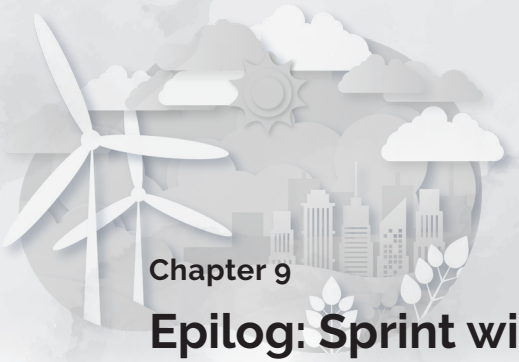

Chapter 9

Epilog: Sprint with Renewable Energy towards Net Zero Emissions 2060

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Today, the term "net zero emissions" is becoming increasingly popular, especially in the field of environmental sustainability. The core of the Paris Agreement is to achieve a balance between greenhouse gas emissions and the greenhouse gases (GHGs) that can be removed from the atmosphere in order to limit global temperature rise to below 2°C (Xu et al., 2023). The negative impacts of global climate change, such as rising global temperatures, extreme weather events, and rising sea levels, are key reasons why net zero emissions are essential. The development of green technologies and the implementation of green policies can be achieved through the cooperation and efforts of all countries to achieve net zero emissions targets. As an epilogue, this chapter focuses on the energy sector, and in particular renewable energy, as a potential pathway to achieving net zero emissions targets.

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Indonesia is a country committed to achieving net zero emissions by 2060 or earlier. With the fourth-largest population and the sixteenth-largest economy in the world, Indonesia is responsible for 3.5% of all greenhouse gas emissions (Climate Watch, n.d.). Indonesia's emissions reached 1.495 billion tons of CO_2 equivalent ($MtCO_2eq$) per year from 2018 to 2020. Recently, Indonesia's per capita emissions have become lower than those of developed countries but are still comparable to those of developing countries. Compared to China and India, whose greenhouse gas emissions significantly increased by more than 400% and 300%, respectively, between 1990 and 2018, Indonesia's 35% increase is considered modest. Deforestation (due to land use) and forest and peatland fires are some of the factors contributing to Indonesia's carbon emissions, accounting for 42% of the country's total greenhouse gas emissions. Fossil fuel use is the second largest source, accounting for 39% of Indonesia's emissions between 2000 and 2020, with the coal-based power sector accounting for the majority of energy sector emissions (World Bank, 2023).

A. The Perspective of Renewable Energy Development

The use of renewable energy is essential to achieving the Sustainable Development Goals (SDGs) by 2030. These SDGs are a roadmap established by the United Nations in 2015 to bring peace and prosperity to people and the planet now and in the future. The SDGs have 17 goals, most of which are related to the environment. The use of renewable energy is directly related to SDG goals 7 and 11 (affordable and clean energy), 12 (responsible consumption and production), and 13 (climate action) (Guchhait & Sarkar, 2023).

Intensive research on renewable energy is needed for a variety of reasons, including climate change, global warming, environmental degradation, and limited natural resources. The main purpose of renewable energy is to minimize carbon and greenhouse gas emissions. The government needs to play an active role and support the stabilization of the market and the spread of renewable energy.

According to Miskiewicz, the growth of renewable energy will be influenced by participation and improvement in e-government, the role of industry, and commercial activities (Miskiewicz, 2022). The use of renewable energy can solve two problems at the same time: the problem of limited energy resources and the problem of emissions. From an economic development perspective, the use of renewable energy has very high initial costs compared to fossil energy. However, as renewable energy technology advances and demand increases, costs will fall. For example, solar energy is predicted to become cost-effective across all industries by 2050 (IEA, 2023). On the other hand, the use of renewable energy can lead to increased employment opportunities and benefit the prosperity of societies (United Nations, 2022).

