COUNTRY PROFILE INDONESIA

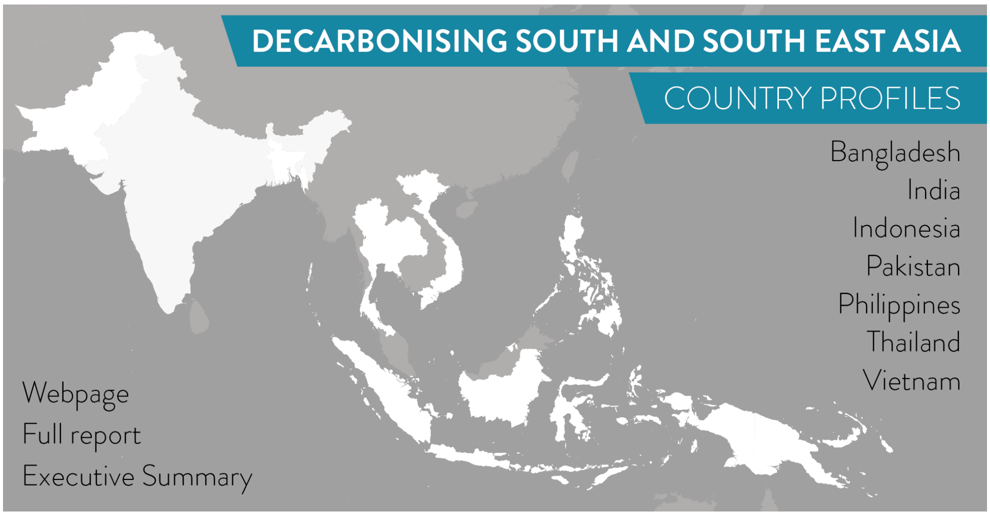
DECARBONISING SOUTH AND SOUTH EAST ASIA

Shifting energy supply in South Asia and South East Asia to non-fossil fuel-based energy systems in line with the Paris Agreement long-term temperature goal and achievement of Sustainable Development Goals

MAY 2019

This country profile is part of the ***Decarbonising South and South East Asia*** report and examines how to shift the energy supply in South Asia and South East Asia to non-fossil fuel-based energy systems in line with the Paris Agreement long-term temperature goal and achievement of Sustainable Development Goals.

Find links to other country profiles and the full report below.


DECARBONISING SOUTH AND SOUTH EAST ASIA
COUNTRY PROFILES
Bangladesh
India
Indonesia
Pakistan
Philippines
Thailand
Vietnam
Webpage
Full report
Executive Summary

Authors

Ursula Fuentes Hutfilter
Anne Zimmer
Fahad Saeed
Bill Hare
Tina Aboumahboub
Ilsa Kelischek
Carl-Friedrich Schleussner

Paola Yanguas Parra
Andrzej Ancygier
Robert Brecha
Jessie Granadillos
Gaurav Ganti
Raghuveer Vyas
Michiel Schaeffer

A digital copy of this report along with supporting appendices is available at:
www.climateanalytics.org/publications

This report has been prepared under the project “Pilot Asia-Pacific Climate Technology Network and Finance Centre”, an initiative of UN Environment and the Asian Development Bank (ADB), funded by the Global Environment Facility (GEF).

gef GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

UN environment
United Nations
Environment Programme

CLIMATE ANALYTICS

Supporting science based policy to prevent dangerous
climate change enabling sustainable development

www.climateanalytics.org

INDONESIA

Key Messages

Climate change impacts – Paris Agreement temperature goal matters for Indonesia

- Indonesia is already vulnerable to the impacts of climate change at the current level of warming of about 1°C above pre-industrial levels.
- Risks from flooding are projected to increase by 12% in a 3°C warmer world- corresponding to the warming projected for current NDCs - which is five times higher than for a 1.5°C warmer world.
- Exceeding 1.5°C would greatly increase the risk of the coastal area inundation due to extreme flooding.
- A world beyond 1.5°C would commit Indonesian coastlines to more than 2m sea level rise in the long run.

Indonesia's energy system: efforts to increase renewable energy, but coal still dominant and expanding, contrary to global trends

- Indonesia is the largest energy user in South East Asia. Its rate of energy consumption growth is among the fastest in the world. Electricity consumption per capita has more than doubled in the last decade. Per capita energy and electricity demand are well below the world average.
- Indonesia has managed to substantially decrease the energy intensity of its economy between 2000 and 2017. However, carbon intensity of energy has increased due to the rising share of fossil fuels (in particular coal) and limited expansion of renewable energy.
- Indonesia has become one of the world's largest coal exporters over the course of the last 15 years, and is striving to reduce fuel imports (e.g. by using domestic coal) and become more energy independent.
- Renewable energy deployment offers benefits such as reducing reliance on fossil fuel imports, improving the still low reliability of electricity supply, providing universal access to modern energy, and reducing air pollution with its massive health impacts.

Transition to renewable energy offers massive benefits

- Indonesia has huge untapped renewable energy potentials. Covering only 1.5% of Indonesia's territory with solar PV installations would generate 23 times the electricity generated currently. It also has a large potential for geothermal and biomass residue not only for electricity but also for heat.
- Indonesia can benefit massively from a rollout of renewable energy. Even under a conservative scenario for 2030, estimates show savings between between 3 and 9.7 billion USD per year from reduced outdoor air pollution, and between 10.4 to 31.3 billion USD per year from reduced indoor air pollution, as well as substantially improve energy dependency and energy access in remote areas and isolated islands.

- The cost savings from implementing IRENA's Remap scenario for India in Indonesia would largely outweigh the costs. Even when only accounting for benefits from reduced air pollution and climate impacts, benefits could be up to 12 times higher than the costs.
- Indonesia could reap benefits form creating local job opportunities in the RE sector.

Targets, projections, and Paris Agreement benchmarks

- In its NDC Indonesia declared an unconditional commitment of 29% emissions reduction compared with business-as-usual. Conditional on international support, it also has the goal of reducing emissions by 41% compared with BAU.
- Indonesia aims at increasing the share of "new and renewable" energy in primary energy supply to 23% in 2025 and 31% by 2050. According to the IRENA Remap scenario, the 2050 renewable energy goal can already be achieved 20 years earlier.
- The 23% share for primary energy is translated into a target 25% share of renewable energy in electricity generation in 2025. Contrary to global trends and trends in the region, and despite the continuing reduction in costs for renewable energy, the Indonesian Electricity Supply Business Plan for 2019 reinstituted a number of large coal project that were to be cancelled or suspended, and revised the contribution of renewables to 12% in 2027 down from a 20% envisaged in the previous plan, and reducing the projected growth of solar energy by 13%.
- The 2025 target is unlikely to be achieved with current policies, and is not in line with the Paris Agreement compatible scenario results for the ASEAN region, according to which a 33% share of decarbonised electricity generation in 2025, and 51% in 2030 would need to be achieved.
- Electricity demand is increasing more slowly than expected under national energy plans, leading to a mismatch between planned capacity additions and likely future electricity demand.
- Coal is still considered as a cheap power source in Indonesia. It is an abundant domestic natural resource, favoured by large government subsidies, and without a carbon price that reflects the high environmental and social externalities. Consequently, coal is the main energy source for power generation (about 60% in 2018) and, under current plans, it will continue to expand substantially.
- The planned new coal power accounts for over 7% of the global coal fleet expansion plans. It by far exceeds the generation benchmarks under a Paris Agreement compatible scenario, which established a phase-out of coal-fired power by 2040 for the ASEAN region.
- Under current plans, the committed emissions from coal-fired power plants would peak only around 2035, with an eventual phase-out only by 2069.
- Demand overestimates in national plans along with rapidly decreasing cost of renewable energy result in a high risk of overcapacity for coal power generation under current expansion plans. This is likely to lead to low utilisation rates, and a high risk of stranded assets, in addition to enormous climate, health, and social and economic externalities.
- Several studies show that a 100% renewable energy scenario by 2050 is possible considering the renewable energy potentials of Indonesia.
- There is thus significant scope for enhanced NDC ambition and developing an ambitious long-term strategy towards 100% renewable energy power generation and electrification of end-use sectors to align Indonesia's energy future with the goals of the Paris Agreement and reap benefits for sustainable development.

