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Indonesia's energy transition: Dependency, subsidies and renewables

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Abstract

Indonesia's economy is highly dependent on the fossil fuel industry as evidenced in measures of non-taxable revenue, energy subsidy, energy mix and regulatory flexibility. To cut carbon emissions by 41% in 2030, the energy system needs to transition faster than anticipated through progressive reforms and investment. Policy makers understandably are fearful of the shocks and unrests resulted from fossil fuel subsidy reform. However, the fears were shown to be an over-reaction, especially if poorer households were supported. The state-owned enterprise, Perusahaan Listrik Negara, is the central player in the tug of war between the fossil fuel and renewable sectors. The government should signal unwavering support for international investment in the renewables, and update the regulation on rooftop solar that boosts return on investment for domestic households. International investors will need modelling of cost competitiveness of wind farms against coal-fired plants in more remote areas.

KEYWORDS
energy policy, energy transition, fossil fuel subsidy, Indonesia, renewable investment

1 | INTRODUCTION

Indonesia is not quite the poster child at international forums on climate change. The total carbon emission of this fast-growing country is the sixth highest in the world. However, its carbon emission per capita sits at 2 tonnes per person—two times lower than the average in Southeast Asia (World Economic Forum, 2021). The energy intensity of 3.2 Mega Joules for every GDP unit is significantly below the whole Southeast Asia (World Economic Forum, 2021). Yet, Indonesia's Nationally Determined Contribution commitments are comprehensively assessed as 'highly insufficient' (Climate Action Tracker, 2021).

At the heart of Indonesia's energy policies is the tinkering of fossil fuel subsidies and the underwhelming renewable investment. The general consensus is to implement fossil fuel subsidy reform gradually and incrementally over decades (Coady et al., 2018). However, without rapid and systemic transitions across the sectors, the global temperature will rise above 1.5 degree Celsius. Energy policy reforms have to be ratcheted up in Indonesia.

The nascent literature on energy policy reform focuses on the technocratic aspect (Resosudarmo et al., 2023), the political economy of regional energy planning (Setyowati & Quist, 2022), and the policy commitment across ASEAN countries (Overland et al., 2021). Many highly credible studies provide insights on a specific aspect of the energy policy regime of Indonesia (e.g., Burke & Kurniawati, 2018) and are sometimes published in less mainstream outlets (e.g., IESR, 2019). The recurring theme cutting across the nascent literature and non-mainstream literature is the many missed opportunities for achieving transformational energy transition.

In this article, we fill a specific research gap by joining the disparate missed opportunities of the *national* energy policy regime of Indonesia through the *political economy* lens. The meta view presents the consolidated logic of the underperforming energy transition. The historic dependency on fossil fuels to grow fast economically has entrenched the use of fossil fuel subsidies. There are no strong economic and political incentives to explore the potential of renewables in the archipelago nation.

The policy solutions may seem straightforward to the outsiders. Only the most involved policy actors understand the challenges for an accelerated energy transition towards net zero by 2060. We outline three main challenges. More progressive phasing out of fossil fuel subsidies brings about fear of unmanageable economic and social consequences (Kuehl et al., 2021). Investors of renewables will not be impressed by the inefficient and uncoordinated bureaucracy that promises openness and speed but delivers the opposite. They have not adequately explored other renewable sources like (offshore) wind energy as the spotlight has been cast on solar energy (Nurlatifah et al., 2021).

Outlined in Table 1, the issues are accompanied by specific strategies in order to achieve the ideal state of various relations between the ruling elites, state-owned company, green investors, and local population. The ways that interests are aligned and recognition is shared (Buur et al., 2020) can explain why the issues for energy transition in Indonesia emerged and sustained.

For the rest of the article, we will lay out the three main issues for energy transition in Indonesia: fossil fuel dependency, underexplored renewable potential, and complicated political landscape. For each issue, we have one or two corresponding strategies of which we detailed their prospects. The state of the strategy implementation is a result of how ruling elites relate themselves with various stakeholder groups. By and large, the relations are

TABLE 1 Outline of issues, strategies, and dependencies.

Issue	Strategy	Relations	Ideal
1. Fossil fuel dependency	5. Remove fossil fuel subsidies	Ruling elites—state-owned company	Compatible interests
	6. Repurpose subsidies	Ruling elites—local population	Mutual recognition
2. Underexplored renewable potential	7. Incentivise rooftop solar	Ruling elites—green investors	Compatible interests
	9. Explore wind potential	Ruling elites—green investors	Compatible interests
3. Complicated political landscape of transition	8. Maintain social and economic stability	Ruling elites—local population	Mutual recognition

driven by the interests of elites and stakeholders. Only strategies for promoting social wellbeing and energy justice involve respectful relations beyond the maximisation of self-interests.

2 | FOSSIL FUEL DEPENDENCY

Indonesia is a resource-rich country with huge production of oil, coal and natural gas and vast potential for generating renewable energy. Despite having more than 443 GW of potential for renewable energy sources, the country's economic and energy policies rely significantly on fossil fuels (RUEN, 2017). Energy consumption in the industrial, household and commercial sectors has been linked to increasing economic growth since 2000 (Dat et al., 2020; IESR, 2020). From 2013 to 2019, fossil fuel has taken up 90% of the primary energy supply while renewables contributed less than 10% every year (see Figure 1). Fossil fuel was used for electricity generation, transportation, and steel & cement production.

Fossil fuel has always been an attractive commodity for generating non-taxable energy revenue. Since 2016, the government under President Jokowi has been bringing in annual revenue from the energy sector of between 45 and 143 trillion Rupiah (Ministry of Energy and Mineral Resources, 2023). The revenue from minerals and coal exports has been significantly ahead of renewables, especially in the few years right before and after the COVID-19 pandemic in 2020 (Figure 2). The non-taxable revenue from the energy sector itself constituted 22.6% of the total government revenue, which was the second biggest source of revenue after domestic tax (i.e. income tax, goods and services tax, tariffs) (Table 2).

The production of coal has fulfiled the country's domestic needs and has made Indonesia one of the largest thermal coal exporters in the world, exporting more than 435 million tonnes since 2018 (Enerdata, 2022; RUEN, 2017). In 2021, coal production met 100% of domestic demands and accounted for 71% of the export commodities (Figure 3). With coal in abundance, the existing power sector has been depending heavily on coal power plants to generate more than 60% of Indonesia's energy supply.