The availability of renewable energy resources has a significant impact on renewable energy production and consumption. Each energy source has a different efficiency, with wind energy having the highest energy efficiency, followed by geothermal, hydro, nuclear[1], and solar. From an application perspective, hydropower is the most common energy source, followed by solar, wind, bioenergy, and geothermal energy (Guchhait & Sarkar, 2023). As shown in Table 9.1, 11 countries in the world have successfully used renewable energy (RE) on a large scale.

Table 9.1 Top Countries in the Use of Renewable Energy

No	Country	% RE used	RE Sources
1	Sweden	100% by 2040	hydro, nuclear[1], wind
2	Costa Rica	98%	hydro, geothermal, wind, solar, biomass
3	United Kingdom	More than 7.5 millions home are powered by offshore wind	wind, tidal, hydro, solar energy
4	Iceland	Almost 100%	geothermal, hydro
5	Germany	46,9% in 2022, 80% by 2030 and almost 100% by 2035	solar, wind
6	Uruguay	98% of its electricity in 2021	hydro, solar, wind, bioenergy
7	Kenya	Over 310 MW from wind farm	wind, solar
8	China	1200 GW by 2030	wind, solar

[1] Indonesia classifies nuclear as new energy.

No	Country	% RE used	RE Sources
9	Morocco	580 MW from solar farm	solar
10	New Zealand	84% of its electricity	hydropower, geothermal dan wind
11	Norway	98% of its electricity in 2016	hydro, thermal, wind

Source: Climate Council (2022); How Electricity Works (n.d.)

In addition to the energy sources mentioned above, waste, which is currently a problem, can also be used as an energy source. Converting waste to energy can solve the waste problem while producing energy and is very important in a circular economy. Here is a comparison of converting waste into fossil fuels: the equivalent waste weights of 1 ton of oil and coal are 4 tons and 2 tons, respectively (Babcook & Wilcox, n.d.). Converting waste to energy as an alternative to landfilling and waste incineration is highly beneficial. Lack of infrastructure, technology, and appropriate rules for waste management leads to persistent problems (Caferra et al., 2023). The most important aspect influencing waste utilization in power plants is the waste location, which is highly influenced by social, legal, environmental, and transportation infrastructure (Silva et al., 2023). One of the drawbacks of the waste-to-energy process is the separation of the waste used as raw material.

Ocean-based renewable energy, such as ocean thermal energy, offshore wind turbines, ocean wave energy, and tidal energy, also offer enormous potential, particularly for countries with large ocean regions. Norway, for example, has the world's largest floating offshore wind park and plans to allocate 30 GW of offshore wind power generation by 2040. It is projected that using renewable ocean energy might reduce CO_2 emissions by up to 3.6 gigatonnes per year by 2050 (World Economic Forum, 2023).

B. The Challenging Path to Net Zero Emissions in Indonesia

The Indonesian government has committed to reducing carbon emissions by 29% by 2030 on a business-as-usual basis and 41% with

international support. The biggest challenge for developing countries like Indonesia is finding a balance between economic growth and greenhouse gas emissions because as the economy expands, emissions will continue to rise. The following are the obstacles Indonesia faces in reaching its net zero emission target of the energy sector.

1. Dependence on fossil fuels

The dominance of fossil energy in the energy sector is a significant source of emissions, and Indonesia is obliged to reduce its reliance on fossil energy by transitioning to renewable energy.

2. Renewable energy technology readiness

This technological readiness is related to technological maturity, technological cost reduction and energy storage technology. In addition, the chosen technology must have a sustainable energy supply. The status of Indonesia as an archipelago with different potential resources from region to region greatly influences the choice of renewable energy technology suitable for use in a given region. This requires a thorough feasibility study of the matter to ensure the suitability of the chosen technology.

3. Financial constraints

Financial sources and systems are a challenge for the Indonesian government, as the transition to renewable energy requires significant investment. Indonesia has several funding sources to explore.

4. Renewable energy policies and regulations

The government has developed several renewable energy policies and laws. However, their implementation does not always meet expectations in terms of supporting the use of renewable energy, and some require additional regulations. Adopting renewable energy in Indonesia requires strong political will.