Introduction

In the last two decades, Indonesia has increased its per capita income, reduced extreme poverty and substantially improved its development indicators. However, most of these indicators are still far below global averages (The World Bank, 2018). Ambitious government policies to extend electricity access in the last decades have resulted in an almost universal access to electricity despite fast population growth in the same period (IEA, 2015). Per capita electricity consumption has more than doubled in the last decade (The World Bank, 2018). Population growth and development needs are likely to see energy consumption continue to grow at a rapid pace. The path that Indonesia chooses to address the growing energy demand has important implications for the global efforts to achieve the Paris Agreement long-term temperature goal.

Indonesia's energy related CO_2 emissions have been rising along with economic growth and energy demand. At the same time the share of fossil fuels (in particular coal) has been growing but the expansion of renewable energy in the energy mix has been limited (IEA, 2018). One of the drivers behind the expansion of coal in the energy mix is its abundance domestically: it has the second largest proven reserve of coal in South and South East Asia, accounting for nearly 17% of the total proven reserves, and has become the world's fifth largest coal producer and the world's second-largest exporter (BP, 2018).

Continued expansion of fossil fuel production and use, as currently planned, is at odds with the achievement of the Paris Agreement temperature goal. However, Indonesia still has time to revise its energy plans and capitalise on the huge untapped potential for renewable energy production to reduce emissions. These offer numerous additional benefits, such as improving access to and reliability of electricity supply and reducing air pollution.

1 Climate Change Impacts: Risks, vulnerability and benefits of limiting mean temperature rise to 1.5°C

1.1 Present day vulnerabilities and risks

Indonesia has witnessed a number of climate disasters in the last 30 years as shown in Table 1. **Flooding events** stand out as the most disastrous type affecting 7.74 million people and resulting in the around 5000 deaths. Moreover, it has incurred losses of more than 6.5 billion US$ due to floods. Indonesia is less vulnerable than most of other countries in South and South East Asia and occupies 69th position in Germanwatch long-term climate risk index[1] list (Eckstein et al., 2018).

Table 1: Climate disaster statistics for Indonesia based on EMDAT database[2] for the period 1989-2018

Disaster Type	Events Count	Total Deaths	Total affected (million people)	Damage (million US$)
Drought	3	683	1.08	89
Floods	148	4 478	7.74	6 665.6
Storm	5	36	0.0163	1

---

[1] The Germanwatch Global Climate Risk Index is an analysis based on one of the most reliable data sets available on the impacts of extreme weather events and associated socio-economic data. However, the index must not be mistaken for a comprehensive climate vulnerability1 scoring. It represents climate-related impacts and associated vulnerabilities but, for example, does not take into account important aspects such as rising sea-levels, glacier melting or more acidic and warmer seas. https://germanwatch.org/en/cri

[2] https://www.emdat.be

1.2 Projections on climate impacts comparing 1.5°C and temperature increase under current pledges

With a global mean temperature increase of 3°C above pre-industrial levels, corresponding to the warming projected for current NDCs, Indonesia would face an **increase in annual precipitation** of more than 7%, which is much higher than if warming is limited to 1.5°C (Table 2). In addition, intensity of floods is projected to increase by more than 12% and extreme precipitation by 9% in a 3°C world compared with 2.3% and 7% increase in a 1.5°C world, respectively.

Table 2: Future projections of different climatic variables averaged over Indonesia, based on an ensemble of CMIP5 Global Climate Models for 1.5°C and 3°C warmer than pre-industrial worlds [3]

Indicator	Historical (1986–2015)	+1.5°C World (Paris Agreement)	+3.0°C World (Current NDCs)
Annual Averages			
Near-Surface Air Temperature (°C)	25.6	+1.0	+2.5
Precipitation	2863.7 mm	+4%	+7.4%
Extreme Events			
Drought: Consecutive drought days (Days)	14.2	+1.4	+0.44
Heat: Annual Maximum of Daily maximum Air Temperature (°C)	31.1	+0.9	+2.2
Flooding: Annual Maximum 5-day Consecutive Precipitation (mm)	154	+2.3%	+12%
Extreme Precipitation: 1 in 20 year Maximum 5-day Consecutive Precipitation Event (mm)	259	7%	9.7%

Table 3: Future projections of Sea Level Rise (cm) as compared to today's level for Indonesia based on the data from Robert Kopp et al. (2014). The values in the brackets in the left column are the temperature difference for each future scenario between the end of 21st century (2081-2100) and pre-industrial period (1850-1900).

Sea Level Rise (cm)	2050	2100	2150	2200
RCP 2.6 (1.6°C)	24	51	75	101
RCP 4.5 (2.4°C)	26	62	97	130
RCP 8.5 (4.3°C)	28	80	137	202

---

[3] The presented values are based on an ensemble of general circulation models (GCMs) from CMIP5 archive. Global Mean Temperature (GMT) increase of 1.5°C and 3°C above pre-industrial levels are derived for 20-year time slices with the respective mean warming for each model separately. The warming levels are derived relative to the historical period 1986-2005 and this period is considered to be 0.6°C warmer than pre-industrial levels (1850–1900). For definitions of extremes indicators, please see (Schleussner et al., 2016)

Indonesia has a staggering 80 000 kilometers of coastline and 17 500 islands, making it one of the most vulnerable countries to the impacts of **sea level rise** (SLR) due to global warming. Paris Agreement limit of 1.5°C would result in substantially lower sea level rise than for higher levels of warming, in particular in the long run. Sea level rise would be around 2 meters in a 4.3°C world compared with 1 meter in 1.6°C warmer world by the end of the 22nd century (Table 3)[4] [5].

