



Chapter 3

Is Indonesia Really Prepared for The Energy Transition? An Analysis of Readiness for Regulations, Institutions, Finance, and Manpower Aspects

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A. Energy Transition Challenges

The global landscape of energy production and consumption is undergoing a significant transformation. With the increasing concerns about climate change, the depletion of fossil fuel reserves, and the need for sustainable energy sources, countries around the world are exploring options for transitioning towards cleaner and more efficient energy systems. Indonesia, as a rapidly developing nation and one of the largest archipelagic countries in the world, is not exempt from this paradigm shift.

Indonesia is a fossil fuel country having adequate fossil fuel reserves, and it has long been dependent on fossil fuels, particularly coal and oil, for its energy needs. It exports natural gas (mainly LNG)

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Nugroho, H., Widyastuti, N. L. & Rustandi, D. (2023). Is Indonesia really prepared for the energy transition? An analysis of readiness for regulations, institutions, finance, and manpower aspects. In A. Kiswanto & R. M. Shoedarto (Eds.), *Indonesia's energy transition preparedness framework towards 2045* (89–122). BRIN Publishing. DOI: 10.55981/brin.892.c813, E-ISBN: 978-623-8372-41-6

and coal on a world scale and was once an OPEC member country. Indonesia's position, which is rich in energy resources, is unique compared to Southeast Asian countries, let alone East Asian industrialized countries that are heavily dependent on fossil fuel imports. Historically, this condition has provided energy security and fuelled economic growth. However, it has also led to environmental degradation, air pollution, and vulnerability to global energy price fluctuations. In light of the Paris Agreement and international commitments to reduce greenhouse gas emissions, Indonesia has recognized the urgency of transitioning to cleaner and more sustainable energy sources. This transition presents both challenges and opportunities, including the need to diversify energy sources, increase energy efficiency, and engage in renewable energy development.

Indonesia is preparing an energy transition to welcome “Golden Indonesia 2045”. Meanwhile, another related scenario is setting up the country's net zero emissions (NZE) to be achieved by 2060.¹ The energy sector's greenhouse gas emission reduction targets in these scenarios are quite ambitious, the largest among ASEAN member economies (ACE, 2022; IEA, 2022). This energy transition plan that Indonesia is preparing, as will be shown in the next section, emphasizes the use of renewable energy and reduces coal consumption as the backbone of achieving the energy sector's emission reduction targets. Such a dramatic transition, however, is not easy to make. This includes how to transform ingrained energy consumption patterns depending on fossil fuels to the dominant projected use of renewable energy. Many aspects need to be prepared to guarantee the success of such an energy transition plan, which will be a gigantic project of change within society.

This chapter presents an in-depth analysis of Indonesia's readiness for energy transition, examining the background to the subject, the

¹ No new formal law/regulation on energy transition has been published yet. The plan is under serious discussion among energy stakeholders especially within the government. In the draft of the National Long-Term Development Plan 2025–2045, it is stated that “net zero emissions is to be achieved by the golden year 2045”.

current conditions of its energy sector, and the methodologies used to assess its preparedness for this critical transformation. Considering those topics, the chapter discusses how Indonesia faces the challenges to make the energy transition work. In summary, it shows Indonesia's experience in making an energy transition in the form of reducing dependence on petroleum. After showing the current conditions related to renewable energy development, analyses were carried out on several factors to support the implementation of the energy transition plan. The factors analyzed are regulation/legislation, institutions, finance, and manpower, which are fundamental factors in development planning.² Based on the analysis, several policies/actions were recommended.

B. The current condition

The spirit of reducing dependence on fossil fuels has been developed in Indonesia for quite a long time (Nugroho, 2018). This is based on the awareness that Indonesia has quite a lot of renewable energy sources.³ Hydropower has been developed on a rather large scale since the 1960s, followed by geothermal since the 1980s. Various other renewable energy, such as micro-hydro and solar power (especially solar home systems) were introduced in the Five-year Development Plan (*Rencana Pembangunan Lima Tahun* - Repelita) era in the late 1980s.

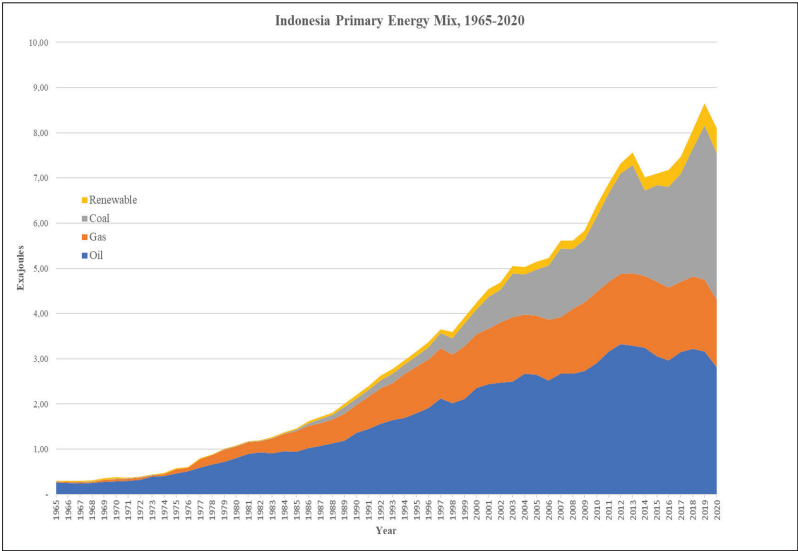
In an era when petroleum production was relatively large (1.7 million barrels production per day in the mid-1970s) but domestic consumption was small, Indonesia's General Energy Policy (*Kebijakan Umum Bidang Energi* - KUBE)⁴ had directed to reduce the country's

² The aspects are usually reviewed when preparing the Indonesia's National Medium Term Development Planning, carried out every five years.

³ Among the potentials of renewable energy for electricity are solar (3,294 GW), hydro (95 GW), wind (155 GW), bioenergy (57 GW), and geothermal (23 GW). Only 0.3% of the potentials have been exploited (Directorate General of New & Renewable and Energy Conservation, 2023).