The government and state electricity company, Perusahaan Listrik Negara (PLN), assured a high level of physical accessibility and affordability across Indonesia including energy-poor areas. While private electricity companies were likely to perform better financially, state-

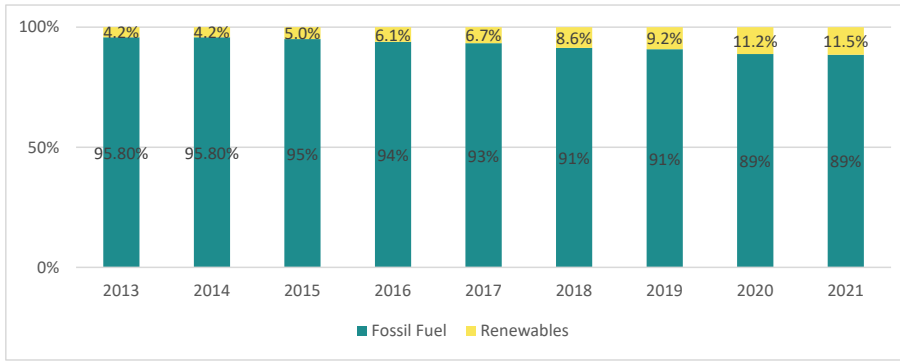

FIGURE 1 Primary energy supply and national energy mix 2013–2021. *Source*: Handbook of Energy and Economic Statistics of Indonesia, 2020; and various news sources and interviews compiled by the authors.

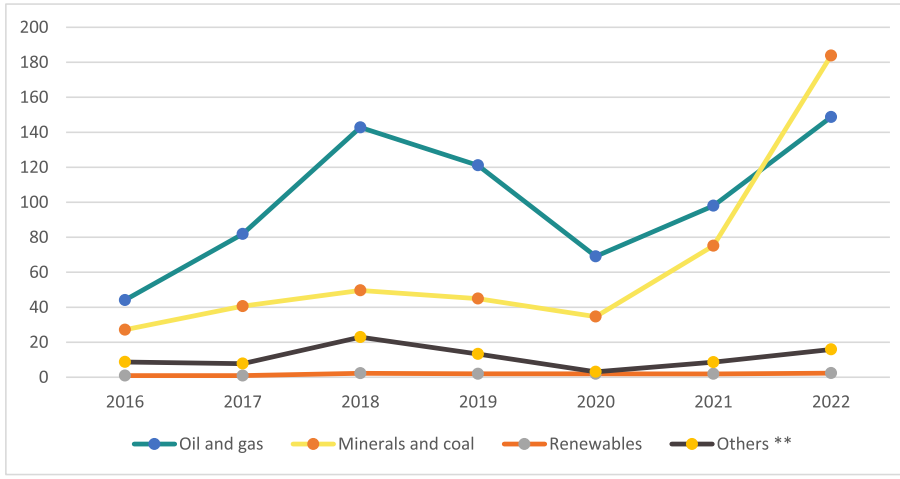

FIGURE 2 Non-taxable energy revenue across years of 2016 to 2022 (in trillion Rupiah). *Targeted amount. **Others include corporate contributions, downstream oil and gas business, domestic market obligation (DMO), data sales, rental services, service revenue and others. *Sources*: MEMR, 2023; authors' analysis.

owned electricity companies were more suitable for achieving non-commercial goals such as providing low-cost electricity to all user groups (Matuszak & Kabaciński, 2021). However, state-owned companies were not particularly good at leveraging the benefits of pro-efficiency market-based measures (e.g., carbon pricing). They were tasked to achieve policy objectives such as ensuring universal access to energy and supporting national development can contradict market efficiency especially when their dominant positions in the market would remain unchallenged for the foreseeable future (Benoit et al., 2022). The inherent trade-off between efficiency and equity was a common dilemma for energy sector reform.

In May 2021, the Indonesian government announced that the national electrification rate had reached an impressive rate of 99.3% in the first quarter of 2021 and expected 100% electrification by 2022 (RUEN, 2017). The electricity price has been relatively low as the government has been heavily subsidising the fossil fuel industry. During Jokowi's presidency, the annual electricity subsidy has been stable at 50 trillion Rupiah on average, while the annual oil fuel subsidy fluctuated between 44 to 97 trillion Rupiah (Figure 4). While the annual subsidies

TABLE 2 Government revenue by sector in 2022 (in trillion rupiah).

Source of revenue	2022		% of total revenue
1. Tax revenue	IDR	2034.55	77.2%
a. Domestic (income tax, etc.)	IDR	1943.65	73.7%
b. International trade (customs, etc.)	IDR	90.90	3.4%
2. Non-taxable revenue (PNBP)	IDR	595.59	22.6%
a. Natural resources (PNBP SDA)	IDR	268.77	10.2%
b. State-owned enterprises (PNBP KND)	IDR	40.60	1.5%
c. Others (PNBP lainnya)	IDR	196.32	7.4%
d. Services (PNBP BLU)	IDR	89.90	3.4%
3. Grants	IDR	5.70	0.2%
Total government revenue	IDR	2635.84	

Source: MoF 2023.

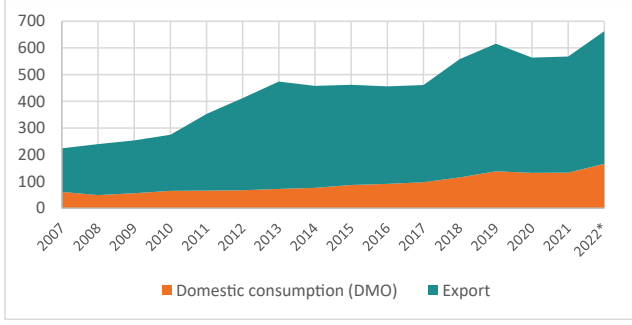

FIGURE 3 Indonesia's coal production (in million tonnes). *Targeted amount. *Source*: MEMR, 2022; RUEN, 2017; authors' analysis.

have been at least halved when compared to the final years of Yudhoyono, the whispers and promises of subsidy reform continued without real policy actions. Subsidy reform efforts have seemingly undergone cycles of gaining political traction followed by the implementation of compromised policy alterations. An illustrative instance of this occurred in anticipation of the 2019 election, during which President Jokowi, seeking re-election, revoked a previously announced electricity tariff adjustment that was proposed a year earlier (Nursyamsi, 2019). Despite economic and institutional analyses showing the feasibility of fossil fuel subsidy reforms (Ministry of Energy and Mineral Resources and Ministry of Finance, 2019), critical actors (e.g., Members of Parliament, the Ministry of Finance, and Ministry of Energy and Mineral Resources [MEMR]) remained adamant that the reforms would bring down the national economy, push more Indonesians into poverty, and throw society into chaos.