Table 4: Exposure of the land area (in km²) for Indonesia in the 1 in 100 year coastal flood plain in 2100, 2200 and 2300 for each mitigation (AMPs) and non-mitigation (RCP 8.5) scenario. The brackets show the values for global sea level rise and global temperature for each scenario. (Brown et al., 2018)

	Modelling Scenario			
	AMP 1.5	AMP 2	AMP 3	RCP 8.5
2100	6 507 (0.4m; 1.6°C)	6 930 (0.5m; 2°C)	7 228 (0.5m; 2.4°C)	9 888 (0.8m; 4.9°C)
2200	9 542 (0.7m; 1.4°C)	11 314 (0.9m; 1.9°C)	13 831 (1.1m; 2.8°C)	42 883 (2.5m; 8.6°C)
2300	12 447 (1m; 1.3°C)	15 697 (1.3m; 1.8°C)	23 776 (1.7m; 2.8°C)	99 058 (4.5m; 9.5°C)

Furthermore, Indonesia's the flood plain area is projected to get inundated by extreme floods in a non-mitigation scenario (RCP 8.5) at a much higher rate than in mitigation scenarios (AMP) already by the end of 21st century. However, this difference would substantially increase manyfold by the end of 22nd and 23rd century (Table 4). Risks posed by tropical cyclones are projected to increase substantially. Under a 2.4°C scenario, the number of Category 4 cyclones will increase by about 80% and Category 5 by 120%[6]. The severity of the tropical cyclone hazard will be further amplified by increases in extreme precipitation and sea level rise.

---

[4] Due to a lack in the scientific literature, we cannot yet provide projections for a 1.5°C scenario. However, global sea level rise by 2100 is about 10cm lower under a warming at 1.5°C compared to a 2°C scenario [IPCC 1.5°C Special Report]. Beyond 2100, only limiting warming to 1.5°C may limit global sea level rise to below 1m,at least 0.5m less than what a 2°C would entail.

[5] There is no tide gauged station for Indonesia in the database developed by Robert Kopp et al. (2014), therefore we used averaged interpolated values of 10 grid boxes bordering Indonesia at 2°x2° resolution.

[6] Relative to 1986-2005 for the Australian Basin (AU), from Bhatia K, Vecchi G, Murakami H, et al (2018) Projected Response of Tropical Cyclone Intensity and Intensification in a Global Climate Model. J Clim 31:JCLI-D-17-0898.1. doi: 10.1175/JCLI-D-17-0898.1

2 Socio-economic context

2.1 Economic background

Table 5: Overview on socio-economic characteristics and development over time (Indonesia)

Indicators on economic and human development		Source	2000	2010	Most recent (2017)
Per capita income	GDP/capita in current US$	WB-WDI	780	3,114	3,847
	GDP/capita adjusting for purchasing power (in PPP, constant 2011 international $)	WB-WDI	5,806	8,434	11,189
Economic growth	GDP growth rate per capita (annual, in %)	WB-WDI	3.5%	4.8%	3.9%
Human development	Human Development Index (HDI)	UNDP	0.606	0.661	0.694 *(Rank 116)*
Population	Population in millions	WB-WDI	212	243	264

Notes: PPP – Purchasing Power Parity. GDP – Gross Domestic Product.

Sources: WB-WDI – World Bank World Development Indicators (The World Bank, 2019)*. UNDP – United Nations Development Program* (United Nations Development Program, 2018a).

With a population of over 260 million people, Indonesia is the world's fourth most populous country. In economic terms, it is the largest economy in Southeast Asia and the tenth largest economy in the world when accounting for purchasing power (The World Bank, 2018). It is classified by the World Bank as a "lower middle-income country" since 2003 and it is one of the G20 countries. In recent years, Indonesia's GDP per capita growth rates have been around 4% since 2010 (The World Bank, 2018). Between 2000 and 2017, Indonesia increased its per capita income (in US$) by a factor of close to five and almost doubled it in terms of purchasing power parity in the same period (see Table 5).

Indonesia made progress in reducing poverty, decreasing the share of people living in extreme poverty (with less than 1.90$ (2011 PPP) a day) from 39% in 2000 to 5.7% in 2017 (The World Bank, 2019). However, in 2017 still over 58% of people have been living on less than 5.50$ (2011 PPP) a day (compared to over 95% in 2000) (The World Bank, 2019).

Between 1990 and 2017, Indonesia has increased its Human Development Index (HDI) value about 31%, from 0.528 to 0.694 (United Nations Development Program, 2018b). Indonesia's 2017 HDI is above the average of all countries in the HDI category of 'medium human development' but it is below average for countries in East Asia and the Pacific. When Indonesia's 2017 HDI value is discounted for inequality, it falls to 0.563, a loss of almost 19% due to inequality (United Nations Development Program, 2018b).

2.2 Energy System status and historic development

Table 6: Energy system indicators for Indonesia: current status and recent development

Energy system indicators		Source	2000	2010	Most recent	
					Value	Year
Primary Energy intensity of the economy (energy / GDP)	Energy intensity level of primary energy (MJ/$2011 PPP GDP)	WB-WDI*	5.31	4.34	3.46	2017
Carbon intensity of energy	kg CO_2 per MJ energy use	WB-WDI	70.85	84.63	86.18	2014
Carbon emissions per capita^{+}	t CO_2 /population	EDGAR	1.39	1.74	2.03	2016
Fossil fuel share in total energy	Share in total primary energy (%)	WB-WDI	61.95	67.15	66.09	2014
Electricity use	Electric power consumption (kWh per capita)	WB-WDI	390.37	634.18	811.90	2014
Fossil fuel share in electricity production	Electricity production from oil, gas and coal sources (% of total)	WB-WDI	84.04	84.15	89.34	2015
Share of coal in electricity production	Electricity production from coal sources (% of total)	WB-WDI	36.43	40.32	55.78	2015
Modern RE share in electricity production	Electricity production from renewable sources, excluding hydroelectric (% of total)	WB-WDI	5.22	5.57	4.78	2015
Renewable energy capacities	Installed RE capacity (in MW)	IRENA				
	Wind (onshore)		-	-	-	-
	Wind (offshore)		-	-	-	-
	Solar (Concentrated)		-	-	-	-
	Solar (Photovoltaic)		0	0	58	2017
	Biogas		-	-	-	-
	Bioenergy (Solid Biomass)		748	1,908	1,732	2017
	Hydropower		4,202	3,741	5,394	2017
	Geothermal		525	1,189	1,950	2017

*Notes:**Calculation of most recent value based on latest available WB-WDI data and growth rates from BP* (BP, 2018). *+CO2 emissions do not include emissions from LULUCF. PPP – Purchasing Power Parity. GDP – Gross Domestic Product.*

Sources: WB-WDI – World Bank World Development Indicators (The World Bank, 2019). *IRENA – International Renewable Energy Agency Database* (IRENA, 2019). *EDGAR emissions database* (JRC, 2016).

Indonesia is one of the world's fastest growing countries regarding energy consumption, and is the largest energy user in South East Asia (IRENA, 2017). In per capita terms however, Indonesia's energy use was less than half of the world average in 2014 but above the average of all lower middle income countries (The World Bank, 2019).

Indonesia has managed to substantially decrease the energy intensity of its economy between 2000 and 2017 (see **Table 6**). However, its carbon intensity of energy has increased between 2000 and 2014. Indonesia's share of fossil fuel sources in total energy consumption has risen from 62% in 2000 to 67% in 2010, but has recently declined again to 66% in 2014 (see **Table 6**).

Indonesia's per capita CO_2 emissions[7] have risen from 1.4 to 2 metric tons of CO_2 between 2000 and 2016 (see **Table 6**), but remain low compared with the world's average of 4.8 tCO_2/capita (JRC, 2016).