⁴ The policy was issued by the National Energy Coordination Board (Badan Koor-

dependence on petroleum by developing non-petroleum energy sources. Due to the immature renewable energy technologies (except for hydropower and geothermal power plants) and the lack of pressure on environmental considerations, while the price of renewable energy was still expensive, the development of the energy sector was limited to other fossil fuels, namely natural gas (since the 1970s) and coal (since the 1990s).



Source: Graphed from Energy Institute (2023)

Figure 3.1 Indonesia Primary Energy Mix (1965–2020)

As a result, shown in Figure 3.1, Indonesia is quite successful in reducing its dependence on petroleum. However, it was achieved through the rapidly increasing development of other fossil energy, especially coal. Meanwhile, despite the increase in utilization, the

dinasi Energi Nasional - Bakoren) which comprise of several ministers having responsibilities in energy-related issues. After being inactive for a long time since the 1998 Reformation Movement, the role of Bakoren was then officially taken up by the National Energy Council whose formation was mandated by Energy Law No. 30 of 2007.

share of renewable energy in Indonesia's energy mix remains low (11.5% in 2021, and even declined to 10.4% in 2022) (IESR, 2022).⁵ Hydro and geothermal contribute the most to the share of renewable energy, particularly in electricity.

To understand Indonesia's energy transition readiness, it is crucial to assess the current conditions of its energy sector. This analysis will consider various factors, including:

- 1) **energy mix:** an overview of Indonesia's current energy mix, highlighting the dominant role of fossil fuels and the share of renewables;
- 2) **energy consumption:** examination of energy consumption trends, sectors driving demand, and per capita energy consumption;
- 3) **energy policy:** an overview of existing energy policies, regulations, and commitments related to clean energy adoption and emissions reduction;
- 4) **infrastructure:** assessment of the state of energy infrastructure, including electricity generation, transmission, and distribution networks; and
- 5) **environmental impact:** an evaluation of the environmental impact of Indonesia's current energy mix, including air and water pollution and greenhouse gas emissions.

Indonesia's energy landscape is characterized by a heavy reliance on fossil fuels, particularly coal and natural gas, which account for a significant portion of the country's energy consumption. While there have been efforts to increase the use of renewable energy sources, progress has been uneven, and the country faces obstacles such as policy gaps, infrastructure limitations, and financial constraints. Understanding the current energy conditions in Indonesia is crucial for assessing its readiness for an energy transition.

⁵ The decline was due to the high growth of nickel smelters in Sulawesi which requires a lot of electricity which is then supplied by the cheap coal power plants.

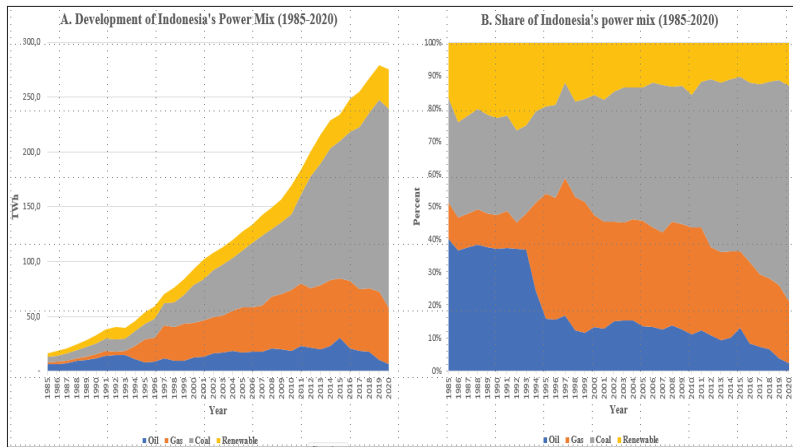
C. How to assess Indonesia's energy transition readiness

The assessment of Indonesia's energy transition readiness is based on a multi-dimensional methodology. This involves:

- 1) **data collection:** gathering data from various sources, including government reports, international organizations, energy companies, and research institutions;
- 2) **policy analysis:** reviewing and analyzing the existing energy policies, regulatory frameworks, and government initiatives related to energy transition;
- 3) **stakeholder interviews:** conducting interviews with key stakeholders, including government officials, industry representatives, environmental organizations, and experts in the field;
- 4) **scenario modeling:** developing scenarios to project potential energy transition pathways and their socio-economic and environmental implications; and
- 5) **comparative analysis:** comparing Indonesia's energy transition progress with other nations that have undergone similar transformations.

By combining these elements, this chapter aims to provide a comprehensive understanding of Indonesia's energy transition readiness. It will highlight the challenges and opportunities facing the nation as it strives to shift towards a more sustainable and cleaner energy future in alignment with global environmental goals.

The increase in coal utilization is seen mainly for electricity generation (Figure 3.2). In the early 2000s, in an age when the world began to intensify its efforts to combat global climate change, Indonesia started accelerating the use of coal.



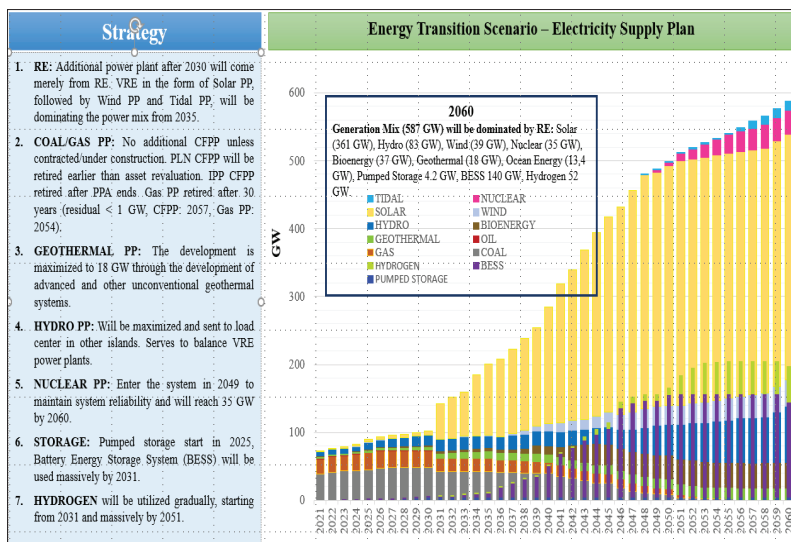
Source: Graphed from Energy Institute (2023)

Figure 3.2 Development of Indonesia's Power Mix and Its Fuel Share

The current positive law, Government Regulation No. 79 of 2014 on National Energy Policy, directs Indonesia's energy mix in 2050 to be composed of coal with a share of 25% or less, petroleum with 20% or less, natural gas with 24% or less, and renewable energy for 33% or more. The NZE/energy transition proposal that is being developed strongly prioritizes the use of renewable energy. Meanwhile, the plan is still focused on the use of renewable energy in electric power. Figure 3.3 shows the major proposal, developed by the Ministry of Energy & Mineral Resources.

