

Article

Life After Oil – Teaching Indonesia's Energy transition

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Abstract: Indonesia is an interesting case study for students of sustainable development and sustainable energy due to its ability to connect the multiple “worlds” it has become part of. Indonesia is an important bridge to Muslim countries, the voice of the Global South in the G20 and a main pillar of the 134-country-strong G77. Indonesia's development trajectory is also key to the achievement of the Paris Climate Agreement as well as of the 2030 Agenda. Students can learn from how Indonesia address contradictions that would have been unsurmountable for other countries. Indonesia's energy transition offers helpful lessons, because of its aspiration to become a developed country by 2045. This goal is only possible when a country is able to effectively address barriers and caveats to sustainable energy. It is interesting how Indonesia focuses on silver linings and come up with pragmatic solutions to energy-related issues. This is followed by the “teaching guide,” which provides recommendations how the lessons from Indonesia can be embedded into a learning experience. The “learning activation approach” is introduced, which encourages students to systematically reflect on the complexity of selected contexts and understand this complexity by looking at the technical issues and processes that allow decision-making.

Keywords: sustainable energy, Indonesia, transformation to sustainability, energy transition, renewable energies

1. Introduction

Indonesia is an interesting case study of the transition towards sustainable energy, because it is a highly relatable country. Indonesia is striking, in particular for scholars of energy policies, climate or environmental politics and development studies, because it is positioned between multiple “worlds”. As a founding member of the Organisation of Islamic Cooperation, Indonesia is seen as a champion of moderate Islam (*umma wasat*) and a global leader with a pragmatic foreign policy. It is also perceived to be an important bridge to Muslim countries [see 1]. In addition, as one of the newest members of the G20, Indonesia is increasingly becoming the voice of developing countries on the international stage [see 2]. Indonesia's value as a global leader can be traced, for example, through its role in the 1955 Bandung Conference and the creation of the Non-Aligned Movement (NAM) – a forum of 120 developing countries [see 3]. Resulting from the NAM is the Group of 77 (G77), a coalition of 134 developing countries at the United Nations and an effective negotiation vehicle by which developing countries can advance their interests in various areas such as international trade and climate change [see 4,5,6]. In addition, Indonesia's pivotal leadership, based on “restraint”, allows it to push for regional integration and cooperation in Southeast Asia (ASEAN) and in the Asia-Pacific region (APEC) [see 7].

Indonesia's development trajectory is also key to the achievement of the targets of the Paris Climate Agreement as well as of the 2030 Agenda for Sustainable Development. If problems of a global dimension, such as climate change, are to be effectively addressed, Indonesia needs to make a contribution [see 2]. The 313% increase in total CO₂ emissions (2018, base year 1990) from Indonesia is significantly driven by its 793% increase in electricity final consumption (2018, from 1990) [8,9]. With more than 270.2 million inhabitants,

Indonesia has the largest population in Southeast Asia, and the fourth-largest population in the world, after China, India, and the USA. Its population is projected to increase to around 318.9 million by 2045 (Badan Pusat Statistik 2018). Because its target to become a developed country by 2045 will most likely lead to an increase in energy demand, Indonesia will need to find additional solutions to make this development goal consistent with its climate protection and sustainability policies [see 10,11]. For example, expanding access to electricity of 1.7% of its population, and to the 32% of its population who have neither access to electricity nor clean cooking technologies could undermine the country's emission reduction targets unless there are credible improvements in energy efficiency and urban planning [9].

Indonesia confirmed its commitment to the Paris Climate Agreement to reduce greenhouse gas (GHG) emissions by 29% from business-as-usual (BAU) with its own capacity, or by 41% with international support, by 2030. To achieve this, Indonesia seeks to reduce GHG emissions from its energy sector by 314–398 million tons of CO₂ by 2030 through the deployment of renewable energy (RE), enhancement of energy efficiency, advancement of energy conservation and the utilization of clean energy technologies (Government of Indonesia 2016). Mandatory energy efficiency policies were also introduced that affected around 18% of Indonesia's total energy use. The International Energy Agency (IEA) [9] notes that these policies prevented 8% of additional energy use in 2018 (with 2010 as base year). After Indonesia's ratification of the Paris Climate Agreement in October 2016 and the drafting of the Climate Change Law in March 2017, the Indonesian government fast-tracked the development of relevant policies. Five months after the ratification, President Joko Widodo issued Presidential Regulation Number 22 of 2017 on the National Energy Master Plan, which formalized the targeted share of new and renewable energy (NRE) in the energy mix from 7.6% of total primary energy supply (TPES) in 2016 to 23% of TPES in 2025 and 31% of TPES in 2050. **New and renewable energy** (NRE) sources is a distinct energy group categorized by the Ministry of Energy and Mineral Resources of Indonesia. Based on Law No. 30/2007, "**new energy**" is defined as energy generated by *both renewable and non-renewable sources* that include nuclear, hydrogen, coalbed methane, liquified coal and gasified coal. The same law defines "**renewable energy**" as including solar, geothermal, wind power, hydropower, and ocean energy (thermal gradient, wave power and tidal power).

Three months later, President Joko Widodo also issued Presidential Regulation Number 59 of 2017 on the Implementation of Achieving Sustainable Development Goals (SDGs) to ensure the achievement of SDGs in Indonesia. Key to this is the improvement of the quality of governance in the country. The principle of *Bhinneka Tunggal Ika* (unity in diversity) has made Indonesia a credible reference for the transformation to democracy and good governance, especially for countries in Asia and for those in the Islamic world [see 12,13]. For example, the German government has classified Indonesia as a key global partner for German efforts to contribute to the global commons, particularly because of its success in addressing the political and economic upheavals at the end of the 1990s [14]. Indonesia has 1,300 ethnic groups [15], which bring with them a diversity of culture, languages and customs, and is considered the most diverse country in the world. Indonesia's governance system reflects this diversity. The leaders of all but one of its 34 provinces, 416 regencies and 98 municipalities are directly elected by the people (the province of Yogyakarta being the exception). Nevertheless, while these government units enjoy concurrent authority, some aspects – including the administration of its natural resources, in particular oil, geothermal, and hydro – are managed centrally and are controlled through state-owned companies. Renewable energy sources can, however, be managed at the provincial

level. The control of the state includes capital, technology and management, policymaking and administration, as well as regulation and supervision.

This article argues that Indonesia is, as a case study, highly valuable for academics and students of sustainable development (in general) and sustainable energy (in particular) due to its ability to connect the multiple “worlds” it has become part of. Indonesia’s experiences offer valuable lessons for a broader number of countries, which can relate to the local conditions as well current and potential challenges Indonesia needs to address. Academics and students can focus on how Indonesia is seeking, or was able to mobilize, additional resources to address contradictions that would have been unsurmountable for other countries. Indonesia’s energy transition offers helpful lessons to other countries, particularly because of its aspiration to become a developed country by 2045, because this goal is only possible when a country is able to effectively address barriers and caveats to sustainable energy. It is interesting to understand better how, for example, Indonesia managed to focus on silver linings and come up with pragmatic solutions to energy-related issues that could be very contentious.

The next part of this article introduces the political framework of Indonesia’s energy transition, briefly summarizing its vision, mission, goals, and targets. This is followed by the “teaching guide,” which provides recommendations how the lessons from Indonesia’s energy transition can be embedded into a learning experience. The “learning activation approach” is introduced, which encourages students to systematically reflect on the complexity of selected contexts and understand this complexity by looking both at the technical issues and at the processes that allow decision-making.

2. Indonesia’s energy system – From an oil exporter to an emerging leader of sustainable energy?

Indonesia, used to be a one-time oil exporter, but became a net oil *importer* after 2000 as its production declined, despite Indonesia having abundant unexploited fossil and non-fossil energy resources. In recent years, Indonesia was able to build itself up again as a net energy exporter when coal became its principal export (11.2% of total energy export value in 2018), with palm oil in second place (8.76%) [16,17]. However, Indonesia is confronted with a rapid increase in energy demand, primarily attributed to the country’s economic development and increasing population. At the same time, as indicated by the Energy Trilemma Index, the demand for energy demand is increasingly being met by increased energy production based on coal and geothermal [18]. For example, Indonesia’s crude oil imports decreased from 401,721 barrel/day in 2013, to 335,833 barrel/day in 2018 and 216,500 barrel/day in 2019 [19]. This index, which was developed by the World Energy Council, ranks countries on their ability to provide sustainable energy through three dimensions: *energy security*, *energy equity (accessibility and affordability)*, and *environmental sustainability*. In 2020, the Index ranked Indonesia at 56th place, which is a significant improvement on its 73rd place in 2013 [20]. Nevertheless, currently most of the domestic energy necessities are still dominated by the use of fossil energy sources such as coal, oil, and gas [see 20,21].