Fossil fuels have been more affordable and reliable than renewables in Indonesia. Policy actors have almost always resorted to fossil fuel plants to guarantee a stable source of mobility and electricity. For example, in 2022, the government reinstated subsidies for a specific type of fuel (BBM Premium) despite its discontinuation from most markets since 2014, except in Jakarta and several Java and Bali cities (Azanella & Nugroho, 2022). Furthermore, despite

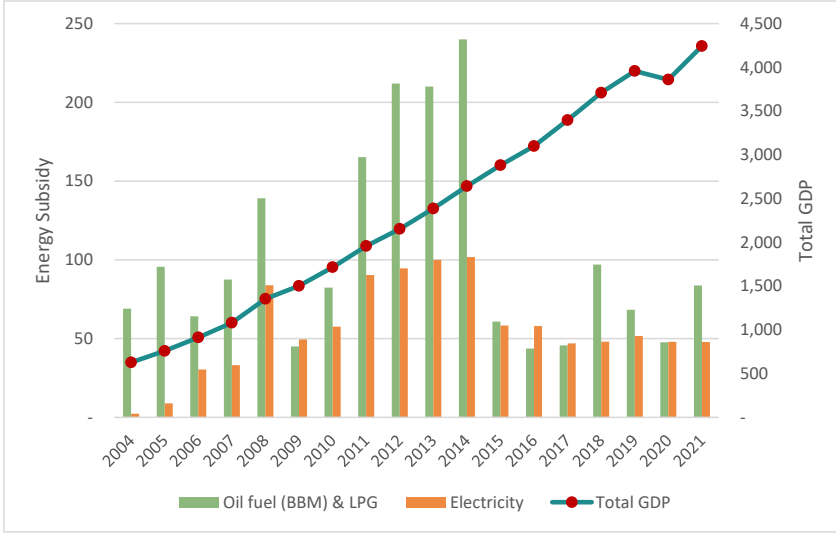

FIGURE 4 Energy subsidy 2004–2021 (in trillion Rupiah). *Source*: RUEN, 2017; Ministry of Energy and Mineral Resources, 2022, 2023; OECD, 2022.

delays and indications of lower-than-anticipated electricity demand, construction persisted for the government's 35-gigawatt coal power plant project (Rahayu, 2024).

In the electricity sector, the problem is that some areas in the outer Java islands have been suffering from recurrent power outages (Burke & Siyaranamual, 2019; Setyowati, 2021). In 2015, a mega power plant was planned to overcome this problem and provide 35.000-megawatt electricity capacity in 210 cities in Java and the outer islands. The plan was to build coal-fired and renewable-sourced power plants with 22 and 13 gigawatts ability respectively. Affected by investor doubt, the new plants were delayed from 2019 and were expected to be in full operation by 2029. The irony was that Java cities experience frequent, scheduled blackouts despite having the greatest number of coal power plants. Meanwhile, cities on the outer islands suffered the most from unreliable power supply. Moreover, some areas experienced an oversupply. In 2020, North and South Sulawesi had the highest reserve margin up to 58%; it was 55% in Sumatra, 47% in Java and Bali, and 42–45% in Kalimantan (CNN Indonesia, 2020). Lower energy demand during the COVID-19 pandemic has further exacerbated this. Fossil fuels might not necessarily be the stability guarantor objectively but they have been subjectively perceived as such.

The country's fossil fuel dependency was maintained by the provision of fossil fuel subsidies and the fear of losing energy security. A planned strategy for subsidy removal will be extensively discussed in Section 5. Its impact on social equity can be mitigated by repurposing subsidies for wider social benefits as laid out in Section 6.

3 | UNDEREXPLORED RENEWABLE ENERGY POTENTIAL

While coal has been at the heart of energy policies, renewable energy sources have increased their share of the primary energy supply by threefold in the past 8 years (Figure 4). In the Presidential Decree No. 22/2017 on the National Energy Plan, the government estimated that the renewable energy mix would rise to 23% by 2025 and 31% by 2050 (RUEN, 2017). However,

with the current progress, it will be an uphill battle for Indonesia to achieve the target on time let alone accomplishing the net-zero emission. In January 2024, the government abandoned the original emission target and reduced the renewable target from 23% to 17% by 2025 (Karyza, 2024). The necessary transformation will only occur if the government cuts its reliance on fossil fuels and expands its renewable infrastructure.

The National Energy Plan (RUEN) has projected 443 GW of potential energy capacity by 2050 that the country aimed to draw from renewable sources, such as geothermal, hydro, bioenergy, solar, wind, and tidal (RUEN, 2017). Initiated in 2017, the Plan aimed to forecast economic growth alongside energy consumption and plant capacity from 2015 to 2050. Beyond the Plan, factoring in Indonesia's geographical and weather conditions clean technologies alone could produce significantly more than the projected 443 GW of electricity. The clean technologies include solar photovoltaic, pumped hydro energy storage, onshore wind power, biomass power, and micro- to small- hydropower (IESR, 2021; Silalahi et al., 2021). Critically, the government struggled to achieve its own projected target. Up until 2021, the installed capacity for renewable energy sources only accounted for less than 8% of the potential energy capacity as predicted by the National Energy Plan (RUEN) (Figure 5). Solar and wind power, in particular, has barely met 1% of its potential.

