Project Clean, Affordable and Secure Energy (CASE) for Southeast Asia
Presents

Start from Here: Understanding Energy Transition in Indonesia

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Project Clean, Affordable and Secure Energy (CASE) Indonesia
on behalf of Project CASE for Southeast Asia

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Start from Here : Understanding Energy Transition in Indonesia

Introduction to CASE Program
The regional programme, "Clean, Affordable and Secure Energy for Southeast Asia" (CASE), is jointly implemented by GIZ, and international and local expert organizations in the area of sustainable energy transformation and climate change: Agora Energiewende and NewClimate Institute (regional level), the Institute for Essential Services Reform (IESR) in Indonesia, the Institute for Climate and Sustainable Cities (ICSC) in the Philippines, the Energy Research Institute (ERI), Thailand Development Research Institute (TDRI) in Thailand. These organizations have set the objective of changing the narrative for energy transition. In Indonesia, CASE is anchored to the Ministry of National Development Planning/National Development Planning Agency (Bappenas) – Directorate of Electricity, Telecommunications and Informatics, and jointly implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Institute for Essential Services Reform (IESR)

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Forewords from Bappenas

Indonesia is committed to support climate change control efforts through the reduction of its greenhouse gas emissions (GHG). According to the Enhanced Nationally Determined Contribution (ENDC) submitted in 2022, Indonesia aims to reduce GHG emissions by 31.89 percent from the Business as Usual level by 2030 with its own efforts or 43.2 percent with foreign assistance, ultimately achieving zero emissions by 2060 or earlier.

One of the efforts to reduce GHG emissions is by transitioning from fossil fuel-based power generation to renewable energy. This energy transition will result in changes in various aspects, such as employment opportunities, development scenarios, and other aspects. Therefore, the right strategy is needed to identify current and future challenges to ensure a just energy transition can take place.

The public plays a significant role in accelerating Indonesia's energy transition. Therefore, it is necessary to increase public understanding and knowledge of the importance of this energy transition program. It is hoped that this book can provide a lot of information and introduce energy transition in Indonesia. Community participation is always encouraged in line with the development planning process carried out by the Ministry of National Development Planning/Bappenas, especially through the Directorate of Electricity, Telecommunications, and Informatics. It is expected that this participation can provide input in the preparation of national development planning documents, both in Long-Term, Medium-Term, and Government Work Plans.

We would like to express our appreciation and highest gratitude to GIZ and IESR through the CASE Program for their excellent cooperation in the writing of this book. We also extend our thanks to all the staff in the Directorate of Electricity, Telecommunications, and Informatics who actively participated in the preparation of this book. Hopefully, this book can benefit the Indonesian people widely so that the energy transition in Indonesia can be achieved.

Jakarta, May 2023
Director of Electricity, Telecommunications, and Informatics Ministry of National Development Planning/Bappenas

Dr. Ir. Rachmat Mardiana, M.A.

Forewords from GIZ

In a rapidly developing world, how we harness and use energy becomes a critical determinant of our collective future. As we contemplate the complexities of modern life, it becomes clear that our dependence on fossil fuels is neither sustainable nor conducive to a healthy environment or life. **"Start from Here : Understanding Energy Transition in Indonesia"** emerges as a guiding light, illuminating the path toward a more sustainable and equitable energy landscape for Indonesia.

In collaboration with IESR in the Clean, Affordable, and Secure Energy (CASE) Program for Southeast Asia, GIZ Indonesia proudly presents a comprehensive exploration of the energy transition in Indonesia.

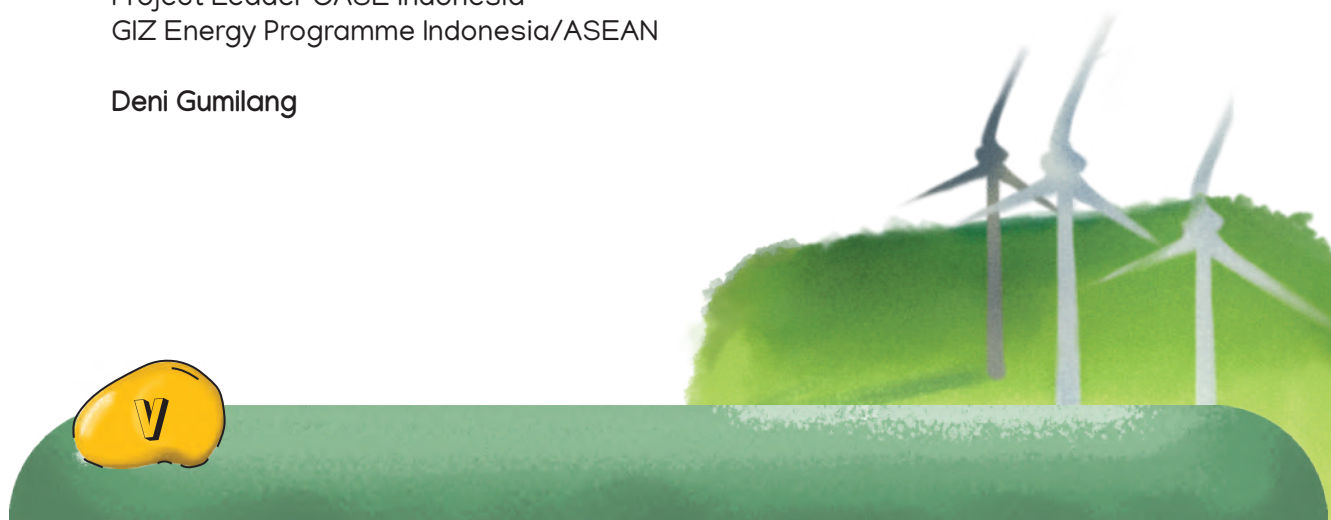
Through the pages of this book, we will embark on a journey through time, retracing the evolution of energy consumption and its impact on Indonesia's fundamental growth. From the early days of development to the latest waves of technology and information, this book navigates the journey of energy usage to its potential in a highly promising future.

"Start from Here : Understanding Energy Transition in Indonesia" offers an informative guide and a call to action. This book is a testament to the power of collective knowledge, emphasizing the vital role played by every individual in steering Indonesia towards an electricity-based future sourced from renewable energy.

GIZ, as a form of cooperation by the Government of the Federal Republic of Germany that supports a good and sustainable quality of life, has implemented various energy projects under the Indonesia/ASEAN Energy Program. We invite you: the current and future generations, to embark on an enlightening journey with us – a journey to uncover the past, understand and live the present, and sow the seeds of sustainability for Indonesia.

Jakarta, May 2023
Project Leader CASE Indonesia
GIZ Energy Programme Indonesia/ASEAN

Deni Gumilang



Forewords from IESR

Welcome to an enlightening journey through the pages of "**Start from Here : Understanding Energy Transition in Indonesia.**" This book is an exploration of Indonesia's energy landscape and the urgent need to transition from fossil to renewable energy systems.

As the Executive Director of Institute for Essential Services Reform (IESR) and the Project Lead for CASE, I am proud to present this book as part of the CASE Program, which aims to raise awareness and public understanding of energy transition in Indonesia, to all of you.

Energy plays a significant role in shaping human civilization. Discoveries like fire, steam engines, and electricity have triggered industrial revolutions and transformed how humans utilize energy resources, propelling us into the modern era. This book embarks on an insightful journey through a brief history, delving into the intricacies of energy use, the interconnectedness of energy, economy, and society, and explaining the importance of replacing fossil energy with renewables.

Fossil energy has indeed shaped civilization and economic progress, but at the same time, it has caused pollution, soil and water contamination, global warming, and even global boiling as the Earth's temperature rises. We are now at a critical juncture that will determine the future of civilization and the fate of humankind. The destiny of all nations, including our own, lies in our success in accelerating sustainable development, reducing fossil energy combustion, and decarbonizing the energy system that has been the primary energy source for the past two centuries.

Through this book, we aim to empower every citizen with the knowledge needed to understand the importance of energy transition and inspire collective action to participate in a process that compels our government and energy planners to take ambitious steps in advancing clean energy utilization and reducing dirty energy, providing affordable, reliable, and sustainable energy access for all of us.

Jakarta, May 2023
Executive Director of IESR

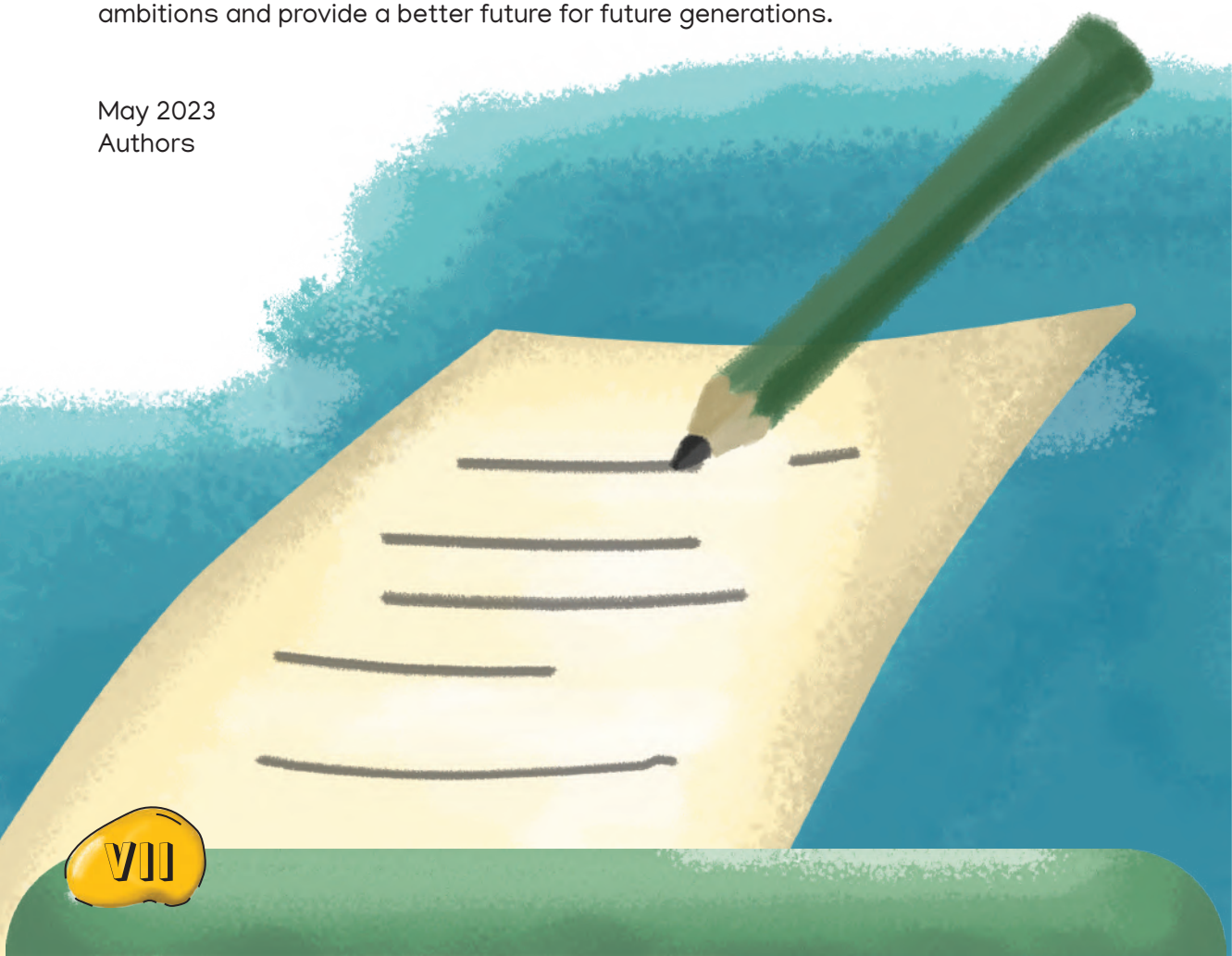
Fabby Tumiwa

Introduction from the Authors:

Energy transition is a hot topic that is starting to be covered more in the Indonesian media. Unfortunately, this topic is still unfamiliar, undiscussed, and not well-understood, except within a limited audience. This is because of the lack of information and knowledge dissemination about energy transition for the general public, especially in simpler language. However, the reality is that energy transition will impact all layers of society. Therefore, to present a summary of various issues related to energy transition in a more understandable language, especially in Bahasa Indonesia, the CASE Program has written a book entitled "**Start from Here : Understanding Energy Transition in Indonesia.**"

This book has eight chapters that comprehensively discuss energy topics, including definitions of energy, types of energy, the impact of energy use, and the urgency of transitioning from fossil to renewable energy. This book is compiled to provide readers with a deeper understanding of energy, especially the energy used in Indonesia, and why Indonesia needs to undergo an energy transition. With increased understanding of energy transition in each individual, the hope is that the public can actively contribute as agents of change to help Indonesia achieve its climate ambitions and provide a better future for future generations.

May 2023
Authors



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What is Energy?

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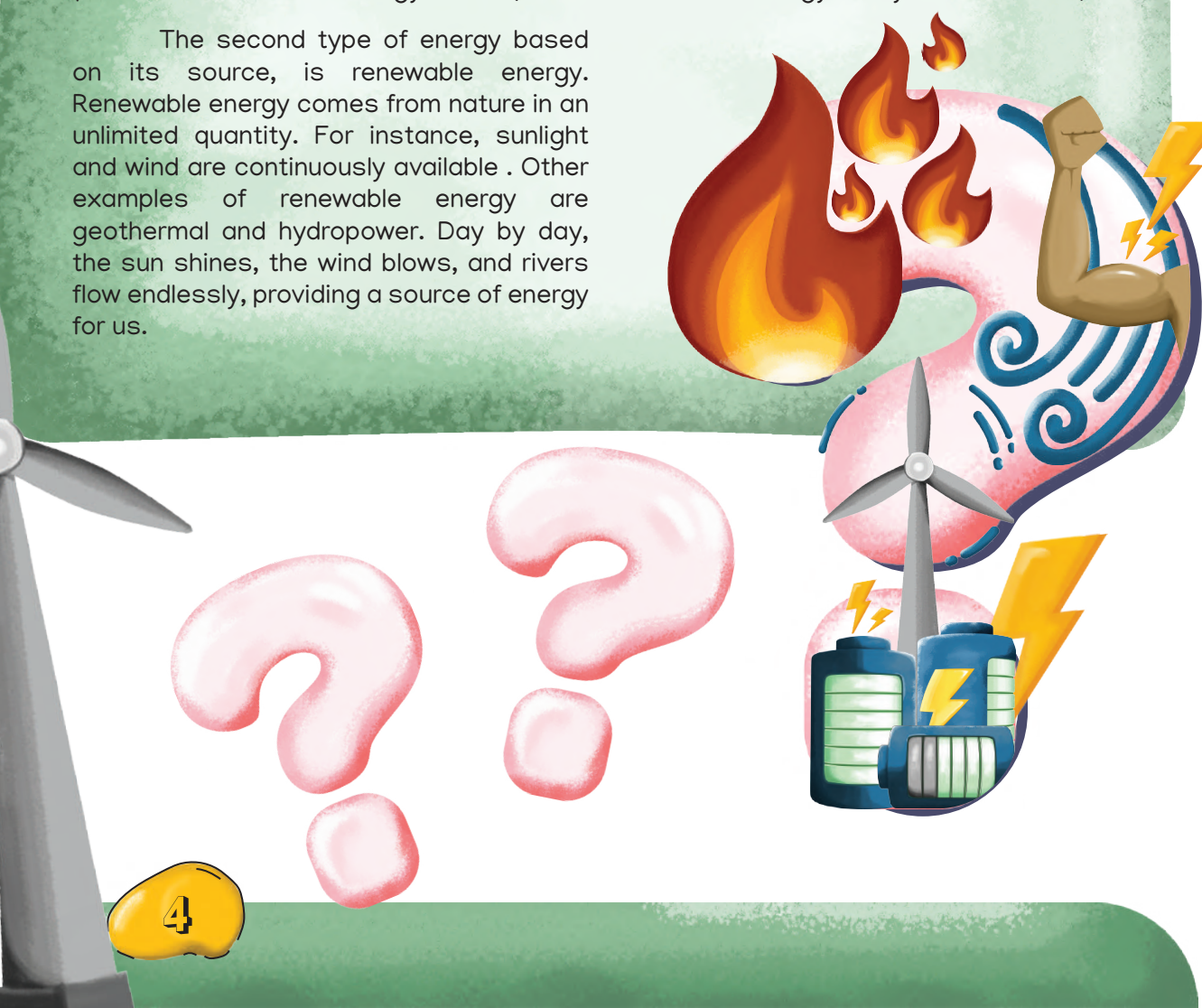
1. What is Energy?

1.1 Definition, Types, and Sources

Energy, in general, is defined as the ability to do work or exert effort. There are six fundamental forms of energy: chemical energy, electrical energy, radiation energy, mechanical energy, thermal energy (heat), and nuclear energy. On the basis of their sources, there are two types of energy: non-renewable energy and renewable energy. Non-renewable energy is a source of energy that can be depleted and cannot be readily replenished within our lifetime. These energy sources require an exceptionally long time to become available again. Why? Because these energy sources originate from fossilized plants and animals buried deep within the Earth - hence, non-renewable energy is often referred to as fossil energy. To this day, fossil energy remains the primary source of energy for fuel, such as coal, petroleum, and natural gas, supplying approximately 80 percent of the world's energy needs (Environmental and Energy Study Institute, 2021).

The second type of energy based on its source, is renewable energy. Renewable energy comes from nature in an unlimited quantity. For instance, sunlight and wind are continuously available . Other examples of renewable energy are geothermal and hydropower. Day by day, the sun shines, the wind blows, and rivers flow endlessly, providing a source of energy for us.



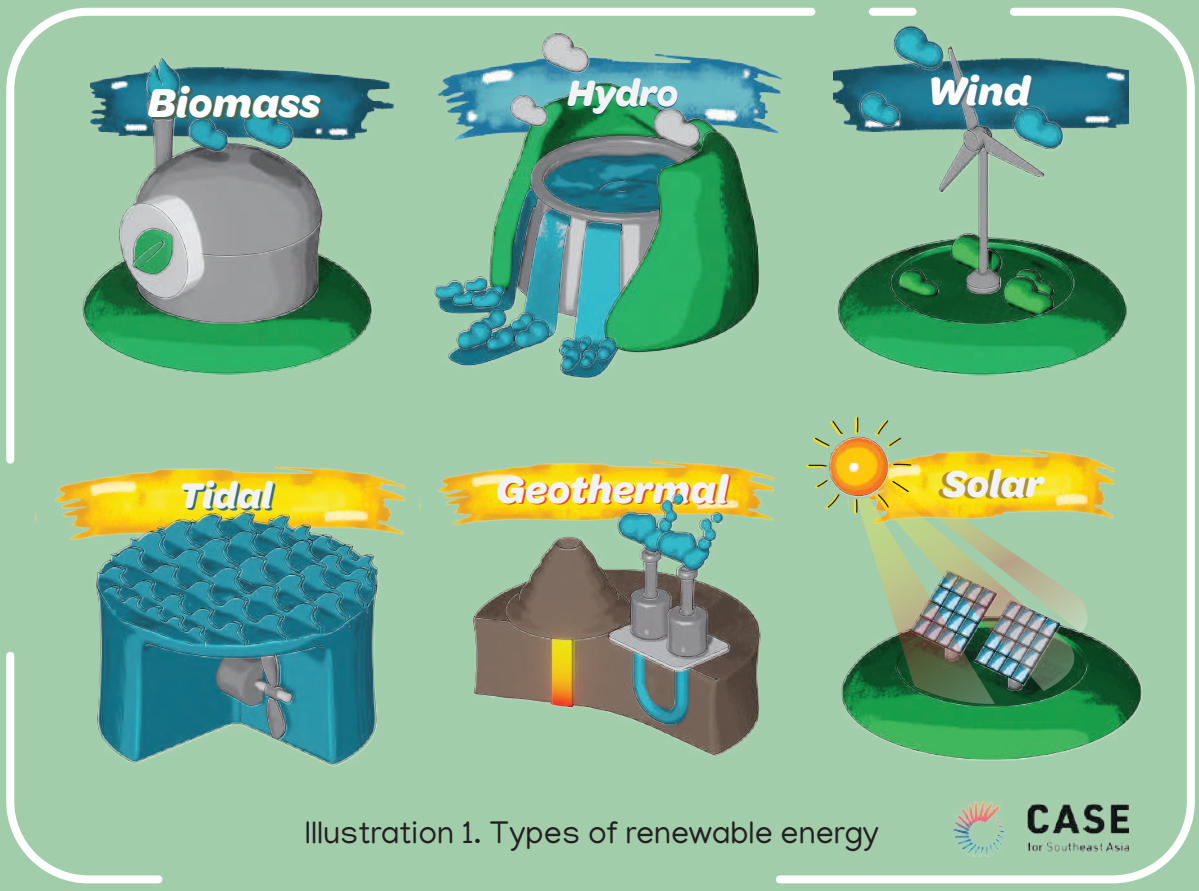


Illustration 1. Types of renewable energy

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1.2 Energy Conversion

Each basic form of energy mentioned above can be transformed into other forms, a process known as energy conversion. Essentially, energy that is available in nature that has not changed in form is referred to as primary energy. The results of the conversion of primary energy into other forms are known as secondary energy. A simple example is the change in energy that occurs in a campfire.

A burning fire is the result of the conversion of the chemical energy in wood into thermal energy and radiation. The process of changing the form of energy can also be seen in the use of fossil fuel in vehicles. Burning petroleum results in chemical energy being converted into mechanical energy, allowing motor vehicles to move.

Human ability to perform energy conversion has had a significant impact on the advancement of civilization. In ancient times, most tasks had to be carried out manually, which took more time. For instance, plowing fields in the time before the invention of plowing machines.

At that time, farmers had to plow fields manually or utilizing animal power. Now, with the technology of plowing machines that convert chemical energy from fuel into kinetic energy, farmers can save time and effort.

Illustration 2. Energy conversion in everyday life

Both non-renewable and renewable energy can be converted. Most non-renewable energy is converted into fuel. It is important to note that the conversion of non-renewable energy sources results in greenhouse gas emissions (Greenhouse Effect is a term used to describe a condition in which the Earth's atmosphere traps heat from the sun, causing the Earth's temperature to rise. Further explanation on the greenhouse effect can be found in Chapter 2.) and air pollution that are harmful to the planet. If we look back at the two examples mentioned earlier - the combustion of petroleum for vehicle fuel and the use of plowing machines - although both expedite processes, they utilize fossil energy sources, and their combustion processes produce greenhouse gas emissions and pollution. As an alternative, renewable energy can serve as a clean energy source that can be converted without generating emissions. Some examples of converting renewable energy sources into secondary energy, such as electricity, include:

1.2.1 Hydropower

Hydropower energy sources can generate electricity using a hydroelectric power plant, which converts the kinetic and potential energy of flowing water into electricity. In a hydroelectric power plant system, flowing water is utilized to turn a turbine. The rotating turbine drives a generator, ultimately producing electricity. Hydropower technology can be used on both small and large scales, depending on the potential availability of water energy.