Indonesia still needs to address critical uncertainties that might undermine its energy system. Based on the World Energy Issues Monitor Report from 2020, Indonesia’s energy transition needs to ensure, in particular, the stability of commodity prices, and to improve its competitiveness as destination for foreign investment. Being a resource-dependent economy, Indonesia is exposed to commodity prices shocks, as was the case in the post-1970s oil booms and the commodity boom from 2001 to 2012 with the exception of the global financial crisis in 2008 [22,23]. Arief Anshory Yusuf [24] claims that from 2009 to 2011, the world prices of many Indonesian export commodities doubled. This led to the

highest ever recorded increase in inequality in Indonesia when the Gini coefficient increased from 0.37 to 0.41 [24]. While there are positive effects of the commodity price increase for the Indonesian economy, such as the increase of income for poorer households, volatiles world prices for coal, oil, gas can generate significant increases in inequality in the country [see 24,25]. Indonesia needs to establish a more predictable, better-targeted, less costly and more effective approach to mitigate the impact of price shocks [22]. Additional efforts are needed to monitor commodity price increases and to respond quickly to help vulnerable households.

In addition, Indonesia's energy transition needs to resolve the critical uncertainty of new and renewable energy resources (NRE) compared to coal energy. A major challenge is the energy sector's dependence on state subsidies to build the necessary infrastructure to keep up with future regional demand. Subsidies to the energy sector were valued at USD 10.88 billion in 2019 (0.90% of GDP) [26]. The Asian Development Bank [27] estimates that necessary increases in national generation capacity up until 2025 will cost USD 154 billion. Securing the needed financing poses a huge challenge following the impact of COVID-19 pandemic on public sector revenues [27]. While the Indonesian government has already initiated reforms in electricity tariff subsidies and eased access to capital for the private sector by establishing a legal basis for open access to transmission lines, the current depreciation of the Indonesian rupiah has increased the cost of US-dollar linked electricity generation and its foreign currency-denominated debt (68% in total). This development has led to a decrease in investment planning by 50% [27].

2.1 The current status of Indonesia's energy system

Indonesia is the largest economy in Southeast Asia and the seventh-largest global economy in terms of purchasing power [27]. Due to the size of its economy and it currently being a major source of world's GHG emission growth, Indonesia is a formidable partner in mitigating climate change by reducing emissions from its energy system. Indonesia's emissions growth of 8% between 2018 and 2019 is so far the largest growth of fossil CO₂ emissions, even faster than that of China (3.4%), United States (-2.6%) and India (1.6%) [28]. Indonesia's average CO₂ emission growth since 2015 of 6.2% is also the largest among all countries (China: 2%, US: -0.7%, India, 3.2%) [28]. The country's economic growth of approximately 5% has been traditionally driven by commodity and agricultural production [27].

Appendix A1 illustrates the relevant characteristics of Indonesia's energy supply and demand. The energy demand of Indonesia's population of about 270 million (2019) [17] was served by a power capacity of 70 GW in 2019 [8]. In 2018, the total primary energy production (oil, gas, coal and renewable energy) was 411.6 MTOE. Around 64%, or 261.4 MTOE, of the total production (of coal and liquefied natural gas (LNG) in particular) was exported [29]. Besides that, Indonesia also imported energy, mainly crude oil and petroleum products, of 43.2 MTOE and a small volume of high-quality coal to meet the needs of the industrial sector. Since 2010, the average annual increase in power production in Indonesia has been 6.3% [30].

Indonesia remains a major producer of fossil fuel energy, despite a decline in crude oil production in the last 10 years, from 346 million barrel in 2009 to 283 million barrels in 2018, due, mainly to aging fields and delays to new projects. Lower demand due to the COVID-19 pandemic and lower oil prices have further strained oil (and gas) production [31]. To meet the demand for refined oil, Indonesia is importing crude oil, especially from the Middle East. Indonesia's oil-import dependency is around 35%.

Indonesia's natural gas production reached 2.9 million standard cubic feet per day MMSCFD in 2018, which was utilized to meet domestic demand in industry (as feedstock

or energy), power plant, city gas (household and commercial) and gas lift of 1.7 million MMSCFD [29]. Indonesia can easily meet its domestic demand in light of its 49.74 billion barrels proven and 27.55 billion barrels potential natural gas resources [17]. Furthermore, gas is also used as an export commodity, in the form of LNG and piped gas of 1.2 million MMSCF. The share of gas exports (through pipeline or LNG) in the total gas production declined from 50% in 2009 to 40% in 2018 [29].

Indonesia's coal production is predicted to increase, especially to meet domestic demand (power plant and industry) and export. The Indonesian government has defined coal energy as an important enabler of energy transition in Indonesia. Coal can either serve as a bridging technology that resolves the intermittency problems of renewables [see 32,33]. Also, the emerging "stranded assets" are difficult to justify in Indonesia, because of the abundance of coal energy sources in the country [see 34,35]. Stranded assets refer to oil and gas resources that have not yet been extracted, but which appear on companies' ledgers. This has the potential to devalue the stocks of these companies, which would affect mutual funds and pension plans, see [36]. It has 149 billion tons proven coal and 37.6 billion tons of potential reserves [27]. The development of coal production in 2009–2018 increased significantly with the production of 557 million ton in 2018. In 2019, coal has dominated Indonesia's power mix with 59% [30]. In the same year, Indonesia has become the world's biggest coal exporter [30]. From the total production, coal exports reached 357 million ton (63%), which was mostly exported to meet the demand in China and India. Indonesia is one of the largest coal exporters in the world, alongside Australia [29].

Indonesia's growth in energy demand is currently one of the highest in the world [9]. Primary energy demand has increased by 3% per year since 2010, mainly due to the growth in the transport sector resulting in a higher consumption of fossil fuels. The total final energy consumption (without traditional biomass) in 2019 was due to transportation (44%), industry (37%), household (14%), commercial sector (4.5%) and the rest to other sectors [17]. The National Energy Outlook expects that energy demand in Indonesia will most likely increase by 5% per year by 2050. Electricity demand is expected to increase, in particular from the industrial and household sectors [27]. According to the Electricity Power Supply Business Plan (RUPTL), the Indonesian government projects that the annual electricity demand will increase by 6.4% in 2019 to 2028 [27]. The COVID-19 pandemic has affected Indonesia's energy demand, as consumption was reduced during the lockdowns, but the increase in domestic demand for food, beverages and medicine has off-set some losses. Fuel consumption in April 2020 decreased by 34%, compared to April 2019, due to lockdowns in big cities [37].

Despite several challenges, Indonesia is still keen to meet its target of 23% of energy from "new and renewable energy" (NRE) sources by 2025 to ensure energy security and independence while fulfilling its global commitment to reducing GHG emissions by developing roadmaps for each technology [38]. Other strategies include the expansion of the use of electric vehicles, with public transport operators (taxis and public buses) acting as trailblazers [38]. However, reducing emissions through electric vehicles will require additional efforts to modernize its grid system and charging infrastructures. A key challenge to the deployment of NRE is the lack of investment in renewable energy that signals a investors' lack of confidence in this sector. With only USD 1.17 billion, the sector has only achieved 65% of its 2019 target of 1.8 billion USD [38]. In Indonesia's National Annual Planning Meeting, the Ministry of National Development Planning (BAPPENAS) [11] reported that in 2020 Indonesia would already have achieved 90% of its target in food, wa-

ter, energy and environmental security, as stipulated by its National Development Priority (RKP). As stated in Government Regulation No. 79 of 2014 on National Energy Policy, the target for NRE is at least 23% of total energy production by 2025 and 31% by 2050 [29].

