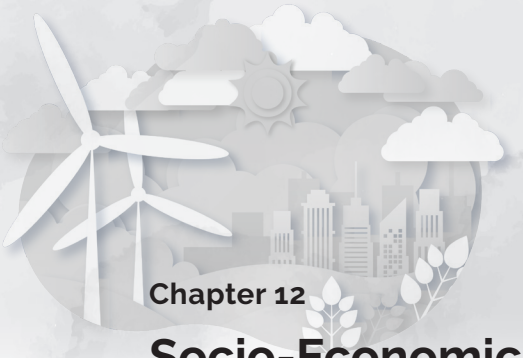


Chapter 12

Socio-Economic Impacts of Renewable and Carbon-Neutral Energy Development

Nevi Cahya Winofa

A. Overview of Socio-Economic Impact of Renewable and Carbon-Neutral Energy Development

Energy is the input of nearly all economic activities. Having the fourth largest population in the world and Southeast Asia's largest economy, Indonesia has the largest energy consumption in the Southeast Asia Region, accounting for 40% of the total energy consumption. Hence, Indonesia's energy supply structure is critical for determining economic development. In COP26, Indonesia has pledged to achieve a 29% reduction in greenhouse gas emissions by 2030 and net-zero emission by 2060. One of the mitigation measures in the energy sector is increasing renewable energy shares by 23% in 2025 and 31% in 2050.

N. C. Winofa
Rice University, e-mail: neviwinofa@rice.edu

Winofa, N. C. (2022). Socio-economic impacts of renewable and carbon-neutral energy development. In H. Ardiansyah, & P. Ekadewi (Eds.), *Indonesia post-pandemic outlook: Strategy towards net-zero emissions by 2060 from the renewables and carbon-neutral energy perspectives* (239–266). BRIN Publishing. DOI: 10.55981/brin.562.c12 ISBN: 978-623-7425-83-0 E-ISBN: 978-623-7425-87-8

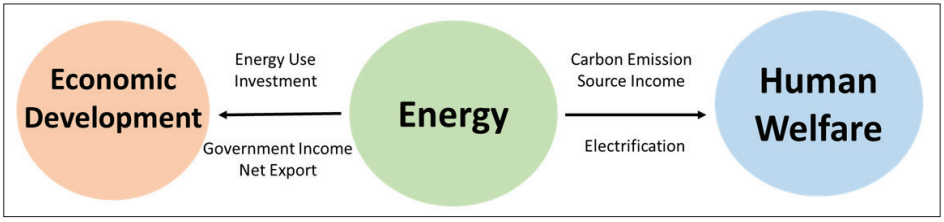
Table 12.1 The Scope of the Chapter

	Socio-Economic Benefit	Key Challenges	Policy and Recommendation
Renewable and Carbon free Energy **Economic Development** **Human Welfare**	**1. Energy Security** a. Diversified Energy Sources b. Reducing Reliance on Import	**1. Competitiveness of Renewable and Clean Energy Cost to Conventional Energy** a. Unfair competition with subsidized fuel b. Unseen positive externalities	**1. Competitive Renewable and Clean Energy Cost** a. Removing Fossil Fuel Subsidy b. Carbon Pricing
	2. Boost Economic Growth a. Increase Investment b. Activate Domestic Industries	**2. Increase Investment in Renewable and Clean Energy Cost** a. Lack of Transparancy and low predictability in procurement b. Risk Allocation c. Unsupportive Tariff System	**2. Accelerate Investment in Renewable and Clean Energy** a. Reforming Tariff Cap b. Restructure Risk Allocation c. Renewable and Carbon Free Energy Auction Program
	3. Job Creation A high Demand of workers from Equipment and Infrastructre **4. Human Welfare** Increase household consumption, income, and improve air-quality	**3. Positive net employment: balancing between growth in renewable and clean energy and losses in fossil fuel employment.** a. Dislocated workers b. A high demand of high skill workforce	**3. Achieving Positive Net Employment** a. Reskilling and Upgrade Skill Fossil Fuel Workers b. Building the skill of new entrance
	4. Gender Equality Broad range of Multi dicipline Role	**4. Low women participation in renewable and clean energy job** a. Cultural, Social Norm, and Stigma b. Low participation in STEM field	**4. Balancing gender participation in deployment of renewable and clean energy** a. Integrating gender in each value chain of renewable and clean energy b. Improving access to STEM education and training

While meeting the environmental objective, energy transition also impacts the social and economic aspects. This chapter reveals a full range of macroeconomic benefits of renewable and carbon-neutral energy deployment: increasing energy security, fueling GDP development, creating job opportunities, enhancing human welfare, and achieving gender equality. Several challenges need to be tackled to maximize the benefit of the energy transition, such as uncompetitive renewable and carbon-neutral energy cost to conventional energy, lack of renewable and carbon-neutral energy investment, gap in achieving positive net employment, and low participation of women in renewable and carbon-neutral energy jobs. Some policies and recommendations are also proposed to address the challenges of renewable and carbon-neutral energy development in Indonesia. Figure 12.1 summarizes the scope of discussion in this chapter.

B. An Overview: Energy Structure, Economic Development, and Human Welfare

The energy structure has a high impact on economic and human welfare. Figure 12.1 shows the relationship between how changes in the energy sector will influence economic and human welfare. Energy contributes to each component of GDP: consumption, investment, government income, and net export. Although the impact of energy structure on human welfare is already reflected in GDP, energy has additional impacts such as carbon emission, source of income, and electrification, which also has a derive impact on the quality of health and education.