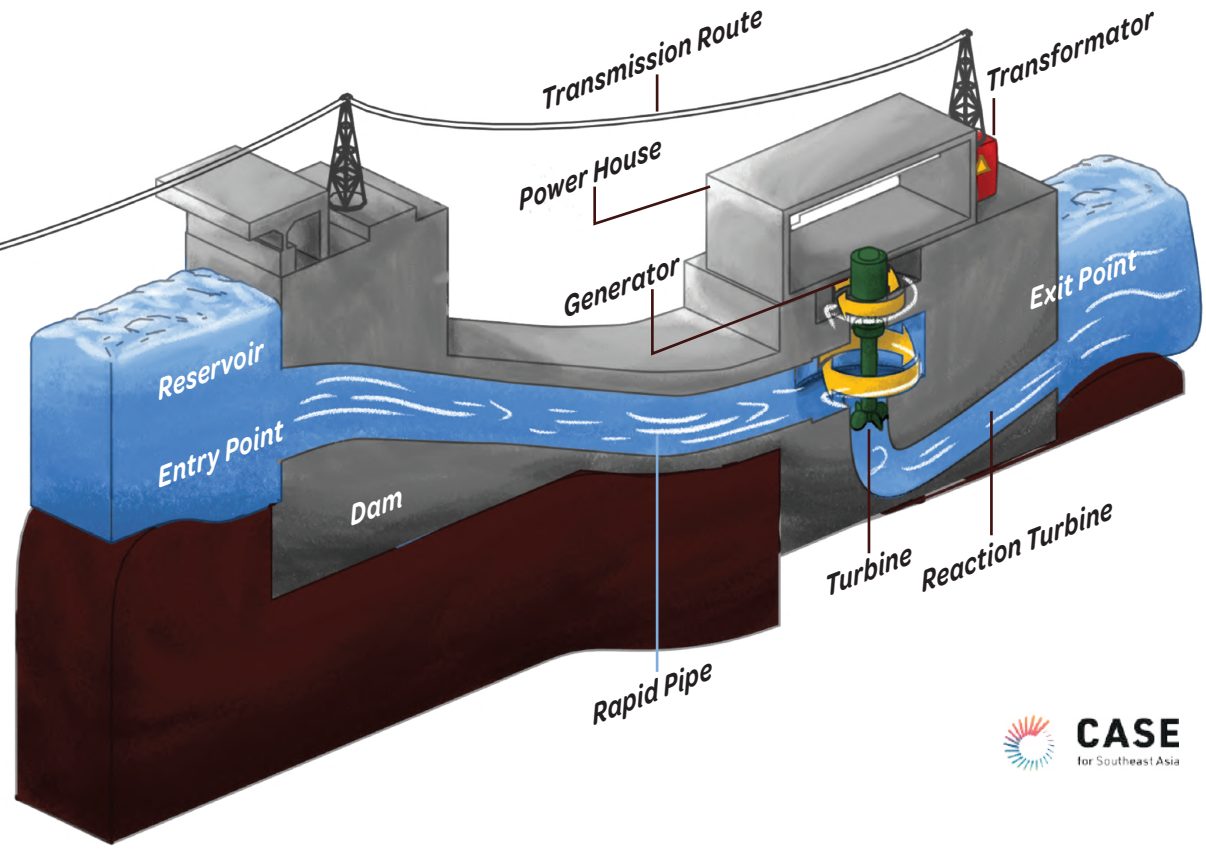
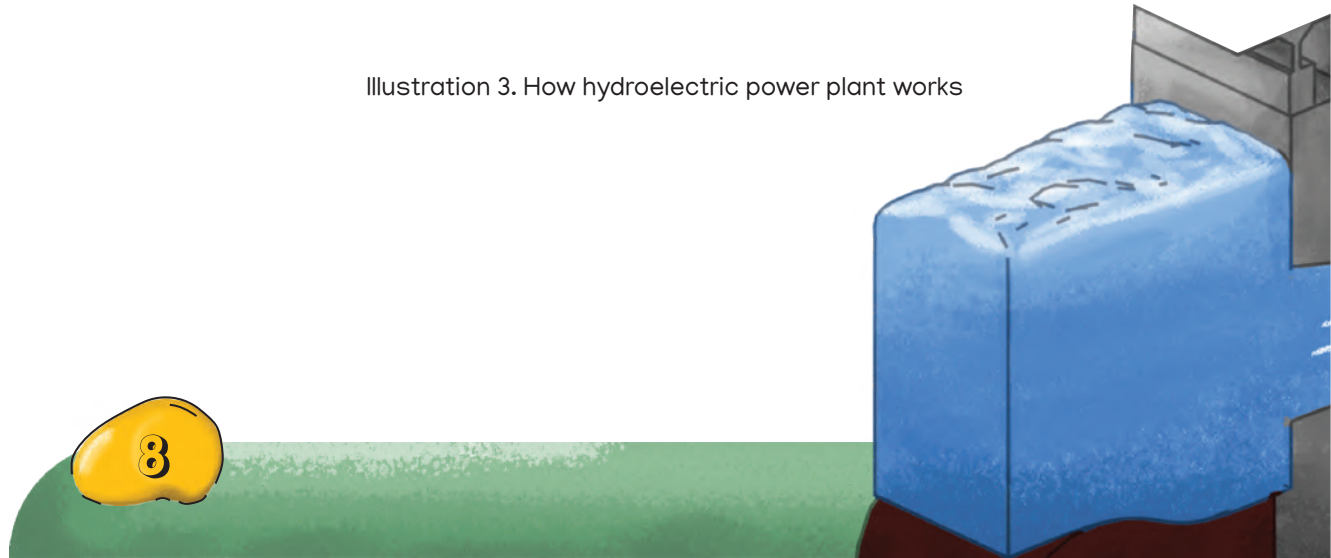


Illustration 3. How hydroelectric power plant works



1.2.2 Wind Energy

Wind energy sources can be converted into electricity through a wind power plant. In a wind power plant, the kinetic energy of the wind rotates a turbine or windmill. This turbine then drives a generator, resulting in electricity production.

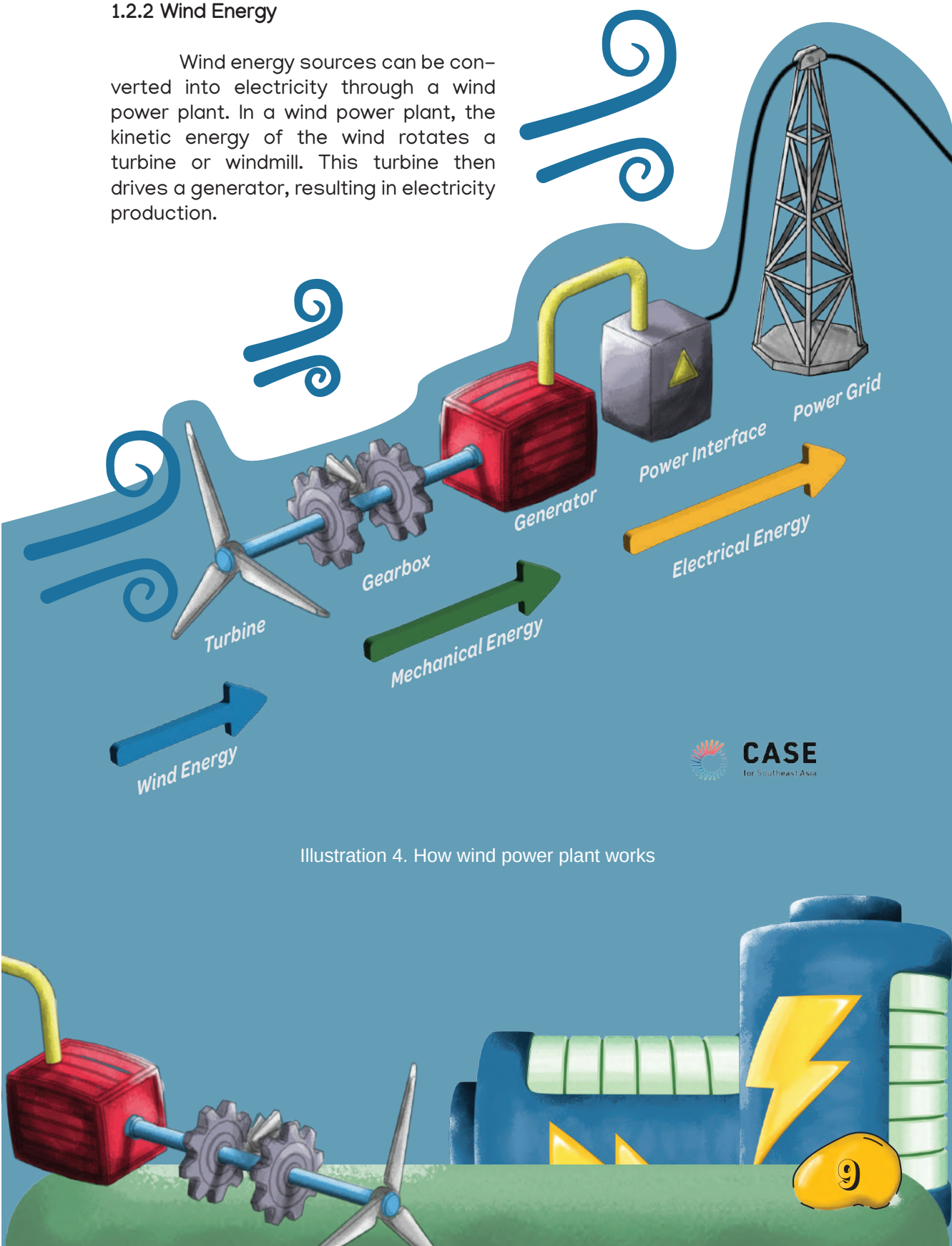
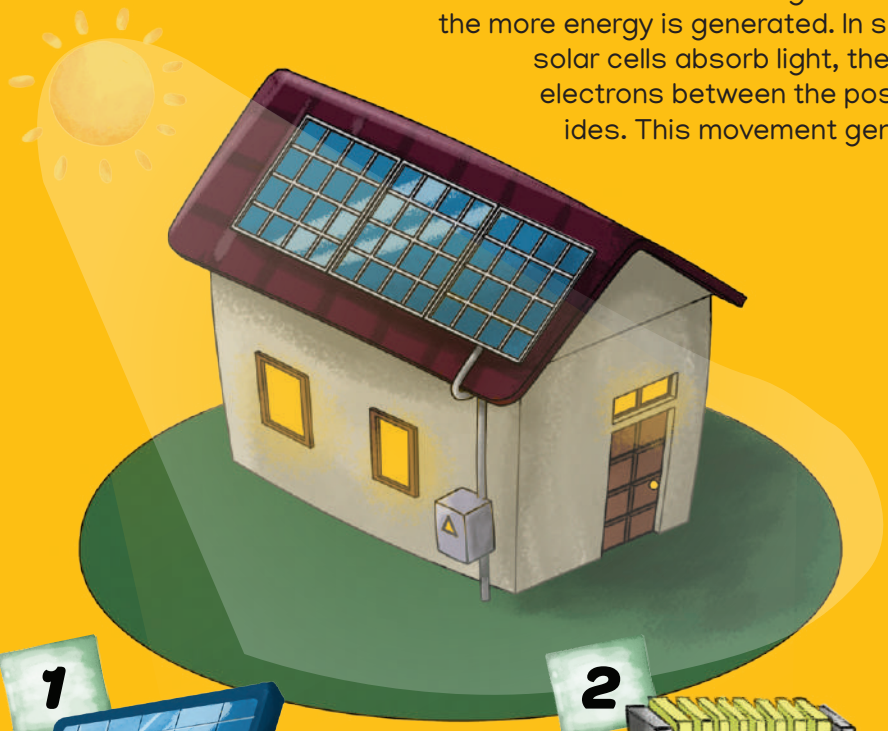


Illustration 4. How wind power plant works

1.2.3 Solar Energy

Solar energy, or energy derived from sunlight, can be converted into electricity using photovoltaic (PV) solar panel technology. Solar panels consist of multiple solar cells arranged to capture and convert large amounts of sunlight. Solar cells are responsible for absorbing sunlight. These cells comprise various photovoltaic components or components that can convert light into electricity.

The more solar cells arranged to form a solar panel, the more energy is generated. In simple terms, when solar cells absorb light, there is movement of electrons between the positive and negative ides. This movement generates electricity.



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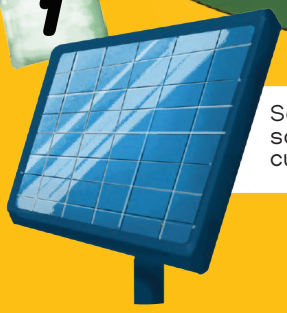
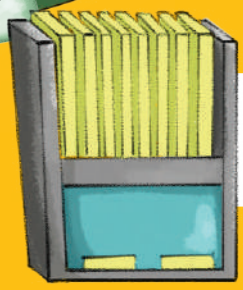


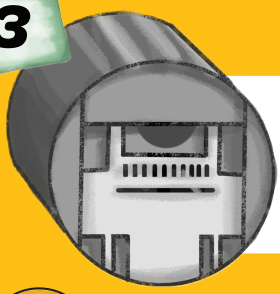
Solar panels convert solar radiation into direct current (DC) electricity.

2



An inverter converts direct current (DC) into alternating current (AC) for use in homes.

3

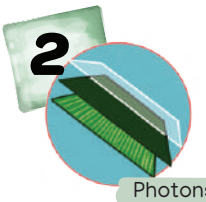


The inverter prioritizes the use of electricity from solar panels first and supplements it from the grid when needed

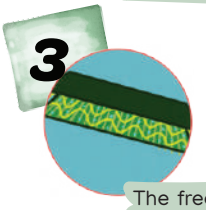
4

When solar panel production exceeds demand, the surplus kWh can be exported to the grid.

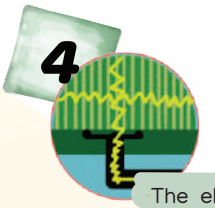
Sunlight consists of tiny particles called photons



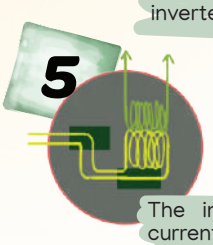
Photons interact with solar panels releasing electrons from silicon atoms within the solar cell.



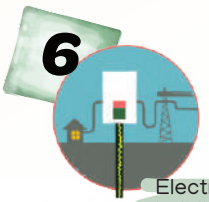
The freed electrons are now free to move, creating an electric current from positive and negative charges present. They the pass through the solar cell layers.



The electric current flows to the edge of the panel into conductive wire leading to the inverter



The inverter converts direct current (DC) into alternating current (AC) used to supply electriicity.



Electricity is then transferred to the building if solar panels are connected to a utility meter, excess power is transferred to the utility grid. This causes the meter to run backward, giving the property credit for surplus electricity.

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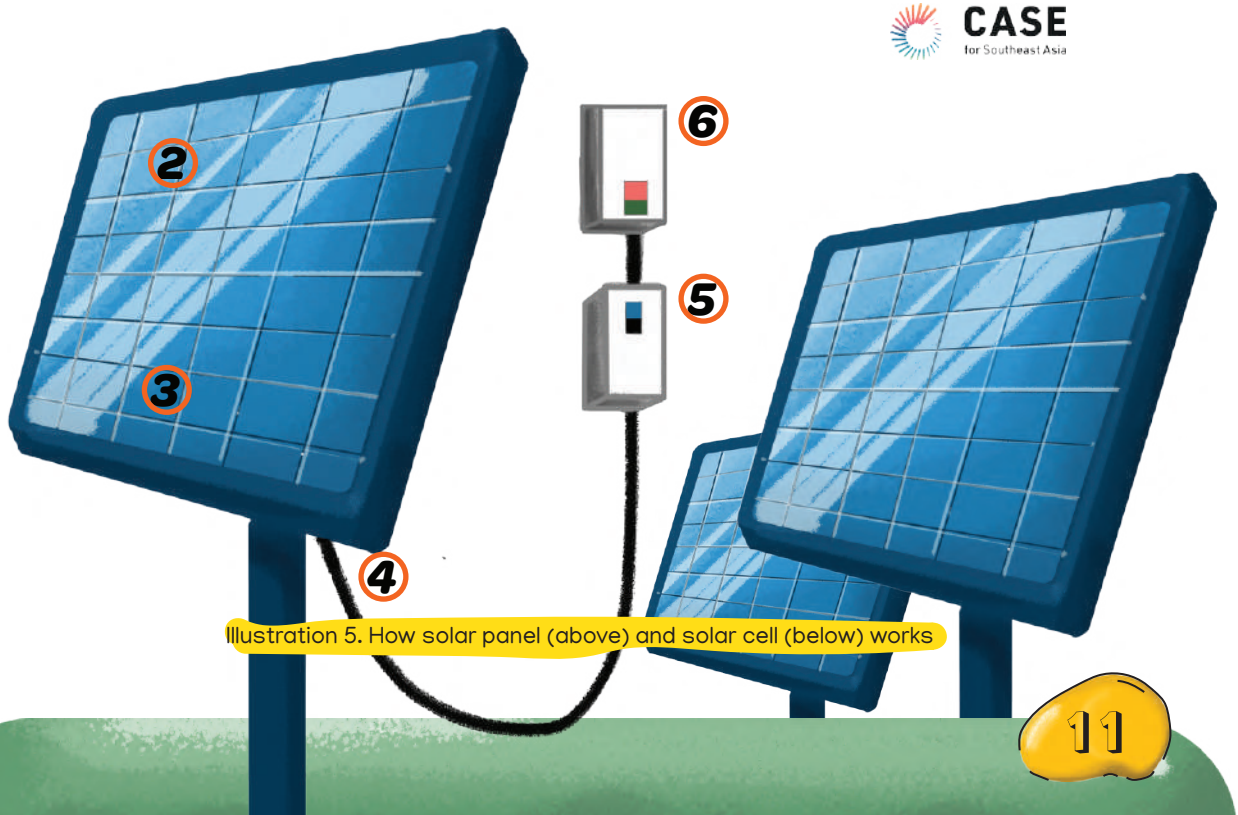
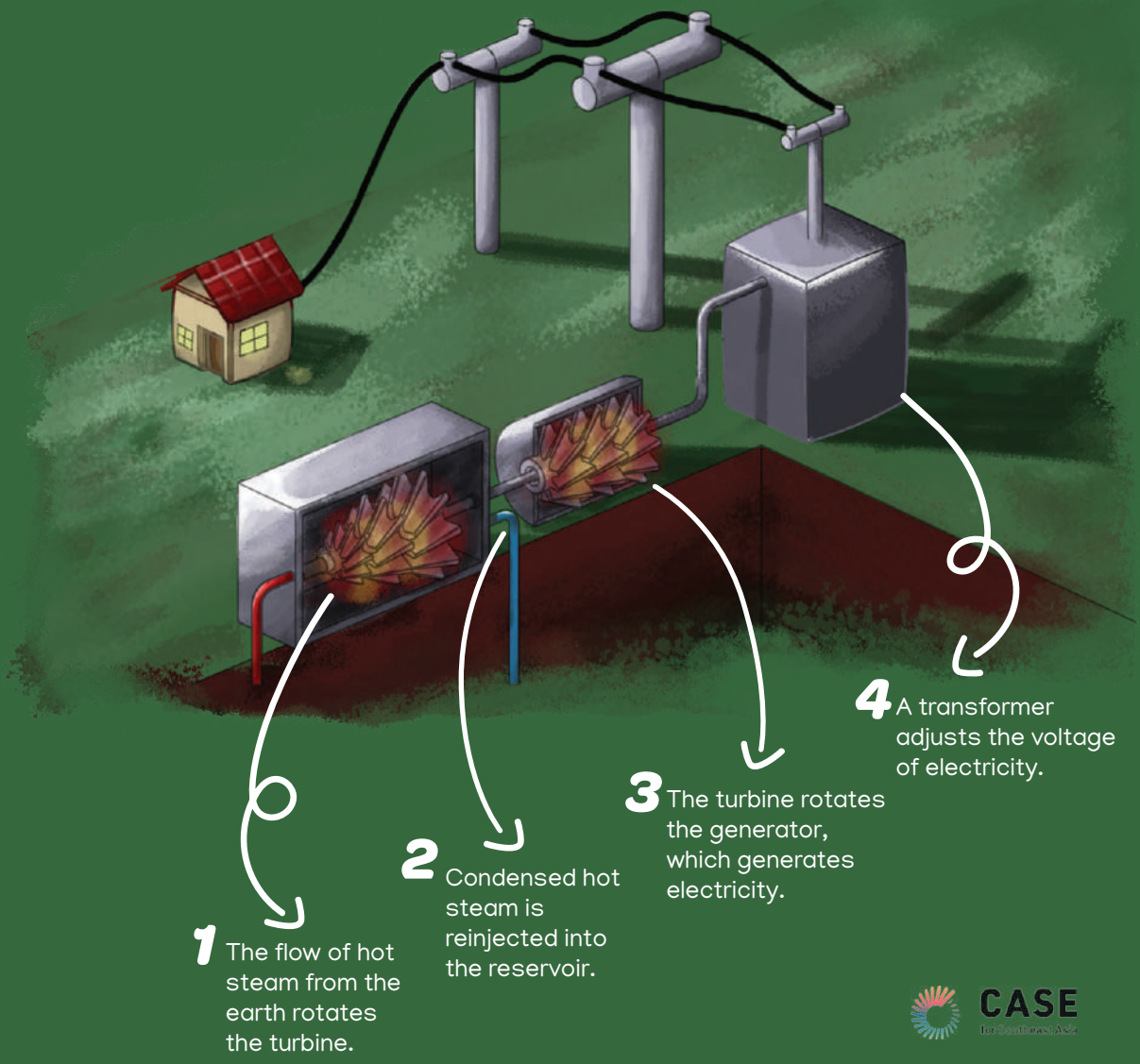


Illustration 5. How solar panel (above) and solar cell (below) works

1.2.4. Geothermal Energy

Geothermal energy can be converted into electricity using a geothermal power plant system. The principle of geothermal power plant operation is to use the earth's hot steam to drive a turbine. The turbine then drives a generator that produces electricity.



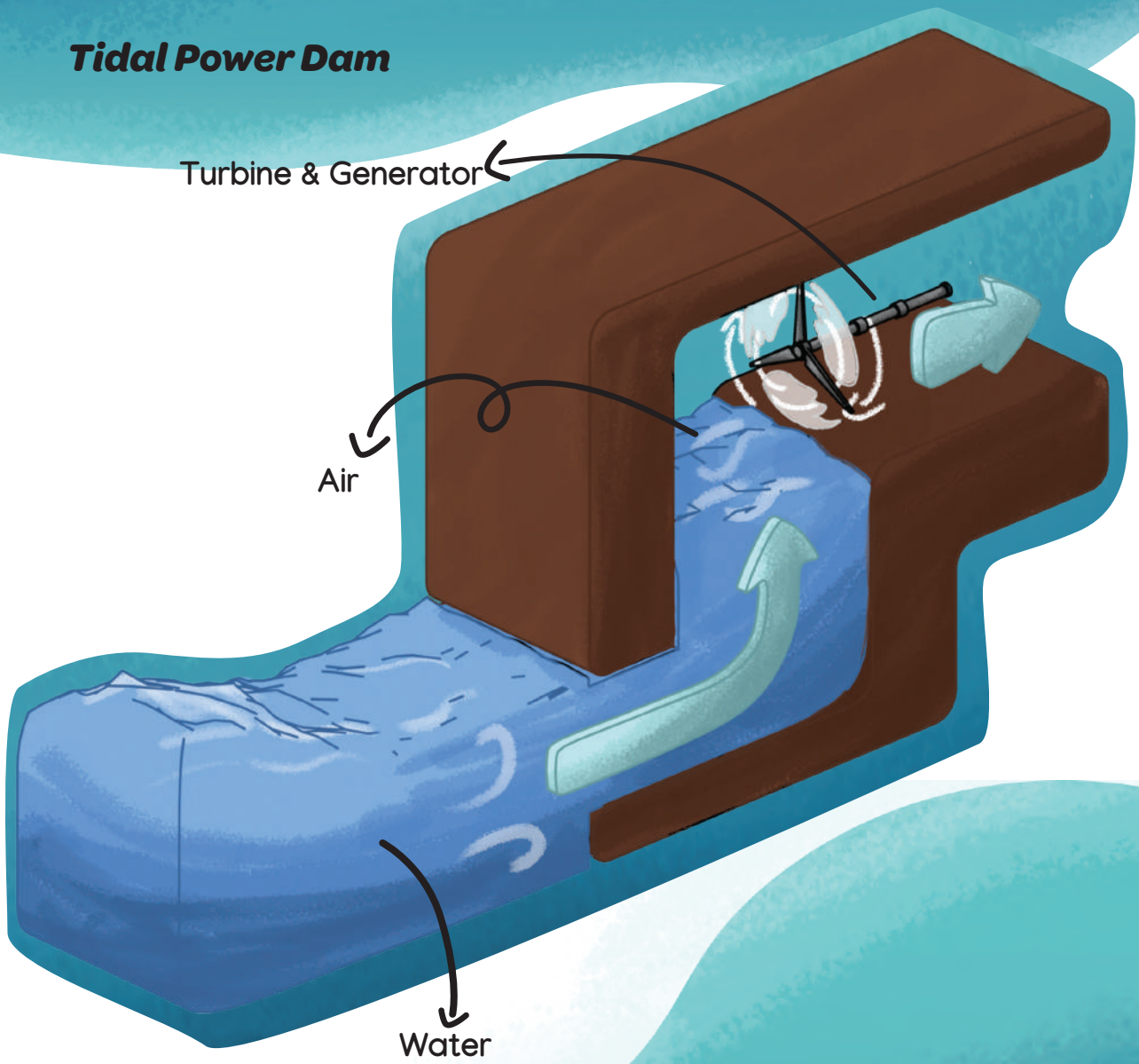
*Geothermal power plant has several types of generator technology to be used depending on the source of the geothermal.