Although there are plans to accelerate the development of renewable energy, including those listed in the recent medium-term development plans, and there is an increase in the amount of energy contributed by renewable energy, there are several obstacles remain to increasing the share of renewable energy in Indonesia's energy mix (Nugroho, 2020).

The "Energy Transition Readiness Index 2021" puts Indonesia in the 71st position among 115 countries in the world (WEF, 2021).



Source: Modified from Ministry of Energy and Mineral Resources (2022)

Figure 3.3 Indonesia's Energy Transition Plan

Compared to the factors analyzed in the Energy Transition Readiness Index of WEF, this paper examines only four main factors, namely legislation, institutions, financing, and labor about the development of renewable energy. Rather than trying to present it quantitatively, this chapter describes the conditions encountered in each aspect analyzed, to provide an in-depth description of the challenges faced and to gain insightful ideas regarding strategic steps that must be taken.

1. Regulations on energy, renewable energy, and climate change

Table 3.1 presents the laws and regulations that have been developed in Indonesia regarding energy and climate change policies in recent decades. After the 1998 Reform Movement, many laws and regulations were born, marking their differences from the previous period when democratic rule was not yet developed in the country.

For oil and gas, since its inception, laws and regulations have been developed to support their activities. The Oil and Gas Law 22 of 2001 liberalized the downstream business of Indonesia's oil and gas industry which was previously carried out only by the state oil and gas company Pertamina. Meanwhile, on the upstream side, Pertamina's authority, which according to Law 8 of 1971 includes tendering for oil and gas blocks, is taken over by the government, and Pertamina is classified as one of the upstream business entities.

Coal is regulated simultaneously with the law on mineral and coal mining, which the current law in force is Law No. 3 of 2020. The spirit of this law is to provide clarity regarding the operation of coal and minerals and encourage them to protect their development. Unlike petroleum, natural gas, and coal, laws directly related to the regulation of renewable energy have not yet been issued.⁶ There is only one law that specifically regulates geothermal, which is Law No. 27 of 2003.

Table 3.1 Law/regulation on Renewable Energy and Climate Change

Year	Law/Regulation	Note
1997	Law #10 of 1997 on Nuclear Energy	There are Government regulations derived from the Law.
2001	Law #22 of 2001 on Oil and Gas	Replaced Law # 8 of 1971 on Oil and Gas Company
2002	Law #20 of 2002 on Electricity	Replaced Law # 15 of 1985 on Electricity. Rejected by the Constitutional Court
2003	Law #27 of 2003 on Geothermal	The only law on Renewable Energy that has been issued. Renewed by Law #21 of 2014.
2004	Law #7 of 2004 on Ratification of the Kyoto Protocol	Indonesia is a Non-Annex Country

⁶ Currently under rigorous and protracted discussions in the House of Representatives.

Year	Law/Regulation	Note
2006	President Regulation #5 of 2006 on National Energy Policy	Introducing national energy mix goals/targets
	President Instruction #1 of 2006 on Provision and Utilization of Biofuels	The basis for the development of biofuels in Indonesia, especially that palm oil.
2007	Law #30 of 2007 on Energy	The mandate is to establish a National Energy Council and to formulate a National Energy Policy.
2008	President Regulation # 26 of 2008 on the establishment of the National Energy Council	The council's main task includes formulating a national energy policy
	President Regulation # 46 of 2008 on the National Council of Climate Change	This was followed by the establishment of the Indonesia Climate Change Trust Fund in 2009.
2009	Law #30 of 2009 on Electricity	Replaced Law # 20 of 2002 on Electricity
	Law #4 of 2009 on Coal & Mineral Mining	Renewed later by Law #3 of 2020
2010	President Regulation # 24 of 2010 on Position, Duties, and Functions of the Ministry of Energy and Mineral Resources	Established the Directorate General of New Renewable Energy and Energy Conservation
2011	President Regulation # 61 of 2011 on National Action Plan for GHG Emission Reduction.	Derived from President SBY 2009 Pittsburgh Pledge. Followed by the launch of the National Action Plan for Climate Change Adaptation.
2013	President Decree # 5 of 2013 on Reducing Emissions from Deforestation and Forest Degradation (REDD+) Institution.	The REDD+ Management Agency was formed
2014	Government Regulation in Lieu of Law # 79 of 2014 on National Energy Policy	Set targets for the share of the national energy mix (by 2050: Oil < 20%, Natural Gas < 24%, Coal < 25%, and Renewable Energy > 31%)

Year	Law/Regulation	Note
2016	Law # 16 of 2016 on Ratification of the Paris Agreement to The United Nations Framework Convention on Climate Change.	Indonesia has submitted its Nationally Determined Contribution to the United Nations Framework Convention on Climate Change (UNFCCC) and has even submitted several updates. The last is by the end 2022.
2017	President Regulation # 22 of 2017 concerning the General Plan of National Energy (RUEN)	The RUEN has been translated into Regional Energy General Plan (RUED). Not all provinces already have their own RUED (the General Plan of Regional Energy)
	President Regulation # 59 of 2017 concerning the Implementation of Achieving the Sustainable Development Goals	A quite comprehensive development program under the SDGs framework, incorporated into programs in the RPJMN (National Medium-Term Development Plan)
2020	President Regulation # 18 of 2020 concerning the Medium-Term Development Plan 2020-2024	The last version of the five-year development plan for Indonesia
2022	Presidential Regulation Number 112 of 2022 concerning the Acceleration of the Development of Renewable Energy for the Provision of Electricity	As an extension of the Regulation of the Minister of Energy and Mineral Resources Number regarding a similar matter.
NA	Law on New and Renewable Energy	In the progress of drafting.
	Law on Energy Transition	Under discussion. Being proposed under the new Government Regulation on National Energy Policy.
	Law on Net Zero Emissions	Under discussion.