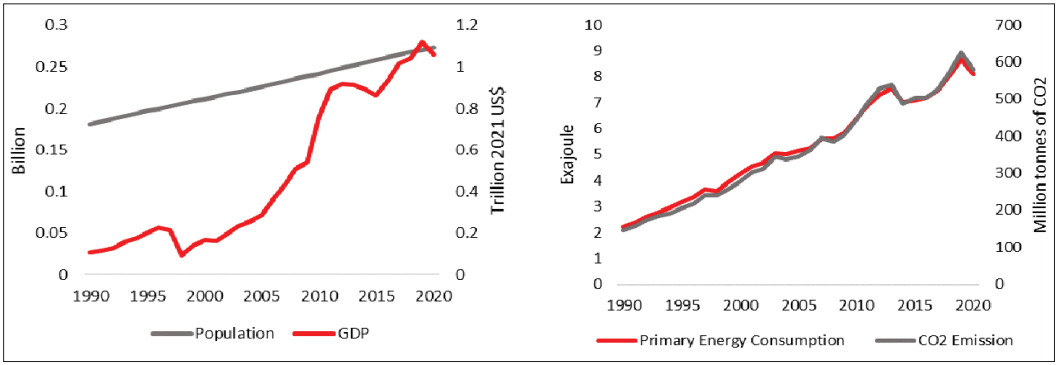


Source: modified from IRENA (2016)

Figure 12.1 The Relationship between Energy, Economic Development, and Human Welfare

1. Current Indonesia's Energy Structure, Economic Development, and Human Welfare

With a population of 277 million which is constantly growing by 1–2% per year between 1990 and 2020, Indonesia has become the fourth most populous country in the world (Worldometers, 2022). Regarding economic development, Indonesia has had a remarkable economic growth of 5% on average GDP growth per year for more than thirty years (BP Statistical Review, 2021). Therefore, the country becomes the largest economy in Southeast Asia and the tenth-largest global economy in terms of purchasing power (World Bank, 2021). This impressive development is also reflected in Indonesia's energy consumption. Figure 12.2 shows that the primary energy consumption has a similar trend with the GDP. Energy demand grows as the economy develops. However, it also can be seen that CO_2 emission also increases as energy consumption increases.

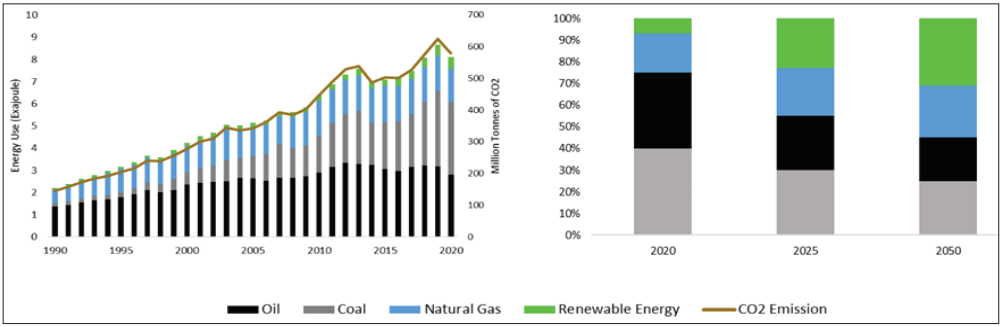


Source: World Bank (2022) & BP Statistical Review (2021)

Figure 12.2 Population and Economic Development (Left) and Total Energy Use and CO_2 Emissions Trend (Right)

Looking into more details, the energy supply in Indonesia is still dominated by fossil fuels which are coal, oil, and natural gas. Figure 12.3 (left) shows the development of Indonesia's energy mix. Although the share of oil consumption has declined, the share of coal has soared especially in the last ten years. Undoubtedly, CO_2 emission

has increased as energy use increases because it was mainly supported by fossil fuels. This condition was the opposite of the country's commitment to reduce greenhouse gas emission by 2030 and to achieve net-zero emissions in 2060. Figure 12.3 (right) shows that fossil fuel contributed 93% to total energy consumption in 2020 (coal: 40%), (oil: 35%), and (natural gas: 18%) while renewables only contributed 7%. It is still far from the country's energy mix transformation target to increase the renewable shares from 23% in 2025 to 31% in 2050 as stated in the Government Regulation No. 79/2014 on National Energy Policy.

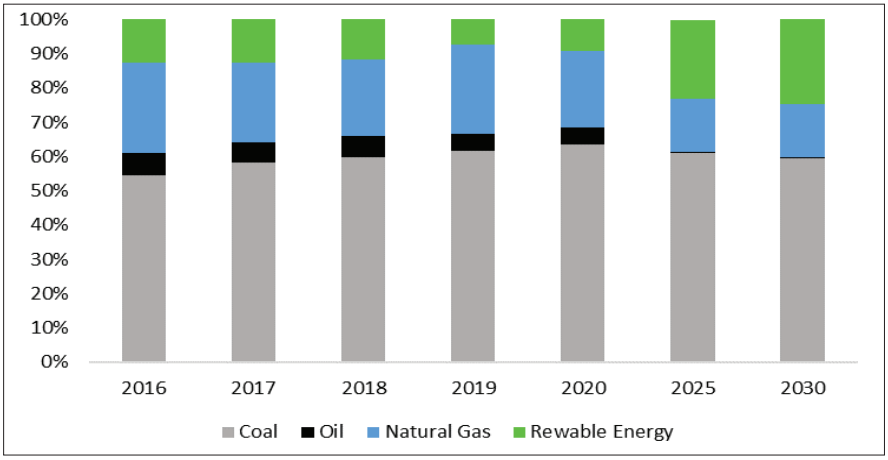


Source: BP Statistical Review (2022)

Figure 12.3 The Development of Indonesia's Energy Mix (Left) and Comparison Between Current Energy Mix and Target in 2020 and 2050 (Right)

The demand for coal mostly came from electricity consumption. The electricity generation still heavily relied on coal. Coal utilization in electricity generation has consistently increased by 2% over the last five years. Accounting for 64%, coal is the main resource of electricity generation in 2020, followed by natural gas at 23%, renewables at 9%, and oil at 5%. According to the National Power Generation Plan in RUPTL 2021–2030, the power generation will continue to be dominated by coal for the next ten years (Figure 12.4). The increase in the share of renewables is from replacing the diesel power generation only from 3T (front, outermost, and disadvantaged) regions. Knowing that fossil fuel is less expensive, the state electricity company (PLN) faces conflicting challenges between increasing the share of renewables

and keeping the rate of BPP (electricity generation cost). Although the PLN applied co-firing to reduce the environmental damage of coal, it will continue to be a major supplier of electricity.



Source: PT PLN (2020)

Figure 12.4 Indonesia Electricity Energy Mix and Its Target in 2025 and 2030

2. How COVID-19 Changes Energy Demand and Economic Structure

Despite impressive economic progress, the sudden shock due to the COVID-19 pandemic has shrunk Indonesia's economic growth by 6% in 2020 (World Bank, 2022). This condition was the biggest falling since the financial crisis in 1998. The rapid spread of the virus has significantly reduced productivity, increased unemployment, loss of life, and closed businesses. This made the government of Indonesia concentrate its effort on the health and economic recovery.