Illustration 6. How geothermal power plant works

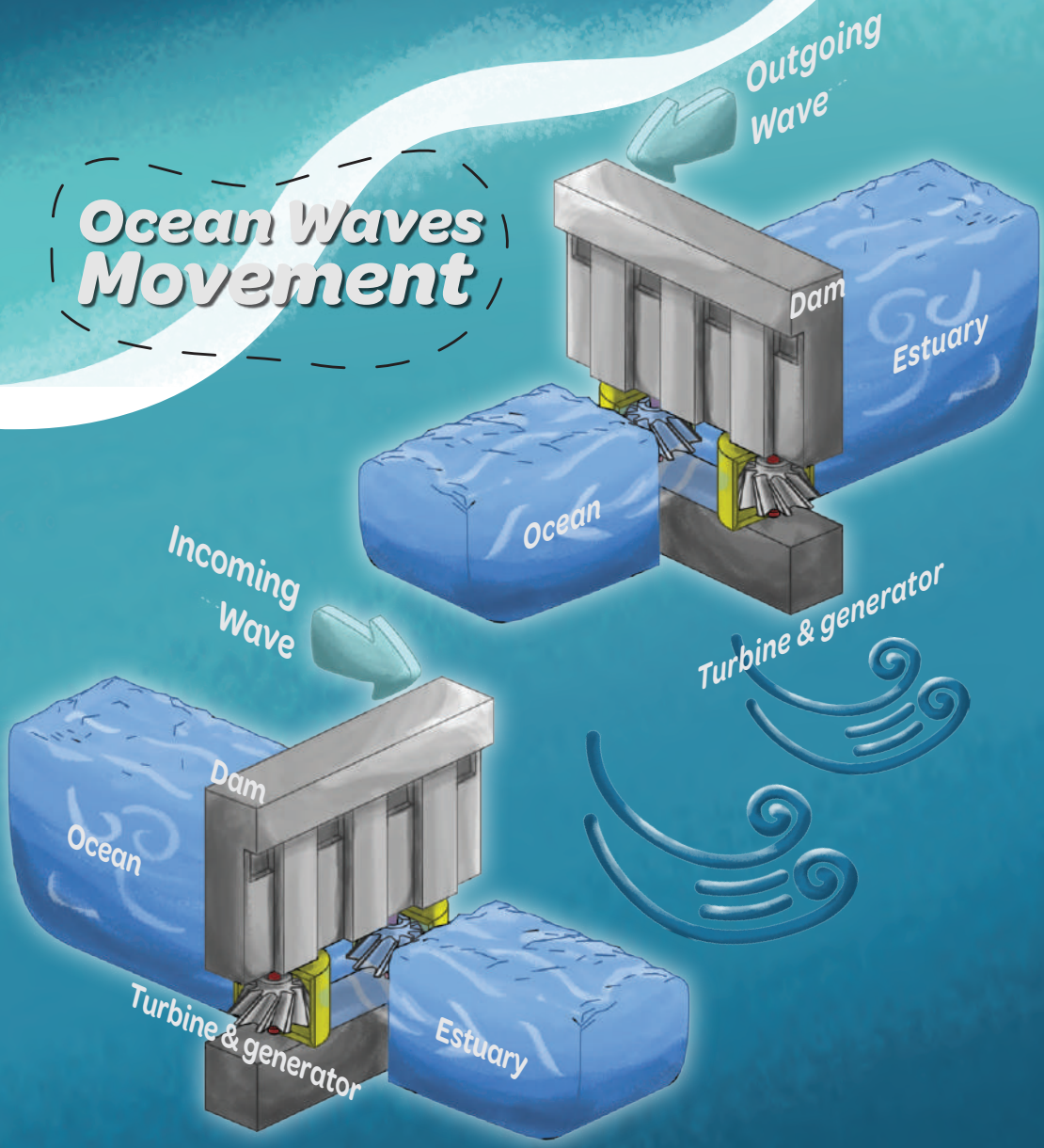
1.2.5. Ocean Energy

Ocean energy is generated from the movement of the ocean . The operation of ocean energy is similar to hydropower, which uses the movement of water to drive a turbine. Generally, the potential for ocean energy that can generate electricity can be divided into three types of potential energy: tidal power, wave energy, and ocean thermal energy.

Tidal Power Dam



Ocean Waves Movement



Ilustration 7. How water column oscillations power plants work using wave motion (left) and how tidal power dam power plants work (right)

These five examples are technologies for generating electricity by converting renewable energy sources into electricity. Compared to burning non-renewable energy sources like oil and coal, electricity generation from renewable energy sources does not produce emissions and pollution. Now that we know where our energy comes from, what about its use in our daily lives?

1.3. How People Use Energy in Daily Activities

Before the discovery of electricity, utilizing energy in daily activities required significant effort. For lighting, people had to hunt whales, extract their oil, and then burn it as a source of illumination. To stay warm, communities needed to gather wood and burn it to produce heat.

Today, we simply need to press an on/off button to activate and deactivate lights and air conditioning devices powered by electricity. Electricity has become one of the most widely used forms of converted energy in everyday life due to its ease of conversion and efficient long-distance transport. With the use of electricity, many devices can be operated automatically, resulting in faster outcomes compared to manual operation. This can be observed in various everyday items, as shown below.

Illustration 8. Comparison of energy use in the past and today.

Besides electricity, another form of secondary energy that is integral to human life is thermal energy. Thermal energy can be obtained from various sources, such as the sun, fire, and electricity. For example, every day we use thermal t energy for cooking. In the past, people used fire generated by burning biomass like wood for cooking. Although the practice of using wood as a cooking fuel is still prevalent today, over time, there have been many ways to generate heat for cooking, such as using gas stoves and electric stoves. This demonstrates technological advancements and changes in energy usage in everyday life over time.

Illustration 9. Evolution of energy use for cooking over time.

With technological advancements, the production of secondary energy now takes only a short time. This makes it easier for people to use energy. For instance, sunlight (solar thermal energy), which in the past was primarily used directly for drying clothes, can now be converted into electricity with solar panel technology. This electricity can be used not only for dryers but also for lighting, cooking, and even charging electric vehicles. Concrete examples of the difference between primary and secondary energy use in everyday life can be found in the following explanations.

1.3.1 Use of Primary Energy

The direct use of primary energy sources can still be found today, especially in remote areas without access to electricity. For example, in coastal communities, fishermen heavily rely on solar thermal energy to preserve the fish they catch and turn it into dried fish. The purpose is to prevent the fish from spoiling quickly, extending its shelf life. Before drying, the fish is usually coated with salt to reduce its water content. When the weather is cloudy or rainy, fishermen face difficulties in drying their fish, which affects the quality of the dried fish. This situation presents one of the challenges of relying on direct energy use.

Another example is the sun-drying of rice to obtain dry paddy. The process yields the best results during sunny weather, while cloudy or rainy weather hampers the drying process. Drying rice is crucial to achieve low moisture content, making it ideal for storage in warehouses or for milling into rice.

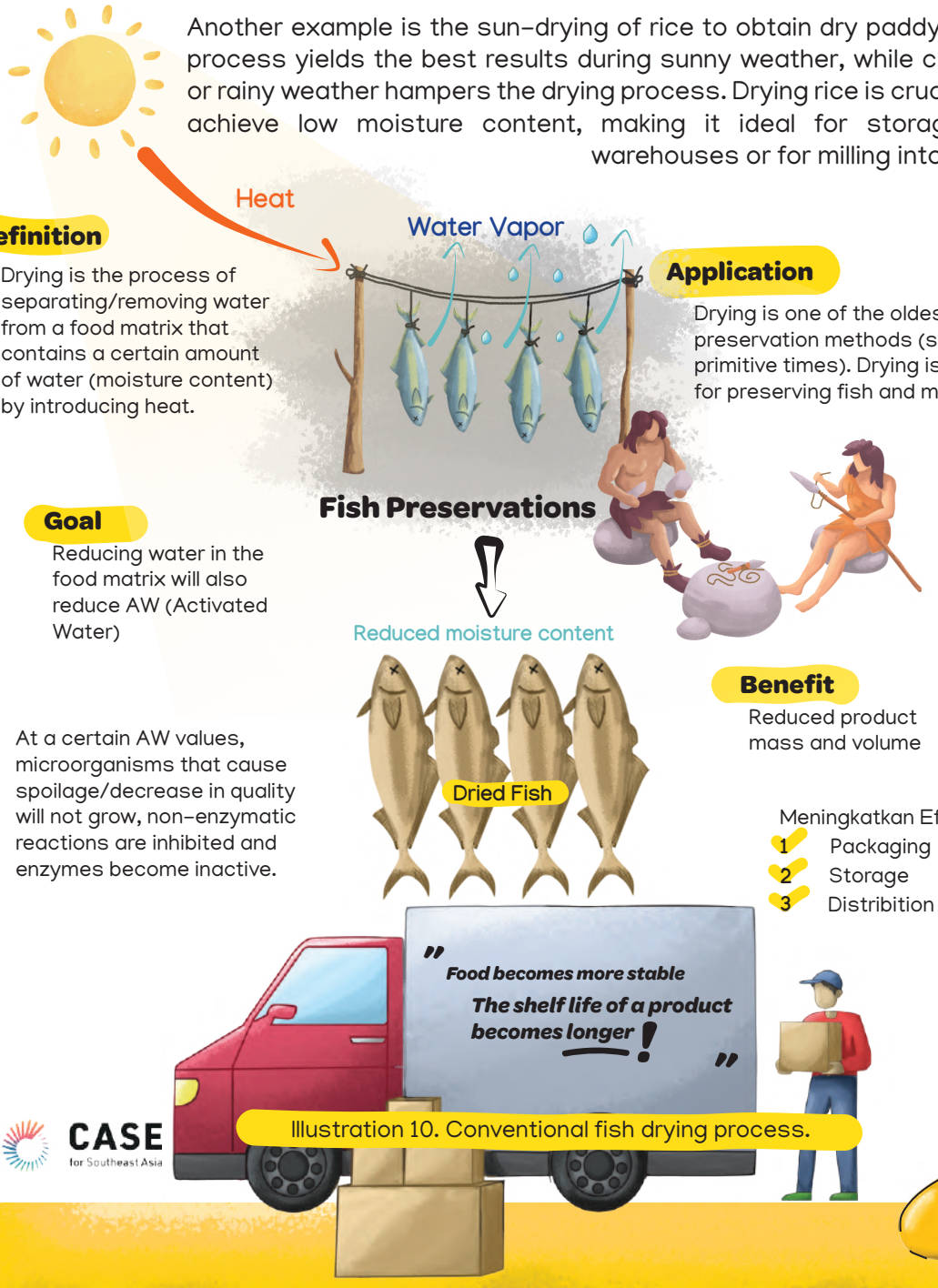


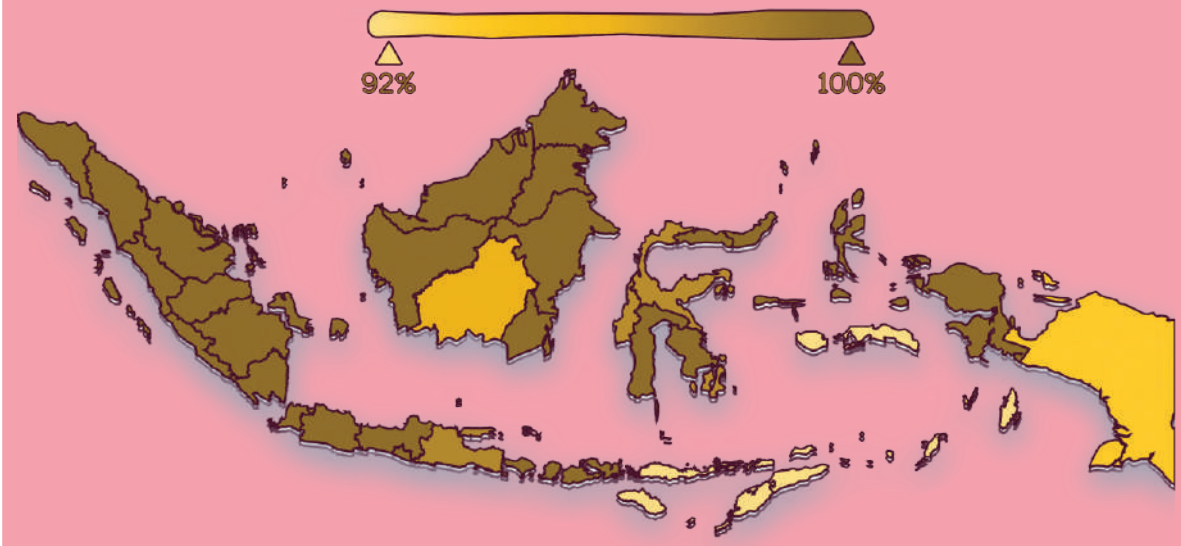
Illustration 10. Conventional fish drying process.

Challenges with direct energy use, like the examples above, include weather dependency. As climate change has disrupted weather patterns, farmers and fishermen have difficulty predicting the weather. During the rainy season, salted fish can't be dried properly, and farmers can't sun-dry their crops. This inconsistency and low quality can ultimately impact product value and reduce the income of fishermen and farmers.

Dependency on direct energy use in basic forms causes people to rely on when and how nature provides these energy sources. One reason for this dependence is the uneven distribution of secondary energy sources, particularly electricity, in remote areas of Indonesia. This situation has social and economic impacts, such as irregular income and low living standards.

The map below illustrates regions in Indonesia that do not have or have limited access to electricity. This is known as the electrification ratio, which is the ratio of the number of household customers with electricity to the total number of households.

Distribution of Electrification Ratio in Indonesia



Source : Ministry of Energy and Mineral Recources, n.d.

Low electrification ratio in most regions in Eastern Indonesia

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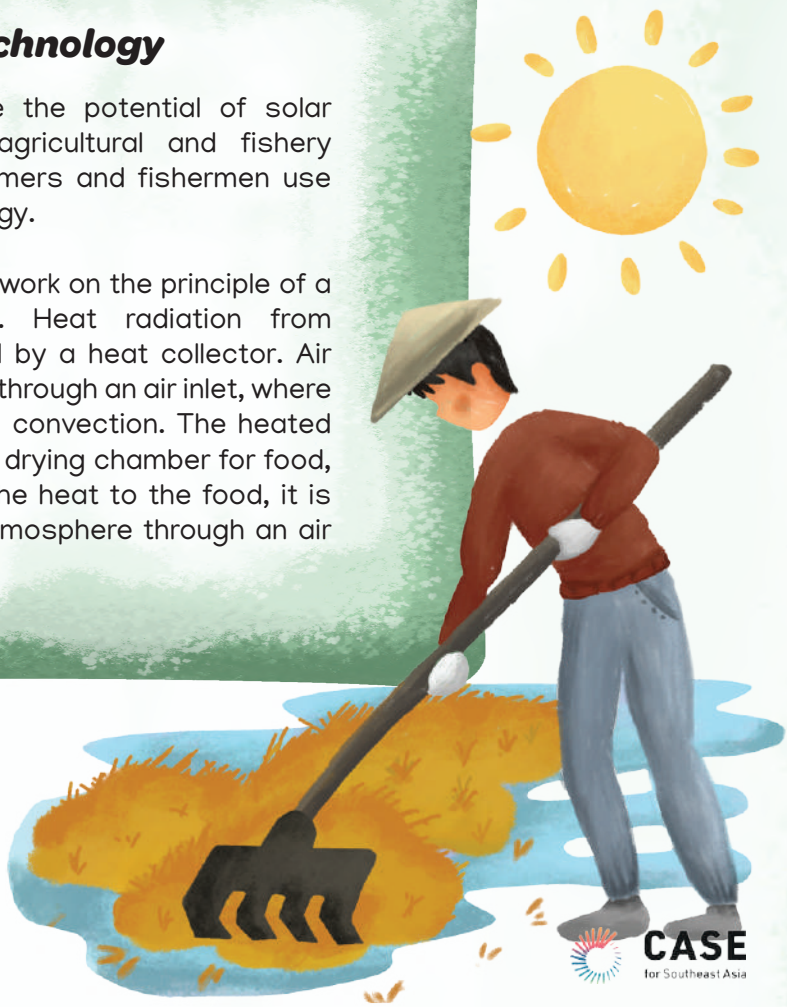
Did you know?

Solar Dryer Technology

To maximize the potential of solar energy in drying agricultural and fishery products, some farmers and fishermen use solar dryer technology.

Solar dryers work on the principle of a greenhouse effect. Heat radiation from sunlight is captured by a heat collector. Air enters the collector through an air inlet, where it is heated through convection. The heated air then goes to the drying chamber for food, and after passing the heat to the food, it is released into the atmosphere through an air outlet.

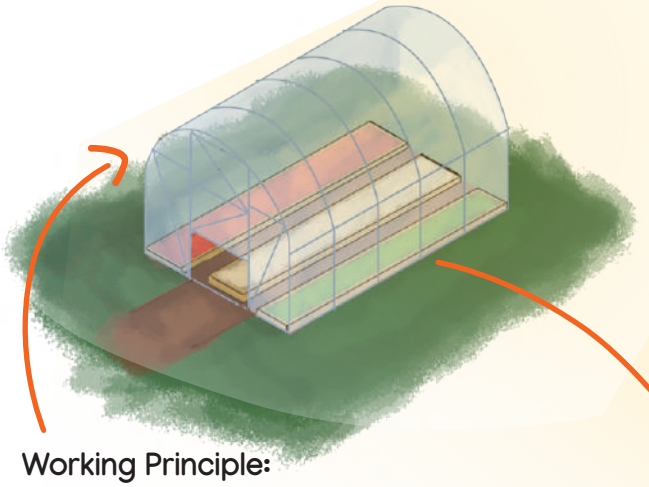


Advantages of solar dryers include accelerated drying processes, more consistent drying results, and reduced potential for food damage due to air pollution, rain, and pests compared to conventional drying methods.

In Indonesia, some farmers, such as coffee, copra, seaweed, and cocoa farmers, have used solar dryer technology to improve the quality of their harvests. This allows farmers and fishermen to produce high-quality agricultural and fishery products, increasing the market value of their products.

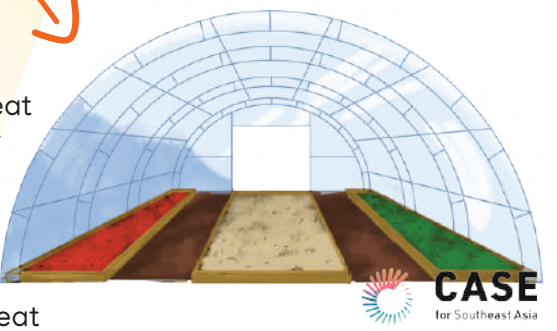
Solar Dryer Usage

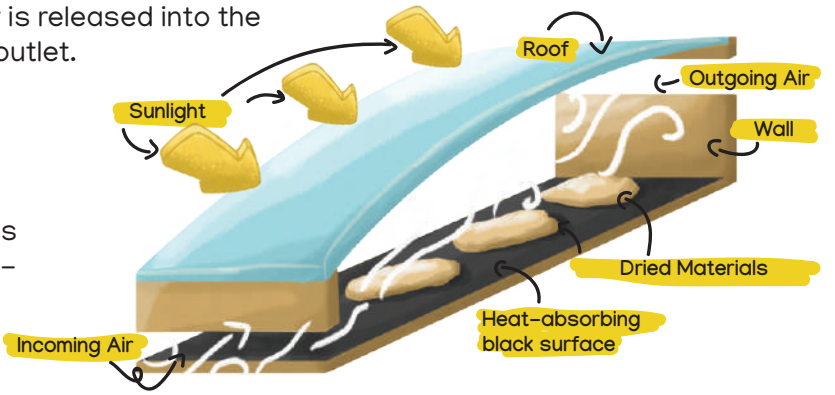
Definition:
A solar dryer is a device that utilizes solar energy to dry agricultural and fishery products.



Purpose:
The purpose of a solar dryer is to expedite the drying process of agricultural and fishery products, provide more consistent drying results, and reduce the potential for food damage due to air pollution, rain, and pests when compared to conventional drying processes.

Working Principle:
The principle is similar to a greenhouse effect. Heat radiation from sunlight is captured by a heat collector. Air enters the collector through an air inlet. The air is then circulated through a convection system. The drying air temperature is greatly influenced by solar heat. The hot air is then passed into the drying chamber where the material is dried. After transferring heat to the material/food, the air is released into the atmosphere through an air outlet.





Applications:
Various agricultural products such as coffee, cotton, seaweed, fish, and more.

Improved Well-being of Farmers and Fishermen:
With better quality agricultural and fishery products, the market value of these products increases. As a result, the income of farmers and fishermen can be enhanced.

1.3.2 Use of Secondary Energy

Compared to the majority of people in remote areas who primarily rely on basic forms of energy, urban communities are more dependent on electricity in their daily lives. In the digital era, electricity usage is becoming more intensive, especially during working hours when almost all electronic devices, such as computers, lights, air conditioning units, and of course, smartphones or gadgets, are active.

Did you know?

Electricity Consumption from Smartphone Usage in Indonesia

On average, people in Indonesia use smartphone apps for 5.5 hours a day, the highest in the world (data.ai, 2021). Meanwhile, a smartphone with a full 100 percent charge can last less than 12 hours with normal use. This means that if smartphones are used intensively, as they are in Indonesia, they need to be recharged more frequently. This data indicates the high frequency of electricity usage by Indonesians in their daily lives, such as for charging smartphones.

DKI Jakarta is one of the provinces with higher electricity consumption compared to other provinces in Indonesia, with 40 percent of electricity usage in DKI Jakarta being for households (Kusnandar, 2019). In addition to electricity, the use of energy in urban areas is also significant, particularly the use of fossil fuels, primarily for motor vehicles.

Urban activities heavily depend on mobility. The movement of people to and from work, school, markets, and other centers of activity contributes to the local economy. Therefore, an uninterrupted energy supply is needed. Where does this energy supply come from? Let's find out in the following sub-section.

Illustration 11. Energy consumption in daily activities

Did you know?

The availability and consumption of energy in a region are closely related to economic growth. However, it's important to note that high energy usage in a region doesn't always indicate that the region has higher economic growth. A region (let's say region A) may have higher economic growth compared to region B (which has higher energy consumption than region A) if region A practices energy efficiency. When a region engages in energy efficiency, it means that the region uses less energy for the same task compared to other regions. This energy efficiency may be achieved by a region adopting energy-saving technologies. Further details on energy efficiency will be discussed in Chapter 7.