2. Institution

The Directorate General of New Renewable Energy and Energy Conservation is a government agency responsible for the development of renewable energy in Indonesia. It was established in 2010 (through President Regulation No. 24 of 2010 on Position, Duties, and Functions of the Ministry of Energy and Mineral Resources). Another institution leading the climate change movement is the Ministry of

Environment and Forestry. The institution that deals with climate change has undergone several changes in the structure and hierarchy of its organization within the central government.

After the 1998 Reform Movement, Indonesia developed a Regional Autonomy Law which is then continued to be refined. The implementation of the law on the local government resulted in the abolition of the Regional Offices of the Central Government, and the establishment of *Dinas*/Regional Offices within the regional/local governments. The development and naming of local government offices are independent, determined by each local government considering their needs and priorities, and often do not refer to those in central government.

Within the central government itself, there are no sectoral agencies with the name “climate change” and “energy transition” except the Ministry of Environment & Forestry for “climate change” and the Ministry of Energy & Mineral Resources for “new, renewable energy and energy conservation”. Within the Ministry of Energy and Mines, the energy transition plan does not seem to have caught the attention of the Directorate Generals in charge of oil, gas, and coal, which still list increasing the production of fossil fuels as their main target.⁷

If the business in the fields of petroleum, natural gas, and coal are encouraged to develop through the formation of large-scale state-owned enterprises (SOEs)—such as Pertamina (oil and gas), PGN (gas), and PT Batubara Bukit Asam (coal)—then there is yet to exist SOE that specifically engaged in the development of renewable energy. Pertamina and PLN (electricity) may have developed organizational units for renewable energy development, but the scale is too small compared to their main businesses in the fields of oil and gas and electricity (which rely on coal-fired power plants).

The private enterprises that are struggling to develop renewable energy are still limited to several EPC companies that assist in the construction of small-scale government-owned projects. Private

⁷ In fact, coal production for the last decade or so has always been above what was planned in the National Medium Term Development Plan.

companies that have their renewable energy projects, for example as IPPs, are still very rare, limited for example to geothermal power plants. Institutions that support research for the development of renewable energy are very limited to a few universities or agencies, such as National Research and Innovation Agency (BRIN). However, until now it is unclear whether there is a direct link between the research work carried out by these institutions and the energy transition or net zero emission program that is being prepared by the government.

3. Finance

Funds for the development of renewable energy in Indonesia so far come from (i) grants from bilateral and multilateral institutions, (ii) governments, both central and regional, (iii) private companies engaged in the development of commercial renewable energy, and (iv) non-governmental organizations.

Grants from international bilateral and multilateral institutions are generally provided for the construction of small-scale or pilot projects, such as photovoltaic, wind power plants, or micro-hydro installations in rural areas or outer islands of the archipelago. These grants are typically only for the physical construction of the project, excluding maintenance, which is usually carried out by the community, who will also collect cash from the use of electricity provided by the facility. Most grant projects like this are not guaranteed to be sustainable. A large part of them operated only in the early years after their installation. After the physical project was built, the transfer of ownership and responsibility of the project usually becomes a problem.⁸

The government, particularly the central one, is the largest source of funding for renewable energy development in Indonesia. It provides money for the construction of renewable energy, especially when it relates to rural electricity and development projects.⁹ The most com-

⁸ The challenges of developing renewable energy projects, from planning to post-construction, can be further seen in Nugroho (2023a).

⁹ Funds are sourced from the state budget (APBN), spent annually after being reviewed by the National Development Planning Agency and the Ministry of

mon energy technologies installed are photovoltaic and micro-hydro. Agencies in the central government implementing the program are not only the Ministry of Energy & Mineral Resources, but also other ministries, such as Assessment and Application of Technology Agency (BPPT)¹⁰, Ministry of Cooperative, Ministry of Marine and Fisheries, and so on. The works were carried out mainly in the past two or three decades. Meanwhile, local governments follow to implement the same work in their respective areas but with a smaller financing capacity. Given the need for renewable energy development particularly in remote areas, the funds provided by the government are insufficient.

Later, the central government reactivated the Special Allocation Fund (*Dana Alokasi Khusus* - DAK) for renewable energy development in the regions, having previously been stopped due to inadequate performance of renewable energy development in the regions. There are various funds with green or clean energy labels offered by several financing institutions, mostly international. However, this opportunity has not been effectively captured. Some things can be noted as obstacles.

First, the domestic bureaucratic procedures. Not only it is known for the long process, but it also makes the offered cheap funds look unattractive. There are several entities (focal points) that manage the funding with different procedures and schemes. This often causes headaches for renewable energy project proponents who are seeking access to funding. *Second*, the ability to implement the full cycle of renewable energy projects is inadequate, even, for example, only preparing a proper project proposal. There are many cases where project proponents, especially from the regions, do not have sufficient capacity to make good project proposals, including funding proposals.

Finance. The annual funding allocation stated in the Government Work Plan is part of the Medium-Term Development Plan with adjustments to the challenges encountered.

¹⁰ Since 2021, BPPT has merged into BRIN. From Repelita IV until the 1998 Economic Crisis, BPPT played an active role in renewable energy development projects, especially solar power in the form of solar home system (SHS) in rural areas.

Third, Indonesia lacks financial institutions that can act as agents for channeling sources of low-interest funds from abroad and at the same time maintaining a minimum interest rate for domestic renewable energy project developers. This impedes the flow of funds because overseas funding institutions usually do not want to provide funds on a project-by-project basis, while domestic funding institutions are constrained by local regulations so they cannot provide low-interest rates to projects that submit requests for funding assistance.