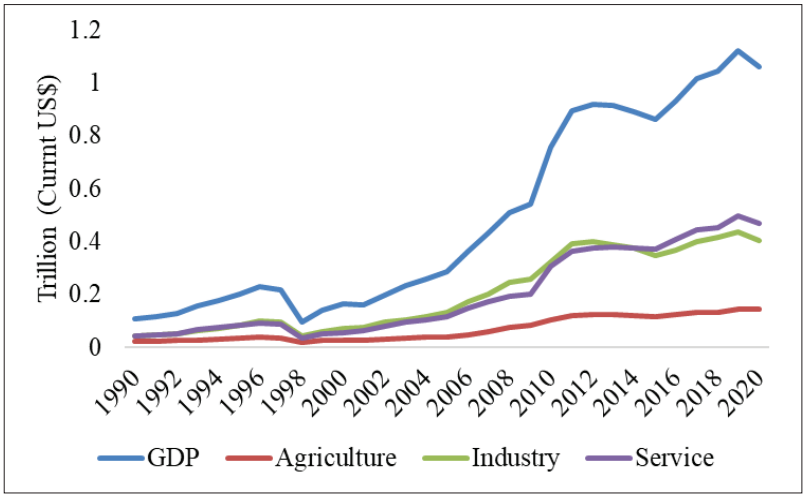
The pandemic has also impacted the energy sector with a decline by 7% in total energy demand. To mitigate the massive spread of the virus, travel restrictions were imposed, leading to a cut-off on gasoline and diesel fuel consumption by 15–20% and jet fuel consumption by 30–0% (McKinsey & Company, 2020). The large-scale restrictions in major cities resulted in a delay in several energy projects, affect-

ing energy companies' profit and reducing the new investment. PT Pertamina (state oil company) and PT PLN reported experiencing US$768 million loss and almost no profit in the first half of 2020, respectively (McKinsey & Company, 2020). Several under-construction projects need to be delayed in renewable and carbon-neutral energy development. Some funding distribution also got delayed because of the concern of project sustainability during the pandemic. As a result, this condition has pushed back the target from the original plan.

Although the country suffers from the shock, its economy will gradually come back as large-scale tracing, tracking, and vaccination of COVID-19 has been widely applied. The World Bank (2021) estimates that Indonesia's economy will continue to recover in 2021 and accelerate in 2022. It is known that economic development will drive an increase in energy demand. The significant growth of energy demand post-COVID-19 is an opportunity to promote renewable and carbon-neutral energy to supply additional energy demand.

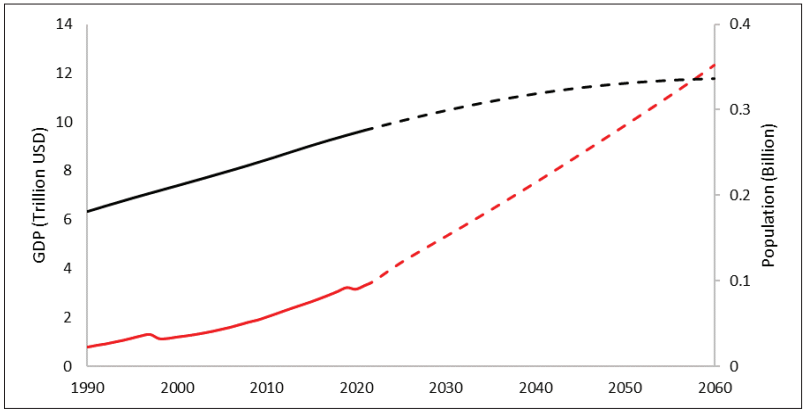
3. Projection of Economy and Energy Demand in 2030 and 2060

As energy efficiency improved, the economy moved from the industrial sector (highly energy-intensive sector) to the service sector (less energy-intensive sector). Figure 12.5 shows the changes in structural economic activity over three decades. It is projected that the service sector will be continuing to grow in the future. Even though Figure 12.6 shows that this is projected to increase until 2030 and even until 2060, energy demand will increase at a slower rate in line with slow growth in population compared to GDP. This is a momentum for renewable and carbon-neutral energy to take over the energy market. While the preparation is underway, consistent energy policies and regulations must be introduced to ensure that Indonesia does not miss the momentum to strengthen the green economy.



Source: World Bank (2022)

Figure 12.5 The Development of Indonesia Structural Economy



Source: World Bank (2020) & OECD (2018)

Figure 12.6 Current and Projection of Indonesia's Population and Economic Growth

C. Socio-Economic Benefit of Renewable and carbon-neutral Energy

While achieving greenhouse gasses reduction targets, the deployment of renewable and carbon-neutral energy has multiple benefits to economic and social development. This subchapter discusses how increasing renewable and carbon-neutral energy share in the energy mix can improve economic and human welfare.

1. Energy Security

Maintaining an adequate and stable supply of energy at a reasonable price has become a serious problem when facing the possibility of economic upheaval. This concept refers to energy security. It is known that energy is the input to economic activity. An inadequate and unstable energy supply potentially disrupts economic activity, leading to macroeconomic dislocation. The probability of disruption is higher when the country relies on other countries to meet its national demand. Any political action restricting the energy supply can be a major national threat. Indeed, by engaging in international trade, the country must face the uncertainty of the world price of energy. In addressing energy security, the idea of diversification of energy sources and reducing imported energy has been echoed. It is known that energy transition plays an important role in those areas while also achieving environmental objectives.

a. Diversifying energy sources

Renewable and carbon-neutral energy can contribute to ensuring a stable energy supply through energy resource diversification. Increasing the share of renewable and carbon-neutral energy in the energy mix gives an ability to substitute among other energy sources, which help to reduce the risk of disruption in the energy supply. It is known that oil and gas prices, sometimes, can be extremely volatile. Thus, the availability of renewable and carbon-neutral energy as a substitute can help avoid price uncertainty. It was seen in Japan when they were facing the oil shock in the 1970s. They tried to diversify their energy

source for electricity generation by increasing nuclear energy, gas and coal and promoting energy efficiency and conservation. Therefore, energy policy needs to be made to reduce the cost of renewable and carbon-neutral energy to benefit energy security.

b. Reducing reliance on imported energy

Increasing renewable and carbon-neutral energy shares can make the country more independent in supplying energy. It is known that Indonesia currently imports 50% of its energy use. The country is net importer of crude oil with more than 236,000 bpd of imported crude oil in 2020 (EIA, 2021). Already net imported crude oil, Indonesia is also predicted to be net imported natural gas for the next five years (McKinsey & Company, 2020). This condition makes local energy production critical to reducing the reliance on energy supply from foreign countries. Deploying renewable and carbon-neutral energy can increase domestic energy production, reducing energy import. While increasing local production, it also pushes the risk of disruption in energy supply from external factors. In this case, an energy policy to increase renewable and carbon-neutral energy investment is valuable to increase its contribution.