1.4 Electricity Generation in Indonesia

If we look around, it's easy to find electricity. How is primary energy transformed into electricity and then distributed for everyday use? The answer lies in power plants. Power plants are used to convert primary energy sources, both non-renewable and renewable, into electricity. There are several types of power plants commonly found in Indonesia, including:

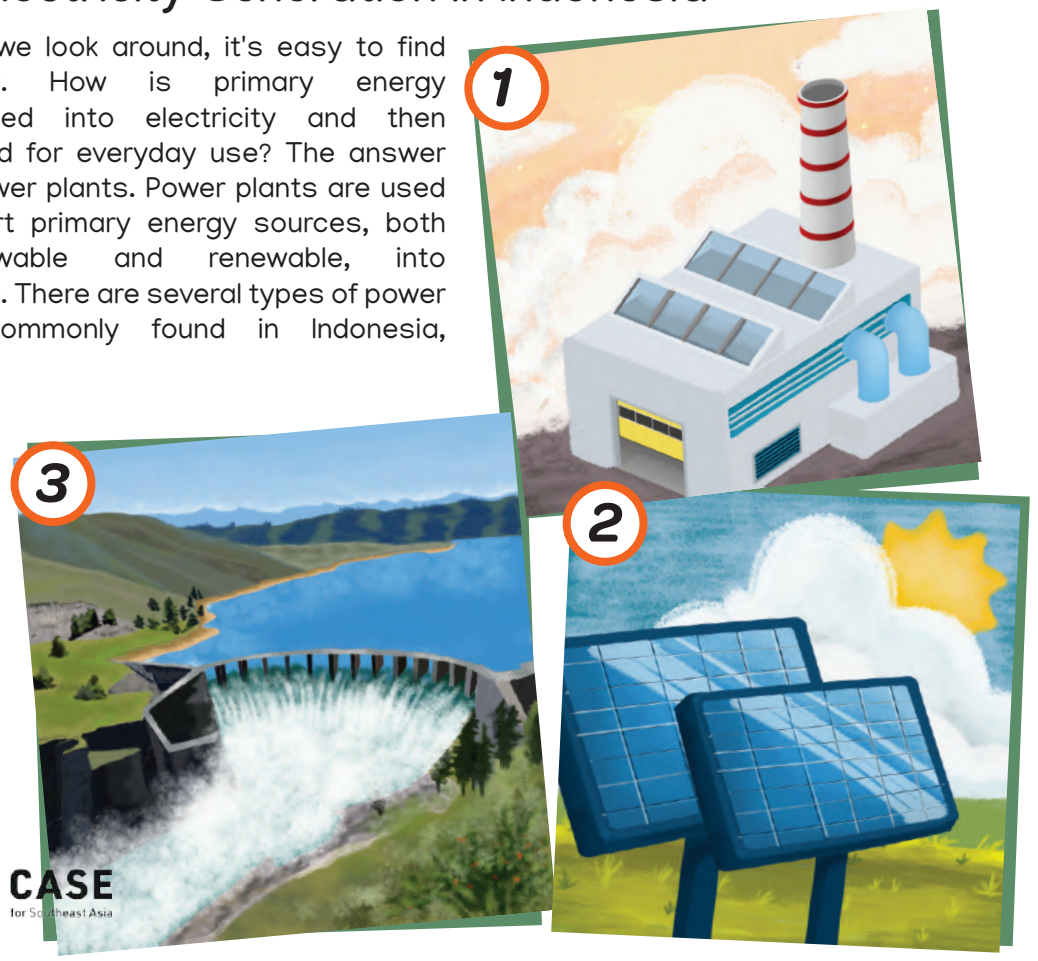


Illustration 12. Clockwise: Diesel power plant (PLTD), solar power plant (PLTS), and hydroelectric power plant (PLTA)

- Steam power plants (using coal as fuel)
- Gas power plants (using natural gas as fuel)
- Diesel power plants (using diesel as fuel)
- Solar power plants (using sunlight)
- Hydroelectric power plants (using water energy)
- Biomass power plants (using organic materials)
- Wind power plants (using wind energy)

The electricity produced by these power plants is then transmitted through high-voltage transmission systems known as High-Voltage Transmission Lines (SUTT) and Extra High-Voltage Transmission Lines (SUTET) to substations, then distributed to utility poles before reaching homes and buildings, where it can be used for various purposes, such as charging gadgets or turning on lights.

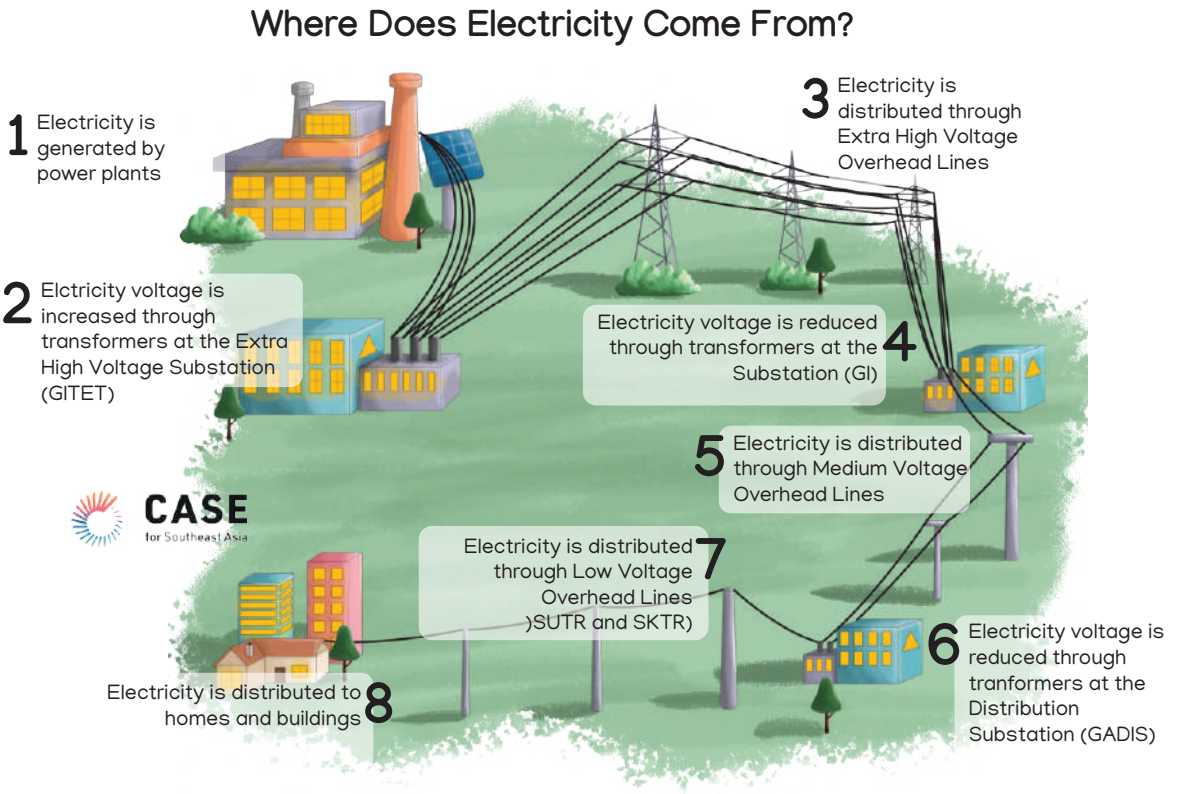


Illustration 13. The journey of electricity from power plants to consumers.

The table below shows the installed capacity of power plants in Indonesia based on their type. Based on the table below, it can be seen that non-renewable energy sources such as coal and gas still dominate the electricity generation in Indonesia. Not only are these energy sources potentially finite if used continuously, but it has also been mentioned above that the combustion of fossil fuels is harmful to life because it generates emissions and causes pollution. So, what are the disadvantages of using fossil fuels?

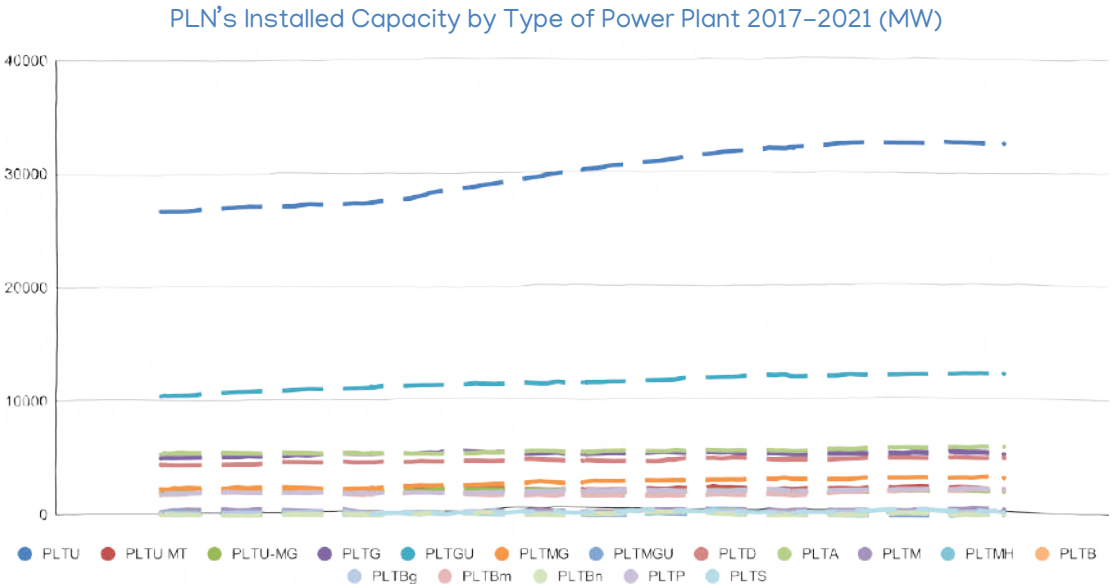


Table 1. Installed capacity of power plant by type of generation nationally in Megawatts (MW)

(Source: Ministry of Energy and Mineral Resources, Directorate General of Electricity, n.d.)

What are the Disadvantages of Using Fossil Energy?

2. What are the Disadvantages of Using Fossil Energy?

2.1 Limited and Depleting

Do you remember another term for fossil energy? Yes, non-renewable energy. Fossil energy is also known as non-renewable energy because it is finite. Yet, energy is one of the basic needs for human survival. Therefore, everyone should have access to readily available energy.

Access to energy is not only important to support basic human needs such as food, lighting, water, and healthcare, but it is also the first and most crucial prerequisite for economic growth, political stability, and national prosperity. If we continue to rely on fossil energy, and it eventually runs out, we will bear many adverse consequences. At the national level, industries will come to a halt due to a lack of energy for operations, and export-import activities will be disrupted, eventually leading to inadequate food supply for the population. This could result in a food crisis and widespread hunger in Indonesia. At the household level, if we cannot access adequate electrical energy, various daily activities will be disrupted. There will be no lighting, no air conditioning, and no gadget charging. Mobility will also be hampered due to a lack of fuel. Additionally, cooking will be challenging due to a lack of gas.

Given the importance of energy in life, it is essential for the country to ensure energy security. According to the National Energy Policy (KEN),[1] energy security is the condition of assured energy availability and public access to energy at affordable prices in the long term, while still considering environmental protection. Therefore, a country's dependence on fossil energy in the long run disrupts its energy security. Energy security needs to be ensured by stopping the reliance on finite fossil energy sources and transitioning to clean, affordable, and continuously available energy sources.

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[1]Based on Government Regulation of the Republic of Indonesia Number 79 of 2014 regarding National Energy Policy, Article 2, the national energy policy is a policy for energy management based on the principles of justice, sustainability, and environmental awareness to achieve energy self-sufficiency and national energy security.

2.2 Produces Emissions and Air Pollution

In addition to being limited in quantity, the use of fossil fuels, which still dominates, is a global concern because burning fossil fuels for fuel produces carbon dioxide (CO_2) and methane gas emissions. These emissions increase the concentration of greenhouse gasses in the atmosphere, leading to an increase in the greenhouse effect and global warming.

The combustion of fossil fuels also releases other gasses , such as nitrogen dioxide (NO_2) and sulfur dioxide (SO_2), which cause air pollution such as acid rain and smog. NO_2 and SO_2 emissions, when released into the atmosphere, can react with water vapor in clouds to form nitric acid (HNO_3) and sulfuric acid (H_2SO_4), which are strong acids. If rain falls from these clouds, it becomes acidic (with a pH lower than the normal pH of rain, which is about 5.6) and is known as acid rain. Acid rain has several effects:

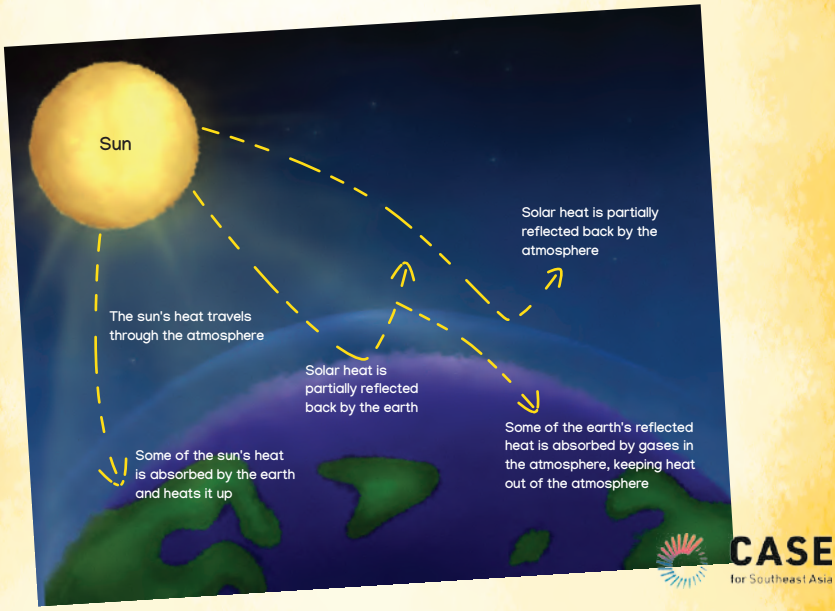
1. On agriculture and forests: The acidity of the soil damages the growth of crops.
2. On water bodies: Acid rain disrupts the ecosystems of aquatic organisms.
3. Direct exposure to humans: It can cause various respiratory problems, including asthma, bronchitis, emphysema, pneumonia, and irritation of the eyes, as well as vision problems.
4. Direct exposure to buildings: It can lead to the formation of rust and decay, causing damage to the structure.

Did You Know?

Greenhouse Effect

A greenhouse is a structure with walls and a roof made of glass designed to trap the heat from sunlight inside, keeping the interior warm even when it's cold outside. This is commonly done by farmers in four-season countries to ensure that farming activities can continue even when nighttime temperatures drop.

The greenhouse effect, on the other hand, is a term used to describe Earth's condition, where it acts like a greenhouse. In this scenario, the heat from the sun is trapped in the Earth's atmosphere, causing the Earth's temperature to rise. Gasses in the atmosphere that can trap heat from the sun are called greenhouse gases (GHGs). Some gasses included in GHGs are carbon dioxide (CO_2), nitrogen dioxide (NO_2), methane (CH_4), and fluorinated gasses (SF_6, HFCs, and PFCs).



Heat from the sun's rays is crucial for life on Earth. Under normal conditions, some of the heat emitted by the sun is absorbed by the Earth's surface, while another part is reflected back out of the atmosphere. As a result, the Earth's temperature remains at an optimal level for life. However, the increase in greenhouse gas emissions, primarily from the burning of fossil fuels and forest fires, causes the heat that should be reflected to become trapped within the Earth's atmospheric layer. This condition is known as the greenhouse effect and leads to an increase in Earth's temperature from year to year.

Furthermore, the burning of coal is a major contributor to air pollution, resulting in the deaths of millions of people each year and being a primary source of water pollution. In 2021, global CO2 emissions increased by two million tons—the highest in history due to the increased use of coal for electricity generation (International Energy Agency, n.d.).

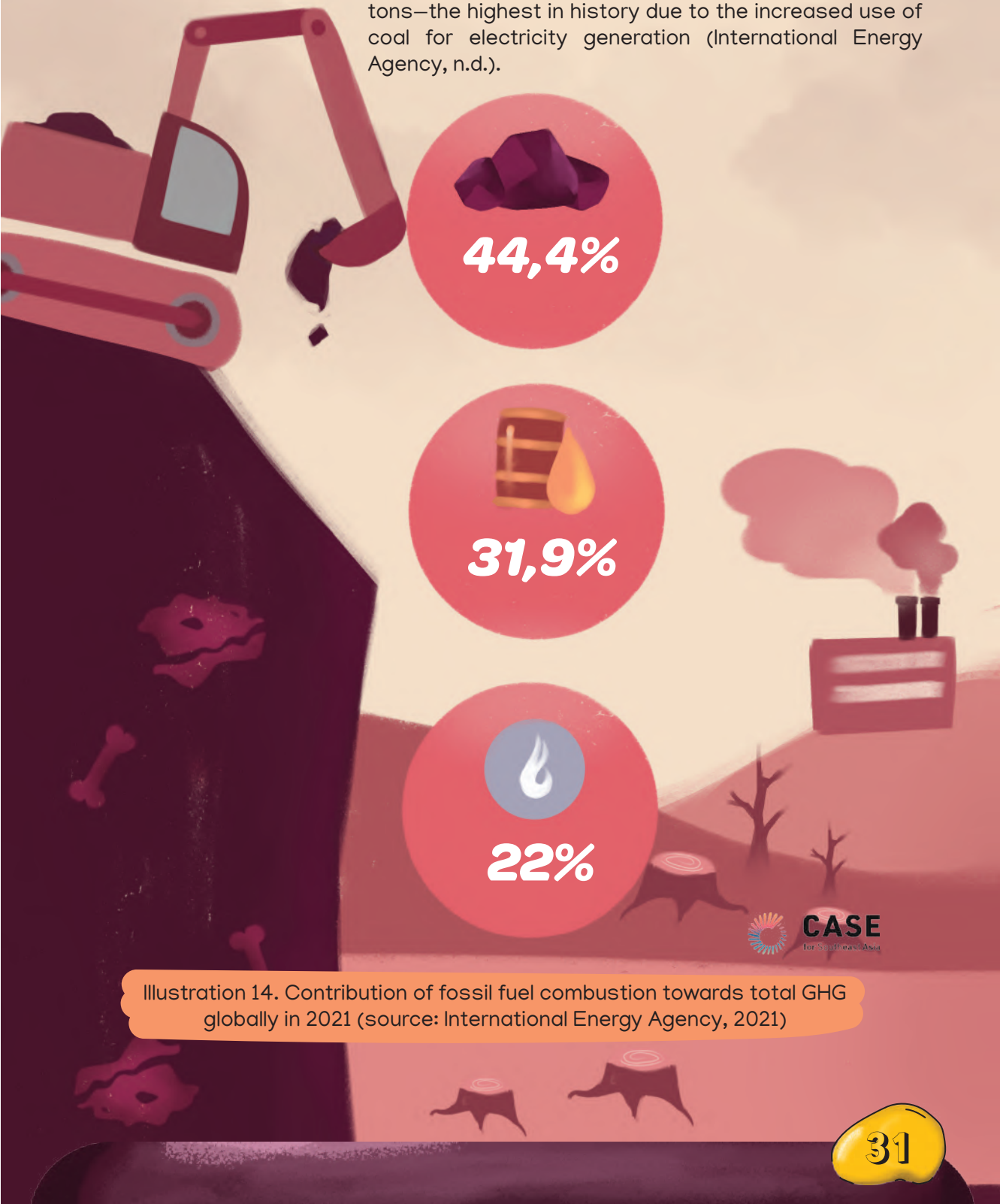
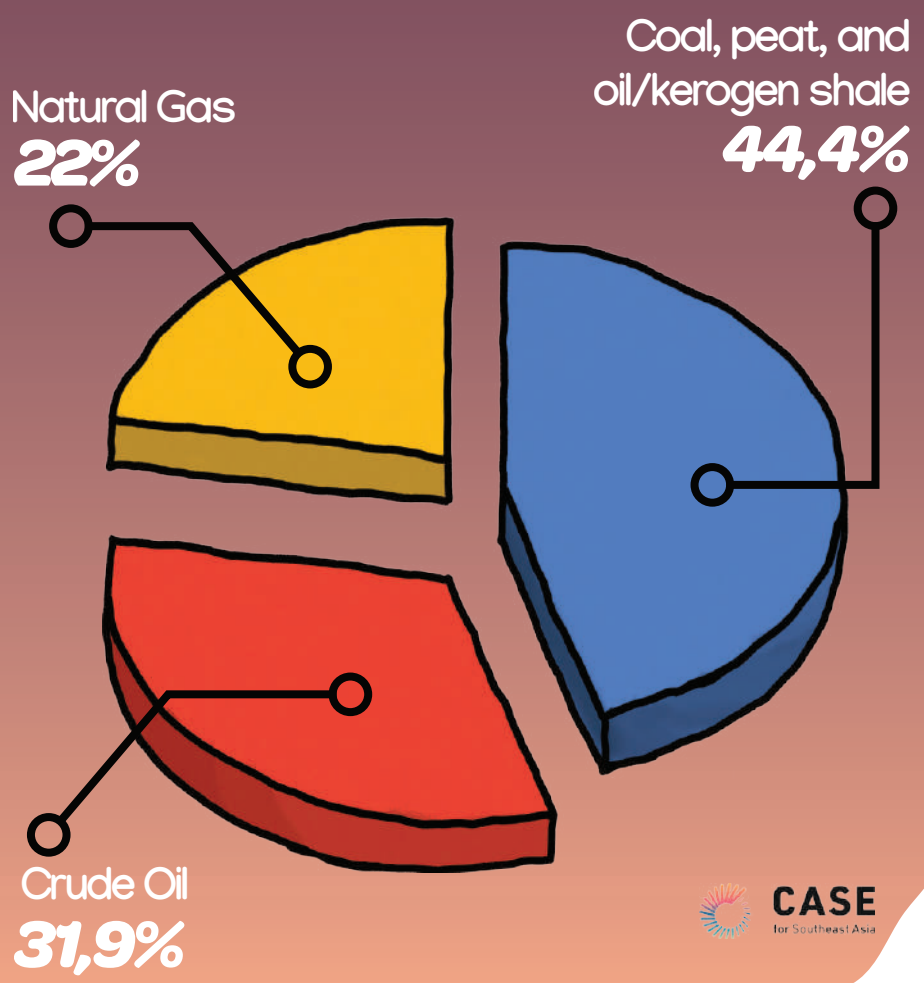


Illustration 14. Contribution of fossil fuel combustion towards total GHG globally in 2021 (source: International Energy Agency, 2021)

Did you know?

Contribution of fossil fuel combustion to total global greenhouse gas emissions in 2021



As a comparison to gauge the impact of fossil fuel combustion, a study made a comparison stating that to offset one million tons of CO_2, it would require one hardwood tree to live for 40 years (CO_2 Meter, 2022). Meanwhile, human activities generate an average of 40 billion tons of CO_2 emissions per year. This means that around 40 billion trees would need to be planted every year, and then you would have to wait for several decades to see the positive effects. By the time 40 years have passed, the trees originally planted would only have removed a portion of the increased CO_2 levels during that time.

2.3. Impact on Climate Change and Disasters

Further consequences of emissions from fossil fuel combustion are climate change and disasters. Energy use is intended to support human well-being. However, the high levels of CO2 emissions from burning fossil fuels lead to global warming and have various impacts on climate change and disasters worldwide. The National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce monitors global climate data, and here are some changes recorded by NOAA up to 2020 (NOAA, 2021):

- Global temperatures have risen by about 1 degree Celsius from 1901 to 2020.
- Sea-level rise has accelerated from 1.7 mm/year in most of the 20th century to 3.2 mm/year since 1993.
- Glaciers are shrinking, with an average thickness reduction of more than 60 feet since 1980.
- The Arctic ice cover at the end of summer has shrunk by about 40 percent since 1979.
- CO2 levels in the atmosphere have increased by about 40 percent since the industrial revolution. Snow melts earlier than the long-term average.

According to scientists at the National Centers for Environmental Information (NCEI) NOAA, global temperatures in 2021 were 0.85 degrees Celsius above the average. NASA states that collectively from 2013 to 2021 were the hottest years recorded since 1880. Increasing temperatures over time alter weather patterns and disrupt the balance of nature, leading to various risks (United Nations, n.d.):

Extreme storms

Storms have become more intense and frequent in many regions. Rising temperatures cause more water to evaporate, increasing extreme rainfall and floods, as well as leading to strong and dangerous storms. The warming of sea surface temperatures also affects the frequency and extent of tropical storms. The risks of natural disasters such as storms include death and significant economic losses.