5. Economic growth

Ensuring sustainable economic growth without increasing emissions is a major challenge for developing countries such as Indonesia.

6. Public awareness and acceptance

Awareness of the importance of zero emissions and the adoption of cleaner technology is a challenge for Indonesia, with communities ranging from Sabang to Merauke and varied access to education and information.

C. Encouraging Green Energy through Regulations and Political Policies

Indonesia's energy transition phase is influenced by the global energy transition and depends on the development of important low-emission technologies. Appropriate policies that increase the use of low-emission technology and provide a clear direction for the necessary changes in each sector are also key factors in reducing carbon dioxide emissions in Indonesia. Improving energy intensity, carbon dioxide emissions from power plants, switching to low-emission fuels, and carbon capture utilization and storage (CCUS) are the four main pillars guiding the energy sector's transition to zero emissions (IEA, 2022). Energy efficiency can be improved through energy efficiency improvements, comprehensive policies, and better energy prices. Renewable energy technology, which is cleaner and more environmentally friendly, can produce low-emission fuel. With the introduction of CCUS, it is possible to continue using cheap fossil fuels and, at the same time, reduce emissions.

The use of renewable energy, together with energy efficiency policies, is crucial in reducing greenhouse gases. A number of industrial and financial policies must be implemented to achieve the goal of net zero emissions. Some of the things needed to support the energy transition include a fiscal framework to help set prices and protect investments, influence the financial system for green investments affected by climate and investment regulations, and trade policies to support companies in green exports and imports. In October 2021, the Indonesian government passed legislation to introduce carbon

pricing tools, including the emissions trading system (ETS), which should start in 2024.

The Indonesian government has introduced various regulations on energy efficiency, especially in industry and construction. Energy efficiency is central to mitigating the effects of future electricity demand growth. Energy efficiency of electrical equipment can reduce the need to build new power plants. The implementation of energy efficiency can reduce electricity demand by approximately 30% by 2050 (IEA, 2022). Indonesia's policies related to standards, such as permissible standards of CO_2 emission, minimum standards of energy efficiency and others, are very necessary to achieve the goal of zero emission. Regarding industry, the Ministry of Industry has published energy consumption and emission intensity limitation standards for green industry certification requirements (*Permenperin* No. 48, 2020; *Permenperin* No. 49, 2020). The Ministry of Public Works and Housing has established regulations on building standards, one of which is the minimum energy efficiency standards for buildings, lighting, cooling equipment and other building systems (*Permen PUPR* No. 21, 2021). The Ministry of Energy and Mineral Resources approved regulations on Minimum Energy Efficiency Standards (MEPS) for equipment and accessories in 2021, which define product scope, test methods, evaluation criteria and labeling (*Permen ESDM* No. 14, 2021).

The Indonesian government has changed the composition of the energy mix to reduce energy sector emissions. In the years 2020–2030, the share of coal will be reduced from 43% to 30%, the share of oil from 31% to 25%, and the share of renewable energy will be increased from 6.1% to 25%. The use of renewable energy is growing, and the focus is on the use of biofuels (biodiesel mixture), the share of which should rise to 40% by 2025.

By 2050, the share of renewable energy replacing coal in electricity generation will produce approximately half of the reduction in energy sector emissions (IEA, 2022). To achieve the goal of zero emissions set by the Indonesian government, coal-fired power plants with extended lifetimes must be highly efficient and equipped with

Carbon Capture Storage (CCS) technology in the future. The use of electricity produced from renewable energy is still limited by the surplus of electricity produced by coal. The integration of renewable energy into the electricity sector requires the cooperation of the State Electricity Company (PLN) and the private sector to invest in network and transmission infrastructure, energy storage and digitization of network systems.

Indonesia is in the process of establishing an Energy Transition Mechanism Country Forum to organize and coordinate energy transition financing to prepare for the retirement of coal-fired power plants. Financial solutions to reduce energy transition costs can be used by combining international donors and philanthropic financing, carbon trading revenues with state budget, private sector and *sukuk* funds to optimize renewable energy resources.