2. Boosting Economic Growth

Energy drives economic growth. The changing structure of the energy supply will directly impact the economic development shown in national GDP growth. A reliable, secure, and most importantly environmentally friendly energy resource is equally important in stimulating economic growth. Bappenas (2021) predicted that the economy will grow 6.1–6.5% on average per year between 2021 and 2050 through a low-carbon growth path. The robust increase in GDP is mainly caused by an increase in renewable and carbon-neutral energy investment and a reduction in energy import.

a. Increasing investment

An increase in renewable energy investment will trigger economic growth. It is known that the characteristic of renewable energy development is capital-intensive. In other words, it has a high upfront investment (physical asset) while having a low operational cost (fuel cost). An increase in the share of renewable energy in the energy mix will increase the demand for investment in infrastructure. Therefore, renewable and carbon-neutral energy investment needs to be scaled up to meet the growing demand.

b. Accelerating domestic industries growth

Another important renewable and carbon-neutral energy role in raising economic development is growing domestic industry. Renewable and carbon-neutral energy development will activate the construction and manufacturing sectors. This can be a source of national income, directly giving additional value to GDP. While stimulating activity in the construction and manufacturing sector, it also contributes to ensuring energy supply and increasing job opportunities. It still does not count the positive impact of the increase in the electrification rate, which also encourages economic productivity. Thus, it is reasonable that renewable and carbon-neutral energy significantly contributes to enhancing economic growth.

3. Job Creation

Job creation is always a national concern because it benefits from skill acquisition, gender equality, and reducing social conflict. Increasing the employment rate is also indirectly related to increasing GDP and improving human welfare. With a well-designed policy, deploying renewable and carbon-neutral energy can result in positive net employment. By pursuing net zero-emission, Indonesia potentially creates 1.8–2.2 million jobs in 2030 in renewable energy, electric vehicle technologies, energy efficiency, land use interventions, and improved waste management (Bappenas, 2021). The increase in employment rate results from the growing renewable and carbon-neutral energy technology industry and its related infrastructure.

Renewable and carbon-neutral energy development will activate a broad range of industries starting from equipment manufacturers industries, the construction and installation, operation and maintenance, and fuel supply until its infrastructure. All these sectors are labor-intensive. It not only needs more workers, but also results in new roles in energy industries that are more specialized. Although there are job losses from conventional energy abandonment, a supported energy transition policy can achieve positive net employment. Therefore, education and skill matching are required to maximize the benefit of renewable and carbon-neutral energy employment.

4. Human Welfare

While decarbonizing the economy, the impacts of renewable and carbon-neutral energy on welfare are equally important. Even though GDP measures country's standard of living, it does not show the full impact on the human welfare of the country. IRENA (2016) reveals that the benefit of an energy transition to human welfare can surpass the GDP growth. Human welfare also needs to consider the effect of the natural resource depletion and health and environmental cost associated with energy resource extraction. Therefore, to understand the impact of renewable and carbon-neutral energy on human welfare, it can be seen from economics (increase in real income and household consumption), social (increasing life expectancy by improving air quality), and environment (reducing greenhouse gas emission).

a. Increased household consumption, income, and improved air quality

Renewable and carbon-neutral energy growth will positively impact the economy. An increase in renewable and carbon-neutral energy investment will encourage the domestic industries to grow, which correlates positively with real income due to the increased employment. Increasing renewable and carbon-neutral energy access also contributes to rising household income. Moreover, increasing the electrification rate helps provide a better health service and improve teaching and learning process. Indeed, deploying renewable and

carbon-neutral energy in the region can give additional revenue to develop a better health and education infrastructure. Most importantly, renewable and carbon-neutral energy contributes to reducing greenhouse gas emission and improving air quality. Bappenas (2021) projects that a net-zero emission path will reduce 87–96 billion tons of CO_2 over 2021–2060, potentially save 40,000 lives in 2045 alone from air pollution reduction.

b. Gender equality

Renewable and carbon-neutral energy development offers a broad range of employment opportunities. It is important to ensure these opportunities are equally accessible to get equal benefits. As an active economic agent, women's contribution can give a more diverse perspective in the workplace, increasing overall energy industry performance. However, perception of gender in terms of social and cultural norms, inadequate skill and education, and lack of gender equality policy are major barriers for women to step up in the energy industry.

Having a multidisciplinary field, renewable and carbon-neutral energy will increase women's contribution to energy sectors. It is reported that renewable and carbon-neutral energy has women representation accounting for 32%, which is 10% higher than conventional energy at 22% (IRENA, 2019). Therefore, renewable and carbon-neutral energy is important in making the energy sector more gender-balanced. Gender perspective in energy policy and preparation for women to be qualified talents for energy transition becomes even more crucial.

D. Key Challenges of Renewable and carbon-neutral Energy Development

While the transition is underway, some challenges need to address to achieve the benefit of renewable and carbon-neutral energy development. This sub-chapter shows the key challenge that needs to be tackled.

1. Uncompetitive Renewable Energy Cost to Conventional Energy

To penetrate the energy market, renewable and carbon-neutral energy must be cost-competitive to conventional energy. Low-cost renewable and carbon-neutral energy can also be the backbone of a decarbonizing economy. Regarding the technology, renewable and carbon-neutral energy have shown a remarkable decline globally over the past decade. For instance, IRENA (2020) reported that the cost of electricity generated from utility-scale solar photovoltaics (PV) has sharply decreased by 85% between 2010 and 2020. Albeit its low cost of technology, renewable and carbon-neutral energy still cannot take over the electricity market in Indonesia. It is seen from the National Power Generation Plan in RUPTL 2021–2030 that power generation will continue to be dominated by coal. Apart from improving technology, the barriers come from an unsupported regulation framework and unrepresented externalities in market price.