Indonesia has the necessary natural resources to achieve this target. The government estimates that the country has the largest global potential for geothermal energy at 23.9 GW and potential for hydropower of more than 94 GW [17]. Indonesia is the third-largest geothermal energy generator in the world after the United States and the Philippines [39]. Indonesia also has a biomass potential of more than 32.6 GW and a biogas potential of 200,000 barrels per day [40]. Currently, Indonesia is the third largest biodiesel producer in Asia, reaching an output of around 370,000 barrels per day [39]. In addition, estimates of potential generation capacity are available for other NRE: 60.6 GW for wind energy, 208 GW for solar energy, and 17.9 GW for ocean and tidal energy [17]. As an archipelago, Indonesia has particularly huge potential in ocean and tidal energy [see 41,42].

The analysis of Indonesia's energy system confirms the need for additional efforts and for an update of its strategies to meet its energy and emission reduction targets. Because of the unexpected drastic increase of its energy demand as well as the COVID-19 pandemic, the Indonesian government intends to revise its targets to get back in track to achieve its energy policy goals. For example, through the Policy Direction for Regional Energy and Mineral Resource Affair Plan for 2022, Indonesia introduced 15.7% as its new target in 2022 to increase the use of NRE by focusing on priority activities. The following section depicts Indonesia's vision and strategies to achieve transition towards sustainable energy. This section will highlight the role of governance and the importance of policy coherence not only among energy policies but also between energy policies and other policies related to climate protection and sustainable development.

2.2 The policy framework of Indonesia's energy transition

With the ratification of the Paris Climate Agreement, Indonesia has committed to reducing GHG emissions unconditionally by 29% against a business-as-usual scenario and, with international assistance, by up to 41% against the 2030 business-as-usual scenario [43]. As one of the most natural disaster-prone countries in the world, Indonesia is particularly vulnerable to climate change. For example, Indonesia faces high mortality risks from multiple hazards, including tsunamis, floods, landslides, and droughts, with about 40% of its population exposed to such hazards [see 44,45]. By 2100, climate change impacts are expected to cost Indonesia between 2.5% and 7% of its GDP [45]. At the same time, Indonesia is the 10th largest GHG emitting countries (532 tonnes in 2018) and the 19th highest in terms of CO₂ emissions per capita (1.7 metric tons CO₂ equi., 2018) [9]. Recognizing the need to make its climate protection goals coherent with its economic goals, the government of Indonesia has developed and implemented various plans since 2014 to improve its ability to harness sufficient sustainable and reliable energy sources and reduce emissions.

Indonesia's energy transition is a top-down process, which was officially launched in 2017 when the Ministry of National Development Planning (BAPPENAS) integrated climate action into the country's development agenda through its Low-Carbon Development Plan (*Pembangunan Rendah Karbon Indonesia*) [46]. The following figure illustrates the political mandate, goals, targets and strategies that encompass Indonesia's overarching energy transition plan.

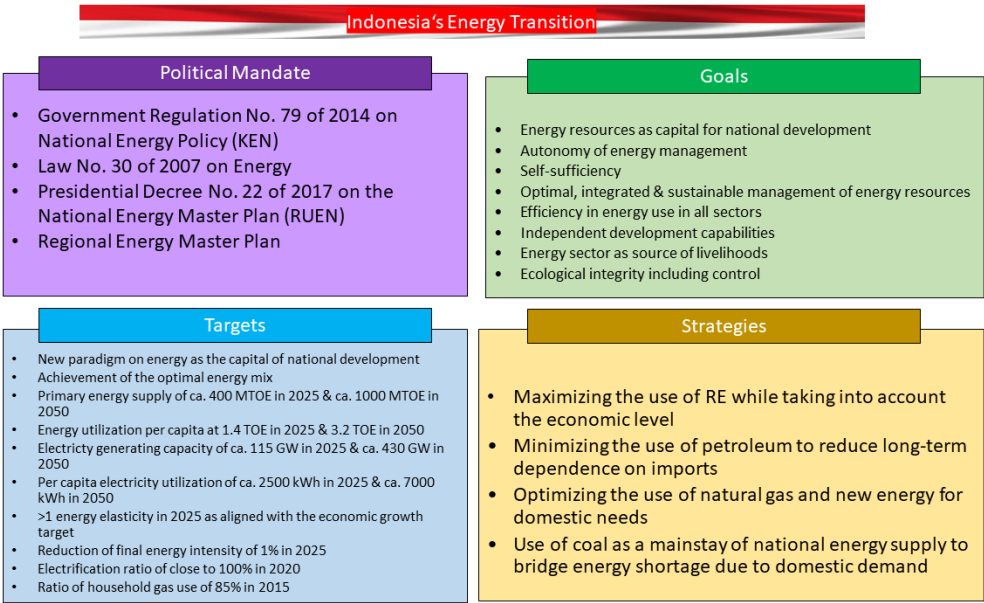


Figure 1. Indonesia’s Energy Transition in a Nutshell (own representation)

The political mandate of Indonesia’s energy transition reflects the vision the government has set to achieve national energy sovereignty, resilience and independence. This vision necessitates a combination of policies to unleash the potential of Indonesia’s new and renewable energy (NRE) sources, which the government estimates to be 441.7 GW, of which only 9.07 GW (about 2%) has been utilized effectively.

Through the **Government Regulation of the Republic of Indonesia Number 79 of 2014 on National Energy Policy (KEN)**, the government has determined the role of NRE to reach at least 23% in the national energy mix by 2025. Indirectly, the policy for implementing the role of NRE has actually been politically strengthened in **Law Number 30 of 2007 on Energy**. In addition, the President has issued **Presidential Decree Number 22 of 2017 on the National Energy Master Plan or Rencana Umum Energi Nasional (RUEN)**. RUEN pertains to the national-level energy management plan that elaborates and implements the KEN. RUEN is also a guideline to realize energy independence and national energy security in supporting national sustainable development. The policies within the RUEN framework are complemented by supporting policies to ensure policy coherence. These include policies on energy conservation, conservation of energy resources, and energy diversification. RUEN also identifies further policies needed for its implementation. These include policies on institutional funding, R&D and application of energy technology, on infrastructure and on improving energy access for people and industry.

RUEN consists of a general energy plan until 2050, including a description of the country’s current national energy conditions and a list of future expectations, vision, mission, goals and objectives of national energy, policies and strategies for national energy management, and closure. The RUEN has set targets to achieve an optimal primary energy mix by 2050 as follows: NRE sources to make up at least 23% of TPES by 2025 and at least 31% in 2050, provided it can be done economically; the share of oil to be less than 25% of TPES in 2025 and less than 20% in 2050; the share of coal to decline to 30% by 2025 and a minimum of 25% by 2050; natural gas to have a 22% share in 2025 and at least 24% in 2050. In addition, concrete targets were identified to characterize the new normal of Indonesia’s energy system. For example, the targeted primary energy supply in 2025 is around 400 MTOE and 1000 MTOE in 2050. At the same time, because the Indonesian

government prioritizes the use of local energy resources, and because of the geophysical condition of Indonesia being an archipelago, coal energy is tapped to fulfil the anticipated gap between supply and demand. However, Indonesia intends to deploy new clean technologies to limit the emissions from coal.

Furthermore, RUEN is a reference point for the **Regional Energy Master Plan (RUED)**. RUEN is elaborated and implemented by the provincial government for the preparation of the RUED to achieve RUEN targets. Both the KEN and RUEN formulated strategies on how the Indonesian government should prioritize the deployment of renewable energy to achieve independence and ensure national energy security. Therefore, to accelerate the development and increase in the use of renewable energy, the Indonesian government aims to regulate it at the level of law, so that renewable energy can become part of the RUEN, which needs to be managed and developed as well as improved and properly utilized. RUEN and RUED serve as long-term guidelines for the development and management of regional energy up to 2050. For regions that produce fossil energy resources, it will have many impacts and implications related to the transition of fossil energy to new and renewable energy. However, the transition to new and renewable energy is something that must be done, despite Indonesia's high dependence on fossil energy, in order to improve the country's energy resilience and independence.

3. Key issues in and challenges to Indonesia's energy transition

This section identifies a collection of key issues that, if left unattended, might both undermine Indonesia's energy transition and lead to the energy sector not achieving its social mandate. These key issues are context-based and represent the different social, political and economic perspectives relevant to the transition process.

3.1 *The high monetary costs of Indonesia's energy transition*

An important determinant of the success of Indonesia's energy transition is the estimated costs and benefits of its implementation. Appendix A2 summarizes the estimated cost (in Indonesian Rupiah) of achieving the targets stipulated by the above-mentioned policies. For example, the cost of electric NRE producing 48.9 GW is estimated at IDR 1,688 trillion. Almost similar is the estimated cost of IDR 1,619 trillion for clean energy technologies, for example to reduce GHG emissions from coal energy. In addition, appendix A2 enumerates the mitigation benefits of achieving these targets.