Between 2000 and 2014, per capita electricity consumption has more than doubled (see **Table 6**). With 812 kWh per capita, Indonesia's electricity consumption remains comparably low, equivalent to about a quarter of the world's average (3,127 kWh/capita) but is above the average of lower middle income countries (767 kWh/capita) in 2014 (The World Bank, 2019). The CIA World Factbook estimates that Indonesia's electricity consumption has risen to 817 kWh/capita in 2016 (CIA, 2019).

The share of fossil fuels in electricity production has increased from 84% to 89% between 2000 and 2015, and the share of coal in electricity production has increased from 36% (2000) to almost 56% (2015) (see **Table 6**). At the same time, the share of electricity produced from modern renewable sources (excluding hydro) has decreased again from 5.6% in 2010 to 4.8% in 2015. Increases in capacities for renewable energy technologies have been limited to geothermal and hydropower with only a very small uptake of solar PV and hardly any wind capacity. Including hydro power, the share of RE in total electricity output was 10.6% in 2015 (The World Bank, 2019).

Indonesia made some progress in improving the efficiency of its power system. Between 2000 and 2014, Indonesia achieved to decrease the share of electric output lost due to transmission and distribution losses from 11.5% to 9.4% (WDI).

---

[7] Excluding carbon emissions from land-use, land-use change and forestry.

2.3 Energy system and sustainable development – potential for benefits of a transition to renewable energy

Table 7: Indicators showing sustainable development implications of the current energy system and potential for benefits of a transition to renewable energy (co-benefits) (Indonesia)

Indicators for co-benefits potential		Source	Most recent	
			Value	Year
Fuel import dependency	Share of national income (GDP) spent on fuel imports (%)	WB-WDI+	2.7	2017
	Public expenditures spent on fuel imports (in billion current US$)	WB-WDI+	27.8	2017
Reliability of electricity supply	Share of firms experiencing electrical outages (%)	WB WDI	22.5	2015
	Power outages in firms in a typical month (number)	WB WDI	1	2015
	Share of sales lost for firms subject to power outages (%)	WB WDI	1.9	2015
Access to modern energy	Share of population with access to electricity (in %)	WB WDI	97.6	2016
	Share of rural population with access to electricity (in %)	WB WDI	94.8	2016
	Share of urban population with access to electricity (in %)	WB WDI	100.0	2016
	Share of primary schools with access to electricity (in %)	SDG-database	79.7	2016
	Share of population with access to clean fuels or technologies for cooking (in %)	WB WDI	58.4	2016
Indoor air pollution and health impacts	Number of deaths attributed to indoor air pollution* (per 100 000 inhabitants)	SDG-database	71	2016
Outdoor air pollution and health impacts	Share of population exposed to levels of fine particulate matter (PM 2.5) exceeding WHO guidelines (in %)	WB WDI	99.8	2016
	Number of deaths attributed to ambient air pollution* (per 100 000 inhabitants)	SDG-database	51	2016

*Note: *age standardised mortality rate of WHO. +Own calculations based on WB-WDI. GDP – Gross Domestic Product. WHO – World Health Organisation.*

Sources: WB WDI – World Bank World Development Indicators (The World Bank, 2019). *SDG-database -Sustainable Development Goals data base* (United Nations, 2019).

Indonesia has become one of the world's largest coal exporters in the last 15 years, yet it is striving to reduce fuel imports (e.g. by using domestic coal) and become more energy independent. In 2017, Indonesia has spent about 2.7% of its GDP **on fuel imports**, which amounted to public expenditures of about 27.8 billion USD (see **Table 7**). A transition to renewable energy could contribute to reducing public expenditures on fossil fuel imports, freeing resources for other investments.

Regarding the **reliability of electricity** in Indonesia, over 22% of businesses in Indonesia report to have been affected by power outages in 2015, with about one outage every month on average (see Table 7). These businesses are estimated to have lost about 1.9% of their sales due to the outages. Its archipelago character with its several thousand islands poses challenges to establishing reliable electricity supply relying on grid-based structures.

Indonesia has made progress in improving **access to modern energy**. Overall, 97.6% of the population had access to electricity in 2016, with full electricity access coverage in urban areas compared with 94.8% in rural areas (see Table 7), leaving about 6 million people without access (ESMAP, 2019). Moreover, over 20% of all primary schools in Indonesia had no access to electricity in 2016, affecting development prospects with regard to education. Renewable energy, especially in the form of mini-grid and off-grid systems such as solar home systems, can provide access to rural and remote areas of the archipelago (see below).

In 2016, the share of people with access to clean cooking fuels was still only 58.4%, leaving more than half of the population exposed to health hazards from **indoor air pollution** due to the burning of traditional biomass inside of dwellings. Accounting for age structure, about 71 out of every 100 000 inhabitants in Indonesia die due to indoor air pollution. The World Health Organisation (WHO) estimated the number of deaths attributed to indoor air pollution in Indonesia to over 130 000 in 2016 (World Health Organisation, 2018).

As Indonesia's energy and transport sectors predominantly use fossil fuels, **outdoor air pollution** remains a serious health concern, especially in urban areas. In 2016, 99.8% of Indonesia's population was exposed to fine particulate matter concentration levels exceeding recommended limits by the WHO. The number of deaths attributed to outdoor air pollution is estimated at about 95 000 in 2016 (World Health Organisation, 2018) – with about 51 out of 100 000 inhabitants dying because of outdoor air pollution.

3 Policies and projections on future development

In its NDC Indonesia declared an unconditional commitment of 29% emissions reduction compared with business-as-usual. Conditional on international support it also has the goal of reducing emissions by 41% compared with BAU (Republic of Indonesia, 2016). While the unconditional emissions reduction target would result in emissions increasing by 160% compared with 2010, the conditional goal would slow down the increase in emissions to around 142% of 2010 level (CAT, 2019).

Indonesia had an electrification rate of 98% in 2016, with 94.7% of the rural population, and 100% of the urban population having access to electricity (ESMAP, 2019). The Electricity Supply Business Plan (RUPTL) prepared by the national electricity distribution company, PLN, aims for an almost complete electrification of 99.5% by 2027 (PwC, 2018). The increased electrification rate is one of the reasons why in 2016 the Asian Development Bank projected Indonesian energy demand to almost double by 2025 and increase six-fold by 2050 compared with 2011 (Asian Development Bank, 2016). However, there are some indications that electricity demand is increase slower than expected. Whereas the RUPTL from 2018 projected annual average growth by 6.9% until 2027, the more recent plan projects growth by 6.4% until 2028 (IEEFA, 2019). This is still more than double the rate of the growth in electricity demand in 2017, which amounted to 3.1% (Mining, 2018) .

The Indonesian Electricity Supply Business Plan for 2019 (RUPTL 2019) further demonstrates the energy policy challenges faced in Indonesia. Several mega coal projects that were to be suspended or cancelled by the Indonesian government were reinstituted in the plan. At the same time, contrary to global and region trends and decreasing costs, the projected growth of solar energy was reduced by 13% leading to an expected increase of approximately 908 MW in the next decade (IEEFA, 2019).