Increased drought

Climate change alters water availability, making water scarcer in various regions, increasing the risk of agricultural drought that affects food production and raises ecosystem vulnerabilities. Additionally, drought can lead to dust and sandstorms that can damage and reduce farmland. In areas experiencing drought, people struggle to find safe drinking water, leading to decreased health and potential fatalities.

Warming oceans, rising sea levels, and threatened marine ecosystems

Oceans absorb most of the heat and CO2 from global warming. Over the last two decades, ocean warming has sharply increased at all ocean depths. As oceans warm, they expand, contributing to rising sea levels. Furthermore, more CO2 being absorbed by the ocean makes it more acidic, endangering the survival of marine ecosystems, including coral reefs, and disrupting the food chain. The impact on humans is a reduced supply of seafood.

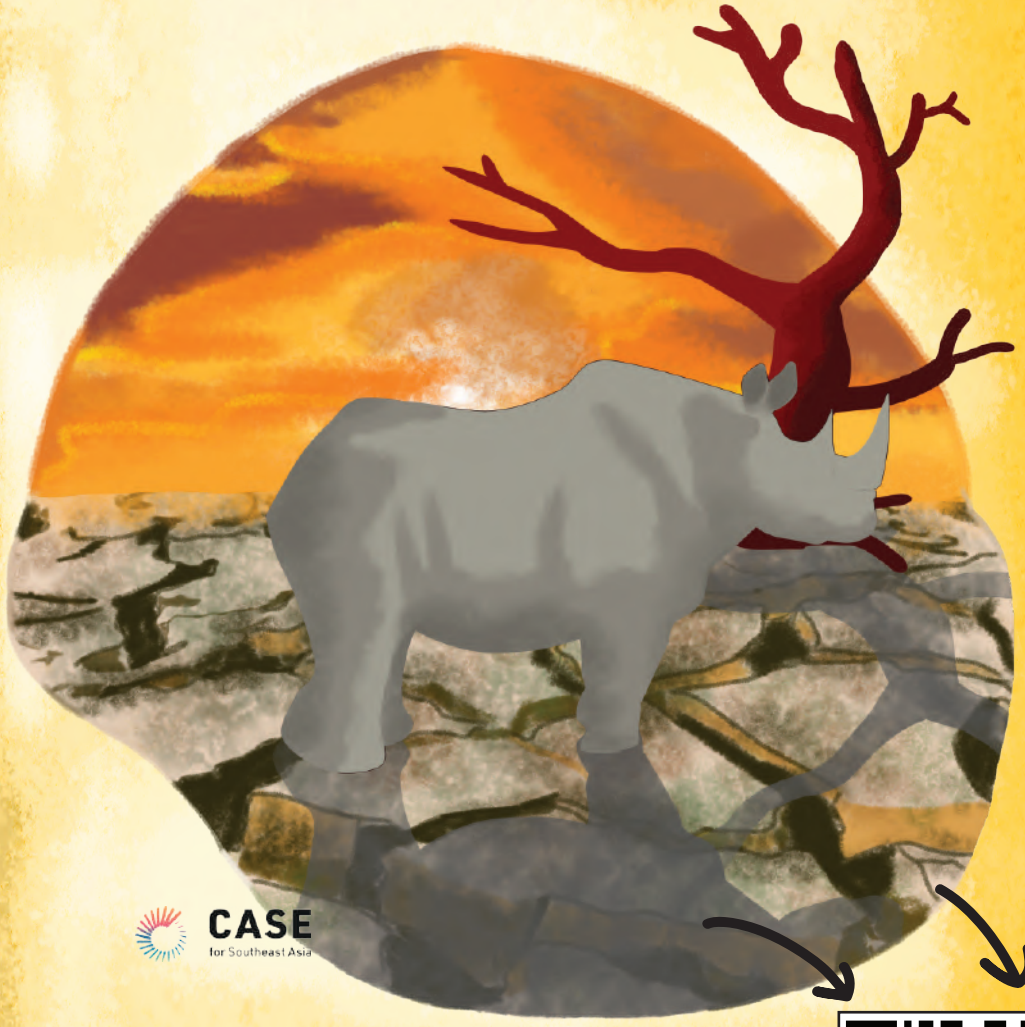
Species extinction

Climate change poses risks to the survival of species on land and in the sea, including due to wildfires, extreme weather, and pest and disease outbreaks. The rate of species extinction due to the climate crisis is recorded as 1,000 times greater than the historical rate. One million species are threatened with extinction in the coming decades. Some species may be able to migrate and survive, but many are predicted to be unable to do so.

Did you know?

One million species are on the brink of extinction

Species extinction is driven by various human activities, including deforestation, environmental pollution, and global warming. As a result, more than one million species are currently on the verge of extinction.



CASE for Southeast Asia

Discover facts about species extinction at the following link or QR code:

bit.ly/Kepunahan1JutaSpesies

Food Crisis

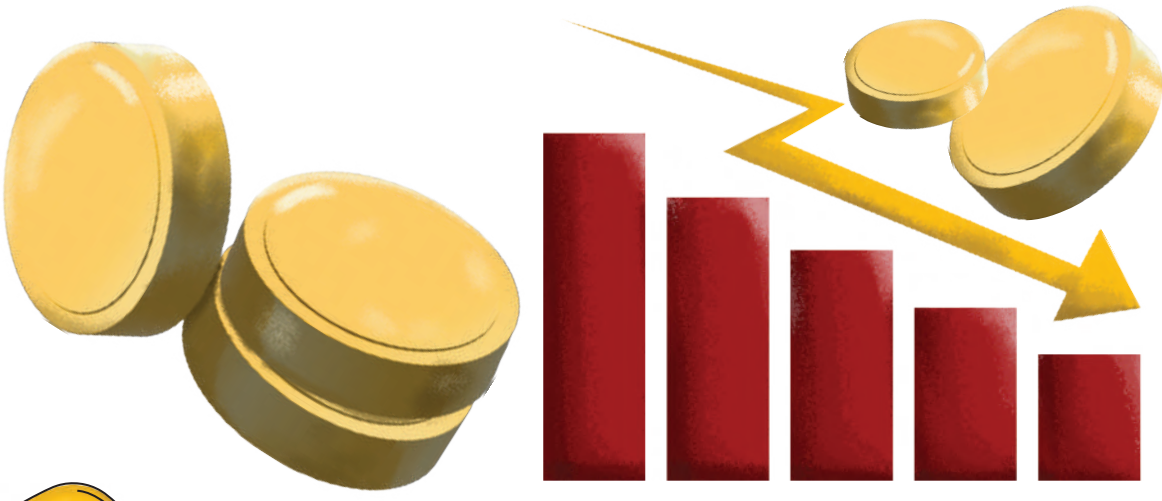
800 million people worldwide do not have easy access to food and must live in conditions of hunger. Amidst the high levels of hunger, malnutrition, and stunting, the Food and Agriculture Organization (FAO) estimates that food production must increase by at least 60 percent by 2050 to meet the demand for food. However, climate change has disrupted the food production process, threatening food security (Food and Agriculture Organization, 2015). This means that many people in the world may experience hunger, and the death toll from hunger could rise.

More Health Risks

Climate change is one of the greatest health threats facing humanity. Every year, environmental factors claim the lives of about 13 million people due to extreme weather events, forced displacement due to disasters, mental health pressures, increased hunger, and malnutrition. Changes in weather patterns expand the spread of diseases, and healthcare systems have not been able to cope with it.

Poverty and Displacement

PClimate change exacerbates factors contributing to poverty and human well-being. For example, flooding disasters can destroy homes, devastate entire regions, and eliminate livelihoods for communities in affected areas. Hot weather can impede outdoor labor and increase the potential for heat-related deaths. Water scarcity can disrupt farmers and herders in food production. Over the past decade (2010-2019), weather-related disasters due to climate change have forced about 23.1 million people worldwide to be displaced every year, making more people, especially women and minority groups, vulnerable to poverty and violence (United Nations, n.d.).



Future Impact Exposure at 1.5°C, 2°C, and 3°C Temperatures

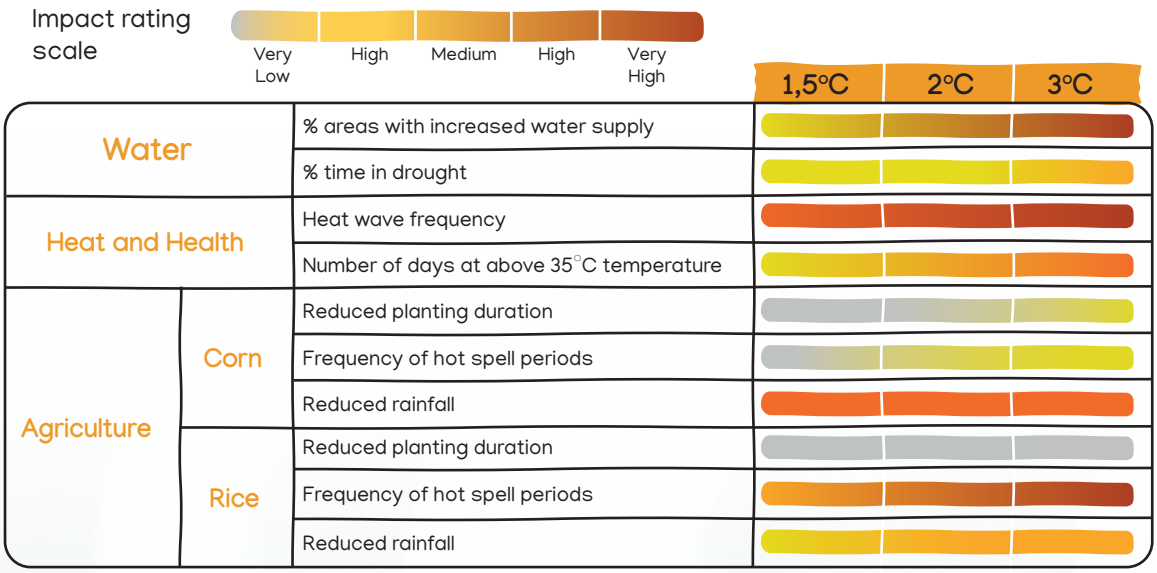
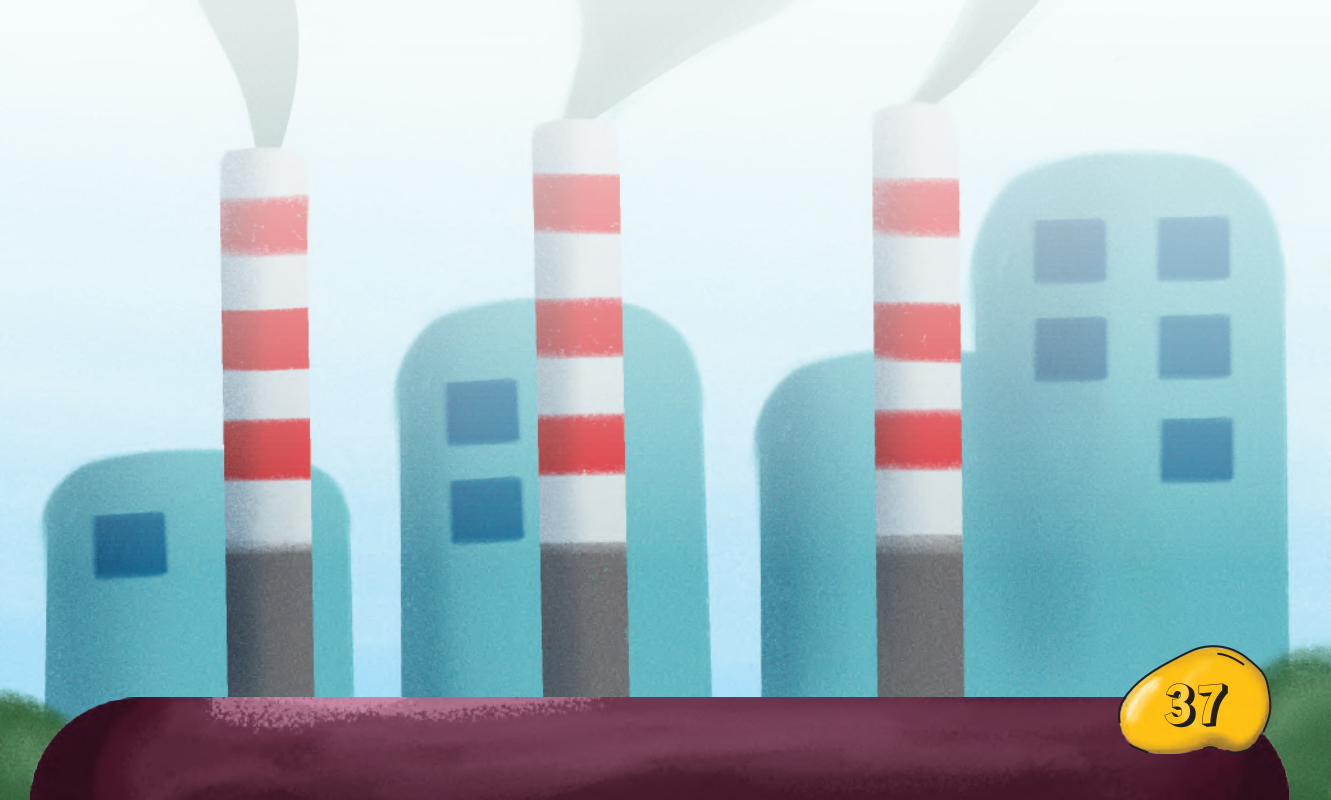


Illustration 15. Future impact exposure to temperature rise at 1.5 degrees Celsius, 2 degrees Celsius, and 3 degrees Celsius (source: Climate Transparency, 2021).

All humans depend on nature and the environment for their livelihood. A safe, clean, healthy, and sustainable environment is part of human rights, including the right to life, the right to health, food, water, and sanitation. Ultimately, climate change caused by emissions and pollution from the use of fossil energy threatens these rights. Nevertheless, why is Indonesia still dependent on the use of fossil energy?




Why Indonesia
Still Relies on
Fossil Energy
?
CASE

3. Why Indonesia Still Relies on Fossil Energy?

3.1. Fossil Energy is Still Abundant

Indonesia has abundant fossil energy sources, especially coal and natural gas. In 2021, Indonesia ranked among the top 10 countries with the largest coal reserves in the world, with approximately 31.69 billion tons, according to the Ministry of Energy and Mineral Resources (MEMR). Additionally, in 2022, Indonesia was the largest coal producer in Southeast Asia, with 687 million tons, 28 percent of which was for domestic consumption. Domestic consumption is generally dominated by the use of coal for electricity generation.

Meanwhile, Indonesia's natural gas reserves in 2021 amounted to 41.62 trillion cubic feet (TSCF)[2], and its crude oil reserves amounted to 3.95 billion barrels. While these figures may not be significant compared to global natural gas reserves, Indonesia still has around 68 potential gas sources that have not been developed. According to Indonesia's Gas Balance 2022–2030, Indonesia will be able to meet domestic needs from these available gas fields. Moreover, it is estimated that in the next 10 years, Indonesia's gas will have a surplus of up to 1,715 Million Standard Cubic Feet per Day (MMSCFD)[3]. However, this availability will diminish—or even run out at some point if used continuously, and it will take hundreds of years to replenish.

[2] The term trillion cubic feet is a measure of natural gas volume used by the oil & gas industry in the United States.

[3] MMSCFD stands for million standard cubic feet per day, or a million standard cubic feet per day. Standard Cubic Feet represents a quantity of gas used to fill one cubic foot at 14.73 Psi pressure and 15 degrees Celsius temperature. Why is this so? If you buy or sell gas in volume units, there is a fairness that must be considered. The same volume of gas at different temperatures and pressures will contain different energy values. One cubic meter of gas cannot be converted into energy without knowing its temperature and pressure. Thus, sellers and buyers must agree on the temperature and pressure at which measurements are made. Hence, the term "standard" is used, which means the agreed-upon conditions. Usually, this standard term, if not stated otherwise, means: 15 degrees Celsius temperature or 1 atmosphere pressure.

3.2. Fossil Energy as an Economic Driver

With the current abundance of fossil energy, it still plays a significant role in Indonesia's economy. Energy consumption and economic growth are closely related because higher Gross Domestic Product (GDP) levels are generally associated with better access, reliability, and affordability of electricity. The availability of electrical infrastructure can stimulate economic growth by serving as a production driver for companies, enabling the delivery of public services, and improving household well-being. Additionally, electricity consumption can lead to increased work efficiency in various fields.

Currently, coal and natural gas are the two main energy sources for generating electricity in Indonesia. Data from the Ministry of ESDM shows that out of the total installed capacity of 81.2 gigawatts (GW) in 2022, about 52 percent (or 42.1 GW) was from coal-fired power plants (PLTU), followed by gas-fired power plants (PLTG/GU/MG) at about 27 percent (or 21.6 GW), with the rest coming from diesel generators and renewable energy sources.

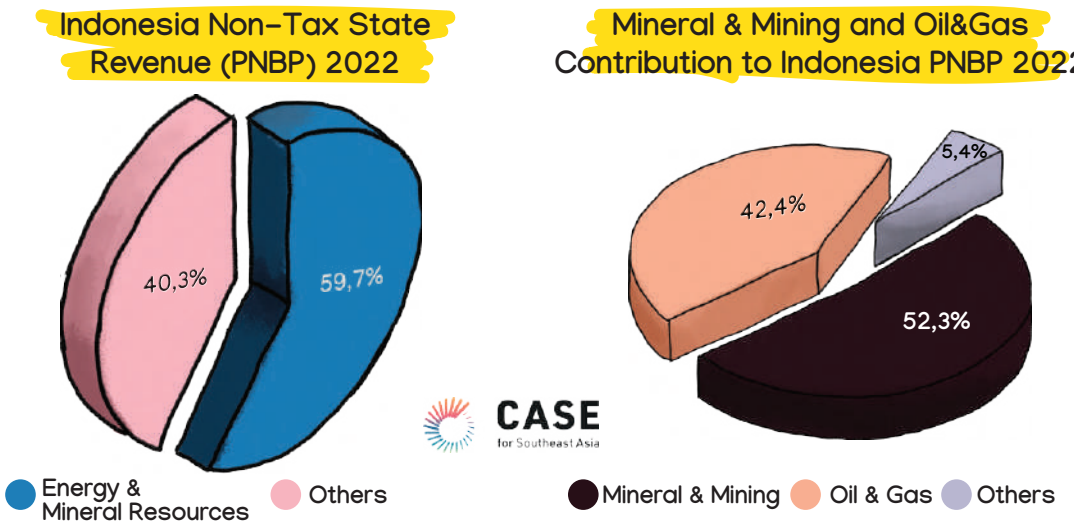


Chart 1. Contribution of mineral & mining and oil & gas to Indonesia's PNBP in 2022.

Furthermore, the oil & gas and coal sectors contribute significantly to state revenue as non-tax state revenue (PNBP). The Ministry of Finance reported that in 2022, the energy and mineral resources (ESDM) sector contributed more than half of the total PNBP, at 59.7 percent. Of this total, the contribution of oil & gas was 42.4 percent, minerals and coal contributed 52.3 percent, and the remaining 5.54 percent came from other sources. The contribution of coal royalties to the total contribution of minerals and coal is significant, at 46.7 percent. Therefore, with a total realization of state revenue in 2022 amounting to Rp 2,626.4 trillion, about 9 percent of it came from oil & gas and coal.

3.3 Limited Affordable Alternatives

The majority of people in Indonesia still rely on the use of fossil energy, not only for the benefit and income of the state, but also because its current cost is relatively affordable compared to other energy sources. When viewed from the perspective of energy management in Indonesia, the country considers three important factors known as the energy trilemma: energy security, energy equity, and environmental sustainability in providing energy for its people. Energy security relates to how Indonesia can effectively manage its energy supply, maintain the reliability of energy infrastructure, and the ability to meet current and future energy needs. Energy equity concerns accessibility and affordability of energy supply for everyone. Meanwhile, environmental sustainability involves clean and environmentally friendly energy utilization, such as the development of renewable energy and other low-carbon energy sources, as well as efficiency on the supply and demand side. An example of the implementation of the energy trilemma is adding power generation capacity to meet increased electricity demand, ensuring fair and equal electricity distribution, maintaining affordable electricity prices, and ensuring that electricity is accepted by the public in a reliable, high-quality, and environmentally friendly manner.

Based on data from PLN, the average generation cost of coal-fired power plants for 2021 was Rp 667.88 per kilowatt-hour (kWh) of electricity produced. When compared to the operating costs of other power generation sources, the operating cost of coal-fired power plants is still much cheaper at present. This is one of the reasons why the government, especially PLN, still relies on fossil fuels, particularly coal, to produce electricity at a low and affordable cost for the public.

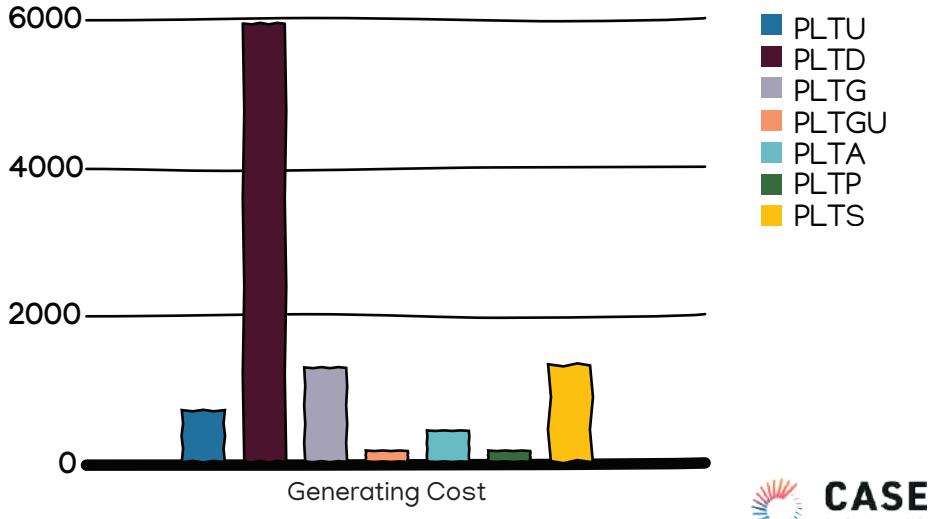


Chart 2. Electricity generation cost based on power plant in Rp/kWh

Did you know ?

Levelized Cost of Electricity (LCOE)

In addition to looking at generation costs as shown above, there is another popular measurement tool used to compare the generation costs of various technologies, known as the Levelized Cost of Electricity (LCOE). LCOE is calculated by comparing the total cost of a generation technology—from investment costs, operation and maintenance costs, to financing costs (interest and weighted average cost of capital/WACC) over its useful life. The smaller the LCOE of a generation source compared to other sources, the cheaper that source is.