The Indonesian government has established a subsidy scheme to alleviate the financial and social burden of the energy transition, particularly for private households. The government set a feed-in tariff for electricity generation from geothermal energy, hydropower, bioenergy and solar energy sources based on their production costs not only in order to accelerate investment in renewable energy technologies but also to ensure price certainty [47]. The government has channeled most subsidies to those regions in Indonesia that are confronted with high costs for grid infrastructure development, which inhibits the expansion of electrification in remote areas. Obligated by Law 30/2009 that was implemented by the Jokowi administration, the government is subsidizing electricity supplies to poor and remote areas in the country [48]. In 2016, the government spent IDR 48.33 trillion for electricity subsidy [49]. However, there is a discussion whether the energy transition can advance if the government continues its huge subsidy programme for fossil fuels, which was IDR 27,050 billion in 2016.

3.2 *The energy–human development nexus in an archipelagic state – The decentralization of Indonesia's energy system*

As an archipelago, Indonesia has a serious challenge in distributing electricity to its citizens, especially to those who live on smaller islands. While the Indonesian government is committed to electrifying the whole country by 2020, there are still more than 1 million households without access to electricity, particularly in rural and remote areas [38]. At the present time, only urban areas have adequate power distribution. Those outside these urban areas are more likely to be confronted by the “poverty–energy trap”, because the lack of access to power means that they are more likely to remain in poverty [50]. Around 50 million Indonesians who live in 40,000 villages on 4,000 islands remain without access to reliable power [50]. In addition, these areas are highly dependent on kerosene lamps or expensive diesel-generators for lighting, which leads to energy bills 10 to 20 times higher than those for people living in big cities. People living in these areas are also more likely to have a lower income, and the lack of reliable energy limits economic growth [see 51]. The lack of energy also undermines the quality of education of children, especially in the information technology era. In a 2019 survey conducted by the World Bank [52], only 29% of the 270 rural and remote primary schools surveyed between 2016 and 2017 were connected to the power grid, and only 17% had internet access. These connectivity challenges, in addition to the huge salary gap, discourage qualified teachers from working in these areas. Around 34% of teachers and 18% of school principals were shown in the survey only to have high school degrees. In addition, 25% of classrooms did not have a teacher at all. Therefore, the electrification of rural areas needs to be a key target of Indonesia’s energy transition. To achieve this goal, Indonesia needs to accelerate NRE power plant development in remote areas [47]. Large-scale centralized power generation may not be suitable for the needs of rural areas. Instead, small-scale off-grid renewable generation systems can help electrify these areas cost-effectively [38]. The decentralization of Indonesia’s energy system will, however, need further structural changes [21,53].

3.3 Coal energy as an indispensable part of Indonesia’s energy mix

Indonesia is considered to have the biggest coal reserves in the world [see 21,33]. In addition, coal energy is often perceived as Indonesia’s way out from its dependence on oil. Therefore, coal energy is more likely to play a significant and long-term role in Indonesia’s energy system. At the same time, the continued reliance on coal as a primary component of Indonesia’s national energy mix over the coming decades undermines the credibility of Indonesia’s climate change mitigation commitments [see 54,55]. Indonesia might become one of the world’s “climate pariahs” particularly not that China has committed to a net-zero emissions goals by 2050, which is more ambitious than Indonesia’s goal of seeing emissions peak in 2030 before declining to net-zero by 2070 [56,57]. Climate pariahs, which include Bolsonaro’s Brazil and Australia, are usually barred from speaking at the UN’s Climate Ambition Summit. Because Indonesia is not expected to sacrifice its economic development for climate protection, the energy transition pathway Indonesia is taking might lead to diplomatic isolation. This might undermine Indonesia’s presidency of the G20, which aims to formulate strategies for a more resilient, productive, sustainable, and competitive global economy [see 58]. This can also affect Indonesia’s access to Official Development Assistance (ODA) as many donors have already begun aligning their ODA and bilateral development cooperation priorities with climate mitigation. For example, around 53% of Japan’s bilateral allocable ODA was marked as climate-related. Other major donors, such as Germany France, UK and Sweden, have significantly “climate mainstreamed” their ODA, with France even making 100% of its whole ODA portfolio compatible with the Paris Climate Agreement [59]. Other arguments against Indonesia’s coal strategy include the negative effects of coal energy to the deployment of renewable energy, because it reinforces existing carbon lock-in [see 32,60]. Also, some experts argue

that there is evidence that the current competitive advantages of coal energy are numbered, because of the emerging global efforts to reinforce carbon pricing, which in the long-term impede Indonesia's global competitiveness [see 61,62]. However, there are also other experts who argue that new clean technologies are emerging that can reduce emissions from coal energy and that carbon capture and storage (CCS) technologies are already available [see 63].

3.4 Public finance and the resource curse

One of the main barriers to Indonesia's energy transition is a paradox. While the abundance of both fossil and non-fossil energy sources in Indonesia supports the implementation of its energy policies, Indonesia is also confronted by the shadow of these resources – the so-called “resource curse”. The resource curse is a major barrier to long-term investment due to the volatility of world prices for the resources Indonesia is exporting [see 64,65]. Public investment is key to Indonesia's energy transition, because it sends the signals needed by the private sector for their long-term planning. While there is a positive correlation between the share of oil and coal mining, and of gas extraction, with district real per capita income [see 66], Indonesia's dependence on revenue from exports of its fossil energy sources makes its public finance more vulnerable to external shocks [see 67]. Ahmad Komarulzaman and Armida Alisjabana [68] observed that there is a persistent negative effect of the mining sector on regional economic growth. However, they also observed that when resource revenues are invested properly in the public sector, the implications of the resource curse are minimized.

3.5 The role of state-owned enterprises (SEO) throughout the entire energy value chain in Indonesia

Indonesia's state-owned enterprises in the energy sector exert an important influence on the country's GHG emissions-reduction goals. More than 100 SOEs (*Badan Usaha Milik Negara* (BUMN)), are the main providers of goods and services that are not or cannot be covered by the private sector. In 2019, Indonesia had 114 state-owned enterprises and this number increases to 772 when all subsidiaries are counted [69]. At a global level, in 2019 SOEs owned 55% of electricity networks and 50% of the world's fossil fuel production assets [70], and in many countries they are prevalent in the electricity sector, where long-term investment determines future GHG emissions [71]. Indonesia's “carbon entanglement” is linked to the SOEs' entanglement with fossil fuels, which are placed under severe financial strain when faced with stringent climate policy [see 71,72]. In addition, because SEOs have wielded massive influence in nearly all of Indonesia's main industries, they are able to maintain inefficient practices, which have led to many of them being in a dire financial state, undermining their ability to implement emission reduction targets. For example, the SOE minister Erick Thohir criticized in December 2018 the fact that only 15 of the SOEs produced 76% of the total profits from SOEs. In addition, according to the Bank of Indonesia, the total SOE debt in March 2020 was USD 55.4 billion [73].

Another challenge is that SOEs are vulnerable to cronyism and conflict of interests, because top SOE positions are traditionally occupied by political allies who do not always have the necessary expertise to effectively run these companies and who are still maintaining their positions in the private sector [73]. Indonesia's state-owned power company, the Perusahaan Listrik Negara (PLN), reported a USD 2.8 billion drop in profit in the first quarter of 2020 (96.5% fall in the first half of 2020) [74]. While this loss was exacerbated by the COVID-19 pandemic, PLN is very often dependent on government aid, because operating expenses (paid in US dollars) frequently exceed revenues (collected in Rupiah) [27].

Because PLN has a monopoly on the transmission and distribution of electricity in Indonesia, the government has no other option than to support the PLN. This represents a key challenge to Indonesia's energy transition – to find a balance between access to cheap electricity and the competitiveness of PLN. While PLN is a provider of a public good such as providing low or no-cost electricity for 31 million of its most vulnerable customers during the pandemic, it is argued that this monopoly is inhibiting the decentralization of Indonesia's energy supply and the deployment of NRE [see 27,37].