In 2014 Indonesian government adopted its National Energy Policy aiming to increase the share of renewables in TPES to 23% in 2025, with 30% of energy coming from coal, 22% from oil, and 25% from natural gas (IEA, 2014). The share of renewables is set to increase to merely 31% by 2050. These assumptions are very conservative: According to IRENA REmap scenario the 2050 renewable energy goal can already be achieved 20 years earlier (IRENA, 2016).

Despite limited adoption, and support schemes for renewables, even existing schemes have proved to be insufficient due to regulatory uncertainty, and the high cost of capital for renewable schemes (Steckel and Jakob, 2018; Yuliani, 2017). This is also driven by the fact that key initiatives are often in the form of decrees and regulations passed by ministries, as opposed to parliamentary legislation, which leads to lower effectiveness (Fankhauser et al., 2017).

BOX: relevant key policies related to energy supply sector

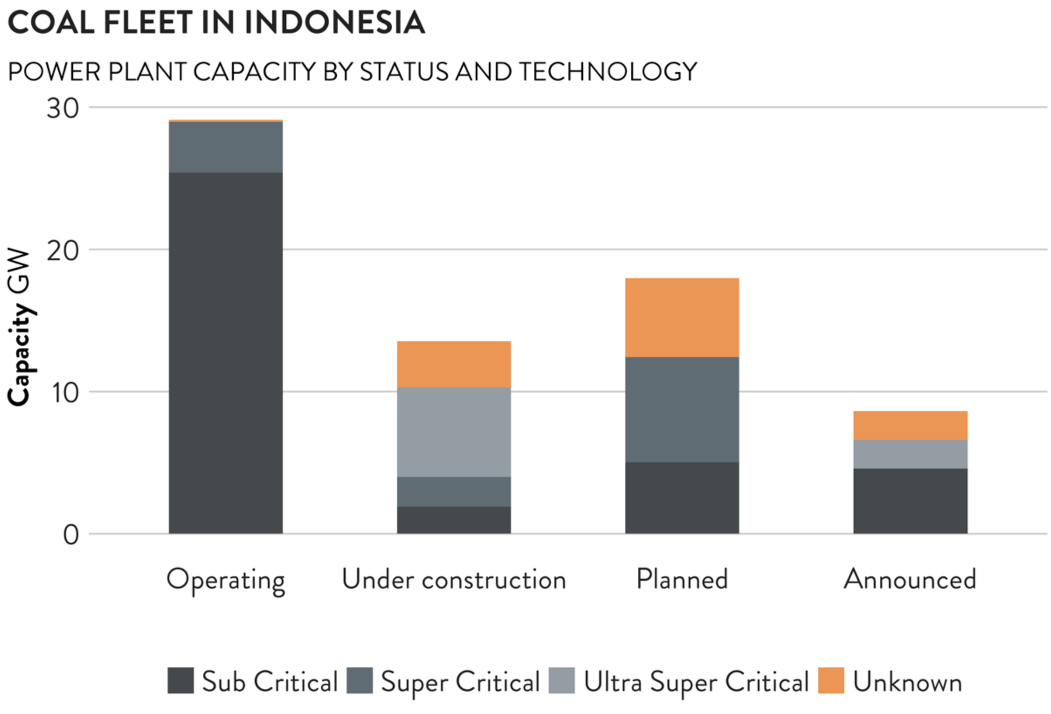
- **Nationally Determined Contribution:** In addition to the unconditional and conditional emissions reduction targets by 29% and 41% respectively by 2030, the NDC also refers to the goals of increasing the share of renewables in the TPES to 23% by 2025 and 31% by 2050 (The Government of Indonesia, 2016).
- **National Energy Policy** from 2014 aims to transform the TPES in 2025 towards 30% coal, 22% oil, 23% renewables and 25% natural gas. It also includes the goal of increasing the share of renewables in TPES to 31% by 2050 (IEA, 2014). The renewable energy target for electricity generation is 25% in 2030**.**
- **Presidential Regulation No. 22/2017 on the National General Energy Plan** (RUEN) aims at implementing the targets set out in the National Energy Policy (Hidayatullah, 2017).
- **Feed-in tariffs for renewables sources of energy.** Their level is determined through negotiations between independent power producers (IPPs) and PLN, Indonesia's national electricity distribution company (Conventus Law, 2017).
- **Blending of biofuels** requires companies holding a license to sell fuel to end users to achieve a certain blending target of biodiesel and bioethanol. For electricity and industry the share of biodiesel amounts 30% by 2020 (Ministry of Energy and Mineral Resources, 2018).

4 Projections on planning for coal

Indonesia contains the second highest proven reserve of coal in South- and South-east Asia, accounting for nearly 17% of the total proven reserves and is the second biggest global coal exporter (BP, 2018). Being an abundant domestic natural resource, favoured by large government subsidies, and without a carbon price that reflects the high environmental and social externalities, coal is still considered as a cheap power source in Indonesia. Consequently, coal is the main energy source for power generation (around 60% in 2018) and, under current plans, it will continue to expand substantially to meet the growing energy demand (Ministry of Energy and Minerals of the Republic of Indonesia, 2018). Indonesia seeks to increase its coal-fired power generation capacity, among other reasons, based on a narrow definition of energy security. Domestic utilisation ensures a continued stream of coal revenue in the context of an uncertain export demand. This is driven by lower demand forecasts in Indonesia's major export markets which include China and Australia (Russell, 2018). Other argument behind the promotion of increased national consumption, is the reduction of the country's dependence on international commodity market fluctuations.

Focus: RUPTL 2019-2028

PLN the state-own utility company that had exclusive right to offtake electricity in Indonesia sets targets for the power mix in its most recent Business Plan (RUPTL 2019-2028). Under this plan, coal would contribute 54.4% and renewables 12.27% to electricity generation in 2027. This plan sees a downward revision in the contribution of renewables, from the previous plan, which envisaged a 20% contribution of renewables by 2027.



SOURCE : PLATTS WEPP GCPT

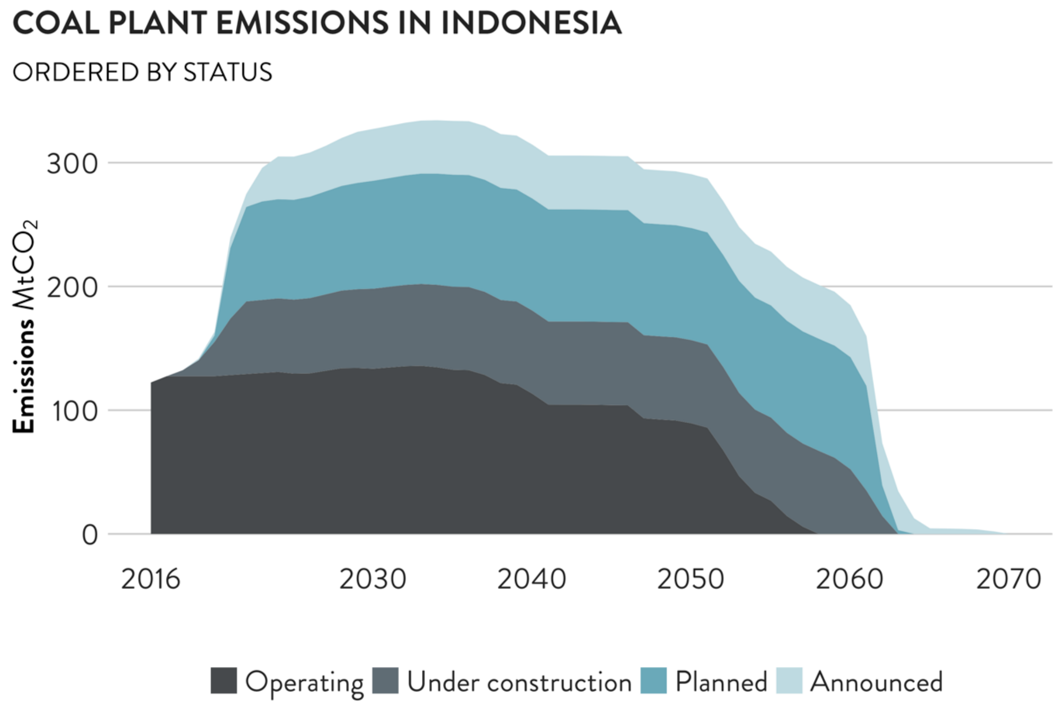
Figure 1: Indonesia's coal fired power generation capacity