a. Unfair competition with subsidized fossil fuel

To be the main player in the electricity market, renewable and carbon-neutral energy needs to be compared head-to-head with conventional energy. As a net coal exporter, Indonesia has a much cheaper electricity generation cost than other energy sources. It is reported that it only costs US$3 cent/kWh from existing coal plants and US$7 cent/kWh from new coal plants (Umah, 2021). Accounting for US$5.8 cent/kWh, the largest solar PV in Indonesia and Southeast Asia, Floating Solar PV Cirata, West Java, still cannot reach the below range of coal cost (Rahman, 2020). The low-cost coal results from government policy that subsidizes coal as input for power generation. Since 2018, the government of Indonesia has required the coal miners to supply 25% of their annual production to the PT PLN at a maximum price of US$70 per metric ton. The purchasing price is so much lower than the market price. It is less than half the market price in January 2022 at US$158.50 per metric ton and a third of market price in November

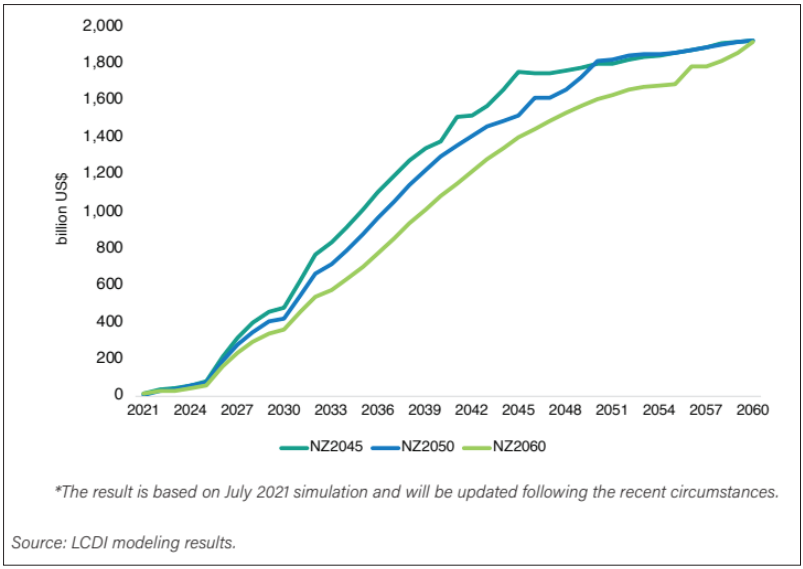
2022 at US$215.01 per metric ton (ESDM, 2022). This condition has made renewable and carbon-neutral energy less attractive compared to coal.

b. Unseen positive externalities

Another challenge is that the positive externalities of renewable energy are still not reflected in its market price. It is known that renewable and carbon-neutral energy is a reliable energy source that saves people's health and the environment. As stated before, Bappenas (2021) projects that a net-zero emission path will reduce 87–96 billion tons of CO_2 over 2021–2060, potentially saving 40,000 lives in 2045 alone from air pollution reduction. Therefore, the value of positive externalities can reduce the cost of renewable and carbon-neutral energy. Likewise, the negative externalities from burning and producing fossil fuels also need to be shown in its market price. IRENA (2015) shows that if externalities associated with CO_2 emission are valued in terms of price (assuming US$20 to US$80/ton of CO_2), the price of electricity generation from fossil fuel increases by US$1 cent to US$13 cent /kWh (depending on country and technology). Giving a value for externalities will dramatically change renewable and carbon-neutral energy competitiveness.

c. Lack of renewable and carbon-neutral energy investment

Renewable and carbon-neutral energy is a high-cost investment since it requires high upfront capital. However, once tapping into the field, the marginal cost of renewable and carbon-neutral energy is almost zero. A sharp decline in the cost of renewable and carbon-neutral energy is supposed to be an opportunity to drive its investment. Bappenas (2021) forecasts required investment to achieve net-zero emission starting from around US$20 billion per year in 2021–2022 (about Rp291 trillion) and an average of US$150–200 billion (Rp2.2–2.9 quadrillion) per year as shown in Figure 12.7.



Source: Bappenas (2021)

Figure 12.7 Investment Needed to Achieve Net-Zero Emission in 2021–2060

However, Indonesia's renewable and carbon-neutral energy investments are still mainly below the country's target. Accounting for US$1.17 billion in September 2019, the investment was 65% of the target of US$1.8 billion (IESR, 2019). Half of the total investment comes from geothermal energy, while a meager contribution is from other renewable energy sources. It is shown that renewable and carbon-neutral energy is still lacking its investment. Regulation uncertainty is a major issue in reducing investor confidence in Indonesia's renewable and carbon-neutral energy investment.

While dealing with resources and technology risks, renewable and carbon-neutral energy investors also need to deal with risk from inconsistent regulation and the effect of market structure. Survey taken by PwC in 2018 indicates that 94% of investors in the Indonesian power sector agree that uncertainty in regulation is a major barrier to new large-scale power generation investment. The regulation uncertainty includes a lack of transparency and low predictability in procurement, risk allocation, and unattractive tariff systems.

d. Lack of transparency and low predictability in procurement

In terms of the electricity market, Indonesia adopts a vertically integrated market structure where PT PLN is the only market player in electricity generation, transmission and distribution, and electricity retailing. This structure gives PT PLN a powerful market power to determine the price in the electricity market. The procurement process by PT PLN can be conducted in three different ways: (1) Direct Appointment, PT PLN directly appoints an IPP to conduct the project. (2) Direct Selection, PT PLN selects a project proposal from more than one submitted IPPs proposal. (3) Competitive Tender, if only the IPPs project is not eligible for direct appointment or selection. The main concern is that the direct selection by PT PLN does not always reach financial closure and is time-consuming (OECD, 2021). In addition, PT PLN agreed to purchase the electricity tariff if the price is less or equal to National BPP. When it is higher, the price will be discussed business to business between PT PLN and IPP. The closed-door negotiation between IPPs and PT PLN gives an impression of a lack of transparency and predictability in procurement. The company takes this as a risk, which also increases the required rate of return of the project. As a result, the price of electricity generation will be higher.

e. Unattractive tariff system

The current tariff system adopted by Indonesia does not give a strong incentive to invest in renewable and carbon-neutral energy development. Under MEMR Regulation No. 31/2009 on Purchased Electricity Tariff by PLN (Persero) from small- and medium-scale renewable energy power generation or excess electricity, the renewable and carbon-neutral energy tariff cap is set based on the average cost of electricity production in each region. The tariff cap is well designed to make it a competitive alternative to renewable and carbon-neutral energy in regions dominated by diesel generation. However, it is too low for other regions dominated by coal plant generation. Figure 12.7

reveals that the price cap is too low, especially for regions with high populations. This potentially discourages investors from investing in renewable and carbon-neutral energy with a high population, while the energy demand is high.