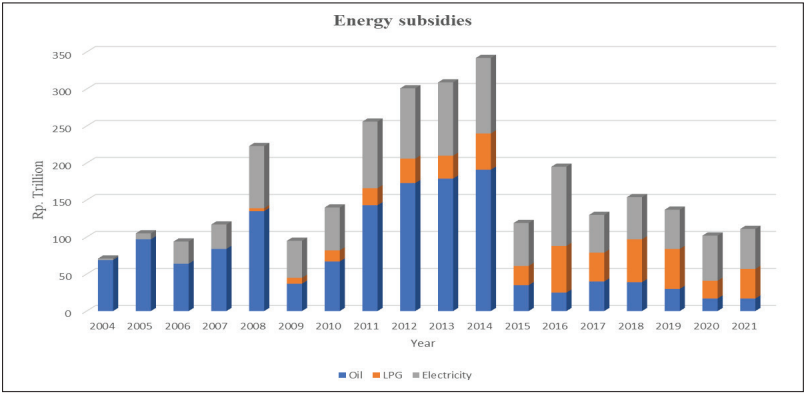
The funding that was available adequately and has been used effectively for the construction of renewable energy projects so far is for hydropower and geothermal power plants, most of which are handled by SOEs, namely PLN and Pertamina. In the scheme, the government seeks loans from multilateral financial institutions and forwards the loans (with subsidiary loan agreements) to the SOEs implementing the project. The bureaucracy took a long time, caused SOEs (whose equity had grown larger) to abandon this scheme and seek their own financing sources (including from the capital market and national and international banks). Later, the construction of hydropower and geothermal power plants was also carried out by IPPs which sought to finance their projects.

In addition to the Infrastructure Fund (SMI) which was developed earlier, the Indonesia Sustainable Finance Initiative (IKBI) has also been developed with dozens of national banks joining. However, like SMI, IKBI focuses on not only on facilitating the distribution of funds for renewable energy development, but also the development of fossil fuels, even including coal (IESR, 2022). Recently, the government has collaborated with several foreign financial institutions to launch the Energy Transition Mechanism (ETM) and Just Energy Transition Partnership (JETP)¹¹ programs, with a focus on funding the early retirement of a number of coal power plants. However, the challenge of this program in terms of energy security is ensuring that renewable

¹¹ The ETM and JETP for Indonesia were both launched in November 2022. See, for example, <https://fiskal.kemenkeu.go.id/fiskalpedia/2022/11/10/21-energy-transition-mechanism>, and <https://web.pln.co.id/pln-jetp/jetp-home>

energy facilities can be built before the early retirement of coal power plants is feasible.¹²

The Indonesian government has so far allocated considerable funds for energy subsidies. Figure 3.4 shows the development of energy subsidies in recent years. The figure shows that energy subsidies are given for oil products (gasoline and diesel), LPG, and electricity in considerable amounts (with about USD 2 billion at the peak in 2014). The latter is basically to secure the purchase of coal by PLN. It is not pointed out that energy subsidies are also provided for renewable energy development.



Source: Ministry of Finance (2023)

Figure 3.4 Indonesia’s energy subsidies (Rp. Trillion)

¹² In terms of energy security, “supply disruption” is something that should not happen. In the 2025–2045 National Long-Term Development Plan, Indonesia is planned to become an industrial country and is projected to experience an increase in energy demand. The energy supply for this development needs to be secured. Early retirement of coal power plants, aside from disrupting the security of energy supply, will also cause significant employment problems. Moreover, most of the construction of new coal power plants was carried out in the era of President Joko Widodo with his “35,000 MW” program; most of the coal power plants in Indonesia are still relatively young. These things are a challenge for programs such as ETM and JETP to participate in answering them.

It has been suggested that energy subsidies, provided by the state budget, can also be used for the development of renewable energy. However, until now, despite the worry of the growing amount of energy subsidies during post Covid-19 pandemic, the subsidies specifically allocated to accelerate the development of renewable energy have not been provided.

4. Manpower

The workforce in Indonesia is characterized by low or middle skills and low education; only about 10% of them are classified as highly skilled workers. The total number of manpower in 2021 was 141 million (Pusditek, 2022).

Indonesia has good experience in constructing and operating hydropower and geothermal power plants. However, for solar and wind power plants (which are projected to grow dramatically in the future), Indonesia's workforce is very limited, even only for the installation works. Indonesia's current solar and wind power plants capacity is small, compared to Malaysia or Thailand in South-East Asia (ACE, 2022; IRENA, 2021a). The domestic production capacity of solar power equipment, such as solar panels, is very small. Therefore, it is still highly dependent on imports although there is a plan to reduce this dependency (Kemenperin, 2015).

Training and skill development are highly regarded by the Indonesian workforce. However, the Job Training Center of the Government of Indonesia (Ministry of Manpower) has not targeted to increase manpower skills in the renewable energy sector in its training program. The largest education and training facility operated by the Ministry of Energy and Mineral Resources is for oil and gas, while the Ministry of Manpower provides training mainly for prospective workers in the automotive industry (especially motorcycles), computer operators, and beauty and fashion. So far, training for workers in renewable energy development is directly provided by companies that build renewable energy facilities, such as PLN or its contractors, in the form of on-the-job training.

Indonesia has the potential to develop renewable energy, not only downstream as a user, but also upstream as a producer of mining materials needed for components of renewable energy technology, such as batteries for solar power or materials for propellers in wind power. However, the labor requirements for these fields, especially those with high skills in the mining and processing industry, are still very small. The employment aspect in the field of renewable energy also needs to pay attention to manpower in the energy sector as a whole, especially for coal which will be greatly affected by the implementation of the energy transition plan. The manpower of the energy sector in Indonesia is around 1.3 million people, or one percent of Indonesia's workforce. About half a million work in the production and transportation of coal is limited to only a few provinces, especially on the island of Borneo and parts of Sumatra.

The oil and gas industry, for example, is characterized as capital and technologically intensive, while the labor need is scanty. Likewise, the electricity industry built so far is more characterized as capital and technologically-intensive. However, until now the number of workers in the fossil fuel industry in Indonesia is still far larger than those working in the field of renewable energy. Employment aspects are still rarely studied in the discussions of renewable energy development in Indonesia, probably because the scale of renewable energy development, so far, is still small.

In the scenarios developed by the National Energy Council (DEN) and the Ministry of Energy and Mineral Resources, several energy technologies that will be developed have been identified. However, the current energy transition plan to achieve a net zero emission target has not yet identified the workforce that will be needed, while the need for the future development of solar and wind power is certainly very large.