Indonesia's 43 GW of current coal power generation capacity represents only 1.9% of global coal fleet, however, if all the coal power plants planned and announced (27GW) are built as currently planned, Indonesia is set to expand its use of coal capacity by 62% expansion from current levels8 (Figure 1). At a global level, this expansion accounts for over 7% of the global coal fleet expansion plans. Nearly 90% of the existing capacity is sub-critical, with higher emission intensity.

While the increasing energy demand of the country is expected to continue in tandem with economic and population growth as well as urbanisation and increasing access to modern energy in the coming years, demand overestimates by national plans, and rapidly changing cost of renewable energy result in a high risk of overcapacity for coal power generation under current expansion plans. These factors are likely to lead to lower than expected utilisation rates of coal power plants, with a significant impact on the profitability of PNL and ultimately on the State income. While there were signs that the government recognised this problem by revising coal capacity additions downwards in the RUPTL 2018-2027, the most recent RUPTL 2019-2028 sees a slight increase in coal-fired capacity additions (Brown and Hamdi, 2019).

---

8 Here, we define current capacity as total operating capacity + capacity under construction, and to expansion plans as planned capacity (permitted and pre-permitted units that have not started construction) + announced capacity.



SOURCE : OWN CALCULATIONS BASED ON PLATTS WEPP , GCPT

Figure 2: Committed emissions from Indonesia's coal plants

Despite the fact that planned coal capacity additions consist mostly of super- and ultra-super critical power plants (with relatively lower emission intensities), the committed emissions from these power plants still represent a significant addition to the emission profile of the country (**Figure 2**). Under current expansion plans for the coal fleet, the committed emissions from coal-fired power plants would peak only around 2035, with an eventual phase-out only by 2069. This far exceeds the phase-out date derived from regional benchmarks in a Paris Agreement consistent scenario, which requires coal-fired power being phased out in the ASEAN region by 2040.

The vulnerability of Indonesia's coal based power-generation is already evident today, with the government having to regulate to protect the profitability of the national operator with measures such as the establishment of a domestic electricity coal price cap of 70 USD/ton (The Carbon Tracker Initiative, 2018). This vulnerability would only be exacerbated by current expansion plans which are likely to lead to overcapacity, low utilisation rates, and a high risk of stranded assets, in addition to the enormous climate, health, and social and economic externalities associated to coal-based power generation.

5 Transition to renewable energy – pathway characteristics, benchmarks, options, potentials, benefits

5.1 Potential and technology options for renewable energy

.

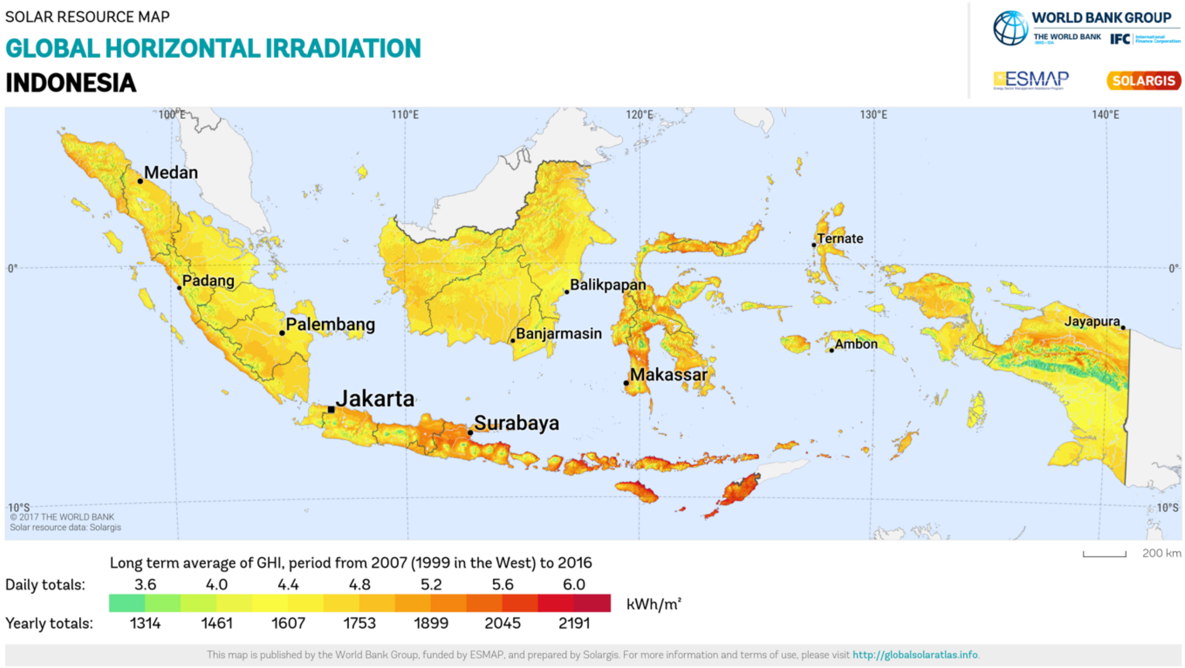

SOLAR RESOURCE MAP
GLOBAL HORIZONTAL IRRADIATION
INDONESIA
WORLD BANK GROUP
THE WORLD BANK
IFC
ESMAP
SOLARGIS
100°E
110°E
120°E
130°E
140°E
0°
10°S
Medan
Padang
Palembang
Jakarta
Surabaya
Banjarmasin
Balikpapan
Makassar
Ternate
Ambon
Jayapura
© 2017 THE WORLD BANK
Solar resource data: Solargis
200 km
Long term average of GHI, period from 2007 (1999 in the West) to 2016
Daily totals: 3.6 4.0 4.4 4.8 5.2 5.6 6.0
kWh/m²
Yearly totals: 1314 1461 1607 1753 1899 2045 2191
This map is published by the World Bank Group, funded by ESMAP, and prepared by Solargis. For more information and terms of use, please visit http://globalsolaratlas.info.