3.6 The outlook for Indonesia's energy transition – Additional efforts needed to achieve the targets

The outlook for Indonesia's energy transition is mixed as the conditions under which it was planned have changed. The country's current economic growth of 5% is lower than the expected 7% to 8%. It even contracted to -2.07% in 2020 due to the COVID 19 pandemic. This has resulted in the realization of the supply and utilization of national energy that is still below the target or has also decreased to -2%. Based on data from MEMR on the achievements of the national energy mix in 2018, the role of NRE in the primary energy mix has reached around 8.55% of total primary energy, or 205.25 MTOE, while the target to be achieved in 2025 is 400 MTOE. The proportion of NRE used for electricity generation has not been maximized because it is constrained by the selling price of NRE electricity, which is still having difficulties competing with fossil energy. There are also problems with the potential destruction of forests during the development of geothermal and hydropower plants. In addition, the substitution of coal fuel for biomass/wood pellet in power generation is still in the planning stage, including implementing a program for mixing fuel oil with bioethanol [75].

In addition, in the industrial sector, the growth in the share of natural gas consumption is still below expectations due to the problem of less-competitive gas prices, and the fact that downstream natural gas (petrochemical) industry planning has not been integrated with that of gas supply and infrastructure development. Apart from natural gas, the use of coal as a raw material for dimethyl ether (DME) is still underdeveloped, even though LPG imports have currently reached 75% of total domestic demand. The non-optimal utilization of electric energy, especially in the industrial sector, is due, among other reasons, to the fact that industrial development planning has not been integrated with electricity supply planning. Furthermore, the development of electric vehicles is still constrained by regulations, infrastructure, batteries (including how to deal with the waste) and the retail price of electric vehicles [75].

The government needs to anticipate the potential negative impacts of the energy transition, and it also needs good management so that the transition process can run according to the target [see 76]. The potential negative impacts of the energy transition are unemployment, environmental degradation, and inequality [see 47]. If these negative impacts are not adequately addressed, public opinion on the energy transition might not reach the critical mass required to implement the policies linked with financial and social burdens. Critical mass refers to the threshold where enough actors are willing to support the policy, which makes this policy more attractive to the wider public. Several governance issues therefore need to be considered in planning the energy transition trajectory [see 77,78]. It is necessary to create conditions that allow for (public and private sector) investment in renewable energy [see 34], and to include public consultation and social dialogue in order to develop and legitimize policies related to social protection and skill development. Moreover, a reliable funding mechanism is needed to support transformative R&D and an equitable transition [see 47,79,80].

Additional efforts are also needed for Indonesia's energy transition to ensure that policies are actually implemented to meet its GHG emissions reduction targets. Based on the NDC attachment, in order to achieve the Paris Agreement target, mitigation measures taken by the Indonesian government related to the energy sector include: efficiency in final energy consumption, the implementation of clean coal technology (CCT) in up to 75% of power plants, an increase in electricity produced by renewable energy technology to 7.4 GW, enabling biofuel to supply at least 90% of the energy demand of the transportation sector, a 100% increase in gas distribution pipelines, and the building of additional compressed natural gas fuel stations. Indonesia is expected to meet these climate mitigation targets as long as the government can maintain the mitigation measures that have been prepared in RUEN. For now the priority the government can pursue is to accelerate the development of power plants by focusing on the development of solar power, hydro power, wind power, biomass power plant, geothermal power plant, and waste-to-energy plant.

The mitigation measures Indonesia is pursuing include four sectors, namely the transportation sector, the industrial sector, the household sector, and the commercial sector. However, it can be argued that the government should only focus on two sectors: the electricity sector and the transportation sector. In the electricity sector, mitigation measures involve increasing the electricity mix from plants based on renewable energy, ending a moratorium on the construction of new steam power plants, applying clean coal technology to operating steam power plants, periodically stopping steam power plants. Then, in the transportation sector, mitigation measures are in the form of electrification in passenger transportation modes, and the use of biofuels/synthetic fuels for transportation modes that are difficult to electrify. The potential impact of the energy transition in these two sectors is the potential risk related to labor issues in the form of job loss, and potential risks related to the loss of infrastructure assets in the energy sector and loss of technology assets in the transportation sector.

4. Teaching Guide – Learning from the sustainable energy transition in Indonesia

This case study on Indonesia's efforts to achieve sustainable energy delivers the necessary components for learning about a very complex subject. It has been designed to match the needs both of the educators and of the learners. The case study offers real situations and challenges. In addition, it presents key issues for a debate in order to motivate exchanges of perspectives. Furthermore, this case study on Indonesia's energy transition has been presented in a way that offers learning that can be applied in other countries. As mentioned in the introduction, Indonesia is an interesting case study because its experiences can be replicated not only in developing countries, but also in some developed countries that are, for example, struggling to phase out coal energy from their energy supply mix.

For many developing countries, especially from Southeast Asia and the Muslim world, Indonesia is seen as a "link" between their desire to maintain traditions and their identity while at the same time embracing modernity [see 1,27,81]. As one of the largest economies in the world, and as the biggest sources of GHG emissions growth, Indonesia's decisions are substantial. Indonesia can also offer important insights to many east European countries, such as Poland and Czech Republic, that are struggling to find the political mandate to present coal energy as an integral part of their energy transition policy [see 82,83]. Therefore, using Indonesia as a case study allows a broader understanding of the various entry points to addressing the complexities of a transition towards sustainable energy. This part represents a teaching or learning guide that provides a lesson plan on

how to maximize the learning process through the case study of Indonesia's energy transition. The next section discusses how this case study can help to achieve most teaching objectives of classes on sustainability. In the next sections, the "learning activation approach" will be introduced.

4.1 Guidelines for using the case study

Unlocking the value of case studies requires a framework for analysis. Educators and students can benefit from a learning framework that can help (1) transform situations into experience, (2) develop analytical tools from this experience, and 3) apply these tools to other situations. This section introduces the pedagogical value of the Indonesian case study.

4.1.1 Teaching objectives and target audience – building future change makers

This case study can help fulfil the teaching and learning objectives of future leaders who see the current momentum on sustainability not as a threat but as an opportunity to achieve human well-being. These future leaders may come from both the public and private sector. They are most likely to come from different academic and professional backgrounds. They might represent both the anticipated winners and losers of the pursued transformation process. While some might push forward ambitious efforts, others might opt for a "sober" change to make sure that the proposed solutions are implemented well so that they do not create new injustices. They could drive both individual and institutional change towards sustainability. This diversity of the target audience should not impede the teaching and learning of transitions towards sustainability. Diversity is even imperative in learning. The complexity of the issues involved is caused by diversity in issues and actors. Addressing diversity when learning about these issues can help enhance the listening capacity, communication and empathy of students.

The case study on Indonesia's energy transition supports the teaching objectives of any course that aims to link transformative knowledge on sustainability with professional skills needed to understand the complexity of any transition towards sustainability. This case study provides useful impulses to enhance the **assessment or judgment skills** of the students. These assessment skills are needed by policymakers to weigh different interests, perspectives, and value systems. They need the **ability to solve problems** and to **formulate priorities**, not only using their "moral compass" but also evidence and reason. These skills need to go beyond merely understanding the technical complexity of issues but also require the development of **empathy**, which allows students to understand, for example, the social equity implications of an action. Moreover, this case study can help cultivate the "**political nous**" of students, or their ability to read power contexts and structures. It also includes the courage of conviction to make both popular and unpopular decisions to solve short- and long-term problems.

Evidence-based policymaking is an integral characteristic of effective policymaking that indicates the ability of policymakers to make their ideological or political worldviews compatible with scientific reasoning. In addition, this case study can help improve the **leadership skills** of students by highlighting their sense of accountability. Although Indonesia's public sector is the main driver of its energy transition, its success is dependent on the ability of the public sector to forge genuine partnerships, not only with the business and industry sector, but also with civil society groups. Indonesia's diversity is for "bad leaders" a hindrance, but for "good leaders" it is an opportunity. For this reason, this case study provides insights on how public deliberation is key to any energy transition. The most effective solutions are not the technically optimal ones but the negotiated ones, – the

outcome of tedious and inclusive bargaining between multiple actors who share the same sense of reality. Therefore, **negotiation skills** or the ability to persuade can also be enhanced through this case study.

These tasks require that students be not only knowledgeable about the technical, social, political, economic, and ecological aspects of the energy transition, but that they are able to **debate in a healthy and constructive manner**. This also implies the need for the students to have a transdisciplinary professional background. In addition, it is expected that while some students are well-informed, for example on the economic aspects of the energy transition, others might provide important insights from the governance side. Students are expected to be **passionate about certain topics**, without them undermining the passion of the others.