Resource nationalism has been strongly embedded in energy policy practices. In its broadest context, resource nationalism denotes state involvement in natural resource sectors with the aim of exerting control over the conditions of private investment (Warburton, 2023). Highlighting evidence from Indonesia's local mining firms, Warburton (2023) illustrated this concept by arguing that domestic firms, including the local oligarchs, had a strong influence over policy as they demanded intervention to help secure contracts and create access to precious mineral mines. Indeed, President Joko Widodo's administration has long been promoting "downstream policy", which prioritised the development of its downstream industry and prohibited the export of raw mineral commodities, especially nickel. Despite the International Monetary Fund (IMF) criticising the ban on nickel for exports lacked a cost-benefit analysis and impacted international trade (International Monetary Fund, 2023), the country remained adamant and believed the policy would be needed to add value to the energy products and contribute to the scaled-up production of electric vehicles (Hujolly et al., 2024). This perception might impact the political decisions on fossil fuel extraction and energy development. The international attention on the export ban would be extended to the poor environmental track record of Nickel extraction in Indonesia (Habir, 2023). Therefore, the pressure from investors, customers, and authorities might prompt policy actions for installing low-emission equipment and diverting away from coal-heavy electricity supply to improve the overall environmental footprint of Nickel commodity processing (Lubis & Maqoma, 2024).

The investment in low-carbon renewable technologies ought to be a long-term strategy that shapes the maturation of an ecosystem rather than a short-sighted pursuit of low-value mineral extraction and component assembly. Since 2017, the investment in the renewable energy sector has been under 2 billion USD, which has been less than 1% of the total investment for the whole energy industry every year (Ministry of Energy and Mineral Resources, 2022). The state-owned electronics maker, PT LEN Industri, has built a factory that primarily assembles solar cells with minimal production capacity, especially for the high-tech polysilicon and silicon wafer (Indonesian Solar Module Manufacturer Association, 2021). The reliance on wafer import from foreign investment partner means that a renewable technology ecosystem was effectively non-existent. The reliance on the international supply chain for sourcing renewable energy

Potential capacity in RUEN (GW)	Geothermal	Hydro	Bioenergy	Solar	Wind	Tidal
	29.54	94.48	32.65	207.90	60.65	17.99

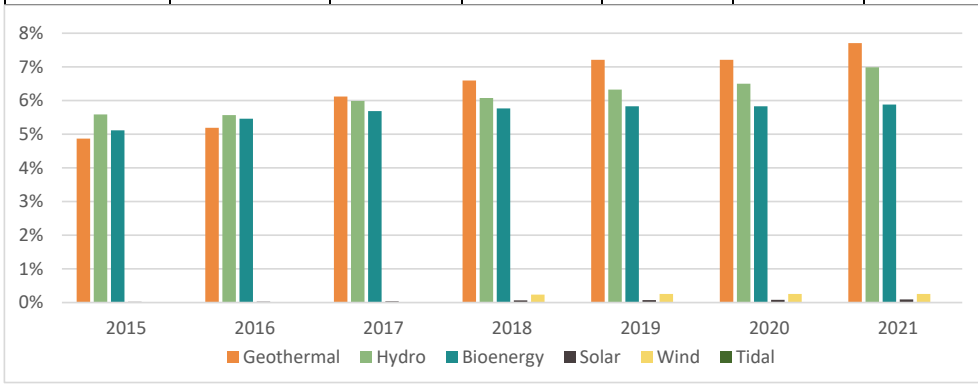

FIGURE 5 Potential capacity indicated in RUEN and the actual yearly installed capacity (*Source*: RUEN, 2017; MEMR, 2021; MEMR, 2022 and authors' analysis). The potential capacity is as of 2015, as indicated in RUEN, 2017. Hydro includes mini-, micro-, and hydropower.

technologies might disincentivise the domestic market. An insufficiently large domestic market would not effectively absorb the renewable production know-how from overseas (Li, Heimeriks, and Alkemade, 2020). The technology ecosystem might struggle to take off. Without an ecosystem, Indonesia might continue to be the hub of assembly but it attracted the economic risk of disrupted production due to shocks from increasingly more volatile trade relations (Binz et al., 2017). To be shielded from such shocks, a mature ecosystem is necessary to support the research and development capability, which leads to new patents and innovative practices especially for the richer provinces of Indonesia (Yan et al., 2020).

Common knowledge suggests that strategic policy support and openness to foreign direct investment are strong enablers of renewable adoption in developing countries but the opposite has been true (Pfeiffer & Mulder, 2013), especially in less democratic countries (Chen et al., 2021). Countries with capable institutions (Pfeiffer & Mulder, 2013) that could build talent pools and production infrastructure (Shahsavari & Akbari, 2018) were more likely to adopt renewable technology faster. Furthermore, an investment in research and development capacity in developing countries would support the sizeable reduction of production cost for solar energy (Shahsavari & Akbari, 2018) specific to the conditions of the countries (Huenteler et al., 2016) as no country lessons were globally applicable (Bourcet, 2020).

Indonesia has the potential of relying almost solely on renewable energy to power its future economy but the market opportunity for renewable infrastructure development has fallen short. As indicated in Table 1, the issue of underexplored renewable potential could be tackled by incentivising the installation of rooftop solar without stalling the exploration of wind energy source in strategic locations. The complexity of implementing such policies is detailed in Section 8 and Section 9 respectively.

4 | REGULATORY FRAMEWORK AND POLITICAL LANDSCAPE FOR TRANSITIONS

The energy policy of Indonesia has been inextricably linked to the quest of maximising economic growth. Understandably, the government had difficulty decoupling the economy from the cheapest form of energy source – fossil fuels. The National Energy Plan (RUEN) has reflected this version of reality. The critics, however, challenged RUEN's basic assumptions. The 2017 indicators were considered outdated as new data showed that energy consumption would not grow as high as initially projected. The primary energy supply, electricity consumption, and power plant capacity should be revised to a much lower level (IESR, 2020). However, the National Energy Plan (RUEN) would not be changed easily, given the cacophony of policy-making involving a myriad of actors.