Figure 3. Global horizontal irradiation based on Global Solar Atlas (The World Bank Group, 2016)

Covering 1.5% of Indonesia's territory with solar PV would allow generating 4.968 TWh of electricity – equivalent to 23-times the total electricity generation in the country in 2017 (CIA, 2019; NREL, 2014). At the same time, Indonesia's average solar radiation is slightly lower than for other countries in South East Asia and also compared to South Asian countries (The World Bank Group, 2016). However, it still has a higher ratio of potential versus current electricity generation compared to India because of the still lower average electricity consumption per capita (808 kWh per year versus 849 kWh for India) and lower population density (146/km^2 versus 407/km^2 for India).

Indonesia's wind potential is comparatively smaller than for other countries of both regions. Only in few onshore areas wind speed at 200 m approaches 300 Watts/m^2. The mean wind power density for the 10% windiest areas is 203 Watts/m^2 (World Bank Group, 2018). The theoretical potential for wind resources has been estimated to be as high as 61 GW (PwC, 2018).

At the same time Indonesia has the largest untapped hydropower potential of all countries of both regions. With 477 TWh it was ranked 8 in the world (Zhou et al., 2015). However this potential decreases substantially if national parks are excluded (Ministry of Energy and Mineral Resources, 2011). Indonesia is also home to roughly 40% of the global geothermal energy potential, and the country has enough resources to generate 28.6 GW of electricity (Nasruddin et al., 2016). Indonesia has also significant potential for energy generation – especially heat – from biomass residue (Carlos and Ba Khang, 2008).

5.2 Reaping opportunities of transitioning to renewable energy: Implications for local jobs and affordability of energy

Indonesia can benefit massively from a rollout of renewable energy. IRENA (IRENA, 2017) has estimated the following benefits for Indonesia for its Remap scenario:

- **Reducing air pollution and related health impacts.** Comparing the REmap to the refence scenario, IRENA estimates that in 2030 Indonesia could benefit from reduced outdoor air pollution valuing between 3 to 9.7 billion USD per year and reduced indoor air pollution from decreased traditional biomass use valuing between 10.4 to 31.3 billion USD per year.
- **Contribute to energy security.** Taking full advantage of Remap options, Indonesia is estimated to reduce its fossil fuel demand by 10% compared to the reference scenario, with a reduction in coal use by 17% and a 9% reduction in oil use. Moreover, modern cook stoves fully replace traditional uses of bioenergy. The share of modern renewable energy in total primary energy supply in the REmap Scenario is 32% compared to 25% in the reference case, contributing to Indonesia’s aim to become more energy independent.
- **Improving energy access and fighting energy poverty.** With is local and decentralized nature, and low and decreasing costs, many RE technologies offer opportunities to improve the access to electricity in poor and especially remote areas and isolated island, contributing to the fight against energy poverty even in areas of the archipelago that are hard to access.
- **Contributing to reducing energy system costs.** IRENA estimates that in 2030 total energy system costs in Indonesia could be 1.7 billion USD lower per year in the REmap scenario compared to the reference scenario, with the largest savings in the electricity sector.

Beyond these benefits of a transition to modern renewable energy, Indonesia could benefits form creating local job opportunities in the RE sector.

Several studies show that a 100% renewable energy scenario by 2050 is possible considering the renewable energy potentials of Indonesia (Matthias Günther et al., 2018; Ram et al., 2017; Wang et al., 2018). Although meeting the electricity demand of Indonesia from locally available renewable resources could be challenging (Wang et al., 2018), it is economically and environmentally feasible (Matthias Günther et al., 2018).

6 Gap analysis: targets, projections, and Paris Agreement benchmarks

Indonesia’s NDC commits the country to an unconditional emissions reduction of 29% below Business-as-Usual emissions by 2030. This can rise to 41%, conditional on international support. The target for the sectors without Land-use, land use change and forestry (LULUCF) has been rated “Highly insufficient” by the by the Climate Action Tracker and is likely to be overachieved under current policy projections (Climate Action Tracker, 2018).

The target to increase “new and renewable” energy to 23% of total primary energy supply (TPES) by 2025, from the current share of 6.5% falls short of the contribution required from Indonesia (26%) to meet the regional target of 23% (for the ASEAN) based on the IRENA Remap analysis for Indonesia.

The related target to increase renewable energy share in electricity to 25% by 2025 is not expected to be achieved with current policies, and is not in line with the results of the Paris Agreement compatible scenario analysed in chapter 2 for the ASEAN region, according to which a 33% share of decarbonised electricity generation in 2025, and 51% in 2030 would need to be achieved, on the way to a fully decarbonised electricity sector in 2050.

Indonesia’s current electricity generation planning falls far short even of this national target, and more so of the potential generation identified in IRENA’s REmap scenarios. These plans continue to commit to a heavy reliance on coal-fired generation at the expense of policy options to support renewable generation (Brown and Hamdi, 2019).

The share of renewable electricity generation in the RUPTL is 12.28% by 2028, which falls short of the potential 38% share of renewables envisioned in the IRENA REmap scenarios for 2030. This difference can largely be attributed to the difference in the contribution of solar and wind generation. The share of geothermal generation by 2028 is 9.63%, which is comparable to the share envisioned in the IRENA scenario.

The expansion of coal power plants that Indonesia is currently planning, accounts for over 7% of the global coal fleet expansion plans. It by far exceeds the generation benchmarks under a Paris Agreement compatible scenario, which established a phase-out of coal fired power by 2040 for the ASEAN region.

Literature

Asian Development Bank (2016). Indonesia. Energy Sector Assessment, Strategy, and Road Map. Available at: https://www.adb.org/sites/default/files/institutional-document/189713/ino-energy-asr.pdf.

BP (2018). BP Statistical Review of World Energy 2018. Available at: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf [Accessed March 14, 2019].

Brown, M., and Hamdi, E. (2019). IEEFA Indonesia: 2019 energy plan falls short - Institute for Energy Economics &amp; Financial Analysis : Institute for Energy Economics &amp; Financial Analysis. Available at: http://ieefa.org/ieefa-indonesia-2019-energy-plan-falls-short/ [Accessed March 19, 2019].

Brown, S., Nicholls, R. J., Lázár, A. N., Hornby, D. D., Hill, C., Hazra, S., et al. (2018). What are the implications of sea-level rise for a 1.5, 2 and 3° C rise in global mean temperatures in the Ganges-Brahmaputra-Meghna and other vulnerable deltas? *Reg. Environ. Chang.*, 1–14.

Carlos, R. M., and Ba Khang, D. (2008). Characterization of biomass energy projects in Southeast Asia. *Biomass and Bioenergy* 32, 525–532. doi:10.1016/J.BIOMBIOE.2007.11.005.

CAT (2019). Pledges And Targets. Available at: https://climateactiontracker.org/countries/india/pledges-and-targets/ [Accessed March 15, 2019].

CIA (2019). The World Factbook. Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/pp.html [Accessed March 14, 2019].

Climate Action Tracker (2018). Indonesia | Climate Action Tracker. Available at: https://climateactiontracker.org/countries/indonesia/ [Accessed March 20, 2019].

Conventus Law (2017). Indonesia - Tariff Framework For Renewable Energy. Available at: http://www.conventuslaw.com/report/indonesia-update-tariff-framework-for-renewable/.