The case study can also provide opportunities for educators to enhance their own skills. By highlighting the diversity of the issues and of the students, the educators need to have appropriate moderation skills to ensure that not only the “loudest” and extroverted can share their views, but also introverted students who often find it difficult to overcome their fear of speaking in front of many people. In addition, the educators are recommended to apply the “Socratic” method to encourage critical debate in the class [see 84]. This method is a form of cooperative argumentative dialogue between students in which educators ask provocative questions or theses to stimulate critical thinking. In the next sections, examples of these provocative questions will be presented. Educators can formulate these questions in a holistic manner by connecting key issues of energy transition to other issues addressed in earlier or future lectures. Finally, the educators can individually decide how much time and effort they would need to spend on this case study. For example, some educators might decide to focus on the applicability of Indonesia’s efforts to their home countries. Other classes might highlight the material resources required to achieve an energy transition. Others might focus on the deliberation or negotiation processes needed to initiate and implement a transition process towards sustainability energy.

4.1.2 Teaching Approach and Strategy – Linking reflection with actions

To achieve the above-mentioned teaching objectives, the so-called “**learning activation approach**” is introduced in this teaching and learning guide, which provides an orientation on how educators can facilitate the learning process. This approach is supported by the notion that students can learn from the Indonesian case study when they are not only conveying but also creating knowledge. The approach starts with students reflecting on the Indonesian case study. They are encouraged to raise questions while thinking deeply about the key issues presented and questioning the underlying assumptions. The following figure depicts how a given context can be studied. As Appendix A3 illustrates, the different contexts pertain to the interlinked dimensions or subsystems, each of which has different sets of key issues, actors or agents, structures, processes and outcomes. The three parts of the learning activation approach: *reflection*, *interactions*, and *actions* reflect the teaching objectives discussed in the previous sections that encourage students to actually create knowledge.

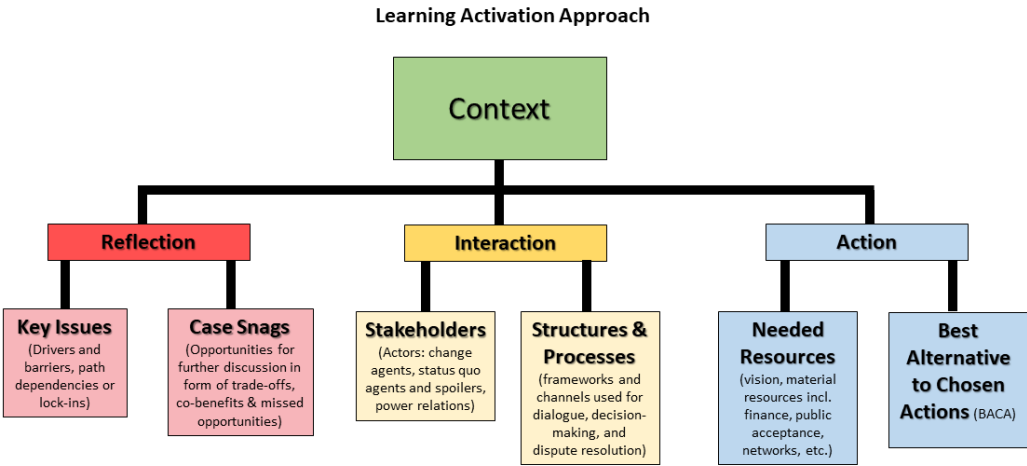


Figure 2. The Learning Activation Framework (own representation, CC BY 4.0)

The **reflection** part provides the space for students to make their own deductions when exploring innovative and out-of-the-box ways of addressing the challenges presented as barriers to transition. As will be discussed in the next section, the key issues related to the Indonesian energy transition should be presented to the students in such a way that their critical thinking is highlighted. The case snags are part of the reflection stage, during which educators and students identify open questions that require further research and debate. In studying cases of energy transitions, these case snags often focus on trade-offs and co-benefits as well as negative and positive externalities. The identification of these case snags is highly dependent on whether those with different perspectives can adequately exchange ideas.

The **interaction** part of the learning approach focuses on the processes of bargaining or joint decision-making between stakeholders. By understanding the motivations and preferences of actors as well as of their advantage, as defined by the resources available to them, students will be able to develop strategies to facilitate interactions between them. As the discipline of negotiation studies demonstrates, a deeper understanding of the structures and processes of collective decision-making and cooperation can reduce transaction costs, and more attention can be given to the actual issues involved [see 85,86,87].

Finally, the **action** part of the learning activation approach refers to the analysis of 1) *actions made* and 2) *the possible alternative actions* to achieve the same policy goal. The case study enumerates the resources utilized to achieve a policy measure or action. With the guidance of the educators, the students are encouraged to come up with the Best Alternative to the Chosen Action (BACA). BACA refers to a possible alternative measure that might lead to the same policy results but with fewer costs. The best alternative to chosen action (BACA) is similar to the best alternative to a negotiated agreement (BATNA) that is used in negotiation studies (see Fisher & Ury, 1991).

4.2 Case Analysis – Learning from Indonesia’s energy transition

Appendix A3 summarizes selected contexts relevant to learning from Indonesia’s energy transition and enumerates key areas educators could highlight in the class.

4.2.1 Geophysical and ecological context

The geophysical and ecological context of Indonesia's energy transition can be broken down into a number of key areas, three of which might be:

- The role of coal energy in Indonesia's energy transition and climate change mitigation policy [see 33,55].
- The limitations or challenges to Indonesia's energy system resulting from the country being an archipelago with more than 17,000 islands that spans a distance of about 5,000 kilometers – equivalent to one-eighth of the Earth's circumference [see 51].
- The status of Indonesia as one of the countries most vulnerable to climate change [see 88,89].

The educators can choose one of the areas and discuss it using the learning activation approach (see Figure 2 above). For each of the key areas, the next step is to introduce the case snags into the discussion. For example, there could be a debate about the role of the first area of interest, coal energy, which could address the following:

- What international assistance is available to reduce emissions from Indonesia's energy sector?
- Does coal energy enjoy public support?
- Is an increasing dependence on coal preventing the deployment of renewable energy in Indonesia?
- Can technological innovation, for example in CCS, resolve the negative effects of coal energy on Indonesia's climate change mitigation?
- How can Indonesia decouple its GHG emissions from its energy demand?
- Are the negative effects or trade-offs of coal energy (e.g., health, air pollution) shouldered by those earning from it?

The possible next step is to instruct students to prepare a stakeholder map of Indonesia's sector. Which public and private sector actors are benefiting from the current integration of coal energy in Indonesia's energy mix? Which among these actors are more likely to oppose any attempts to phase out coal energy? Which frameworks or platforms are used to hold a dialogue between groups? Is there an emerging leader? How are non-state actors engaged in the dialogue? How many Indonesians are directly and indirectly employed in the coal energy sector? The educators can connect the discussion to previous lectures and classes or academic literature on policy entrepreneurship, or to how these actors are able to influence policymaking [see 34,90].

The action part of the learning activation approach can be implemented by the educators by highlighting the role of coal energy in ensuring energy security in Indonesia. For the BACA, students can discuss whether there are possible scenarios for Indonesia's energy system to relinquish coal energy for the sake of climate protection. Here some sample questions to think about:

- Should domestic tax be introduced to help build up the needed infrastructures for renewable energy?
- Is there political will and capability within the Indonesian government to relinquish coal energy?
- How can the knowledge and understanding of policymakers at the national and local levels be increased to empower them to develop a policy and regulatory framework that supports renewable energy development and sustainability?
- Is climate protection a viable argument to risk the reliability and affordability of energy in Indonesia? If not, can Indonesia realistically achieve its NDC with coal being as a mainstay energy?

- Which additional efforts can be done to offset emissions from coal energy? Will Indonesia prefer emission trading schemes rather than actually reducing emissions?
- Can improvements in energy efficiency be enough if emission trading schemes become too expensive?

4.2.2 The economic development context

The economic development of Indonesia is an important context of its energy transition. The key areas in this context are most likely related to economic growth. Examples of these include:

- The potentials of bioenergy as an important driver of economic growth in Indonesia [see 91]
- Efforts to decouple economic growth from energy demand [see 92]
- Sustaining economic growth in an archipelagic state [see 51].