The energy policy and practices in the country have been dependent on the critical actors in the energy sector. The MEMR might lead the development and monitoring of RUEN, along with the National Energy Council (DEN). However, the energy companies were consulted in the process—some more extensively than others. The state-owned companies PLN and Pertamina, under the jurisdiction of the Ministry of State-Owned Enterprises, were in charge of the electricity and oil industry. They were not completely against the transition away from fossil fuels and towards renewables. In 2020, PLN released a revised electricity procurement plan (RUPTL) that had a slightly bigger proportion of renewables to meet the annual target and was claimed to be the greenest RUPTL in Indonesia's energy history (Ministry of Energy and Mineral Resources, 2021). Pertamina, on the other hand, was exploring the use of geothermal sources; it did not, however, give Pertamina much say in the overall energy strategy of Indonesia. In fact, PLN could speak louder, given its monopoly over the management of energy supply from power plants. PLN controlled and operated 100% of the distribution network among 85.6 million customers in Indonesia by 2022 of which 78.3 million came from the industry sector (Perusahaan Listrik Negara, 2023). The monopoly has allowed PLN to implement a take-or-pay (TOP) scheme for coal-fired power plants. As coal had a hefty overhead cost, PLN paid for a contractually determined minimum volume even if the coal delivery was not taken up. This scheme reduced the risk for the coal company but incentivised an oversupply of coal-generated electricity (Hasjanah, 2023). Further addition of renewable energy capacity was unjustifiable unless the electricity oversupply issue was resolved (Cindy & Fitriyanti, 2021). The resolution should start with PLN giving up the take-or-pay scheme with the institutional support from government ministries that were concerned about the financial sustainability of PLN (Diela, 2017).

Another hindrance is the additional cost that the government had to bear with the transitions. An important bill was facing a bottleneck: the New and Renewable Energy Bill (RUU EBET). The Bill regulated the general framework of renewable energy sources and arguably gave a breather for investment. However, the government had to pay for the premium price of the renewables. The existing Presidential Regulation No 4/2020 has allowed the direct purchase of electricity from renewable sources without an auction or streaming via PLN. This Feed-in-Tariffs (FiT) framework affected PLN's local production costs (BPP) and electricity tariffs. They could be kept low with the public money. The Bill was circulated among key ministries since 2019. However, the government has been disinterested in spending public money on energy transition, and therefore it was reportedly hesitant to approve the draft of EBET Bill (CNBC, 2021).

While the Widodo administration had seemingly progressive regulations to create a carbon market, regulators were largely captured by the conglomerate of fossil fuel companies. In June

2022, political parties in the Indonesian parliament agreed to make the EBET Bill a priority (Berkas, 2022) buying President Widodo 60 days to generate an internal consensus. The EBET Bill provided legal certainty for attracting investments for renewables (Huzaini & Pratama, 2020). However, it classified coal gasification and nuclear power plants as renewables (Karyza, 2022). The energy trilemma of security, affordability, and sustainability has been a delicate balancing act for many Indonesian Presidents. The aspiration of progressive transition has been frequently weighed down by the institutions entrenched in the interests of fossil fuel benefactors.

5 | REMOVE FOSSIL FUEL SUBSIDIES

Each Indonesian consumed 36 Gigajoule of energy every year. This was half that of the Southeast Asian average (World Economic Forum, 2021). 63.4% of its electricity was generated by coal and only 11.8% from renewables (World Economic Forum, 2021). A future of stranded assets may ensue if the Indonesian government does not steer away from the carbon-intensive generation of electricity (van der Ploeg and Rezai, 2020). So far, Indonesian enterprises have expanded speedily owing to low electricity prices driving up energy demand (Sarwar et al., 2017). For every kWh, they have been paying US$ 10.9 cents, which was 16% cheaper than the regional average and 21% of the world average.

Cheap electricity in Indonesia can be partially explained by its fossil fuel subsidies of 2.6% of GDP—5.4 times the regional average (World Economic Forum, 2021). The increasing awareness about the harm of these subsidies and the government has supported a gradual removal of the subsidies—one category at a time (Maulidia, Dargusch, Ashworth, and Ardiansyah, 2019). The 2013–2015 subsidy reform has resulted in a spike in energy prices and subsequently a 7% reduction in electricity use. A further 6% reduction can be achieved if all the subsidies were removed (Burke & Kurniawati, 2018). Particularly in the fossil fuel sector, the government employed the Domestic Market Obligation (DMO) as a subsidy mechanism for coal commodities. Under this system, PLN was mandated to procure coal at prices set by the DMO, which has been lower than global market prices. As a result, this mechanism arguably created an uneven playing field for renewables versus fossil fuels as the guaranteed lower coal prices consistently undercut the competitiveness of renewable energy sources.

The fears of fiscal imbalance, unmanageable inflation, and social unrest resulting from further reduction were unfounded according to experts in the Indonesian government. During the 2014 subsidy reform, the electricity tariff was raised but cost of goods and services did not inflate significantly. The protests were short-lived and mild compared to previous reforms. Panic buying at gas stations also stopped when the price was adjusted. The government measures cushioned most of the anticipated impacts (Ministry of Energy and Mineral Resources and Ministry of Finance, 2019).

However, the pandemic has set the trajectory of subsidy phase-out on a different path. On top of the US$6.8 billion yearly subsidies for the energy sector, the Indonesian government allocated US$6.6 billion specifically for the fossil fuel state-owned enterprises such as the PT PLN and PT Pertamina (Sumarno & Sanchez, 2021). To cushion the impacts of rising global oil prices, the Jokowi administration could have resorted to the old trick of giving more energy subsidies for a short-term fix. This would be a missed opportunity for reallocating the subsidies for another project, such as the new capital project in Kalimantan (Nasution, 2022). Moreover, the emission and renewable targets have been revised in January 2024 to reflect a shift towards economic priorities driven by fossil fuels (Karyza, 2024).

According to modelling results covering 32 countries including the ones with the largest spending on subsidies, a complete removal of consumer fossil fuel subsidies will reduce the carbon emission by 5.46 billion tonnes of CO_2 between 2021 and 2030. This is equivalent to the annual emissions of 1000 coal-fired power plants or 3.8 billion cars. Fossil fuel subsidy reform can reduce emissions by 6.3% in Indonesia (Kuehl et al., 2021).

Keeping fossil fuel subsidies is short-sighted as outlined in Section 2. A reform would reduce unfair competition between fossil and renewable energies, economic inefficiencies, and the risk of stranded assets. However, radical subsidy removal has been shown to wreck economic and social havoc in developing countries (Kuehl et al., 2021). The subsidy reform will need to be complemented with social and economic support strategies, which will be presented in the following Section.

