Chapter 4

Summary

November 2022

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Chapter 4

Summary

This chapter summarises and analyses trends common to the four countries studied based on the analysis in the previous chapter and makes sector-specific recommendations.

1. Common Trend

1.1. Energy Efficiency and Carbon Intensity

As shown in Table 4.1, in the 20 years from 2000 to 2020, energy conservation (TES per GDP) progressed in all the four countries studied, but the carbon intensity (CO_2 per GDP) worsened.

Table 4.1. Summary of Energy Efficiency and Carbon Intensity

Indonesia	TES per GDP	CO_2 per TES
2000	0.40	1.64
2020	0.23	2.28
Malaysia	TES per GDP	CO_2 per TES
2000	0.32	2.38
2020	0.27	2.48
Philippines	TES per GDP	CO_2 per TES
2000	0.27	1.71
2020	0.16	2.15
Viet Nam	TES per GDP	CO_2 per TES
2000	0.31	1.54
2020	0.30	3.02

GDP = gross domestic product, TES = total energy supply.
Source: Author.

1.2. Energy Consumption, Energy Efficiency and CO_2 Emissions

Table 4.2 summarises the indicators analysed in Chapter 3. While some indicators improved, some indicators worsened from 2000 to 2020.

We summarise and analyse the common trends in each of the electricity and heat production sector, manufacturing (iron and steel) industries, transport (roads) sector, and residential sector.

1) Electricity sector

The factors behind the worsening of the carbon intensity, despite the progress of energy conservation, include an increase of the coal consumption in TES. From 2000 to 2020, coal consumption increased 5.7 times in Indonesia, 9.4 times in Malaysia, 3.6 times in the Philippines, and 11.6 times in Viet Nam.

The coal-fired electricity generation also increased. From 2000 to 2020, coal-fired electricity

generation increased 5.3 times in Indonesia, 11.2 times in Malaysia, 3.5 times in the Philippines, and 38 times in Viet Nam.

Despite that, the efficiency of coal-fired electricity generation is low at 33% in Indonesia, 34% in Malaysia, 32% in the Philippines, and 31% in Viet Nam.

In connection with these circumstances, the CO_2 emissions in the electricity and heat production sector also increased. From 2000 to 2020, the CO_2 emissions in the sector increased 3.6 times in Indonesia, 3.2 times in Malaysia, 3.2 times in the Philippines, and 13.1 times in Viet Nam. Generally, coal is known as having a high CO_2 emissions factor.

Observing from the above, it is considered that the increase of the coal-fired electricity generation in the electricity and heat production sector is related to the increase of the CO_2 emissions in the four countries studied, or to the worsening of the carbon intensity in other words.

2) Iron and steel subsector

In Indonesia and Viet Nam, there is connection between the final energy consumption in the iron and steel subsector and the increase of CO_2 emissions. In addition, steelworks were domestically operating in both countries in the 2010s.

In the 20 years from 2000 to 2020, the final coal energy consumption in this subsector of Indonesia increased 489 times, and the CO_2 emissions in this sector increased 10.7 times.

In the 10 years from 2010 to 2020, the final coal energy consumption in this subsector of Viet Nam increased 15.8 times, and the CO_2 emissions in this sector increased 14.5 times.

Observing from the above, it is considered that the increase in the final energy consumption of coal in the iron and steel subsector in both Indonesia and Viet Nam results in the increase of the CO_2 emissions.

The indicator of EE&C in the iron and steel subsector improved by 0.37 points in the Philippines, but that in Indonesia and Viet Nam worsened, by 0.38 points in 20 years, and by 0.22 points in 10 years, respectively. These figures represent energy consumptions exceeding the crude steel production.

3) Road transport

The final energy consumption in the transport sector increased in 20 years. The consumption increased 2.3 times in Indonesia, 1.9 times in Malaysia, 1.2 times in the Philippines, and 3.5 times in Viet Nam. The road sector accounts for a large portion of the final energy consumption in the transport sector. In the Philippines, where data on the number of vehicles owned are available, the CO_2 emissions, as well as the number of vehicles owned, increased. The energy source of almost all automobiles is fossil fuels. With the progress of motorisation, the number of vehicles owned increased, resulting in an increase of CO_2 emissions in the road transport sector. The country's situation, where vehicles using fossil fuels represent a major portion of the total, while next-generation automobiles such as electric vehicles account for only a small percentage, is understood to be similar to situations of the other studied counties.

4) Residential sector

The final energy consumption in the residential sector in 20 years decreased in Indonesia and Viet Nam and increased in Malaysia and the Philippines.