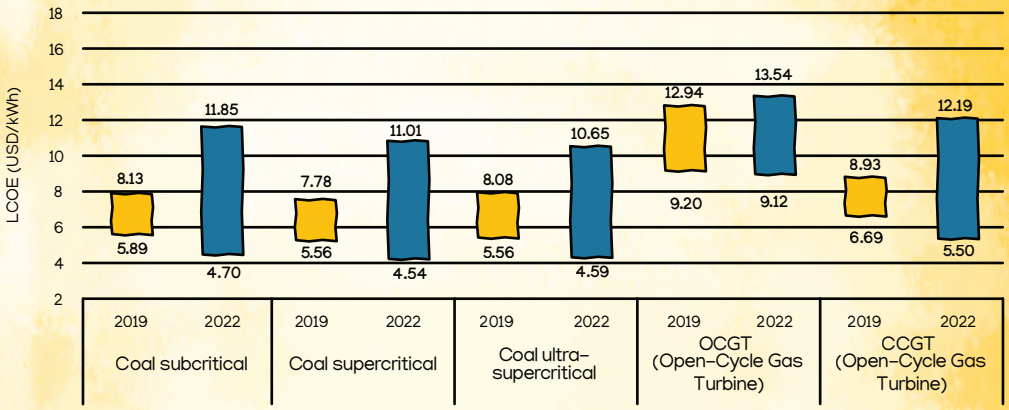


Chart 3. Changes in LCOE values for main power plants in Indonesia in 2019 and 2022. (source: Institute for Essential Services Reform, 2023)

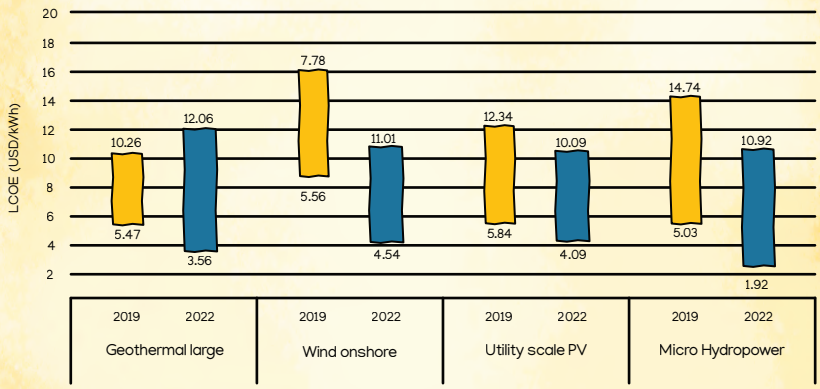


Chart 4. Change in LCOE Values for Renewable Energy Technologies in Indonesia in 2019 and 2022 (source: Institute for Essential Services Reform, 2023)

The two charts above show a comparison of LCOE (Levelized Cost of Energy) values for various power generation sources in Indonesia in 2019 and 2022. chart 3 (above) displays the LCOE values of the primary power generators in Indonesia, which are still dominated by fossil energy sources (coal and gas).

Meanwhile, chart 4 (below) represents the LCOE values of renewable energy technologies. Higher values represent high-end costs, while lower values indicate low-end costs.

Based on both charts above, you can observe changes in the LCOE range in 2019 and 2022 for each power generator. What's particularly interesting from this data is the lower LCOE values for renewable energy technologies in 2022 compared to the LCOE values of fossil energy power generators in 2022. This means that in 2022, electricity from renewable energy sources has a more competitive price compared to fossil energy.

You can read more at the following link or QR code:

bit.ly/LCOE-IESR-2023

However, Indonesia's dependence on fossil energy does not bring only positive impacts. In reality, there are at least three major risks that Indonesia faces by continuing to rely on the use of fossil energy, namely threats to energy security, vulnerability to fluctuating fossil energy prices, and the risk of a decrease in national income due to the loss of the global fossil energy market.

What are the Risks of Fossil Energy Dependency ?

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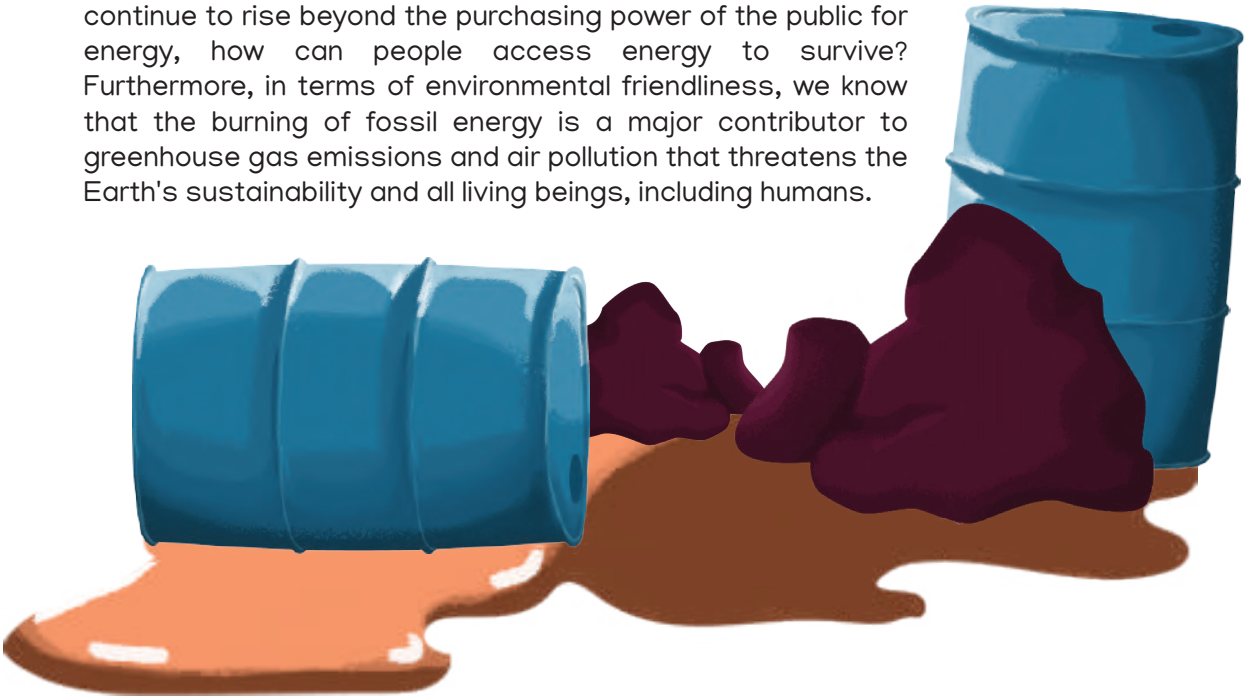
4. What are the Risks of Fossil Energy Dependency?

4.1. Threats to Energy Security

Remember what energy security is? The term energy security has been discussed in Chapter 2. The level of a country's energy security is determined by four factors: energy availability, energy accessibility, environmental friendliness, and affordability. Based on these four factors, Indonesia's energy security in 2022 is categorized as stable, scoring 6.7 out of 10.

Indonesia's energy supply, which is dominated by fossil energy, leads to a low score for Indonesia's energy security because the availability of fossil energy cannot be guaranteed in the future to meet Indonesia's energy needs. Additionally, fossil energy prices often experience increases. If prices continue to rise beyond the purchasing power of the public for energy, how can people access energy to survive? Furthermore, in terms of environmental friendliness, we know that the burning of fossil energy is a major contributor to greenhouse gas emissions and air pollution that threatens the Earth's sustainability and all living beings, including humans.

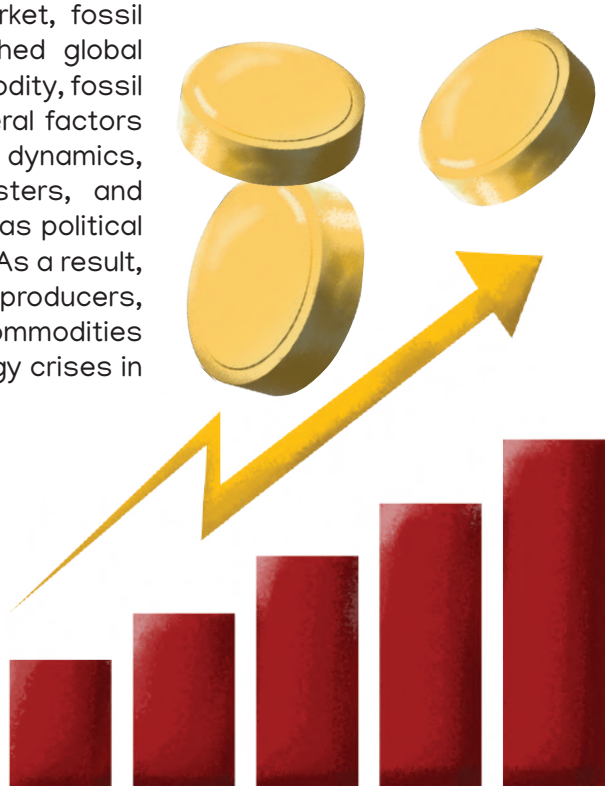


Energy security is closely related to the national economy. For example, the textile and clothing industry in Indonesia contributes 13.7 percent of Indonesia's total GDP in 2022, equivalent to IDR 35.17 trillion (Rizaty, 2022). If energy security is disrupted, and energy supply cannot meet the industry's needs for optimal operation, industrial productivity will decline. The impact is that even a 10 percent reduction in productivity can lead to a loss of IDR 9.57 trillion in Indonesia's economy. In other words, the income and welfare of the people will decrease.

4.2. Fluctuating Fossil Energy Prices

The second risk is fluctuating fossil energy prices. Did you know that fossil energy, such as oil, natural gas, and coal, is a global commodity? This is because various sectors of life require fuel to function, so various parties are scrambling to find these resources.

Due to the high demand in the market, fossil energy has become a highly watched global commodity. As a global traded commodity, fossil energy prices are influenced by several factors such as supply and demand dynamics, geopolitical tensions, natural disasters, and others. For example, in 2022, there was political tension between Russia and Ukraine. As a result, Russia, one of the world's largest gas producers, restricted the supply chain of gas commodities in the global market, resulting in energy crises in various countries worldwide.



The nature of the global energy commodity market is always changing, known as "boom and bust." This explains how high demand will lead to significant price increases (boom). However, after some time, the commodity market will be followed by periods of low demand, which also lead to price decreases (bust). From a national perspective, the increase and decrease in energy commodity prices pose challenges in planning energy procurement. This then has implications for the government's obligation to ensure energy availability while still guaranteeing the social and economic well-being of the country and its people. The Indonesian government needs to ensure that its people can afford to buy and consume energy. One way to do this is by providing subsidies. When fossil energy prices continue to rise, the government must consider the sufficiency of subsidies. If subsidies are no longer sufficient, the worst impact that can be experienced by the public is high energy prices, making energy unaffordable—an essential commodity for ensuring human survival (e.g., gas for cooking, gasoline for vehicles, and electricity for lighting).

4.3. Threats to National Revenue due to Reduced Global Demand for Fossil Energy

Indonesia is known as one of the world's largest coal exporters. According to the Ministry of Energy and Mineral Resources (MEMR), Indonesia exported approximately 456 million metric tons of coal in 2020, generating revenue of around USD 15 billion. The International Energy Agency (IEA) report states that global coal exports will reach 1.35 billion tons in 2022, and Indonesia is expected to contribute 35.04 percent, equivalent to 473 million tons of coal, to the total international energy export.

This report shows that coal, as one of the natural resources, plays a significant role in Indonesia's economy. However, countries worldwide through the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris have agreed to increase efforts to mitigate climate change, including in the energy and electricity sectors. As a result, countries around the world are committed to improving environmental quality and health, one of which is by reducing the share of fossil energy use. In addition to the UNFCCC agreement, the trend to reduce fossil energy use is also driven by various factors, including the competitiveness of renewable energy technologies, which are becoming more competitive, and consumer demand in the industrial market to produce commodities sustainably without harming the environment.

Countries such as China, India, and Japan, which have been major markets for Indonesian coal exports, are gradually shifting to renewable energy and reducing their dependence on coal. Meanwhile, forecasts from the European Electricity Review 2023 show that total fossil fuel power generation in Europe will decrease by 20 percent—twice the previous record in 2020 during the Covid-19 pandemic. With the decrease in electricity production from coal-fired power plants in Europe, it is likely that European countries will import less coal in 2023 compared to 2022. Furthermore, governments and global investors are divesting from coal-based energy and fossil fuels, which will affect the demand for coal.

For countries with high reliance on the export of fossil energy commodities like Indonesia, this trend can have a significant impact on their national economies. There is a possibility of a decrease in national income due to reduced global demand for fossil energy. Moreover, those who worked formally and informally in the fossil energy sector will face layoff as a direct impact from the transition towards renewable energy.

As the world shifts to cleaner and more sustainable energy sources, Indonesia also needs to find alternatives to generate national income and create new job opportunities for people whose livelihoods currently depend on the fossil energy sector. Therefore, before the country and its people suffer the negative consequences of the loss of the global fossil energy market, it is crucial for Indonesia to prioritize energy transition and consider developing an economy based on renewable energy.

Why is Energy Transition Urgent?

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for Southeast Asia

5. Why is Energy Transition Urgent?

5.1. Understanding Energy Transition

The term "transition" refers to a process of change or transformation from one state to a new state. In the context of energy, "energy transition" refers to a change in the dominant use of energy sources from one type to another. Energy transition itself can be caused by various factors, such as energy commodity market conditions, geopolitical situations, and the impact of energy use on nature and the environment.

For example, around the 1970s to the 1980s, the United States and Germany underwent an energy transition from being predominantly based on oil to energy sources dominated by coal. The energy transition from oil to coal at that time was caused by the volatility of oil prices in the global market, which made it difficult for many countries to prepare adequate budgets to meet their energy needs. At that time, the relatively stable price of coal and its abundant availability compared to oil became an attractive energy alternative for many countries.

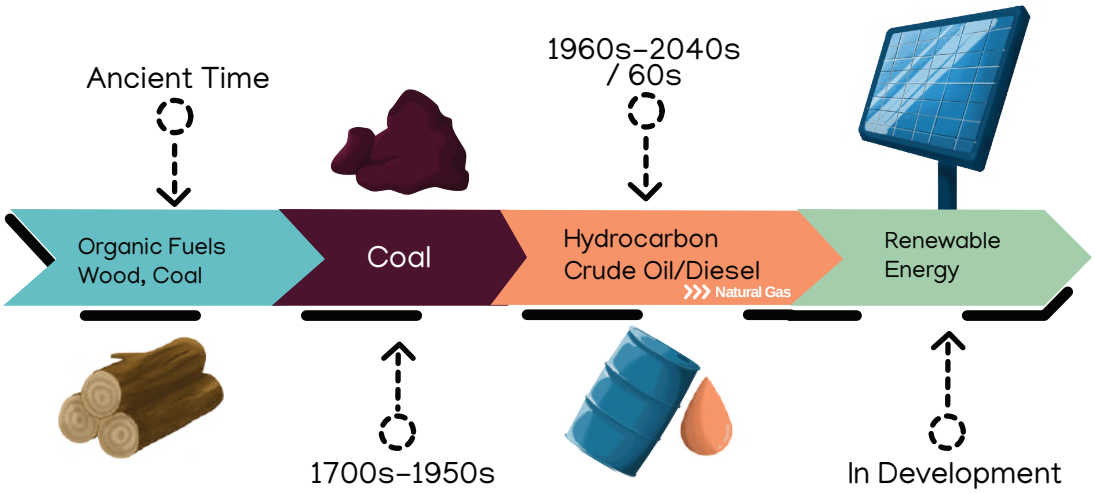

Illustration 16. Energy transition over time

As scientific knowledge has advanced, scientists have conveyed that the energy transition towards coal that occurred during that time had negative environmental impacts. Research shows that coal is a dirty source of energy—even dirtier than oil because it produces significantly more emissions. The increase in emissions has contributed to rising air pollution, environmental damage, global warming, and the frequent climate disasters we've experienced recently.

After many decades have passed, in recent years, the term "energy transition" has started to resurface, including in Indonesia. As a country still heavily reliant on coal for energy and its economy, various parties both domestically and internationally have called on Indonesia to transition from fossil-based energy to renewable energy sources. However, an energy transition effort requires collaboration from various parties, including policy changes, technological advancements, and changes in behavior and consumption patterns related to energy.

5.2. Challenges and Opportunities of Energy Transition

The energy transition in Indonesia certainly has its own challenges and opportunities. To ensure a smooth energy transition without harming specific groups, collaboration and participation from various stakeholders are required. Here are some of the challenges and opportunities of the energy transition in Indonesia:

Challenges of energy transition:

1. **Cost.** One of the biggest challenges in transitioning from fossil energy to renewable energy is the substantial cost involved. Renewable energy sources and technologies known to be sustainable solutions, such as wind and solar energy, are generally more expensive than fossil energy. This is due to several factors, including Indonesian government policies that provide subsidies for domestically consumed coal through price ceiling policies to keep coal prices low—even lower than renewable energy.

Did you know?

Levelized Cost of Electricity (LCOE)

The government plays a crucial role in the affordability of a commodity, especially for one as vital to the nation's well-being as energy. One common strategic policy is fiscal policy (policies related to government spending and/or the use of tax instruments to influence economic conditions).

One example is price ceiling and floor policies. Price ceiling policies are designed to set a maximum price for a commodity to protect consumers' purchasing power. On the other hand, price floor policies set a minimum price for a commodity to protect producers.

In the context of the energy sector in Indonesia, this applies to the coal commodity market. The Indonesian government requires coal miners to sell a portion of their products to the domestic market (known as domestic market obligation, DMO) to ensure a consistent domestic electricity supply. In implementing the DMO policy, the Indonesian government has set a price ceiling of USD 70 per ton of coal as the price that PT PLN, the state-owned electricity company, must pay as consumers.

2. Infrastructure. Another challenge is the limited electricity transmission infrastructure, such as the power grid. Renewable energy grid integration refers to the connection of renewable energy sources to the main electricity grid. Renewable energy grid integration allows widely scattered renewable energy sources in one area to be accessed by other regions. In Indonesia, the potential for renewable energy sources is spread across the archipelago. However, economic activities are concentrated in specific regions. For example, economic activities in Indonesia are concentrated in Java, Madura, and Bali (Jamali). Meanwhile, the highest potential for new and renewable energy (NRE)[4] is outside Jamali, such as in East Nusa Tenggara, Sumatra, Kalimantan, and Sulawesi, where economic activities are not as high as in Jamali. Due to limited electricity grid interconnection infrastructure, renewable energy sources cannot be used efficiently and effectively in various regions.

[4] According to the New and Renewable Energy Bill (NRE Bill), new energy is any type of energy derived from or produced by new processing technologies for non-renewable and renewable energy sources. Meanwhile, renewable energy is energy that comes from or is generated by renewable energy sources.

3. Technology. The adoption of renewable energy in Indonesia also faces challenges in terms of technology adoption and project development. For instance, Indonesia has limited capabilities, both financially and in terms of human resources, to adopt energy storage systems. Developing renewable energy technology requires expertise, which is currently limited in Indonesia. From an economic perspective, renewable energy technology has become increasingly competitive globally in recent years. However, investments in renewable energy technology and projects in Indonesia tend to be low. Some reasons for this include limited information for banks and investors about the actual risks of renewable energy projects, which are lower than fossil energy projects, and the lack of government policy support to provide confidence for developers to invest in renewable energy. To overcome these challenges, the government must increase investment opportunities, raise public awareness, and create training programs to build expertise.

4. Policy and Politics. Because energy and electricity are vital sectors for a nation and have an impact on the lives of all its citizens, policy and political processes play a crucial role in energy transition. Developing public policies related to energy transition requires a thorough, precise, and transparent process, factors that are rare and difficult to achieve in Indonesia. For example, frequent changes in policies, regulations, and government priorities hinder investors from committing to renewable energy projects in the long term. Other factors such as corruption and bureaucracy also pose challenges because they can slow down approval processes and increase the costs of renewable energy projects. According to a survey conducted by IESR, the majority of renewable energy project developers state that there are many aspects that need improvement to enhance the supportive climate for energy transition in Indonesia. Seventy-five percent of respondents stated that the process of obtaining approval for renewable energy projects takes a long time. This condition affects the long project completion period and leads to higher transaction costs, causing many investors to be uncertain about the rate of return or return on investment from these projects (Institute for Essential Services Reform, 2023).

Opportunities of energy transition:

1. Job Opportunities. The transition to renewable energy is expected to create many green job opportunities.[5] The growth of the renewable energy sector, such as the construction of hydroelectric power plants, will require civil and environmental engineers and electrical technicians with expertise in renewable energy. In 2045, it is estimated that 15 million new green jobs will be created (Koaksi Indonesia, 2022). Green jobs are not limited to technicians and engineers; there are many other green job categories based on arts, social, and economic sectors that are already emerging. For example, sustainable fashion designers, green building specialist architects, sustainable tourism workers, and policymakers specializing in environmental sustainability. Some examples of green job fields that we can explore and pursue are:

Fields of work that have the potential to address climate change and other environmental problems include:	Examples of Green Jobs in the Asia-Pacific Region
• Restoring existing stocks and green construction. • Waste management and recycling. • Public transportation. • Sustainable agriculture and food production. • Certified sustainable forestry and preventing deforestation. • Manufacturing and supply chain management. • Energy supply and efficiency. • Preservation of biodiversity and ecosystems.	• Building restoration service professionals (China). • Mangrove planters in climate adaptation programs (Vietnam). • Solar energy system technicians (China). • Geothermal exploration specialists (Indonesia). • Organic farmers (The Philippines). • Waste recyclers in well-organized cooperative settings (Indonesia). • Local ecotourism guides (Samoa). • Public infrastructure workers in coastal areas (Bangladesh). • Wetland restoration workers (Thailand). • Energy auditors in the shrimp processing industry (Bangladesh)

Table 2. Job Fields and Examples of Green Jobs
(source: International Labor Organization, n.d.)

[5]According to the International Labor Organization (ILO), green jobs are intended to reduce the environmental impact caused by companies and economic sectors, to a level that can preserve the environment. Specifically, but not exclusively, this includes jobs that can help protect ecosystems and biodiversity; reduce energy, material, and water consumption through highly efficient strategies; decarbonize the economy; and reduce or prevent all forms of waste and pollution.

2. Economic Growth. Besides improving people's well-being through green job creation, the energy transition can increase investment and foreign direct investment in the country. As mentioned earlier, the demand for energy transition in Indonesia comes not only from within the country but also from abroad. From a macroeconomic perspective, investment is a critical component in national GDP calculations. If Indonesia prioritizes energy transition and opens up to international support, the development of renewable energy and increased investment in the sector will positively contribute to the national economy.

3. Environmental Quality Improvement. Specifically, the transition to renewable energy will significantly reduce greenhouse gas emissions and mitigate long-term climate change effects. By utilizing renewable energy, Indonesia's power generation system is expected to achieve emission-free conditions by 2060 and can support the mitigation of global temperature increases below 1.5 degrees Celsius in the long term. There are many benefits to be gained from reducing greenhouse gas emissions and mitigating climate change. Some of these benefits include better health due to reduced air pollution, guaranteed food availability by avoiding crop failures often caused by extreme weather changes, protection from natural disasters like floods, landslides, and storms caused by climate change, guaranteed access to clean drinking water by avoiding droughts, and secure land for habitation by avoiding rising sea levels.

4. Energy Resilience. As explained in the previous section, energy transition plays a key role in Indonesia's energy resilience. With abundant renewable energy potential spread throughout the archipelago, Indonesia has the option to free itself from dependence on fossil energy and ensure the availability of clean, affordable, and sustainable energy for its entire population. Especially for people in remote areas, the use of renewable energy can increase Indonesia's electrification ratio by reaching remote villages. Not only does electricity provide illumination, but access to electricity can also improve people's quality of life and enhance their well-being.

In conclusion, the current energy transition still faces several challenges. However, these challenges can be overcome if all parties, including the government, private sector, civil society, young people, scientists, and others, play their respective roles and collaborate to drive the energy transition. For example, the government can issue policies that promote investment in renewable energy technology, so that more investors support energy transition in Indonesia, both in terms of technology, business, education, and more. On the other hand, public enthusiasm for switching to more environmentally friendly technologies and renewable energy sources also requires government support. This can be achieved through subsidies for electric vehicles and regulations that encourage the installation of rooftop solar panels, allowing individuals to play a role in the energy transition. Additionally, the education sector can support the energy transition by preparing young people with the appropriate skills and capabilities.

Did you know?

Renewable Energy vs. Sustainable Energy

The terms "renewable energy" and "sustainable energy" are often used interchangeably. There is some overlap between the two, as many sustainable energy sources are renewable energy sources. However, these two terms are not exactly synonymous.

Renewable energy comes from sources that naturally replenish themselves at a rate that allows us to meet our energy needs in our lifetime and the future. Sustainable energy sources come from sources that can meet our current energy needs without sacrificing the needs of future generations.