The development of renewable energy technology in the future, such as for solar and wind power, is projected to grow very large. It requires highly specialized experts whose procurement must also be prepared, for example through postgraduate education or research at universities and research institutions such as BRIN. Cooperation for

the preparation of experts like this within the framework of Indonesia's current energy transition has not been sufficiently developed. The need for manpower for the development of more specific technologies in the energy transition plan, for example for the construction of nuclear power plant and battery energy storage system (BESS), is also not well identified.

D. Indonesia's level of readiness

Indonesia has made efforts to maintain its energy security, including by securing domestic energy supplies and increasing the use of clean and renewable energy (Nugroho, 2015). However, to support the energy transition plan that is now being discussed, several works, including accelerating the deployment of renewable energy, must be carried out.

To be able to develop, renewable energy requires several supports, including regulation, institution, finance, and manpower aspects (Nugroho et al., 2021). The analysis taking these factors into account is briefly shown below.

1. Regulation

Analysis of legislation looks at whether the law prioritizes the development of renewable, or puts renewable energy on a level playing field with the much more mature fossil fuels, or let both of them compete with each other. Laws and regulations regarding renewable energy are compared to those about overall energy development, especially with fossil fuels.

The main question is whether the existing law is sufficient to encourage the development of renewable energy ahead of fossil energy. Furthermore, the analysis also looks at the readiness of laws regarding the energy transition and even net zero emissions.

Based on a search of the legislation as shown in Table 3.1, it is found as follows.

- 1) No specific law regarding renewable energy has been issued, while oil & gas, and coal have long had it.

- 2) The current law on energy and electricity has not emphasized the strong priority of using renewable energy.
- 3) The current legislation on national energy policy (Government Regulation No. 79 of 2014) targets the share of renewable energy as only small compared to the share of fossil fuels.
- 4) The ratification of several international agreements on climate change was not all followed up with laws to regulate their implementation at the project level, let alone for their implementation at the regional/local level.
- 5) Neither energy transition nor net zero emissions laws have been developed.¹³

Indonesia at the national level supports international agreements on global climate change including ratifying the Paris Agreement (2016). However, the law on the ratification of such international agreements has not been relegated to technical regulations under it, including facilitating implementation and encouraging compliance with the agreement.¹⁴ In order to accelerate the development of renewable energy, shortcut of legal efforts have been made by enacting a presidential regulation, compared to struggling to stipulate laws regarding the development of renewable energy or regarding reducing greenhouse gas emissions. This can be seen, for example, by the enactment of Presidential Regulation Number 112 of 2022 concerning the Acceleration of Development of Renewable Energy for the Provision of Electricity.¹⁵

¹³ According to the Energy & Climate Change Intelligence Unit, Indonesia is at the bottom of the “race to zero”, especially in terms of the readiness of the law on net zero emissions. See Nugroho (2023b).

¹⁴ Indonesia submitted its Nationally Determined Contribution and Long-Term Strategy as requested by the Paris Agreement to the UNFCCC. However, how this is translated into domestic legislation is not entirely clear.

¹⁵ The enactment of this President Regulation can be understood as a correction to the previous ESDM Ministerial Regulation, namely ESDM Ministerial Regulation Number 50 of 2017 concerning the use of renewable energy sources for electricity supply, which proved to have discouraged development of renewable energy later. Pricing policy was among the weakest factors. See Nugroho, 2022.

Based on the findings, it can be concluded that existing laws and regulations do not yet support the implementation of the energy transition plan. The development of renewable energy is still placed in a far weaker position than that of fossil fuels. There is a clear absence of laws that support the development of renewable energy, the energy transition, and efforts to achieve net zero emissions. Weaknesses in the regulatory aspect need to be corrected immediately because they will become the foundation for future renewable energy development and accelerate the energy transition and the move towards net zero emissions. It is impossible for a major change, such as an energy transition, to be carried out without the support of laws that facilitate it.

2. Institution

Is the existing energy institution in favor of promoting renewable energy development than fossil energy? Are not the institutions in the field of developing renewable energy, both in government and business entities, too small compared to those that have been established to develop fossil fuels?

The analysis of the institution also focuses on “who leads/coordinates the renewable energy and net zero emission program and how effective it is”. Are the existing institutions strong enough to support the goals of the energy transition plan? What things are still missing and need to be improved? Our survey of data in 37 provinces and 514 regencies and cities in Indonesia found that agencies with the main task of “developing renewable energy” were either scarce or almost nonexistent. The existing agencies/institutions are not equipped with adequate human resources and funding related to renewable energy development. Development of renewable energy and mitigation/adaptation to climate change is not a high priority for local government institutions, compared to the development of basic infrastructures such as village roads, primary schools, electricity supply, and public health facilities.¹⁶

¹⁶ This is clearly stated by local government offices in the national development deliberation meeting which is held annually by the National Development Planning Agency. Almost all of the problems that local governments complain about

A similar pattern occurs in the issue of global climate change. The agency that acts as a focal point or leading sector is the Ministry of Environment and Forestry. However, this agency is limited in its ability or authority to carry out inter-sectoral coordination between central government offices and government offices in provinces and districts/cities.¹⁷

The Directorate General of New Renewable Energy and Energy Conservation is still a relatively young institution and does not have the experience that has been possessed by other Directorates-General, especially the Directorate General of Oil and Gas, and the Directorate General of Mineral and Coal. The Directorate General of New Renewable Energy and Energy Conservation does not have strong control over local government agencies in the development of renewable energy in their area; its role is more limited to the dissemination of what is planned by the central government. As a result, in addition to some miscommunication, what has been planned by the central government often takes a long time to be implemented in areas where renewable energy development is carried out.

The target of reducing carbon dioxide emissions or achieving net zero emissions is not clear and should be done by what offices or institutions, as the organizational units in the government, have their own key performance indicators (KPIs) which sometimes conflict with reducing carbon dioxide emissions goal. This can be seen for example in the coal production target and development of electricity production.

Compared with the oil and gas and coal business, the ability and scale of business in the existing Indonesian renewable energy sector are still very weak or small. There are no business institutions in the

are still related to basic infrastructure such as roads and electricity. The issue of global climate change has not yet become a concern. Small survey was usually conducted as a preparation part for the national development plan deliberations.

¹⁷ In some cases, the role as a “leading sector” is taken over by the National Development Planning Agency, for example in issuing the National Action Plan for Reducing GHG Emissions, as well as ensuring the projects are included in the National Medium-Term Development Plan.

field of renewable energy, both government-owned and private, whose scale is large enough to be compared, for example with Pertamina or PT Bukit Asam, two government-owned companies engaged in the oil and gas and coal sectors.