Eckstein, D., Hutfils, M.-L., and Winges, M. (2018). *Global Climate Risk Index 2019. Who Suffers Most From Extreme Weather Events? Weather-related Loss Events in 2017 and 1998 to 2017*. doi:978-3-943704-04-4.

ESMAP (2019). Tracking SDG7 | Progress Towards Sustainable Energy. Available at: http://trackingsdg7.esmap.org/ [Accessed March 18, 2019].

Fankhauser, S., Kazaglis, A., and Srivastav, S. (2017). Green Growth Opportunities for Asia. *Ssrn*. doi:10.2139/ssrn.2982871.

Hidayatullah, R. (2017). ASEAN Nuclear Series Part 2: Nuclear in Indonesia – 50 Years and Counting.

IEA (2014). National Energy Policy (Government Regulation No. 79/2014).

IEA (2015). Southeast Energy Asia Outlook 2015. Available at: www.iea.org/t&c/ [Accessed December 7, 2018].

IEA (2018). World Energy Outlook 2018. Paris.

IEEFA (2019). IEEFA Indonesia: 2019 energy plan falls short. Available at: http://ieefa.org/ieefa-indonesia-2019-energy-plan-falls-short/.

IRENA (2016). Renewable Energy Outlook for ASEAN. Available at: www.irena.org/publications, [Accessed February 18, 2019].

IRENA (2017). *Renewable Energy Prospects: Indonesia, a REmap analysis, International Renewable Energy Agency (IRENA), Abu Dhabi, www.irena.org/remap.* doi:10.1145/347642.347800.

IRENA (2019). IRENA Dashboard - RE database. Available at: http://resourceirena.irena.org/gateway/dashboard/ [Accessed March 14, 2019].

JRC (2016). EDGARv.4.3.2 - Fossil CO2 and GHG emissions of all world countries. *Janssens-Maenhout, G., Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Olivier, J.G.J., Peters, J.A.H.W., Schure, K.M.* Available at: edgar.jrc.ec.europa.eu/booklet2017/EDGARv432_FT2016_CO2_per_capita_emissions_1970-2016.csv [Accessed March 19, 2019].

Matthias Günther, Irina Ganalb, and Stefan Bofinger (2018). A 100% Renewable Electricity Scenario for the Java-Bali Grid. Available at: https://ejournal.undip.ac.id/index.php/ijred/article/view/13910/pdf [Accessed April 18, 2019].

Mining (2018). Indonesia’s push for electrification and its impact on domestic coal – report. Available at: http://www.mining.com/web/indonesias-push-electrification-impact-domestic-coal-report/.

Ministry of Energy and Mineral Resources (2011). Project for the Master Plan Study of Hydropower Development in Indonesia. Available at: http://open_jicareport.jica.go.jp/pdf/12037610.pdf [Accessed March 18, 2019].

Ministry of Energy and Mineral Resources (2018). “Bioenergy in Indonesia: Rules and Implementations. Available at: https://www.ieabioenergy.com/wp-content/uploads/2018/09/1.5-Elis-Heviati.pdf.

Ministry of Energy and Minerals of the Republic of Indonesia (2018). Power supply business plan (RUPTL) 2018 to 2027 (Pengesahan rencana usaha penyediaan tenaga listrik pt perusahaan listrik negara (persero) tahun 2018 s.d. 2027).

Nasruddin, Idrus Alhamid, M., Daud, Y., Surachman, A., Sugiyono, A., Aditya, H. B., et al. (2016). Potential of geothermal energy for electricity generation in Indonesia: A review. *Renew. Sustain. Energy Rev.* 53, 733–740. doi:10.1016/J.RSER.2015.09.032.

NREL (2014). Solar Resources by Class and Country. Available at: https://openei.org/doe-opendata/dataset/solar-resources-by-class-and-country/resource/3e72f32a-7de1-4e5d-a25a-76928769625f [Accessed March 15, 2019].

PwC (2018). Power In Indonesia: Investment and Taxation Guide.

Ram, M., Bogdanov, D., Aghahosseini, A., and Oyewo, A. S. (2017). Global 100% RE System: Southeast Asia - Indonesia, Papua New Guinea. Available at: https://www.researchgate.net/publication/320756200_Global_100_RE_System_Southeast_Asia_-_Indonesia_Papua_New_Guinea [Accessed March 19, 2019].

Republic of Indonesia (2016). First Nationally Determined Contribution.

Russell, C. (2018). Indonesia wants to export more coal, buyers ignore the call: Russell | Reuters. Available at: https://www.reuters.com/article/column-russell-coal-indonesia/column-indonesia-wants-to-export-more-coal-buyers-ignore-the-call-russell-idUSL4N1WR24R [Accessed March 19, 2019].

Schleussner, C.-F., Lissner, T. K., Fischer, E. M., Wohland, J., Perrette, M., Golly, A., et al. (2016). Differential climate impacts for policy relevant limits to global warming: the case of 1.5°C and 2°C. *Earth Syst. Dyn.* 7, 327–351. doi:10.5194/esd-7-327-2016.

Steckel, J., and Jakob, M. (2018). On the political economy in Indonesia and Vietnam - Common Economics Blog. Available at: https://blog.mcc-berlin.net/post/article/keeping-the-lights-on.html [Accessed December 7, 2018].

The Carbon Tracker Initiative (2018). *Economic and financial risks of coal power in Indonesia, Philippines, Vietnam*.

The Government of Indonesia (2016). First Nationally Determined Contribution. Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Indonesia First/First NDC Indonesia_submitted to UNFCCC Set_November 2016.pdf [Accessed March 19, 2019].

The World Bank (2018). Country Overview - Indonesia. Available at: https://www.worldbank.org/en/country/indonesia/overview [Accessed March 14, 2019].

The World Bank (2019). World Development Indicators database. Available at: https://databank.worldbank.org/data/reports.aspx?source=world-development-indicators [Accessed January 30, 2019].

The World Bank Group (2016). Global Solar Atlas.

United Nations (2019). Sustainable Development Goals database. Available at: https://unstats.un.org/sdgs/indicators/database/ [Accessed February 19, 2019].

United Nations Development Program (2018a). Human Development Index database. Available at: http://hdr.undp.org/en/data# [Accessed March 13, 2019].

United Nations Development Program (2018b). Human Development Indices and Indicators: 2018 Statistical Update - Indonesia. Available at: http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/IDN.pdf.

Wang, C., Dargaville, R., and Jeppesen, M. (2018). Power system decarbonisation with Global Energy Interconnection - a case study on the economic viability of international transmission network in Australasia.

World Bank Group (2018). Global Wind Atlas.

World Health Organisation (2018). Global Health Observatory data repository. Available at: http://apps.who.int/gho/data/node.main.BODAMBIENTAIR?lang=en; [Accessed March 15, 2019].

Yuliani, D. (2017). Is feed-in tariff policy effective for increasing deployment of renewable energy in Indonesia? Available at: www.wider.unu.edu [Accessed January 7, 2019].

Zhou, Y., Hejazi, M., Smith, S., Edmonds, J., Li, H., Clarke, L., et al. (2015). A comprehensive view of global potential for hydro-generated electricity. *2622 | Energy Environ. Sci* 8, 2622. doi:10.1039/c5ee00888c.