The main questions for reflection the educators and students are recommended to discuss are:

- How will the current economic growth (in light of the COVID-19 pandemic) affect the implementation of the energy transition?
- How will the energy transition in its current trajectory most likely affect Indonesia's future economic growth?

When addressing these questions, the educators and students can recapitulate from previous lectures and classes on how economic growth is very sensitive to projected energy demand. The educators can present Indonesia's declining economic growth in the last five years (5.6% in 2013, 5.04% in 2014, and 4.88% in 2015) and the students can reflect on the reasons for this decline. Was it related to the weakness of Indonesia's energy system? Are volatile world oil prices negatively affecting Indonesia's investment environment? Is there a direct correlation between world energy prices and Indonesia's economic outputs?

Indonesia's economic growth increased in 2016, 2017 and 2018 by 5.03%, 5.07% and 5.17% respectively. Are the reforms in Indonesia's energy system, implemented during this period, directly or partly responsible for this growth? From 2019 to 2020, with the slowing global economy, uncertainty in global financial markets, and a decline in the volume of world trade (particularly during the Covid-19 pandemic), Indonesia's annual economic growth rate went from 5.02% in 2019 to -3.48% in 2020 [93]. Educators and students can discuss how this decrease is likely to undermine the implementation of the RUEN. Indonesia set a target for energy supply of 169 MTOE in 2016, growing to 400 MTOE in 2025, and reaching 1012 MTOE in 2045. The RUEN assumed that economic growth would be stable.

The economic growth assumption is also reflected in the "2045 Indonesian Vision", published by the National Planning Board [11]. Indonesia's economic growth in subsequent years will be supported by increasing domestic demand, including consumption and investment as well as better export growth in the manufacturing sector, which is the country's main energy consumer.

The case snags in this context can evolve around the following questions:

- The 2045 Indonesian Vision and Indonesia's energy transition assume an economic growth driven by increasing domestic demand, including consumption

- and investment. Does economic growth need to be predominantly driven by consumption? There is a debate (e.g. about degrowth) that sustainable development and some principles of consumption are not compatible, because consumed resources are not only scarce but involve exploitation of natural resources [see 94].
- The COVID-19 pandemic has amplified the “resource curse” in Indonesia [see 64,65]. Under what conditions can economic growth be sustainable in Indonesia? Which policy reforms are needed to address this paradox in Indonesia?

The discussion on these case snags can be extended, and include examples from the students’ home countries. Are their countries also confronted with the resource curse? Are efforts being made to find a new paradigm of economic growth that is not solely based on consumption but on created value?

The next step for discussion refers to how stakeholders to economic growth interact with each other. Educators and students should identify which actors are benefiting from the current economic growth paradigm. Are there actors, particularly from the academic community and civil society, who demand a new debate on sustainable economic growth and how it is affected by, or is affecting, Indonesia’s energy transition? Which actors have assumed leadership in furthering a dialogue on economic growth? How is the energy sector participating in this debate? Are there impulses from the energy sector on improving efficiency in the energy demand sector? Are these impulses scalable to other levels? What platforms are available to exchange insights about economic growth and about efficiency in energy demand? Is media (and social media) covering related debates?

The action part of the learning activation approach will most likely refer to policy instruments that aim to increase domestic demand, including consumption and investment. The educators and students should identify some of the relevant policies that aim to improve export in the manufacturing sector, which is Indonesia’s main energy consumer. After identifying these policies, students should evaluate the implementation of these policies. They can come up with a list of the resources needed to implement them as well as resources that are needed to address negative effects of these policies. For example, improving manufactured exports can be achieved by lowering taxes or by eliminating market barriers that were placed to protect Indonesian players. Can these new policies expose Indonesian manufacturers to more competition? Students might also come up with alternative policies, for example by maintaining protectionist policies or by building up domestic consumption of the yields of the country’s manufacturing sector. This could mean introducing new policies that aim to increase the purchasing power of Indonesian households.

4.2.3 The governance context

The governance of any transformation process towards sustainability requires a broader understanding of governance [see 95,96] and that of Indonesia’s energy sector is very complex. In the case study, the following governance-related key areas were introduced, which can be further elaborated by the educators:

- Public finance of sustainable energy transition [see 97,98]
- The role of state-owned enterprises (SEO) throughout the entire energy value chain in Indonesia [see 27]
- The decentralization of Indonesia’s energy system [21,53]

Educators and students can start the reflection by evaluating the current state of Indonesia’s public finance. How much uncertainty is there surrounding public finance? How is Indonesia capable of financing its energy transition? What are the main barriers for the Indonesian government to ensure public investment in the energy sector?

One of the main barriers that will be most likely be identified is Indonesia's dependence on exporting resources. The resource curse is a major barrier to long-term investment due to the volatility of world prices for the resources Indonesia is exporting [see 64,65]. The educators can, for example, connect this discussion with earlier lectures or comparisons with other energy-exporting countries such as Saudi Arabia or the United Arab Emirates. The recognition of the resource curse as a major barrier to energy transition due to the uncertainties in public financing allows the identification of policies that can mitigate the effects of the resource curse. These policies include the diversification of the economy and efficient monitoring of commodity prices. Additional policies can be developed to address the emerging income inequality in Indonesia resulting from increasing trade surpluses.

If the educator were elaborate on the main areas of public finance, the educators and the students could start the discussion by reflecting on the general role of public finance. A debate on a "small government" can warm up the students. What level of state subsidies should the Indonesian government provide for its energy transition? What are the main barriers for the Indonesian government to ensure public investment in the energy sector? The following list of case snags can initiate further discussions:

- Should taxpayers shoulder the debt of Indonesia's state-owned electricity company, PLN with its current short- and long-term debt of an estimated IDR 694.79 trillion?
- Are state subsidies to energy companies reinforcing incompetent management?
- Is the liberalization or privatization of the PLN the effective way to enhance its competitiveness? Should the energy sector remain under state control?

The discussion on these case snags can be also extended to include examples from the students' home countries. Are there good models of privatized energy sectors in their home countries? What are the common challenges these countries need to be resolve?

The next step is to map out the interactions between actors and the processes or structures used to address challenges in public finance. For example, the political framework of Indonesia's energy transition, as stipulated by KEN, RUEN and RUED facilitates the coordination efforts between government agencies such as the Ministry of Energy and Mineral Resources (MEMR) (as the principal agency for the energy transition), Ministry of Public Works and Public Housing and the Ministry of Environment and Forestry. The established National Energy Council brings together seven ministries and energy sector stakeholders to deal with crisis conditions and energy emergencies. The students can learn more about this council and discuss how they cooperate with each other. Which among these council members can be regarded as change agents and which are status quo agents? Are there spoilers? Do they have the necessary resources? Is the MEMR a credible leader?

The action part of the learning activation approach can be executed by looking at current efforts to improve public financing of the energy sector in Indonesia through public-private partnerships (PPTs). Following the Asian financial crisis in the early and mid-2000s, Indonesia implemented a legal and institutional framework that serves as the basis for more private participation in infrastructure construction, finance and management [99]. The educators can discuss the limitations of PPT in sectors that are highly dependent on state subsidies in order to maintain affordability. They could formulate strategies on how this challenge be resolved. For example, they can question how affordability is measured and which threshold is acceptable to the public. They can also discuss whether state-owned enterprises (SOE) such as the PLN can and should act as a private rather than a public partner. Finally, the students can be invited to come up with the BACA or possible alternatives to PPT. If students prefer to stick with PPT, they could focus on how the current PPT framework in Indonesia can be improved. For example, community-based PPTs

(CBP3S) have been introduced in many energy management projects in other countries [100]. Students can also extend the discussion to the PPT efforts in their home countries.

4.3 Further recommendations on teaching Indonesia's energy transition

Educators are recommended to close the teaching of the case study by referring to additional reading and references. Indonesia's case study can be connected or compared to other country case studies. The comparison of Indonesia with other countries that are experiencing similar challenges has empirical value. For example, comparing Indonesia's liberalization of its energy sector to that of the Philippines can lead to valuable insights.

This case study also presented case snags that can help identify concrete examples that could be the subject of further studies or discussions, such as efforts to decouple emissions from energy demand or from economic growth, which can shed more light on emerging debates on degrowth or on sufficiency.