Presidential Decree Number 112 of 2022 sets the prices of renewable energy at the same level or lower than the price of grid electricity produced by coal (*Perpres* No. 112, 2022). This low price of renewable energy can also be achieved by removing the Internal Market Obligation (DMO) for carbon and local content requirements of the renewable generation system, making it more competitive with fossil energy prices. The Indonesian government has also begun to limit or prohibit the construction of new coal-fired power plants, except for entities involved in the resource sectors or supporting important national strategic projects.

D. Accelerating renewable energy in Indonesia's energy system

These are several important strategies and aspects that the Indonesian government must address to boost the use of renewable energy in Indonesia.

1. Policy framework

These are many critical strategies and aspects that are important for the Indonesian government to adopt and strengthen policies that

promote the use of renewable energy. This policy consists of setting clear targets, creating incentives, and creating a regulatory framework to attract investment in the renewable energy sector. For the effective development of renewable energy in Indonesia, the political will of the government is very important. In addition, the government also needs to carry out an impact analysis before implementing policies or regulations.

2. Regulatory stability

Regulatory stability is an important part of creating an investment climate for renewable energy. Stable and predictable laws make it easier to attract the investment needed to build a cleaner and more sustainable renewable energy infrastructure.

3. Investment and financing

It is important to develop an investment system that attracts both domestic and foreign investors, offering, for example, tax incentives, subsidies, and favorable loans for renewable energy projects. Various financing schemes can be developed for renewable energy initiatives, one of which is sharia financing, as Indonesia has a huge Muslim population (86.7%) (Badan Pusat Statistik, 2022). All the government needs to do is to inform people about this financial system, provide competent and reliable financial managers, and facilitate the operation of this finance with advanced technology.

4. Public-private partnership

It is believed that the partnership between the government and the private sector will accelerate the introduction of renewable energy. The partnership is also believed to ensure that the project primarily benefits the local community.

5. International Cooperation

International cooperation is necessary to promote information, technology development and implementation of renewable energy

in Indonesia, especially with countries that are successful in the use of renewable energy.

6. Capacity building

Experts in renewable energy technology are very important. There are a number of things that can be done to achieve this expertise, including creating various educational and training programs in the field of renewable energy.

7. Technology diversification

Diversification of renewable energy sources is critical, especially in Indonesia, which has many potential natural resources such as solar, geothermal, hydro, wind, and biomass. Combining different renewable sources is very profitable in terms of consistent and sustainable energy supply. These renewable energy sources should be a part of the optimum energy mix of the country.

8. Resource assessment

There are many renewable energy sources in Indonesia that are scattered, so in-depth research is needed to choose the best place to develop renewable energy projects.

9. Power grid integration

Building a modern and integrated power grid in Indonesia is also critical, especially with distributed renewable energy sources in different regions. This includes transmission and distribution networks, applications of smart grid technology, and increase in energy storage capacity.

10. Public awareness and support

Increased public awareness of the importance of renewable energy can lead to faster adoption. Renewable energy is beneficial to society both economically and environmentally. Campaigns promoting the urgency of adopting renewable energy can be carried out in an engag-

ing and organized manner using several media platforms that are now easily accessible to the public. The young generation may also be empowered to increase public support.

11. Environmental considerations

Before implementing a renewable energy project in the region, a comprehensive environmental assessment must be carried out so that environmental sustainability is considered in the project.

Indonesia has taken several initiatives to promote net zero emissions and the use of renewable energy. However, there is still a lot of work to be done, mainly in terms of investments, strict regulation, and public awareness. Multifaceted research and development of renewable energy technology must also be supported, as Indonesia has significant natural resource potential and human resources. Each region in Indonesia has a different renewable energy potential. Through careful planning, in-depth feasibility studies, strong government support, and community involvement, each region is expected to be able to take full advantage of renewable energy. Achieving net zero emissions and transitioning to renewable energy are essential parts of global efforts to address climate change.

Indonesia is moving towards a golden age and will become one of the countries with the largest economy in the world, becoming a new Indonesia with renewable energy.

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