For example, biofuel falls under the category of renewable energy but may not be considered sustainable. The combustion of biofuel produces greenhouse gases, although in lower quantities compared to the combustion of fossil fuels. Additionally, the cultivation of crops for use as biofuel feedstock could potentially divert land use from forests and agriculture. However, biofuels remain a significant part of the green energy revolution. The primary challenge with biofuels is finding ways to maximize energy output while minimizing the negative impacts of biomass sourcing and biofuel combustion.

Another example of sustainability challenges with renewable energy use is the production process and waste generated by renewable energy technology. Not all renewable energy technologies are inherently sustainable. For instance:

1. Solar Panels

The manufacturing process for solar panels has negative environmental impacts due to the use of caustic chemicals like sodium hydroxide and hydrofluoric acid. Additionally, the solar panel industry consumes a significant amount of water and electricity (often sourced from fossil fuels) during production. Once decommissioned, solar panels can become waste. If left unaddressed, it's estimated that by 2050, discarded solar panels could potentially contribute to 10 percent of global waste. However, environmentally friendly solar panel production processes and recycling technologies are emerging.

2. Wind Turbines

Wind turbines can generate significant waste because wind turbine blades are made from materials that are difficult to recycle. However, there is growing interest in developing technologies to recycle the glass fiber composite material from wind turbine blades, and some are repurposing discarded blades for use in bridge construction and other applications.

3. Hydropower

Most hydroelectric power plants require large dams that can disrupt aquatic ecosystems. Additionally, the construction of hydroelectric power plants often involves deforestation and can disrupt terrestrial ecosystems. One solution is the development of small-scale hydroelectric power plants that minimize impacts on water and terrestrial ecosystems.

The sustainability aspects of renewable energy technologies are still debated. However, the long-term impacts of fossil energy use are greater and more hazardous to the sustainability of life on Earth compared to the negative aspects of renewable energy technologies. Moreover, as technology advances, scientists and engineers continue to innovate in creating sustainable renewable energy technologies.

How Renewable Energy Can Become a Clean, Affordable, and Sustainable Energy Option for Indonesia?

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for Southeast Asia

6 How Renewable Energy Can Become a Clean, Affordable, and Sustainable Energy Option for Indonesia?

6.1. Renewable Energy Potential

Indonesia has an extraordinarily vast potential for renewable energy sources. According to a study by IESR in 2021, Indonesia has a renewable energy potential ranging from 6,811.3 GW to 7,879.4 GW.[6] For comparison, just 1 GW can provide electricity to 750,000 homes. Imagine the immense potential of renewable energy sources that Indonesia possesses.

To put it into perspective, the total installed capacity of power plants in Indonesia in 2022 was approximately 81 GW (Ministry of ESDM, 2023). Indonesia's renewable energy potential is nearly 100 times greater. This means that Indonesia has a substantial foundation for an energy transition. Of the total renewable energy potential in Indonesia, solar energy is the largest contributor with a potential ranging from 6,749 GW to 7,714 GW. The rest is followed by wind, biomass, and hydropower. The chart below illustrates the potential of renewable energy sources in Indonesia based on their sources.

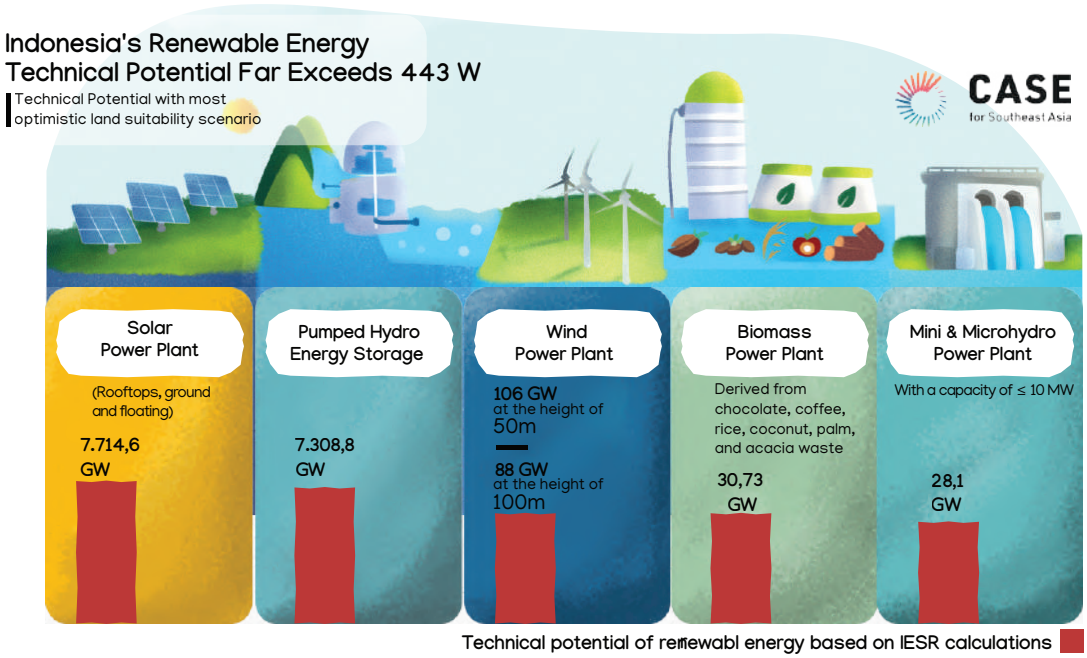
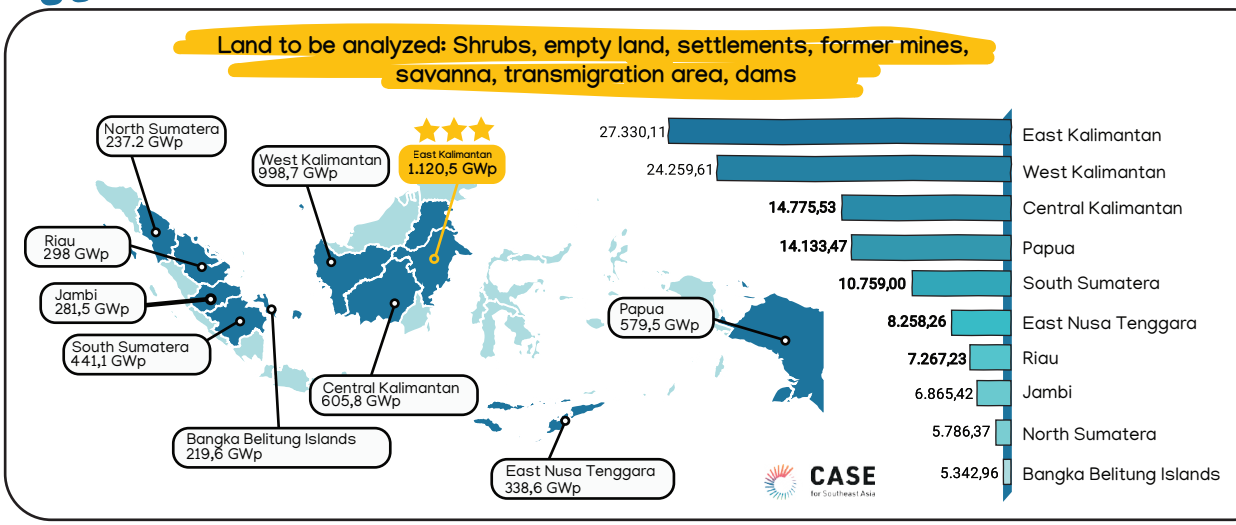


Chart 5. Renewable Energy Potential in Indonesia (source: Institute for Essential Services Reform, 2021)

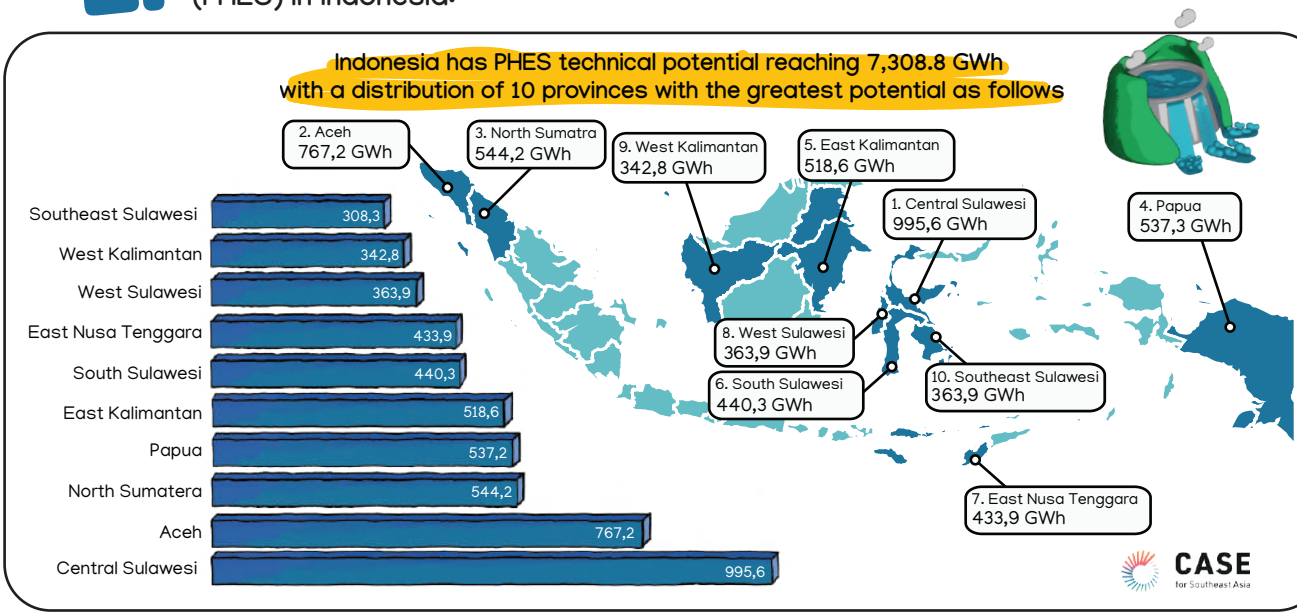
[6] The results of the IESR study indicate two scenarios of Indonesia's renewable energy potential, namely 7,879.4 GW (scenario 1) or 6,813.3 GW (scenario 2), consisting of solar power (7,714.6 GW in scenario 1 and 6,749.3 GW in scenario 2), micro-hydro power (28.1 GW in scenario 1 and 6.3 GW in scenario 2), wind power (19.8 GW to 106 GW), and biomass power (30.73 GW).
This study shows a greater potential compared to the renewable energy potential data provided by the government as recorded in the General Plan for National Energy (RUEN).

Kalimantan, West Java, Central Java, East Java, West Nusa Tenggara, North Sumatra, South Sumatra, and Papua. In the infographics below, you can see the distribution of renewable energy potential across Indonesia based on the type of generator and its potential size (in GW), including[7]:

1. Top 10 provinces with the greatest potential for solar power plants (PLTS) in Indonesia:

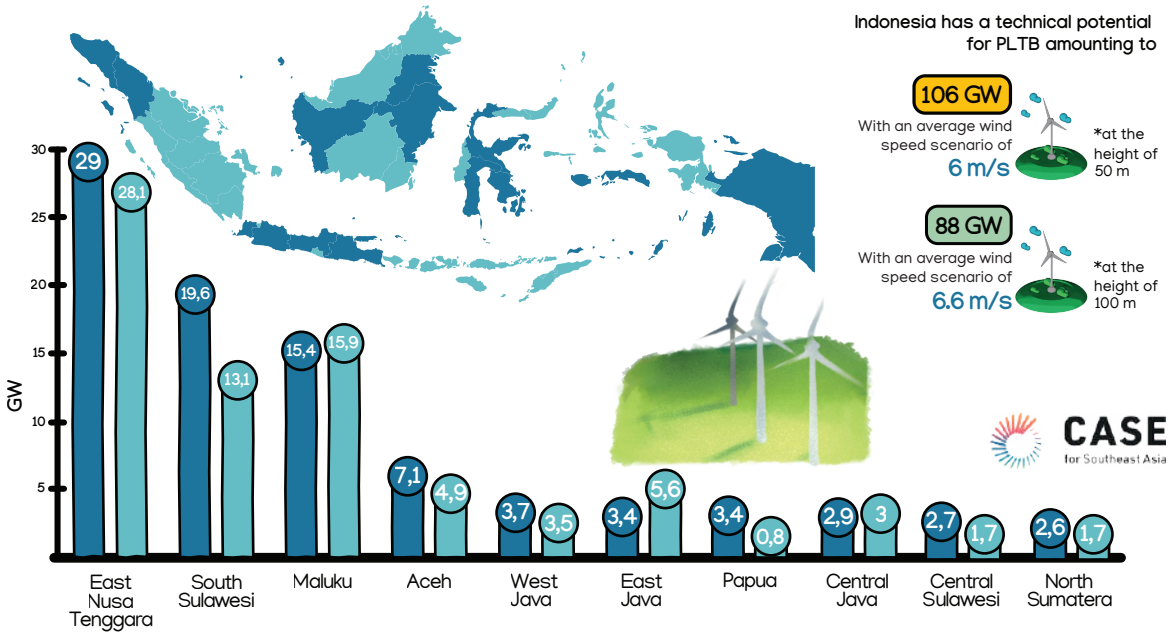


2. Top 10 provinces with the greatest potential for pump hydro energy storage (PHES) in Indonesia:

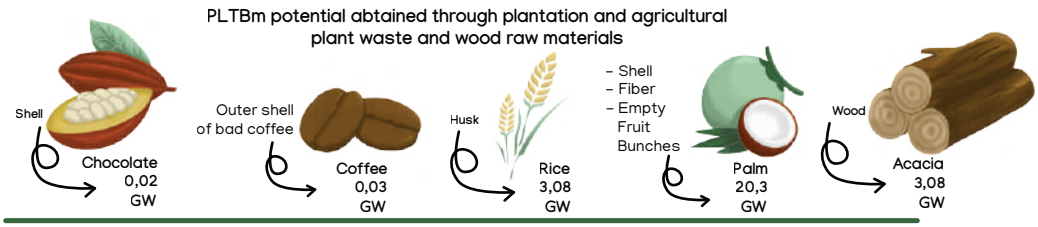


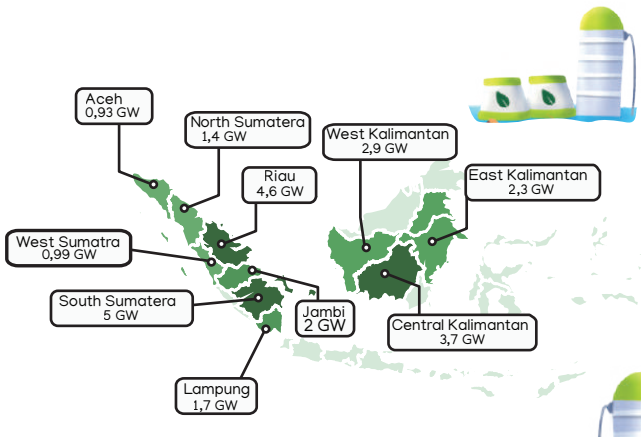
[7] Complete report can be downloaded at bit.ly/Beyond443GW

3. Top 10 provinces with the greatest potential for wind power plants (PLTB) in Indonesia:



4. Top 10 provinces with the greatest potential for biomass power plants (PLTBm) in Indonesia:





The greatest potential is on the islands of Sumatra and Kalimantan, which are palm oil producing areas.

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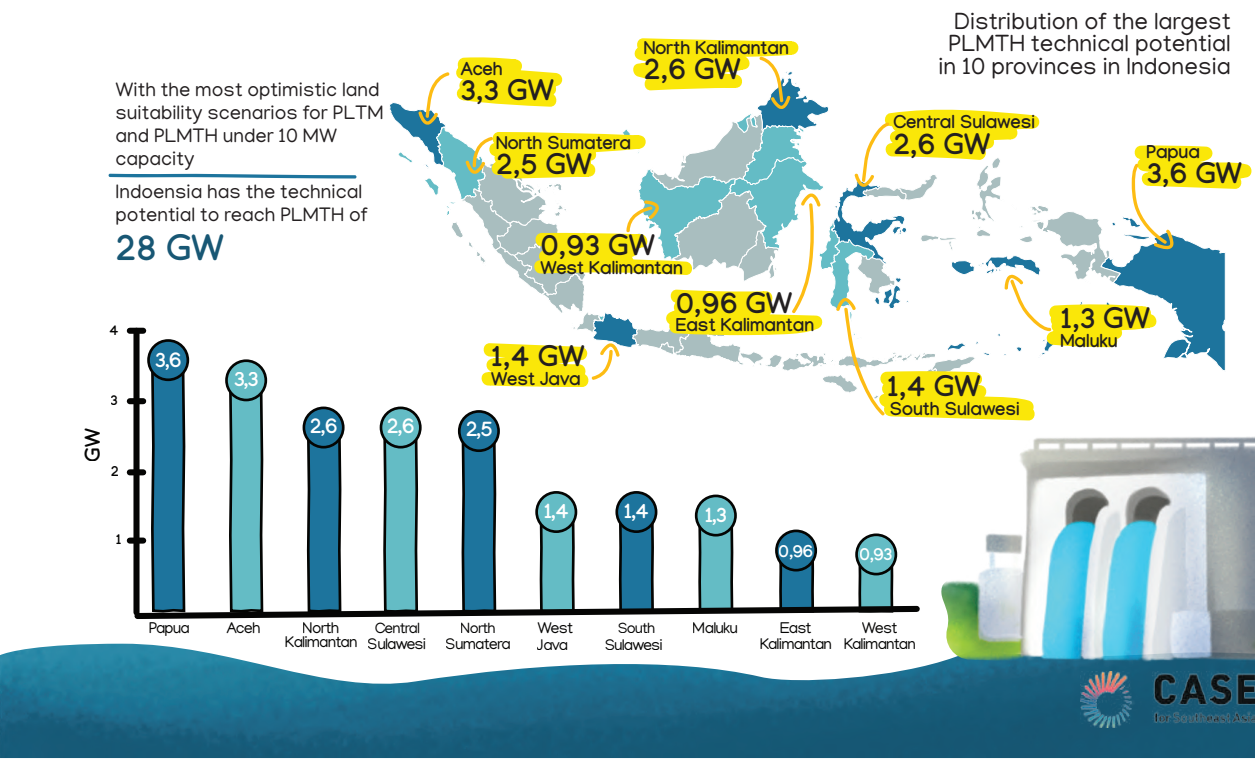
5. Top 10 provinces with the greatest potential for mini-hydro (PLTM) and microhydro (PLTMH) power plants in Indonesia:



If Indonesia optimally utilize its renewable energy potential, it can rapidly achieve its greenhouse gas emission reduction targets as outlined in the Enhanced Nationally Determined Contribution (ENDC)[8], which is 31.89 percent independently and 43.20 percent with international support. With such vast potential, what are the benefits of using renewable energy?

6.2. Benefits of Renewable Energy

Previously, we discussed the negative impacts of fossil fuel use, from global warming to unreliable energy security if Indonesia relies on fossil fuels. We also explored the opportunities that come with prioritizing the transition from fossil fuels to renewable energy. In addition to these opportunities, there are numerous benefits of renewable energy for our lives, including:

[8] Nationally Determined Contribution (NDC), or Nationally Determined Contribution, is a climate action plan to reduce emissions and adapt to climate impacts. Each Party to the Paris Agreement is required to create an NDC and update it every five years. The Ministry of Environment and Forestry as the National Focal Point of the UNFCCC on September 23 2022, has conveyed increased ambitions for reducing greenhouse gas emissions through Indonesia's Enhanced NDC (ENDC) document.

1. **Low Emissions:** Renewable energy sources are sustainable and do not produce pollution and emissions. Developing and using these energy sources can significantly reduce dependence on fossil fuels, the main contributors to greenhouse gas emissions and climate change. According to the World Health Organization (WHO), about 99 percent of people in the world breathe air of low quality that threatens their health (World Health Organization, n.d.). Air pollution, largely caused by burning fossil fuels, is a major cause of death worldwide. By switching to clean energy sources like solar and wind, we not only address climate change but also create a healthier environment and prevent respiratory diseases.

2. **Renewable and Never Depleting:** With a continuous energy supply, renewable energy ensures national energy security. It guarantees a more stable and less vulnerable energy supply. The benefit for us and future generations is the assured availability and access to clean energy over time.

3. **Energy Independence:** Due to its local-scale production, renewable energy is less affected by geopolitical crises, skyrocketing prices, or sudden disruptions in supply chains, thus protecting consumers from various external factors. On a sub-national scale, remote areas, especially those not connected to the national grid, can achieve energy self-sufficiency by optimizing local renewable energy sources, such as solar and micro hydro power.

Did You Know?

Renewable energy development to improve the quality of life for communities

In 2010, IESR conducted a study on the best models for developing locally-based renewable energy. The purpose of this study was to explore how the development of renewable energy at the local level and access to energy could enhance the quality of life for local communities.

This study was carried out in two locations: Cipta Gelar Village and Cibuluh Village in West Java. The focus of the study was Micro-Hydro Power Plants (PLTMH). Based on the study's findings, it was discovered that access to energy, especially for lighting, improved the social and economic well-being of local communities. One of the reasons for this was that with lighting, children could study after sunset. As a result, the quality of education for s tudents will improve.

Furthermore, the electricity supply from PLTMH successfully increased access to information for the residents of both villages, through radios and television broadcasts. In fact, in Cipta Gelar Village, people could access the internet. One of the greatest achievements with the availability of electricity was the establishment of a tofu factory in Cibuluh Village. The construction of this factory created job opportunities and improved the economic well-being of the local community.

From several studies of renewable energy power plants development, , IESR concluded key factors to succeed small-scale renewable energy technology development and utilization, including:

1. Involvement of the communities and ownership mindset towards renewable energy plants.

2. Communities involvement will ensure renewable energy projects to last longer and more sustainable

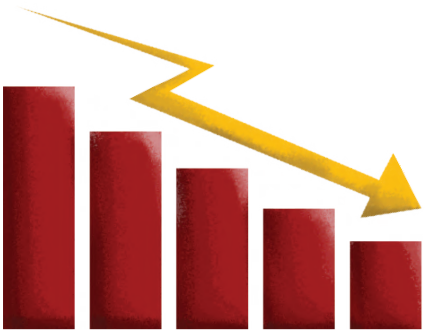
3. Empowering the community through capacity building.

4. The importance of stakeholders collaboration through funding and in nurturing the community (local non-governmental organizations, local governments and philanthropies).

Alleviating poverty through developing access to energy has several requirements , such as recognition of the communityies right to energy, strong political will from the local government, detailed and specific targets and strategic plans , long-term funding support, and involvement of local communities in its implementation and sustainability.

4. Cost Savings: Renewable energy is, in fact, the cheapest energy source in most countries today. The cost of renewable energy technologies has been rapidly decreasing. For example, the cost of solar energy decreased by 85 percent between 2010 and 2020, and onshore and offshore wind energy costs dropped by 56 percent and 48 percent, respectively, on a global average. In contrast, global prices for gas and coal have been on the rise (United Nations, n.d.).

Electricity from renewable energy sources has the potential to provide 65 percent of the world's total electricity supply by 2030. If achieved, this can lead to 90 percent decarbonization in the electricity sector by 2050 (United Nations, n.d.).[9] Therefore, how can we contribute to daily life to support the energy transition and achieve decarbonization?



[9]Decarbonization is the process of stopping or reducing carbon gas, especially carbon dioxide, which is released into the atmosphere as a result of a process, for example the burning of fossil fuels.