Having said that, an incremental reform is as much a risk to the government given that fossil fuel will lose its value in the market over time. The Prabowo government should use the easy money from fossil fuels today to invest in a just-in-time energy transition that protects the most vulnerable tomorrow (Laan & Maino, 2022).

6 | REPURPOSE SUBSIDIES

Fossil fuel subsidies for electricity and oil are often not an efficient safety net for disadvantaged households. The wealthier households benefit more from the subsidies due to greater energy access and everyday consumption. Subsidy reforms would generate savings to be reallocated for financial compensation and renewable energy subsidy. Fuel subsidies are turned from regressive to progressive, supporting a just energy transition (Kuehl et al., 2021).

The immediate resistance from the policymakers is the increase in the cost of living, especially for low-income households. However, keeping the current fossil fuel subsidies will continue to disproportionately benefit the wealthy. In addition, 10.4% of the country's GDP is unaccounted for externalities (World Economic Forum, 2021), such as environmental damages and health complications that affect poorer households more heavily (Suryadhi et al., 2019). If the policymakers genuinely care about inequality issues, they should banish the fossil fuel subsidies and reallocate the savings for social assistance to the poorer households and renewable investments. This will take Indonesia halfway towards meeting its renewable target of 31% (Hartono et al., 2020).

The government has a couple of options for reallocating fossil fuel subsidies in order to cushion the financial impacts on poorer households. The first being replacing existing lamps with LED lamps for low-income residents with 450 VA and 900 VA electricity capacity limits. It would contribute to 27% of the energy decarbonisation path for achieving the emission reduction target—29% by 2030 (Letschert & McNeil, 2020). This grant programme may cost US$310 million, but the corresponding saving on subsidies is US$207 million annually for the next 15 years (Nurliyanti et al., 2021). A national initiative of promoting energy-efficient appliances specifically LED lightbulbs in a Bogor neighbourhood was shown to be effective when there was locally relevant campaigns and household participation (Nakano et al., 2018).

While being climate-effective and cost-efficient, this scheme could run into the usual trouble of weak implementation in Indonesia. Poorer households may be willing to receive the subsidies but may choose to purchase temptation goods (e.g., alcohol and tobacco) or even everyday essentials rather than the LED light bulbs (Evans & Popova, 2017). Some other commonly

known challenges include making beneficiaries dependent on financial support which is disruptive to the local economy in the short term and is not sustainable to the government in the long term (Handa et al., 2018). The challenge of conditional cash transfer is not new to the Indonesian government. The integration of other welfare programs with this subsidy will reduce the potentially low uptake of lamp replacement (Nugroho et al., 2021).

The government has recently announced the changes in the distribution of electricity subsidies by 2022. Instead of subsidising electricity prices through PLN, they will distribute electricity allowance in the form of cash and coupon (Kompas, 2022). Since February 2022, MEMR has also started distributing discounted vouchers for those interested in installing rooftop solar panels. A clear mechanism of such innovations would generate cross-subsidy for lower-income households with lower energy consumption.

The poorer households are also further protected if the government provides targeted assistance to the trade and factor markets and not to the nontraded sector. The prices of tradeables (e.g., agricultural and manufacturing goods) are determined by the world market. The non-tradeables (e.g., education, tourism, and transport services) are protected from international competition, and hence their prices can be adjusted by domestic producers (Coxhead & Grainger, 2018). In the event of higher energy prices, the producers of non-tradeables can pass it on to their consumers, who are likely to use more services and have greater purchasing power due to their highskilled jobs. Conversely, poorer households spend more on tradeables and therefore are less affected by price hikes of non-tradeables (Coxhead & Grainger, 2018; Manning & Yo Aswicahyono, 2011). In fact, Indonesia could become the leader in swapping fossil fuel subsidies with renewable subsidies, resulting in the largest amount of emission cut (i.e., 10% of its current level). Indonesia will need to banish all fossil fuel subsidies—including electricity, transport, and gas eventually and reinvest 20% of the savings in energy efficiency and 10% in renewables (Kuehl et al., 2021). This move will complement the plan of reaching a fully operational carbon trading market in the same year (Ungku & Christina, 2021).

Some may consider shifting the purpose of subsidies from maintaining energy security to supporting welfare support as illegitimate spending of tax payer's money. However, we argue that this shift should be considered as an investment that buys social stability and political support for facilitating the necessary energy transition. Moreover, this investment is temporary; the repurposed subsidy will be relevant until renewable energy becomes affordable to all. Some scholars even proposed a more progressive restructuring of existing energy planning practices by encouraging participatory economic valuation and equalising the social, economic and environmental interests when prioritising policy measures (Jenkins et al., 2021). It speaks to the higher principle of industrial policy for energy transition should consider the economic interests of not just the ruling elites but also the vulnerable households (Pianta & Lucchese, 2020) who are sometimes forced to make their voices heard in more economically destructive ways like protest and resistance.

Repurposing subsidies is an economic, social, and political move. The inherent tension between social equity and economic efficiency will continue to be a political debate. This is manifested in incompatible interests of various groups of decision makers as we detailed in Section 2. Without aligned interests to reform fossil fuel subsidies, the renewable energy potential is underexplored as shown in Section 3. Therefore, the Indonesian government cannot afford to leave this energy transition to the market and will need to provide incentives for mass-scale adoption of renewables (see Sections 7 and 8).

7 | INCENTIVISE ADOPTION OF ROOFTOP SOLAR

The potential contribution of rooftop solar systems in residential households to emissions reduction could be easily underestimated. The combined capacity of households with more than 1300 VA rooftop panels was between 35 and 116 GWp, which translates to at least 20% of the electricity demand in Indonesia in 2019 (IESR, 2019). The adoption of a rooftop solar system has been low, but interests were high. 9–11% of households expressed the willingness to install the system (IESR, 2021) even though the majority of the households understood that rooftop solar was more economical than purchasing energy from PLN (Haryadi et al., 2021). The solar system owners could sell excess energy to the PLN grid, but 35% of the contribution will be discounted under the net billing system. The removal of such a discount would encourage significantly more households to install rooftop solar (Hidayatno et al., 2020).