Source: OECD (2021)

Figure 12.8 The Comparison between National BPP and Regional BPP with Its Population

f. Gap in achieving positive net employment

While accelerating the transition to renewable and carbon-neutral energy will create more jobs, it also results in job losses in the conventional energy industry and its supply chain. PT PLN has pledged to cut coal-fired generation and stop building new coal plants after 2023 and start to abandon coal after 2055 to achieve the net-zero emission target of 2060. As one of the largest producers and net exporters of coal, Indonesia had more than 121,000 employees in the coal sector in 2019 (Laird, 2021). It still did not include the number of workers in its supply chain, local economy, retail, food services, and other dependent sectors. If the coal generation is stopped, there will be a reduction in the employment rate, which also impacts the GDP and human welfare. To achieve the benefit of the energy transition, it is important to ensure that the gain from renewable and carbon-neutral energy development exceeds the loss from the reduction in fossil fuel use, which results in positive net employment. It is known that fostering energy transition potentially creates 1.8–2.2 million

jobs in 2030 (Bappenas, 2021). Therefore, to maximize the potential, several challenges need to be tackled such as worker dislocation and education and skill gap.

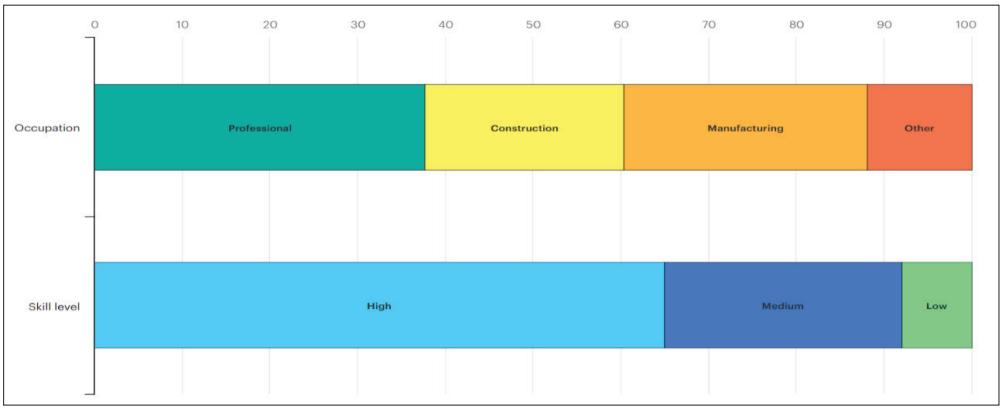
Dislocated Workers

The total new jobs created from renewable and carbon-neutral energy might surpass the job losses from conventional energy. However, where new jobs growth is not always the same as a place with job loss. Most jobs associated with fossil fuels are geographically concentrated and integrated with the local economy. Compared to 1.8–2.2 million jobs created by renewable and carbon-neutral energy, the loss of 121,000 employees seems insignificant. However, it will deteriorate the local economy and community. Currently, it happens in the United States and China. Although the coal industry only represents 0.06% of the United States workforce and 0.4% of the Chinese workforce, the disruption of coal mine closure to the regional and local economy is inevitable (World Bank, 2018). Therefore, a strategic energy policy is required to ensure that energy will not severely impact not only the workers but also the local economy and community associated with the industry to achieve a "transition for all."

Shortage of high-skills workforce

While deploying renewable and carbon-neutral energy creates job opportunities, it still faces a challenge in finding qualified talents. Undeniably, the renewable and carbon-neutral energy industry requires high-skilled level laborers. Figure 12.8 shows that highly skilled workers dominate each value chain stage of renewable and carbon-neutral energy development. For example, the development of solar PV under the RUKN scenario for Indonesia needs high-skill workers such as engineers and management professionals at 52% while the demand for medium to low-skill workers such as technical and non-professional workers at 48% (GGGI, 2020). It can be an opportunity for workers who lost their jobs in the fossil fuel industry because education and skills from conventional energy can also be transferred to renewable and clean resources. However, the rapid development of renewable

and carbon-neutral energy results in a higher future demand for new talents. Therefore, preparing the new talents is necessary to benefit from energy transition.



Source: OECD (2021)

Figure 12.9 The Value Chain of Renewable and Carbon-Neutral Energy and Its Level of Skill Required

g. Low women participation in renewable and carbon-neutral energy job

Mostly in charge of fulfilling their family's energy needs, women have a major role in the decision-making of household energy consumption. However, they are still underrepresented in energy policy-making and the energy industry. Women face challenges from internal and external factors. While most women internally lack training opportunities in science, technology, engineering, and mathematics (STEM) programs, they also must face cultural and social challenges.

Cultural, social norms, and stigma

A cultural and social norm is the most common challenge for women when contributing to energy sectors. The perception of gender roles that women have full responsibility in household work and childcare (and even elderly care) has limited women's participation in overall economic activity. Allocating their time to household work, women

have limited time to fully engage in formal education and work. Another perception is that the energy sector is dirty, too technical, and unsafe. It is far from what society expects from a women's job, which is mostly related to secretary and administration. The dynamics of conventional energy politics give the impression that energy is a "dirty" business. Then, having low participation in STEM programs deteriorates women's confidence to pursue careers in energy sectors that seem too technical. Lastly, the safety and remoteness of field location issues also contribute to low energy sector jobs.

Low participation in STEM field

It is undeniable that renewable and carbon-neutral energy sectors are STEM-intensive fields. The low participation in the STEM field makes women underrepresented in renewable and carbon-neutral energy sectors. International Labor Organization (2017) reported that only 24.4% of Indonesian women studied a program related to STEM compared to men at 50%. Having time constraints linked to household responsibility, women also have limited access to education and training in the STEM field. Women are likely presented in minor income-generating activities such as administrative sectors and underrepresented in more technical sectors. This condition makes households less likely to invest in women's education, narrowing women's education access. The confidence gap between men and women in math due to the myth of the math brain makes STEM programs less attractive to women.

E. Policy and Recommendation to Maximize Socio-Economic Benefits of renewable and carbon-neutral energy

Although it has a broad range of benefits for social and economic, some barriers still need to be addressed. Some policies and recommendations are proposed to tackle the barrier and foster the transition.

