownout economic cost: PHP 400 million a day. Retrieved from: http://newsinfo.inquirer.net/779467/ brownout-economic-cost-p400m-a-day. See also: ABS CBN News (2017). Dark Nest in El Nido. Power outages to hurt tourism. Retrieved from: http://news.abs-cbn.com/business/05/18/17/dark- nest-in-el-nido-power-outages-to-hurt-tourism.

[7] DOE (2017a). Power Development Plan 2016-2040 Retrieved from: https://www.doe.gov.ph/electric- power/power-development-plan-2016-2040.

[8] Mei and Xie (2016). Intensification of landfalling typhoons over the northwest Pacific since the late 1970s. Nature Geoscience, 9, 753-757. The Researchers also found that typhoons in East and Southeast Asia have intensified by nearly 15% since the 1970s, which translates to a 50% rise in potential destructive power.

[9] Some RE sources, such as wind and solar power, are referred to as 'variable RE', since they are non dispatchable but rely on the availability of wind or sun to produce electricity. Other RE sources, such as hydropower, biomass or geothermal power, are sometimes referred to as 'controllable RE'.

[10] DOE (2016a). Historical Coal Importation. Retrieved from: https://www.doe.gov.ph/historical-coal-importation, Also DOE (2016b). Coal Importation by country. Retrieved from: https://www.doe.gov.ph/coal-importation-by- country

[11] The indigenous coal resources in the Philippines are mainly made up of sub-bituminous coal or lignite. Most power plants in the Philippines are built to run on imported higher-quality coal, of which less is needed to produce the same amount of energy than with lower-quality coal.

[12] In September 2017, Hurricanes Harvey and Irma hit the US states of Texas and Florida. Filipino consumers felt the effects when domestic diesel, gasoline and kerosene prices rose. In June 2016, Indonesia threatened to temporarily halt coal exportation to the Philippines after Indonesian sailors were abducted by the militant Abu Sayyaf group. Coal transport continued with larger boats. See Reuters (2016a). Indonesia says coal on hold for Philippines after seven sailors abducted. Retrieved from: http://www.reuters. com/article/us-indonesia-security-philippines/indonesia-to- resume-some-coal-shipments-to-philippines-amid-piracy-concerns-idUSKBN12U0EQ?il=0. Also Reuters (2016b). Indonesia to resume some coal shipments to Philippines amid piracy concerns. Retrieved from: http://www.reuters.com/article/us-indonesia-security/indonesia-says-coal-on-hold-for-philippines-after-seven- sailors-abducted-idUSKCN0ZA06S;

[13] Euromonitor (2017). Coal Price Recovery Offers a Glimpse of Hope to the Global Coal Mining Industry, But the Effect is Unlikely to Last Long. Retrieved from: http://blog.euromonitor.com/2017/02/coal-prices-recovery-glimpse- hope-global-coal-industry-effect-unlikely-last.html. See also: Reuters (2017). Australian Spot Coal Prices hit highest since May amid mine outages, strong demand. Retrieved from: https://www.reuters.com/article/coal- asia/australian-spot-coal-prices-hit-highest-since-april-amid-mine-outages-strong-demand-idUSL3N1JV1SO.

[14] Theoretical potential denotes the theoretical maximum of recoverable resources. Technical potential includes only that part of potential which is recoverable with current technology. Economic potential denotes the part of resources which can be extracted economically. As technology and economic fundamentals change, so do technical and economic potentials.

[15] IRENA (2017). Renewable Readiness Assessment: The Philippines. International Renewable Energy Agency, Abu Dhabi.

[16] IEEFA (2017). Electricity Sector Opportunity in the Philippines. Retrieved from: http://ieefa.org/wp- content/uploads/2017/05/ Electricity-Sector-Opportunity-in-the-Philippines_May-2017.pdf

[17] A hybrid system is a power or energy generation facility that makes use of two or more types of technology,

[18] ADB (2016). Romblon's Cobrador Island Gets 24-Hour Power From New Hybrid Solar-Diesel System. Retrieved from: https://www.adb.org/news/romblon-s-cobrador-island-gets-24-hour-power-new-hybrid-solar-diesel-system

[19] PowerWater (2013). Solar/Diesel Mini-Grid Handbook. Retrieved from: http://www.powerwater.com.au/__data /assets/pdf_file/0016/61630/SolarDieselGridHandbook.pdf

[20] In the Philippines, this was demonstrated by a solar PV/hydro hybrid project on Mindanao in 2004. For more information refer to: https://energypedia.info/images/b/b5/Philippines_Grid- connected_Solar_PV_Hydro_hybrid_demonstration.pdf

[21] DOE (2017c). Gross Power Generation by Plant 2016. Retrieved from: https://www.doe.gov.ph/sites/default/ files/pdf/energy_statistics/bgross_power_generation_by_plant_2016.pdf; also DOE (2017b). 2016 Philippine Power Situation Report. Retrieved from: https://www.doe.gov.ph/sites/default/files/pdf/electric_power/power_ situationer/2016_philippine_power_situation_report.pdf

[22] The topic of economically optimal variable RE scale-up will be covered in a separate factsheet in this series.

[23] NREL (2017). Greening the Grid: Solar and Wind Grid Integration Study for the Luzon-Visayas System of the Philippines.

[24] The topic of future energy planning requirements will be covered in a separate factsheet in this series.

Business Insider (2017). How solar energy saved a Puerto Rican farm from hurricane Maria. Retrieved from: http://www.businessinsider.com/r-how-solar-energy-saved-a-puerto-rican-farm-from-hurricane-maria-2017-10

Energy for All (2017). Cobrador Island Solar Diesel Hybrid Project. Retrieved from: https://energyforall.asia/projects/cobrador-island-solar-diesel-hybrid-project

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Published by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

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Printed and distributed by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Place and date of publication
Makati City, Philippines
March 2018

On behalf of

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

of the Federal Republic of Germany