As alluded before, rooftop system owners in urban areas should not be capped for their supply to the energy grid. In rural areas, households should not receive the solar system as a plain gift. This discourages participation in system maintenance. Institutions can be established for providing partial subsidies and supporting owners sell excess energy to generate an income. (Al Irsyad et al., 2019). Especially suitable for rural areas, this was a decentralised scheme that complements the highly centralised solar power plants run by the MEMR. Policies for these two types of solar generators ought to be coordinated at both federal and regional levels to prevent misallocation of maintenance funds (Sambodo et al., 2021). In both urban and rural areas, government's subsidies should be sufficient for households to receive payback in 7 years and an internal rate of return of 11% (Siswantoro & Ridho, 2021). The Indonesian Government did listen to good policy advice. Through Presidential Regulation No. 26 of 2021, it has removed the discounts and extended the claim period of unused credits (Bissett et al., 2021).

Indonesia's overall policy regime was considered much more stable than many other Southeast Asian countries (World Economic Forum, 2021). However, Indonesia's feed-in-tariff scheme has been swung back and forth as the regulators tried to figure out how best to set the tariffs, frustrating many rooftop owners and farm investors. The tariff rates were arbitrarily determined by a combination of geography, currency, voltage, and production cost (Guild, 2019) rather than simply the fluctuating energy demand (Burke et al., 2019). A more critical issue is the prevention of PLN from procuring renewable energy, which is currently more expensive than the production cost (biaya pokok produksi). The government needs to fill the price gap to allow procurement above production cost if subsidy is made available. Enabling the reverse auction and cost calculation mechanism will require an alignment with the economic priorities of the Ministry of Finance, and the Procurement Plan of the MEMR and PLN (Asian Development Bank, 2020).

The Government in fact has been dependent on PLN to accelerate the adoption of rooftop solar. MEMR Reg No. 26/2021 has been in place for a couple of years but PLN resisted it, resulting in the failure of achieving the target for installed solar capacity (Simanjuntak & Citraningrum, 2023). While rooftop solar owners are permitted up to 100% feed-in-tariff, they are restricted to install 10–15% of the system capacity with a series of limiting conditions for exporting surplus solar energy to the PLN grid. As long as the coal-fired energy generation is not dialled down, surplus solar energy will not be economically attractive to the electricity supply sector and therefore financially favourable to rooftop solar owners (Larasati & Mafira, 2023). A further barrier is the availability of solar panels. As well-intentioned as the industrial policy might be, the Indonesian government's ambitious push to achieve 90% of local

content requirement (TKDN) by 2025 may deter investment from overseas energy manufacturers (Agarwal et al., 2023). The dependency on local players (i.e., PLN and domestic manufacturers) may hold back the scaling up of installed solar capacity and its contribution to the electricity grid.

The removal of discounts in favour of feeding solar energy into the energy grid was achieved after many attempts. Similarly strong advocacy will be needed for setting tariff rates based on market demand and legislating reverse auction. Without government intervention, there will not be sufficient incentives for scaled-up and affordable solar energy generation to counter fossil fuel dependency as detailed in Section 2.

8 | IMPROVE INVESTOR'S CONFIDENCE

The International Energy Agency has made a case for renewable investment at three times the current level for the next decade to keep global warming below 1.5°C (Cozzi et al., 2023). Foreign investors might find Indonesia attractive due to its relatively more open trading market and higher energy use within the Southeast Asia region (Djulius, 2017). Presidential regulation No. 10 of 2021 on Omnibus Law has reduced the number of business fields restricted for foreign investors from 350 to 46. This sets the stage for the potential ratification of the EU-Indonesia trade agreement, through which the EU would like to gain market access to unrestricted business fields like financial services, renewable energy, and waste management. The opening up will require the Indonesian government to undertake in-depth investigations into Indonesia's ability to comply with international practices of negative listing, performance requirements of foreign companies, support for state-owned enterprises, and licencing efficiency (Yan Ing & Losari, 2021).

Renewable investors have been further reassured by the regulation of the Financial Services Authority, requiring banks to disclose their sustainability records and allowing investors to better assess the greenness and profitability of potential investment options. The government could leverage the relatively high credit rating (World Economic Forum, 2021) to de-risk private investment in energy infrastructure. The recent inclusion of energy efficiency initiatives in green bonds or *sukuk* (Liebman et al., 2019) should be heavily promoted within the international market. In addition, investor confidence can be stabilised with renewable subsidies and cost updates (Liebman et al., 2019). While more fossil fuel subsidies were given, the government has tasked PLN to develop a real-time monitoring system for rooftop solar potentially used for cost updates (Bissett et al., 2021).

The private sector for deploying renewables has been especially handicapped by slow permit issuance, long tariff negotiation, and entrenched market monopoly (Maulidia, Dargusch, Ashworth, and Ardiansyah, 2019). The price competition will never be fair between renewables and fossil fuels if the fossil fuel subsidies are not removed, carbon emission is not taxed, feed-in tariffs for new renewables are capped, and energy prices are not set based on real-time demand (Burke et al., 2019). Levelling the playing field will attract more renewable investment, which is commonly believed to be applicable to large islands with economies of scale only. In fact, even the insignificant market of mid-sized islands will find the most feasible solution to be a combination of diesel and renewables with micro-grid technology (Kimura et al., 2020). The sunny islands of Indonesia have not fully tapped into the renewables (as explained in Section 3) due to their poor capability in project management and technology manufacturing. With an education level above the regional average (World Economic Forum, 2021), local implementers need to

catch up with the international standards for technology selection, component production, and project delivery (ADB, 2020).

9 | EXPLORE WIND POTENTIAL

As illustrated above, energy investors are most welcoming of an open, transparent, efficient, resilient, and capable market. They are also seeking emerging technology opportunities in unexplored markets. Located in Java, Madura, and Bali, the JAMALI energy grid supplies 149.9 TWh in 2019, of which 70% was sourced from coal-fired power plants and 23% from combined cycle gas turbines. Rooftop solar has started to contribute a miniscule amount, whereas wind farms were expected to do the same at a later stage. JAMALI stands out as having the most promising investment potential for wind farms, boasting an exceptionally competitive generation cost of 6.91 US cents/kW, according to recent research (Hesty et al., 2021). Nevertheless, this promising potential must contend with the entrenched presence of fossil fuel infrastructure in the region. Given that current fossil fuel power plants adequately have met the peak load demands, urgent measures will be required to expedite their phase-out and facilitate the transition to wind energy systems. East Nusa Tenggara on the other hand presented a much more attractive case for wind farm investors due to the government's regulation on ceiling price of tariff. The Ministry of Finance also offered incentives such as import duty exemptions, tax holiday, and tax allowance to make the overall return on investment more appealing (Hesty et al., 2021). This kind of infrastructure investment generated by-products such as local economic development and welfare support in the frequently neglected rural regions (Sambodo et al., 2021).