1. Competitive renewable and carbon-neutral energy Costs

In line with cost reduction in renewable and carbon-neutral energy, supporting policies are required to ensure it can fairly compete head-to-head with fossil fuel.

a. Removing fossil fuel subsidy

While cutting greenhouse gas emissions, removing fossil fuel subsidies in electricity generation can increase the competitiveness of renewable and carbon-neutral energy in the electricity market. By cutting off the subsidy, the fences of market barriers for renewable and carbon-neutral energy will disappear. Hence, renewable and carbon-neutral energy can enter the market and actively compete with fossil fuels. As the subsidy is eliminated, it is faster to reach the backstop price and provide an opportunity for renewable and carbon-neutral energy as an energy substitute. Indeed, subsidies to fossil fuels give a wrong price signal to the user to consume more of the commodity. It is contrary to the country's decarbonization objectives.

b. Carbon pricing

Carbon pricing is the key solution to increase the competitiveness of renewable and carbon-neutral energy by revealing the actual cost of renewable and carbon-neutral energy and fossil fuel. The practice of carbon pricing has been widely adapted to achieve mitigation targets. The implementation of carbon pricing can vary from one country to another. Carbon pricing can be a tariff on per tons emission produced. It is reported that The High-Level Commission on Carbon Prices projects that carbon prices will be at least in the range of US$40–80/tCO$_2$ by 2020 and US$50–100/tCO$_2$ by 2030 to achieve the temperature limit in the Paris Agreement (World Bank, 2020). Besides helping renewable and carbon-neutral energy competes with fossil fuels, carbon pricing also can increase government revenue. Indonesia also has decided to implement carbon pricing as a mitigation measure in the NDC commitment. It can be a big step for Indonesia to achieve net zero-emission 2060.

2. Accelerate Investment in renewable and carbon-neutral energy

The deployment of renewable and carbon-neutral energy requires a huge amount of investment. A strong policy is needed to attract potential investors to invest in Indonesia's renewable and carbon-neutral energy projects.

a. Reforming tariff cap

The BPP is set as a price cap for renewable and carbon-neutral energy. Understandably, that the government wants to ensure the affordability of electricity generation. However, the BPP reference in some regions does not reflect the actual price of electricity generation. For example, in the regions of Java and Bali, electricity generation is dominated by coal. It is known that PT PLN still received subsidies to purchase electricity from coal plants. Using cheap coal as a price cap for renewable and carbon-neutral energy in this region is unfair. It would be better if the tariff cap is set based on the marginal cost of each technology. By combining this approach with the auction program, renewable and carbon-neutral energy prices can be lower, which is an incentive to invest in renewable and carbon-neutral energy projects.

b. Renewable and carbon-neutral energy auction program

While reducing the cost of renewable and carbon-neutral energy, an auction is the best instrument to facilitate transparent and predictable electricity procurement processes. One of the auction's objectives is to alter market barriers for the new market entrants. The auction mechanism can be different from one country to another. Mostly, the project development participates in the auction by submitting the electricity price per unit. Then, the government will evaluate the offer document with the price and sign an agreement with the auction winner. In terms of the evaluation project, it is almost the same as the procurement process adopted by PT PLN. However, it is more open to the public.

3. Achieving Positive Net Employment

As the transition toward renewable and carbon-neutral energy continues to create new jobs, job losses from fossil fuels are not inevitable. Dislocated workers and a shortage of high-skilled level workers are challenges to achieving positive net employment from renewable and carbon-neutral energy. Some recommendations are reskilling, upgrading fossil fuel workers and building skills for new entrances.

a. Reskilling and upgrading skill for fossil fuel workers

A closely related skill between fossil fuels and renewables technology and its supply chain makes the skill interchangeable, which will benefit the workers. Recognizing the transferable skills from the fossil fuels industry to the renewable and carbon-neutral energy industry is important to assist the workers dealing with job losses. Figure 12.9 shows interchangeable skills between fossil fuels and renewables. Supplementary education and training will give provision for the workers to encounter job losses. However, the employment losses impact not only the workers, but also the local economy and community, which strongly rely on fossil fuel production. Long-term engagement and social dialogue between stakeholders, workers, businesses, and local communities are needed to understand how the change in energy structure will impact their income and how to deal with it soon.

b. Building the skill of new entrants

Planning and preparation for new talent are required of a high demand for high skill levels. Early exposure to climate change and how renewable and carbon-neutral energy contribute are important to increase awareness and drive problem-solving skills to prepare youth to be future energy professionals. Integrating renewable and carbon-neutral energy knowledge in STEM programs, social studies, etc. will attract youth interest in pursuing renewable and carbon-neutral energy career. A well-designed curriculum structure addresses the demand for cross-disciplinary skills, emerging skills (technology, storage, resource), and innovation and entrepreneurship will elevate the new talent skill.

Skills are interchangeable between fossil fuels and renewables

US tradespeople survey response as to the likelihood of them working in selected energy sectors, 2020 (%)

Role	Wind	Solar	Oil	Natural gas
Wireman	47%	63%	32%	43%
Roofer	43%	64%	36%	57%
Electrician	33%	66%	47%	50%
Construction labourer	38%	56%	64%	66%
Stationary engineer	28%	40%	64%	80%
Operating engineer	28%	46%	67%	72%

Source: Ferris (2021)

Figure 12.10 The Value Chain of Renewable and Carbon-Neutral Energy and Its Level of Skill Required

4. Balancing Gender Participation in Deployment of renewable and carbon-neutral energy

The equitable participation of women and men will improve the overall sector's performance. However, the barriers such as cultural, social norms, stigma, and inequality in education access can result in a slow rate of sector development. Therefore, a strong policy is required to ensure women's participation so that the benefit of a diversified workforce can foster the development of renewable and carbon-neutral energy. Some recommendations include integrating gender in each renewable and carbon-neutral energy sectors value chains and improving access to STEM education and training.

a. Integrating gender perspective in each value chain of renewable and carbon-neutral energy

To ensure gender equality in renewable and carbon-neutral energy sectors, all genders should be included in each value chain. It is important to recognize the roles and potential contribution of gender in those areas to maximize the overall sector performance. According to the role and potential contribution, human resources policies for equal opportunity and quotas for gender parity are needed to

be implemented. Equally important, a supporting working environment is necessary to increase gender equality. Imposing a human resource policy tackling gender discrimination and sexual harassment, and guaranteeing the safety of the employees is critical to gender participation.

b. Improving access to STEM education and training

Having low participation in STEM programs, women are underrepresented in energy sectors. Improving STEM education and training access can potentially increase women's participation in energy sectors. Highlighting women role models who pursue careers in STEM programs can give self-esteem to other women to choose the same pathway. This also can increase people's awareness that women have potential in STEM programs and start to invest in women's education. Investing more in women's education will give more access to women to be engaged in STEM programs. A supportive environment is also needed to increase women's participation in the education system. It can be done by designing curricula that maintain gender interest in STEM programs.