The case study also revealed the need for students to widen their perspectives on various issues. It is recommended that educators conclude by facilitating a feedback round in which students (preferably in smaller groups) answer the following questions:

- What was my connection to the energy issue before and did I discover new connections through the Indonesian case study?
- Have I learned something new through the Indonesian case study that changed my view or position on one issue?
- Did the Indonesian case study lead me to understand better the challenges confronting my home country?
- Did I discover something from the Indonesian case study that can be applied to my home country?
- Are there other areas of interest in each context that are also important and that should be further discussed?
- Have I come up with a BACA that I never thought of before and of which I am now a "fan"?
- How I learned something important by listening to the views or perspectives of my classmates?

5. Conclusion - Addressing Indonesia's specific challenges for a transition towards clean and green energy

Indonesia's energy transition is complex. Nevertheless, it is unique due to Indonesia's local realities. Energy is a sensitive issue for most developing countries. Indonesia is no different. Energy is subjected to political, societal, and ecological considerations such that addressing it requires a holistic and transdisciplinary approach. Because it touches different justice and equity issues, energy policies need to be outcomes of public debate and consultation. Above all, in order to implement energy transition, the government of Indonesia must take into account the realities of increasing energy demand and the availability of both fossil and non-fossil energy sources. Because Indonesia has committed to GHG mitigation, the government explores ways to deploy renewable energy while minimizing the intermittency factor. The challenges of the transition towards clean and green energy include: Indonesia's abundant stock of gas and coal, production and price of oil and gas, the need for infrastructure to ensure reliable and affordable energy access across more than 17,000 islands, import of oil and LPG, cost of renewable energy utilization, energy efficiency and conservation, ensuring sufficient science and technology expertise, geopolitics and environment, and the national energy reserve.

For many countries, particularly for those in Southeast Asia, Indonesia has been a role model. Indonesia used to be an oil exporter, but after 2000 it became a net importer as its production declined, though it does meet much of its own energy needs from indigenous oil and coal production. Despite this, Indonesia still maintains a strategic position in the region, because of its size, abundant fossil, non-fossil energy and other sources. Indonesia is trapped in various carbon lock-ins through which shifting to renewable energy entails high transaction costs that are difficult to justify. As long as Indonesia’s economic architecture is heavily dependent on fossil fuel, the extent of the country’s ability to expand the use of renewable energy remains questionable. At the same time, Indonesia’s GHG emissions are one of the highest in the world. Its energy demand continues to increase due to its rapid economic development and increasing population. Therefore, from the perspective of climate mitigation, Indonesia needs additional impulses, in particular to break these carbon lock-ins.

Exacerbating the challenges to Indonesia’s energy transition is the COVID-19 pandemic. Apart from current energy transition issues, Indonesia has hardly tried to achieve the target that has been set. However, due to the pandemic and a decline in economic growth, Indonesia must face the fact that it needs to recalculate its target in terms of current conditions. This could mean further adjustments in Indonesia’s climate mitigation goals. Mitigation measures that have been set and delivered to UNFCCC must be kept, but this could be done, for example through the strategy of focusing only on two major sectors: electricity and transportation.

Indonesia’s energy transition is, as this case study indicates, a pragmatic endeavor. Its academic value lies in its relatability and its function as a role model for other developing countries, particularly those that seek to find the “sweet spot” between global GHG emissions reduction commitments and a transition towards reliable and affordable energy.

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Appendix

Appendix A1. Characteristics of the Indonesian Energy System (data sources: DEN [21,29], IEA [8,9,101], IRENA [102], MEMR [17])

Indicators	Indonesia
Population [29]	270.2 million (2019)
Size [17]	1,916,906.77 km ²

Gross National Income (GNI), atlas method (current USD)	USD 4,050 (2019)
GNI per capita [17]	IDR 59,054,440 (2019)
Gross Domestic Product (GDP)	USD 1.2 trillion (2019)
Unemployment rate [17]	5.6% (2019)
Total primary energy production (2019) [29]	411.6 MTOE (2018) (64% of which exported)
Total final energy consumption (without biomass) [29]	114 MTOE (2018)
Energy intensity per capita [101]	29.82 (MMBtu/person) (2018)
Primary energy supply [17,29]	1,559,295 thousand BOE (2019)
NRE (share in primary energy supply mix) [17]	9.18 % (2019)
Oil (share in primary energy supply mix) [17]	35.03 % (2019)
Coal (share in primary energy supply mix) [17]	37.28 % (2019)
Gas (share in primary energy supply mix) [17]	18.51 % (2019)
Total renewables installed capacity (both on-grid and off-grid)	10.17 GW [38] Hydropower: 5.4 GW Geothermal: 2.13 GW Bioenergy: 1.9 GW Mini/micro hydro: 464.7 MW Wind: 148.5 MW Solar PV: 152.4 MW Waste power plant: 15.7 MW
Final energy consumption [17]	1007.26 million BOE (2019)
Primary energy supply per capita [17]	5.92 BOE/capita (2019)
Primary energy consumption per capita [17]	3.53 BOE/capita (2019)
Provision of power plants [29]	66.8 GW (2018)
Electricity production in TWh [18]	295 TWh (2019)
Electrification ratio [29]	98.81 % (2018)
Per-capita electricity utilization [29]	1,077 KWh (2018)
Reduction of final energy intensity [29]	1% annually (2019)
Ratio of household gas consumption [29]	85% (2015)
Self-sufficiency level (% of TPES) [18]	195% (2018, since 2018 increasing)

No. of people directly employed in the RE sector [102]	519,200 (incl. 494,400 in liquid biofuels and 17,800 in hydropower) (2020)
Share of nuclear energy in %	None
CO ₂ emissions (metric tons per capita) [17]	1.7 tonnes CO ₂ equi., per capita (2018)
GHG emission level (metric tons) [17]	532 tonnes (2018) – <i>an increase of 313% on 1990 levels</i>
Share of global carbon emissions [9]	1.68% (2018)

Appendix A2. Costs & benefits of Indonesia's energy transition [103]

	Production activity	Saving activity	Mitigation (million tonne CO ₂)	Estimated cost (IDR trillion)
Electric NRE	48.9 GW		156.6	1,688.0
Non-electric NRE	Biodiesel: 9.2 million KL Biogas: 19.4 million m ³		13.8	84.0
Energy conservation		117 TWh	96.3	92.3
Clean technology	102 GW		31.8	1,619.0
Oil and gas	LPG and kerosene conversion: 5.6 million ton Gas station: 143.75 MMSCFD Gas networks: 2.4 million SR		10.0	16.6
Reclamation	145,200 Ha		5.5	4.0

Appendix A3 Selected contexts of the Indonesian energy transition – Learning Activation Approach

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Context	Reflection		Interaction		Action	
	Key areas	Case snags	Stakeholders	Structures & processes	Needed resources	Best Alternative to Chosen Action
Geophysical and ecological context	coal energy	international assistance on	policy entrepreneurs	policy cycle	infrastructures	CCS
	archipelagic statehood	mitigation	role of non-state actors	clearing houses for is-	technological innovation in	energy subsidies
	vulnerability to climate change	CCS	urban vs. rural	lands	CCS	emission trading
		public acceptance of coal	peripheries	coordination with other	policies to ensure reliability	carbon pricing
		deployment of RE		archipelago/	and affordability of energy	energy efficiency im-
		poverty-energy and educa-		island nations		provement
		tion-energy nexus				
		technological innovation				
Economic development context	post-pandemic economic	new paradigms of economic	public and private sec-	national development	policy instruments that aim	improving purchasing
	growth	growth	tors	planning	to ease trade relations	power of domestic house-
	bioenergy as driver of eco-	post-COVID 19 recovery	exporting sectors (e.g.			holds
	nomic growth	resource curse	manufacturing)			
	decoupling emissions from		public sector			
	economic growth		non-state actors			
	sustaining economic growth in		subnational actors (cit-			
	an archipelagic state		ies and regions)			
Governance context	public finance	liberalization or privatiza-	government agencies	National Energy Council	public-private partnerships	community-based PPT
	SOEs	tion of energy sector	state-owned enterprises	framework established by	digitalization	roll-back of liberalization
	decentralization of the energy	state subsidies to SOEs such	stakeholders to the en-	REN	diversification	decentralization of the
	sector	as PLN	ergy sector	RUEN & RUED	modernization of infrastruc-	energy sector
					ture	

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