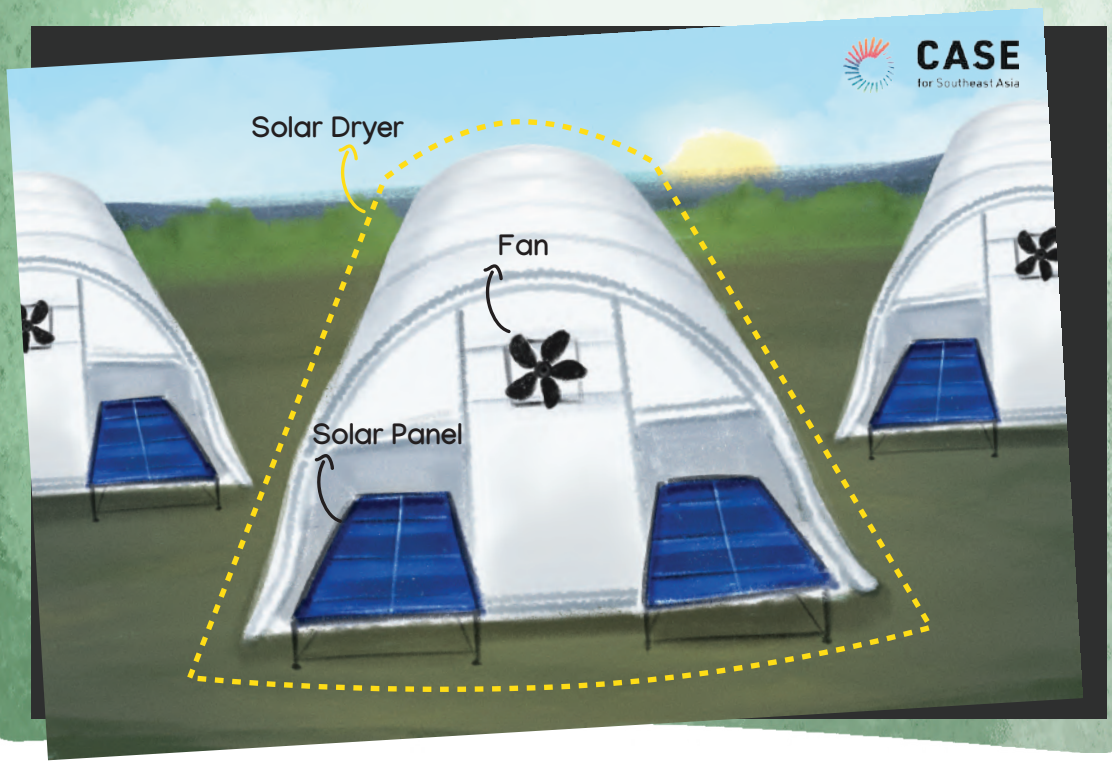
Did you know?

Solar Dryers Modification Using Solar Panels

In the "Did You Know?" section of Chapter 1, we discussed a technology called solar drying, which uses solar thermal energy to dry agricultural products. With the advancement of solar panel technology, there's now a modification to solar dryers that utilizes solar panels to generate electricity as a power source for the fan in the solar dryer. Previously, the fan was powered by electricity sourced from fossil fuels.

The fan is utilized for air circulation within the solar dryer, maintaining a dry environment and minimizing the growth of mold on the dried products/food. The fan operates by expelling the evaporated moisture from the products/food out of the solar dryer.

This technology enhances the efficiency and effectiveness of the product/food drying process by reducing drying time, minimizing the energy required by farmers, reducing contamination of agricultural products by pests, pollution, and rainwater, and mitigating the growth of mold on agricultural produce.



What Can We do to Support Energy Transition in Indonesia?

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7. What Can We do to Support Energy Transition in Indonesia?

7.1. Changing Habits to Be More Energy-Efficient

As energy consumers, we must ensure that our energy usage is not harmful to ourselves, others, the environment, and other living creatures. Changing our behavior and becoming more conscious of energy use will not only reduce our monthly energy costs but also have a positive impact on the environment by reducing CO2 emissions, making our environment a healthier place to live. Small actions can have a significant impact on the environment when done collectively.

There are two practical things we can do in our daily lives to support the energy transition and reduce CO2 emissions. These two things are energy conservation and energy efficiency. Energy conservation involves adjusting our behaviors and habits to be more energy-efficient, such as simply turning off lights and AC when not needed. On the other hand, energy efficiency involves using technology that requires less energy to perform the same functions. For example, choosing LED lights over incandescent bulbs, which consume more electricity and need to be replaced more often. Energy-efficient bulbs like LEDs use 25 to 80 percent less electricity and last 3 to 25 times longer than traditional incandescent bulbs. While energy-efficient bulbs may initially be more expensive, their energy savings and longer lifespan make them more cost-effective in the long run.

Changing habits require time and adaptation. Some people can change their habits quickly, while others might need more time. The following are some tips that can help us in transitioning to a more energy-conscious approach:

1. Identifying Energy Consumption Habits

For example, ask yourself whether you always turn on the lights when entering a room, even when it's bright outside. If you do, is it out of habit? Or do you always run the air conditioner? Could this be addressed differently, such as by opening a window or wearing cooler clothing?

2. Identifying the Impact of Energy Consumption Habits

If you were to stop some of these energy-consuming habits, what would be the consequences? For instance, by not constantly using the air conditioner, you could reduce your monthly electricity bills, save money for other purposes, and decrease your contribution to the dangerous CO2 emissions that harm the environment and people's lives, including your own.

3. Identifying the Consequences of Energy Consumption Habits

Changing habits isn't always easy, but it can be done with consistency. As a first step, you can set up reminders for what needs to be done or avoided. For instance, you could simply place stickers on your light switches to remind you to turn them off when they're not needed, or you could use a timer for your air conditioner.

Did you know?

The benefits of wise energy consumption

Changing energy consumption behavior has an impact on both personal and global levels. By reducing energy consumption, primarily derived from fossil fuels, you can:

1. Lower monthly energy bills and use the savings as a financial cushion.
2. Contribute to the energy transition process.
3. Reduce domestic demand for fossil energy.
4. Contribute to cleaner air for the health of the people around.
5. Save the Earth and its inhabitants from the threats of climate change disasters.

7.2. Being Wise in Mobility and Choosing Energy Sources

Emissions from the transportation sector contribute to about a quarter of the global greenhouse gas emissions (United Nations Sustainable Transport Conference, 2021). As vehicle users, there are several things we can do to reduce our use of personal motor vehicles and transition to using public transportation, walking, biking, or ride-sharing.

Of course, this needs to be supported by adequate infrastructure. For example, if a city is designed with good pedestrian, cyclist, and public transportation connectivity, it can encourage people to reduce their use of personal motor vehicles. This requires synergy between government policies, urban infrastructure, and community behavior. An approach developed by the United Nations (UN) highlights the relationship between vehicle users and government policies. This approach is called "avoid-shift-improve," which emphasizes the importance of community involvement in reducing unnecessary mobility. It can be supported by centralized urban infrastructure and policies aimed at reducing emissions, such as vehicle restrictions.

Furthermore, there needs to be efforts by the community to conserve and efficiently use energy, including transitioning to public transportation. The government can promote this behavior by implementing policies like fuel taxes, toll charges, and public transportation campaigns. However, it's also essential for the government to improve public transportation infrastructure and accessibility, including investments in electric vehicles.

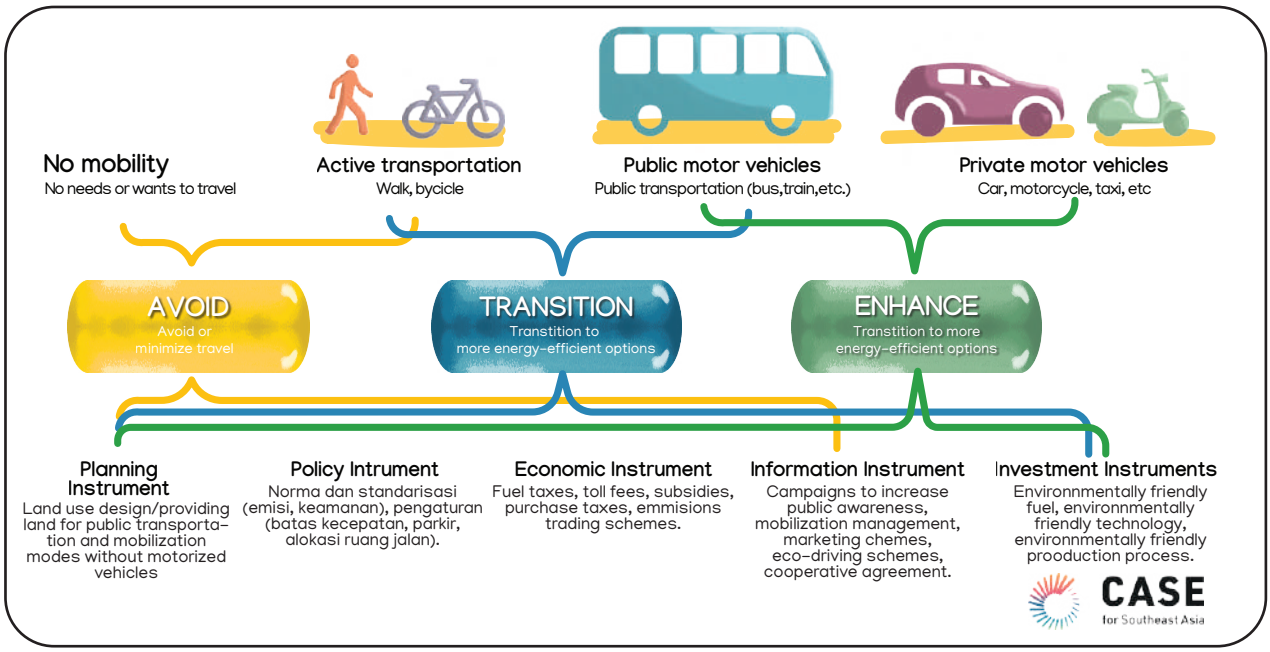


Illustration 17. Avoid-transition-enhance approach to drive the wise use of vehicles (source: TUMI et al., 2019)

In addition to being wise in energy use, we also need to be wise in choosing energy sources. One way to promote the energy transition is by using solar panels as a source of electricity at home. Although the installation cost can be relatively high, the use of solar panels offers significant long-term advantages, not only personally but also for the environment and the planet.

Other than being a clean source of electricity, solar energy is often used as an alternative to combat rising conventional electricity prices, which are sometimes not subsidized. Solar energy primarily comes from the sun, which can be obtained for free. Geographically, Indonesia is located on the equator, making it rich in solar energy potential. Solar energy can also be used to generate heat or solar thermal energy. Small-scale solar thermal systems for homes can be used as room heaters.

Solar panels do not require complex and excessive maintenance. They need to be cleaned periodically, usually once a month. Solar panels typically have a usable life of several decades. Solar panel providers usually offer reliable maintenance services, so you don't have to worry about it yourself.

Transitioning to solar panels can be a concrete step in the effort to save the Earth, especially in Indonesia, where the majority of electricity is still generated from environmentally unfriendly coal combustion.

Did you know

Do you want to install rooftop solar panels, but you have no idea where to start? you can start with solarhub.id.

IESR has created a platform called SolarHub for potential rooftop solar panel users to find information about solar energy and connect with rooftop solar panel service providers.

Through the SolarHub platform, you can calculate your rooftop solar panel installation needs at home and choose and connect directly with the nearest rooftop solar panel service providers in your city.

Visit solarhub.id or scan the QR code below!

7.3. Advocating and Collaborating Among Communities

In addition to individual actions, we can also mobilize communities around us through advocacy for a more significant impact. Advocacy can be defined as a process in which individuals or groups communicate and engage in activities aimed at influencing the behavior of other groups or specific policies. Collective actions like advocacy have the power to support policies and implement the energy transition. This is important because the voice of the community needs to be included in the energy transition process, as energy is fundamentally owned by everyone for the well-being of society.

Advocacy can target two audiences. First, advocacy campaigns can be conducted to encourage the public to support energy transition efforts. In a campaign, there are influencers or key opinion leaders (KOLs). They are public figures who serve as role models for many people, thereby having significant influence in shaping public perceptions and mobilizing the public.

Second, while the role of individuals in public is important, appropriate regulations and policies are also needed to create a supportive energy transition system and infrastructure. The lack of political will from the government can be influenced by lobbying advocacy that demands prioritization of energy transition policies.

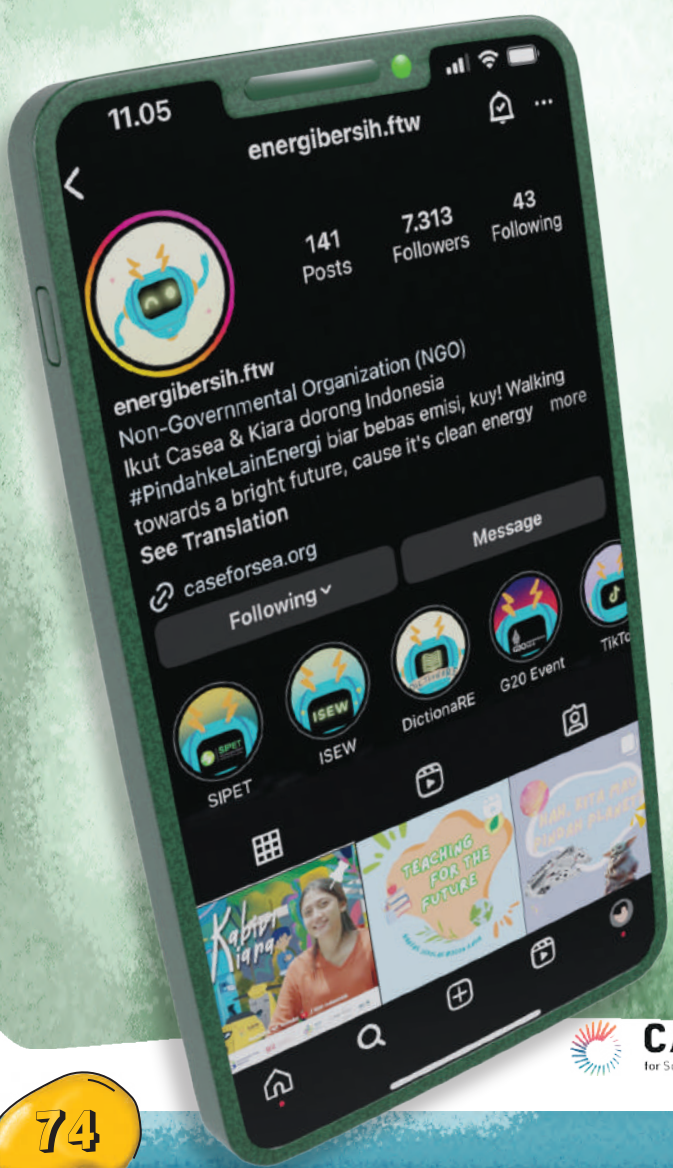
One form of campaign often used and in which we can easily participate is social media campaigns. Social media creates an open space for organizations, climate activists, and scientists to reach more people worldwide. For example, UK-COP26 and Greenpeace use social media platforms not only to share valuable knowledge about the current climate situation but also to collaborate with artists, activists, politicians, and educational institutions to show how the world is currently facing a climate emergency.

Not only large organizations but also individual actors can be found on social media campaigning for climate change and energy transition-related issues. There are still many other offline campaign forms, such as through research, exhibitions, art performances, music, films, collective actions, and more. There are no limits to creativity in campaign forms as long as the goals and methods are positive and do not harm others. Campaigns can also start on a small scale, such as within your neighborhood, school or campus, community, and beyond.

Did you know

Energy transition campaign through social media and short movies.

One example of a social media campaign addressing energy transition issues is the Instagram and TikTok account @energibersih.ftw. On this account, you can find many interesting facts about energy transitions that are easy to understand and topics that relate to our daily lives. Although it was just established in early 2022, many people have followed @energibersih.ftw and even interacted on the account. If you manage an account, one tip to increase engagement with your audience online is to actively communicate on your social media platform, as done by @energibersih.ftw.

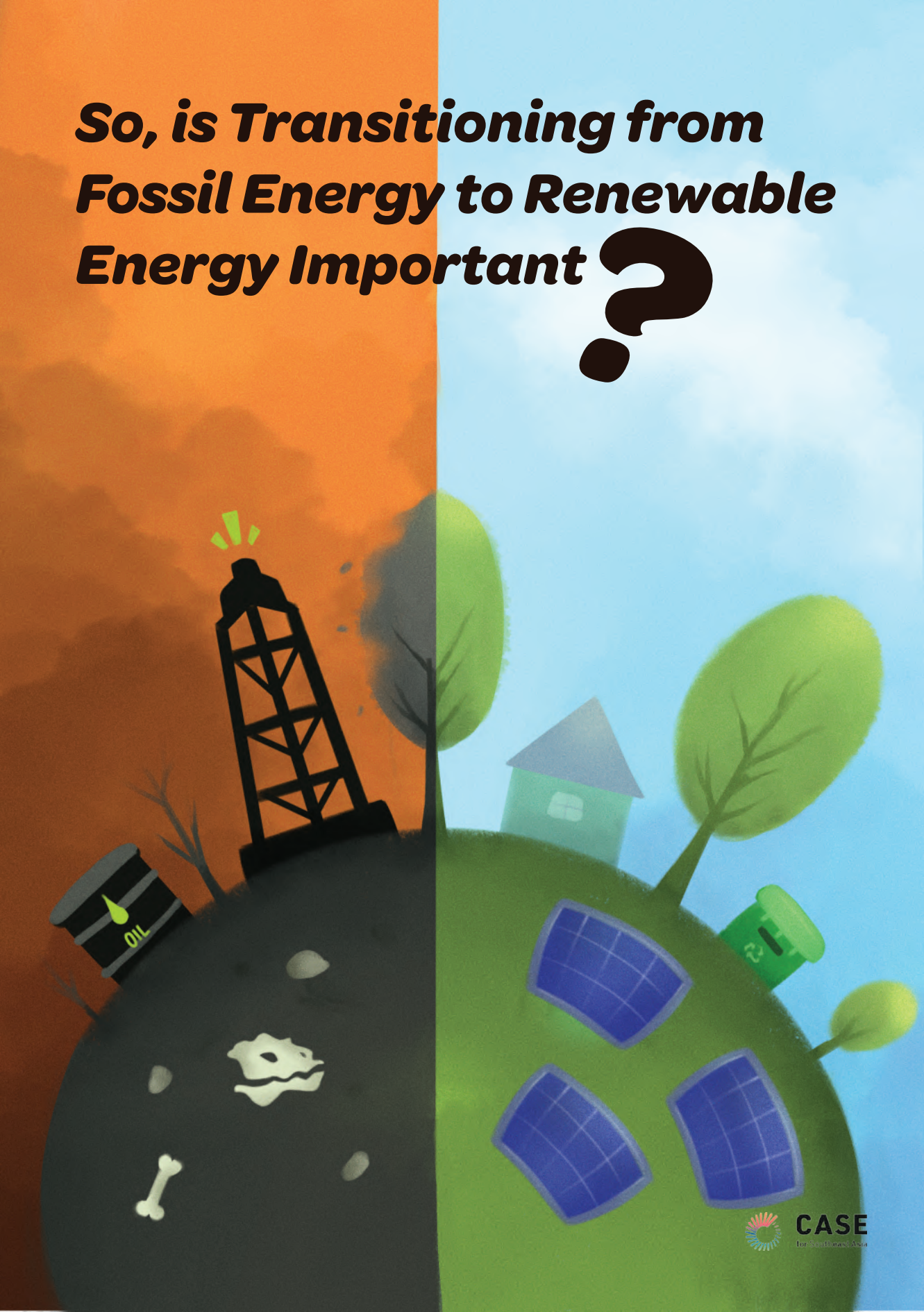


CASE for Southeast Asia

In addition to social media, there are also energy transition campaigns through short movies, such as "Mimpi Kiara" and "Kabin Kiara." These short movies tell the story of a young person's dream of having a sustainable future, and how they realized their dream through real actions, inspiring the audience to support the energy transition through real actions.

You can watch the films at **bit.ly/MimpiKiara and bit.ly/KabinKiara.**

So, is Transitioning from Fossil Energy to Renewable Energy Important ?



8. So, is Transitioning from Fossil Energy to Renewable Energy Important?

Nowadays, most countries, including Indonesia, are highly dependent on fossil fuels as their energy energy source. However, fossil fuels are non-renewable and one of the largest sources of emissions causing the climate crisis. The impact of the climate crisis affects not only the environment but also the livelihoods of creatures within it, including us humans. The climate crisis leads to various natural disasters, food crises, and even deaths.

Countries have begun to show their commitment to mitigate global warming and lowering their emissions through the Paris Agreement at COP 21. Indonesia aims to reduce emissions by 31.89 percent unconditionally and 43.20 percent conditionally. This ambition can undoubtedly be achieved through a transition from fossil energy use to tapping into Indonesia's potential for renewable energy. In the energy transition journey, strategies, foundations, and infrastructure are needed to ensure sustainability and justice for all layers of society, especially minorities and vulnerable groups.

Energy transition in Indonesia will involve every layer of the communities. As explained in the previous chapters, although energy transition is mainly carried out by the government and policymakers, the success or failure of these efforts is largely determined by the public. The general public as real drivers plays a crucial role, and the energy transition should involve the public's role for the common good.

A new concept and technology for energy transition can be said to be successful when its use and utilization are actively carried out by, from, and for the public themselves. Although renewable energy trends are not yet an everyday habit for most people, promoting a bottom-up approach in the long term will be very beneficial.

In the end, the energy transition's objective is the well-being of communities. Therefore, it is necessary to transition towards clean, affordable, and sustainable energy for all layers of society. To achieve this, all actors, including the government, private sector, academics, investors, youth, and civil society, need to work together and do their respective roles.

Abbreviations

AC	: Air Conditioner
AHP	: Analytical Hierarchy Process
BBM	: Bahan Bakar Minyak
DEN	: Dewan Energi Nasional
DMO	: Domestic Market Obligation
EBT	: Energi Baru dan Terbarukan
ENDC	: Enhanced Nationally Determined Contribution
ESDM	: Energi dan Sumber Daya Mineral
FAO	: Food and Agriculture Organization
GRK	: Gas Rumah Kaca
GW	: Gigawatt
IEA	: International Energy Agency
IESR	: Institute for Essential Services Reform
JAMALI	: Jawa Madura Bali
KEN	: Kebijakan Energi Nasional
KOL	: Key Opinion Leader
kWh	: Kilowatt-hour
LCOE	: Levelized Cost of Electricity
LED	: Light-emitting Diode
MIGAS	: Minyak dan Gas
MMSCFD	: Million Standard Cubic Feet per Day
NDC	: Nationally Determined Contribution
NOAA	: National Oceanic and Atmospheric Administration
PBB	: Perserikatan Bangsa-Bangsa
PDB	: Produk Domestik Bruto
PHES	: Pump Hydro Energy Storage
PLTA	: Pembangkit Listrik Tenaga Air

Abbreviations

PLTB	: Pembangkit Listrik Tenaga Bayu
PLTBg	: Pembangkit Listrik Tenaga Biogas
PLTBm	: Pembangkit Listrik Tenaga Biomassa
PLTBn	: Pembangkit Listrik Tenaga Bakar Nabati
PLTD	: Pembangkit Listrik Tenaga Diesel
PLTG	: Pembangkit Listrik Tenaga Gas
PLTGU	: Pembangkit Listrik Tenaga Gas dan Uap
PLTM	: Pembangkit Listrik Tenaga Mini
PLTMG	: Pembangkit Listrik Tenaga Mesin dan Gas
PLTMGU	: Pembangkit Listrik Tenaga Mesin, Gas, dan Uap
PLTMH	: Pembangkit Listrik Tenaga Mikro Hidro
PLTP	: Pembangkit Listrik Tenaga Panas Bumi
PLTS	: Pembangkit Listrik Tenaga Surya
PLTSa	: Pembangkit Listrik Tenaga Sampah
PLTU	: Pembangkit Listrik Tenaga Uap
PLTU MT	: Pembangkit Listrik Tenaga Uap Mulut Tambang
PLTU-M/G	: Pembangkit Listrik Tenaga Uap Mesin/Gas
PNBP	: Penerimaan Negara Bukan Pajak
SUTT	: Saluran Udara Tegangan Tinggi
SUTET	: Saluran Udara Tegangan Ekstra Tinggi
TSCF	: Trillion Square Cubic Feet
UNFCCC	: United Nation Framework Convention on Climate Change
USD	: United States Dollar
UUD	: Undang-Undang Dasar
WHO	: World Health Organization

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