References

Agarwal, R., Hansmann, T., Tan, K. H., Agarwal, V., Lath, V., & Yi, Z. (2020). *Ten ways to boost Indonesia's energy sector in a post pandemic world*. McKinsey & Company. https://www.mckinsey.com/industries/oil-and-gas/our-insights/ten-ways-to-boost-indonesias-energy-sector-in-a-postpandemic-world

BP. (2021). *Statistical review of world energy 2021 70th edition*. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Ferris, N. (2021). *Investment in skills is key to realizing the clean energy transition*. Energy Monitor. https://www.energymonitor.ai/policy/just-transition/investment-in-skills-is-key-to-realising-the-clean-energy-transition

Grafakos, S., Senshaw, D., Quezada, D., and Toro A. (2020). *Employment assessment of renewable energy: Indonesian power sector pathways*. Green Growth Institute (GGGI). http://greengrowth.bappenas.go.id/wp-content/uploads/2020/07/Employment-assessment-of-renewable-energy-Indonesian-power-sector-pathways-NEAR-NDC.pdf

Government Regulation of the Republic of Indonesia Number 79 of 2014 on National Energy Policy. (2014). https://policy.asiapacificenergy.org/sites/default/files/Government%20Regulation%20No.%2079%3A2014%20of%202014%20%28EN%29.pdf

International Energy Agency (IEA). (2021). *Additional workers in the NZE scenario by occupation and skill level, 2020-2030*. https://www.iea.org/data-and-statistics/charts/additional-workers-in-the-nze-scenario-by-occupation-and-skill-level-2020-2030

Institute for Essential Services Reform (IESR). (2019). *Indonesia clean energy outlook: Tracking progress and review of clean energy development in Indonesia*. https://iesr.or.id/wp-content/uploads/2019/12/Indonesia-Clean-Energy-Outlook-2020-Report.pdf

International Renewable Energy Agency (IRENA). (2015). *Renewable power generation cost in 2014*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_RE_Power_Costs_2014_report.pdf

International Renewable Energy Agency (IRENA). (2016). *Renewable energy benefit: Measuring the economics*. https://www.irena.org/publications/2016/jan/renewable-energy-benefits-measuring-the-economics

International Renewable Energy Agency (IRENA). (2019). *Renewable energy: A gender perspective*. https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Gender_perspective_2019.pdf

International Renewable Energy Agency (IRENA). (2020). *Renewable power generation costs in 2020*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_Power_Generation_Costs_2020.pdf

Laird, F. (2021). *The future without coal: The sustainable development solutions network*. SDGs Today. https://storymaps.arcgis.com/stories/3b7359e3f06049d9b5904736a5c97877

Ministry of Energy and Mineral Resources (ESDM) Regulation No. 31/2009 on purchased Electricity Tariff by PLN (Persero) from small and medium scale renewable energy power generation or excess electricity, Republic of Indonesia (2019). https://jdih.esdm.go.id/peraturan/Permen%20ESDM%2031%202009.pdf

Ministry of Energy and Mineral Resources (ESDM). (2022). *Harga batu bara acuan*. https://www.minerba.esdm.go.id/harga_acuan

Ministry of National Development Planning (Bappenas). (2021). *A green economy for a net-zero future: How Indonesia can build back better after COVID-19 with the low carbon development initiative (LCDI)*. https://lcdi-indonesia.id/wp-content/uploads/2021/10/GE-Report-English-8-Oct-lowres.pdf

Organization for Economic Cooperation and Development (OECD). (2021). *Green finance and investment: Clean energy finance and investment of indonesia policy review.* Organization for Economic Cooperation and Development.

PT Perusahaan Listrik Negara (PLN) (Persero). (2021). *Rencana pengusahaan penyediaan tenaga listrik 2021-2030*. https://gatrik.esdm.go.id/assets/uploads/download_index/files/38622-ruptl-pln-2021-2030.pdf

Rahman, R. (2020). *Indonesia kicks off largest solar power plant development*. The Jakarta Post. https://www.thejakartapost.com/news/2020/12/18/indonesia-kicks-off-largest-solar-power-plant-development.html

U.S. Energy Information Administration (EIA). (2021). *Country analysis executive summary: Indonesia*. https://www.eia.gov/international/content/analysis/countries_long/Indonesia/indonesia.pdf

Umah, A. (2021). *Berapa harga listrik dari PLTU?* CNBC Indonesia. https://www.cnbcindonesia.com/news/20210728110803-4-264235/berapa-harga-listrik-dari-pltu

World Bank Group. (2018). *Managing coal mine closure: achieving a just transition for all*. https://www.worldbank.org/en/topic/extractiveindustries/publication/managing-coal-mine-closure#:~:text=A%20Just%20Transition%20for%20All%20means%20people's%20livelihoods%20and%20communities,workers%20ahead%20of%20job%20losses.%22

World Bank Group. (2020). *States and trend carbon pricing 2020*. Doi: 10.1596/978-1-4648-1586-7. https://openknowledge.worldbank.org/bitstream/handle/10986/33809/9781464815867.pdf

World Bank Group. (2021). *Indonesia's economy grew in 2021 despite COVID-19, will accelerate in 2022, World Bank report says*. https://www.worldbank.org/en/news/press-release/2021/12/16/indonesia-economy-grew-in-2021-despite-covid-19-will-accelerate-in-2022-world-bank-report-says

World Bank Group. (2021). *The World Bank in Indonesia: Overview*. https://www.worldbank.org/en/country/indonesia/overview#1

World Bank Group. (2022). *World Bank open data*. https://data.worldbank.org/

Worldometers. (n.d.). *Indonesian population (Live)*. Retrieved January 19, 2022, from https://www.worldometers.info/world-population/indonesia-population/