Against this development is the continuation of the Chinese investment in sixteen coal-fired power plants across Indonesia (Suarez, 2021). In the scenario of a 5.2% GDP growth, investments in Sumatra, Java-Bali, and Kalimantan might yield a negative return on investment simply due to investment saturation and lower demand in the period of 2018–2022. However, Sulawesi and Maluku-Papua remained desirable for investment, promising at least 6.4% and 15.6% return respectively (Kang et al., 2021). These figures might not mean much anymore given that planned projects will not be shelved and the new projects will be banned given China's recent commitment of stopping overseas coal investment. Indonesia has lost its last major funder (Suarez, 2021) and the largest domestic energy provider vowed to build the last coal plant by 2023.

Maluku-Papua (3188 MW) could generate a wind capacity similar to that of Sumatera (4688 MW) while Sulawesi (8380 MW) could generate twice as much (Hesty et al., 2021). The government needs to undertake an in-depth economic evaluation of wind farms against coal-fired power plants. This will prepare Indonesia for receiving future renewable investment under the Belt and Road initiative, which already makes up 57% of the total overseas energy investment in 2020. Indonesia has benefited from none of these so far (Nedopil, 2021).

The promising trial of the Sidrap Wind Farm in Sulawesi would generate 75 MW of energy. The turbines were propelled by seasonal but strong wind. Critically, stakeholders at all levels including the local farmers and regency government were engaged through the processes of feasibility evaluation and permit application. Apart from ensuring the infrastructure delivered the anticipated capacity, this project has addressed governance issues such as partnership arrangement, environmental impact, and land access. The Memorandum of Understanding between PT Perusahaan Listrik Negara Persero (PLN) and PT UPC Renewable-energy

Indonesia (PT URI) cemented the collective acquisition of operational know-how, including the advances in generator technology, turbine placement, and equipment transportation. The impact assessment has picked up long-term disruptions to the local ecology and ongoing conflicts due to land acquisition and community displacement (UPC Renewables, 2016). However, the lynchpin of making the trial possible was the involvement of private investors in a sector typically monopolised by state-owned enterprises. Not many private investors will be as patient and adaptable under a policy ecology that is volatile and devoid of incentives (Maulidia, Dargusch, Ashworth, and Wicaksono, 2019).

Much about the economics of wind power in Indonesia remains unknown. The cost-benefit analysis of integrating wind energy in the Eastern Sumba grid showed wind power would be more costly than the average electricity price back in 2018. However, the new map of wind energy potential (Hesty et al., 2021), the tentatively successful trial in Sulawesi (Lisapaly, 2021), and technological advancement in turbine and off-shore models (ADB, 2020) should be compelling signs for more in-depth studies. It is timely to replicate the economic calculations of solar energy (IISD, 2020) for the wind sector at a granular level in light of the highly variable wind speed across regions and seasons (Abdillah et al., 2022).

10 | CONCLUSION

Indonesia's economy has been highly dependent on the fossil fuel industry. A high proportion of the non-taxable revenue of the Indonesian government came from coal exports. To keep energy prices low, the government has been doling out generous fossil fuel subsidies. Their removal would be the lynchpin to accelerated growth in the renewable sector, contributing plenty more to the national energy mix. The ties between fossil fuel companies and the regulators have been close and difficult to severe. Pro-reform policymakers are well-aware of the uphill battle of convincing the Ministry of Finance to level the playing fields between fossil fuels and renewables.

The removal of fossil fuel subsidies would be met with the greatest resistance as policymakers are concerned about the potential economic shocks and social unrest. Experiences from other regions seem to suggest a gradual removal is the prudent option. Moreover, the livelihood and cost of living of poorer households ought to be the primary focus. Savings from the fossil fuel subsidies can be reallocated to energy saving programs or welfare support for the poorer consumers.

The low adoption of rooftop solar is the result of multiple factors including affordability and reliability. The regulators can pull leverages that make the return on investment much more attractive. This will not contradict the exciting development in floating solar farms around the archipelago. Apart from solar, Indonesia also has a huge but neglected potential for developing wind energy generation. New modelling has identified areas like East Nusa Tenggara, Sulawesi and Maluku-Papua for more in-depth feasibility studies. The scaling up of the successful trial in Sulawesi should be part of a comprehensive national modelling of which the results would support critical decisions of public and private investors.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are derived from the following resources available in the public domain:

(1) Indonesia Presidential Regulations No. 22/2017 on National General Energy Plan (RUEN), https://www.esdm.go.id/assets/media/content/content-rencana-umum-energi-nasional-ruen.pdf;
(2) Indonesia Presidential Regulations No. 112/2022 on the Acceleration of Renewable Energy Development for Power Supply, https://ebtke.esdm.go.id/post/2022/09/15/3261/telah.terbit.peraturan.presiden.ri.nomor.112.tahun.2022.tentang.percepatan.pengembangan.energi.terbarukan.untuk.penyediaan.tenaga.listrik.
(3) MEMR (2023), "Laporan Kinerja Kementerian ESDM 2022", https://www.esdm.go.id/assets/media/content/content-laporan-kinerja-kementerian-esdm-tahun-2022.pdf.
(4) MEMR (2022), "Laporan Kinerja Kementerian ESDM 2021", https://www.esdm.go.id/assets/media/content/content-laporan-kinerja-kementerian-esdm-2021.pdf;
(5) OECD (2023), Gross domestic product (GDP) (indicator). doi: 10.1787/dc2f7aec-en.
(6) PLN, 2022, "Laporan Tahunan PLN 2022: Leading the way to empower the nation", https://web.pln.co.id/stakeholder/laporan-tahunan.
(7) Ministry of Finance, 2023, "Laporan Keuangan Pemerintah Pusat 2023 (audited)", https://media.kemenkeu.go.id/getmedia/dca93798-033d-4d61-9a4f-bf112fd834ab/LKPP_2022.pdf?ext=.pdf.

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