Research institutions, such as those owned by several universities in Indonesia or even BRIN have research in the field of renewable energy, but it is too early to confirm that they are connected to the energy transition or net zero emission program that is being discussed. It can be summarized that the current institutions are not strong enough to support the ambitious target of the energy transition plan.

3. Finance

As stated above, Indonesia is still practicing energy subsidies, which is quite huge. So far, almost all of the energy subsidies have been spent to finance the provision of fossil fuels so that they can be consumed cheaply by the public. This is certainly an unhealthy symptom (Beaton et al., 2015). Although the debate, including in parliament, for the use of a portion of energy subsidy funds for renewable energy development, has not been quite successful so far, efforts to do so must continue. It will be dangerous if subsidies continue to be provided for the use of fossil fuels, while not providing a significant amount of funds for the development of renewable energy. The need for renewable energy funding especially for solar and wind power will be very large as their demand will grow dramatically.¹⁸

The continuous drop in renewable energy costs, such as for solar and wind power, provides an excellent opportunity to boost their development.¹⁹ However, the current level of Indonesia's investment in

¹⁸ It is estimated that investment for solar and wind power alone will reach USD 400 billion by 2060, or require an average of USD 10 billion over the next 40 years. This is larger than the current investment in power plant construction which is around USD 6 billion/year (PLN, General Plan for Electricity Provision 2021-2030)

¹⁹ It is also important to note that the technological cost of solar (or wind) power does not necessarily lower the cost of producing electricity from it. In the case of Indonesia, land acquisition is an increasingly expensive

renewable energy is still inadequate, even though some investment in coal is diverted to renewable energy development. Therefore, investment in the development of renewable energy must be sourced more aggressively and the effectiveness of its utilization must be increased.

The government must also be more assertive in realizing the net zero emission target, including in the form of allocating funds for the energy transition plan and reducing the share of funds for fossil fuel subsidies. The role of several ministries, such as the Ministry of Finance, the National Development Planning Agency, as well as the Ministry of Environment and Forestry, both as National Designated Authorities and as focal points from various international funding sources, must be translated into more effective operations and larger targets.

Coordination with local governments to jointly achieve the goal of net zero emission development needs to be continuously strengthened, including that the central government assists in financing and increasing the capacity of local governments in developing renewable energy. The Special Allocation Fund for renewable energy development provided by the central government to local governments needs to be continued, especially for some local governments in the eastern and island regions with low fiscal capacity.

Indonesia needs to develop institutions that concentrate on developing renewable energy, including for its capacity building and financing national targets. One example is International Renewable Energy Development Agency (IREDA) in India. The new institution is tasked with providing easy access to finance and technology for various renewable energy projects spread across Indonesia. The institution might raise funds from the government and other sources, especially international ones, which are now underutilized. This institution is to channel sources of finance with renewable energy projects in need of them all over the country with attractive terms and conditions.

component of costs. Meanwhile, with the increasing capacity of solar and wind power to be built, the need for more land will increase.

When setting targets for their emission reductions, developing countries such as Indonesia use the terms “unconditional” and “conditional”, where unconditional refers to target sets based on their resources, while conditional refers to targets the country would undertake if international aid is provided. Because, for example, the Paris Agreement is open for financial assistance from developed to developing countries, and such funds are available quite a lot (OECD, 2022), the Indonesian institutions tasked with finding funds for renewable energy development must work harder to be able to utilize these funds.

In addition to continuing to provide direct funds for the energy transition program, the government must also provide incentives for the development of renewable energy by the private sector, for example in the form of tax breaks or prioritizing energy from renewable sources. Other innovative alternative financing methods, such as blended finance or public-private partnership schemes for renewable energy development, must also be developed.

4. Manpower

Renewable energy development is labor-intensive compared to capital-intensive fossil fuel industries. However, renewable energy that creates more jobs is not the same for every type of technology (IRENA, 2021b). Each of the renewable energy technologies has its structure and supply chain. Manpower requirements are different, for example between photovoltaic and geothermal, or between wind and hydro. The need for manpower is also different in each stage of their development (installation, operation, sales, etc.).

In Indonesia, the selected renewable energy technologies such as hydro, geothermal, and solar PV could create about 3.7 million direct jobs by 2030, whereas about 2.1 million direct jobs would be with PLN (GGGI, 2020). The energy transition plan under the current proposal would require much more manpower. Challenges will be faced in the supply of manpower for the development of renewable energy to meet the target of net zero emissions. This problem needs

to be overcome by increasing the capacity and quality of training in the field of renewable energy which will be carried out not only by central ministries, but also by local governments, vocational schools and universities, and even the private sector.

Does the need for manpower also consider what manpower is needed for industrial development, such as photovoltaic components or batteries in the country? Indonesia proclaimed that developments in the field of renewable energy must also encourage the manufacture of its components domestically (The Republic of Indonesia, 2020). This will certainly create a lot of additional workers, where the industry for manufacturing renewable energy components is still underdeveloped, particularly in the outer islands of the country.

Indonesia lacks the capacity, including in the field of manpower, for the development of renewable energy industry, which will be very likely to increase largely in the future. This problem needs a quick solution. In addition to calculating the workforce that will be needed for renewable energy development or making energy transitions, it is also important to formulate how to prepare them. The Ministry of Energy and Mineral Resources' capacity-building program should increase the allocation of activities and funding for renewable energy training, compared to the current trend of prioritizing training activities in oil and gas and coal mining. Investments in training workers in the field of renewable energy need to be increased so that they are on par with or even better than the facilities that have been built for training in the fields of oil and gas and coal, such as Oil and Gas Training Center in Cepu, Central Java.

It is important to strengthen coordination with other ministries, especially the Ministry of Manpower so that the major work of preparing the workforce to meet the energy transition goals can be carried out smoothly and more widely. This will be pursued, for example, by filling out training in Job Manpower Centers under the Ministry of Manpower with more renewable energy content.

Developers of renewable energy facilities cannot be expected to directly address the labor problem for the energy transition plan. For

example, on-the-job training will no longer be sufficient due to the large workforce requirement, while the basic capabilities of Indonesian workers in this field are not yet adequate.

Can we expect a shift in the workforce from those currently working in the fossil fuel industry to the renewable energy industry? Things like this are also important to observe, especially for coal, although coal's large role occurs only in a few regions in Indonesia, in particular South and East Kalimantan. However, this problem should not only be a concern of the central government but also local governments, especially those with coal mining areas, including its transportation.

D. Closing

To conduct a comprehensive assessment of Indonesia's long-term energy transition preparedness, extending our analysis to encompass the years 2045 and beyond, possibly up to 2060, it's essential to summarize the key findings and present actionable recommendations for policymakers and stakeholders. This is important, considering that Indonesia is a country with significant energy transition potential, abundant renewable energy resources, but there are needs to address environmental and energy security problems.

There are several things that can be underlined as important findings in assessing Indonesia's readiness to face year 2045.

- 1) **Renewable Energy Potential.** Indonesia possesses abundant renewable energy resources, including solar, wind, hydro, and geothermal. These resources can play a crucial role in reducing the country's reliance on fossil fuels and mitigating climate change.
- 2) **Energy Security Concerns.** Indonesia's heavy dependence on fossil fuels, especially imported oil, poses significant energy security risks. Reducing this dependency is vital for ensuring stable and affordable energy supplies in the future.
- 3) **Environmental Challenges.** The country faces substantial environmental challenges, including air pollution, deforestation,

and biodiversity loss, largely driven by its reliance on fossil fuels. Transitioning to cleaner energy sources can help address these issues.

- 4) **Policy Framework.** Indonesia has made significant strides in developing a policy framework to support renewable energy development and energy efficiency. However, there is room for improvement in terms of regulatory clarity and consistency.
- 5) **Investment Opportunities.** The energy transition presents substantial investment opportunities, both domestically and through international partnerships. Attracting investment in renewable energy projects can drive economic growth and job creation.
- 6) **Infrastructure Development.** Investment in infrastructure, including grid expansion and modernization, is essential to support the integration of renewable energy sources into the energy mix.

The discussion above shows that Indonesia is not yet well prepared to carry out energy transition work that will last until 2045 and even 2060 in the future. There are considerable challenges in terms of regulation, institution, finance, and manpower that must be resolved within the available time frame. To be implemented smoothly and achieve its goals, the concept of the energy transition plan as proclaimed by the Government of Indonesia, i.e. NZE 2060, requires several careful preparations.

- 1) On Regulation
 - a) Issue the law on renewable energy as soon as possible.
 - b) Prepare a law on energy transition and its derivative technical regulations.
 - c) Include key points of the Energy Transition Plan into Indonesia's 2025–2045 Long-Term Development Plan.²⁰
 - d) Replace the current National Energy Policy with a new one more aligned with the energy transition plan and net zero emissions target.

²⁰ The long-term plan is currently in the initial phase of preparation.

- 2) On Institution
 - a) Appoint or form a commission/agency that will be responsible for leading the overall climate change and energy transition activities.
 - b) Develop government organizations at the central and regional levels with units that are responsible for renewable energy development, energy transition, and climate change issues.
 - c) Form an SOE with a focus on renewable energy development. Its size is to be equivalent or larger to that which has been developed for oil and gas development, and coal.
- 3) On Finance
 - a) Reduce (or even eliminate) subsidies for fossil fuel use. Use a part of the energy subsidies for developing renewable energy and financing energy transition projects.
 - b) Develop a special agency that handles financing specifically for renewable energy development and energy transition plans, and at the same time attract funding from domestic and international sources. Training on the preparation of financing for renewable energy development implementers in the regions is one of the main tasks of this agency.
- 4) On Manpower
 - a) Anticipate the need for manpower for energy transition activities that will grow gradually in the future. Identify the specific skills to be prepared.
 - b) Prepare training/skill enhancement facilities through Job Training Centers and other educational institutions, including their offices in the regions. Develop cooperation with universities and research institutions such as BRIN to prepare high-skilled specialists.

- c) Anticipate the need for manpower for the development of the manufacturing industries related to the energy transition plan.
- d) Plan for shifting manpower in the coal industry to renewable energy.

In preparing regulatory, institutional, financial, and labor aspects, other supporting steps are also required, as seen below.

- 1) **Diversify the Energy Mix.** Develop and implement a clear strategy to diversify Indonesia's energy mix, focusing on increasing the share of renewables while gradually reducing dependence on fossil fuels.
- 2) **Strengthen Regulatory Framework.** Enhance the regulatory framework to provide consistency and transparency for investors. Ensure that policies and incentives are conducive to renewable energy development.
- 3) **Invest in Research and Development.** Allocate resources to research and development in renewable energy technologies to improve efficiency, reduce costs, and adapt solutions to Indonesia's unique geography and climate.
- 4) **Infrastructure Development.** Prioritize the expansion and modernization of the electricity grid to accommodate the integration of intermittent renewable energy sources. Invest in energy storage solutions to enhance grid stability.
- 5) **Energy Efficiency.** Implement energy efficiency measures across various sectors, including industry, transportation, and buildings, to reduce overall energy consumption and minimize waste.
- 6) **International Collaboration.** Collaborate with international partners and organizations to access expertise, technology, and financing for energy transition projects. Engage in knowledge sharing and capacity building initiatives.
- 7) **Public Awareness and Education.** Launch public awareness campaigns and educational programs to inform citizens about

the benefits of renewable energy and the importance of energy conservation.

- 8) **Incentivize Investment.** Create attractive incentives for private sector investment in renewable energy projects, such as tax incentives, subsidies, and streamlined permitting processes.
- 9) **Monitor and Adjust.** Establish robust monitoring and evaluation mechanisms to track progress and make necessary adjustments to energy transition plans as needed.
- 10) **Climate Adaptation.** Develop strategies for climate adaptation and resilience, considering the potential impacts of climate change on energy infrastructure and resources.

In conclusion, Indonesia stands at a crucial juncture in its energy transition journey. By embracing renewable energy sources, improving regulatory frameworks, and fostering international collaborations, Indonesia can significantly enhance its energy security, reduce environmental impacts, and promote sustainable economic growth. Implementing these recommendations will be essential to achieving a successful and smooth energy transition in the country.

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