In Indonesia, traditional energies began to significantly decline around 2010, while modern energies increased. The GDP per capita of Indonesia increased from $1,839 in 2000 to $3,758 in 2020. That of Viet Nam increased from $1,148 in 2000 to $3,318 in 2020. It is considered that, in both countries, electrification has progressed with improvement of living standards, and the number of home appliances used has increased. It is also considered that means of cooking and hot-water supply have been converted from biomass and charcoal to LPG.

In Malaysia, since around 2000, the percentage of traditional energies used has been very small, while the consumption of electricity has continued to increase. The GDP per capita of Malaysia increased from $6,414 in 2000 to $10,620 in 2020. Electrification had already progressed in 2000; therefore, it is considered that even more home appliances have been used with improvement of living standards.

In the Philippines, the consumption of traditional energies has not declined and remained flat, but that of modern energies, electricity, has increased. The GDP per capita of the Philippines increased from $1,831 in 2000 to $3,269 in 2020. It is expected that the consumption of modern energies, mainly electricity and LPG, will continue to increase in the future.

The EE&C indicator of the residential sector of the Philippines has remained unchanged. That of Indonesia improved until 2010, but has been on an upward trend in recent years. That of Malaysia and Viet Nam has continued to increase.

The populations of the four countries have all increased. In addition, the number of households has increased, and the number of home appliances has increased faster than the growth of the population and the number of households. It is considered that the final energy consumption has also increased.

Table 4.2. Summary of Indicator Transition (2000 vs 2020)

Items		Unit	20 Years Transition (2000～2020)			
			Indonesia	Malaysia	Philippines	Viet Nam
Energy Consumption Index	Population	Times	1.3	1.4	1.4	1.2
	GDP	Times	2.6	2.3	2.5	3.5
	GDP per Capita	Times	2.0	1.7	1.8	2.9
	TES	Times	1.5	1.9	1.5	3.4
	of which, amount of fossil fuel	Times	1.8	1.9	1.8	6.2
	of which, fossil fuel dependency	%	11 ↑	0	11 ↑	39 ↑
	of which, coal	Times	5.7	9.4	3.6	11.6
	Electricity Output	Times	3.1	2.6	2.2	9.0
	of which, coal-fire electricity output	Times	5.3	11.2	3.5	38.0
	Final Energy Consumption	Times	1.3	2.1	1.4	2.7
	of which, final energy consumption (Industry)	Times	1.9	1.6	1.4	4.6
	of which, final energy consumption (Iron and Steel)	Times	10.0	NA	1.5	*10.0
	of which, final energy consumption (Non-metallic minerals)	Times	43.0	NA	0.0	*2.5
	of which, final energy consumption (Transport)	Times	2.3	1.9	1.2	3.5
	of which, final energy consumption (Residential)	Times	0.6	1.7	1.3	0.8
	Final energy consumption of Coal by Iron and Steel Sector	Times	489.0	NA	NA	15.8
Energy Efficiency Index	TES per GDP	Point	0.17 ↓	0.05 ↓	0.11 ↓	0.01 ↓
	CO_2 per TES	Point	0.64 ↑	0.1 ↑	0.44 ↑	1.48 ↑
	EE&C Indicator of Iron and Steel Sector	Point	0.38 ↑	NA	0.37 ↓	*0.22 ↑
	EE&C Indicator of Non-metallic minerals Sector	Point	0.04 ↓	NA	NA	*0.03 ↑
	EE&C Indicator of Road Sector	Point	0.35 ↓	0.34↓	1.00 ↓	9.08 ↓
	EE&C Indicator of Residential Sector	Point	0.03 ↑	0.15 ↑	0	0.18 ↑
	Thermal Efficiency fossil fuel-fired	Point	0.03 ↓	0	0.01 ↓	0.05 ↑
	Thermal Efficiency coal-fired	Point	0.02 ↓	0.1 ↓	0.06 ↓	0.08 ↑
CO_2 Emission Index	CO_2 Emission	Times	2.1	2.0	1.9	6.6
	of which, CO_2 emission by Electricity and Heat Production sector	Times	3.6	3.2	3.2	13.1
	CO_2 emission by Iron and steel sector	Times	10.7	NA	1.3	*14.5

EE&C = energy efficiency and conservation, GDP = gross domestic product, TES = total energy supply.
Source: Author.
*Data duration is from 2010 to 2020

1.3. Energy Efficiency and CO_2 Emissions Reduction Policy

1) Carbon neutrality declaration

As shown in Table 4.3, Indonesia declared carbon neutrality in 2060, while Malaysia and Viet Nam declared carbon neutrality in 2050. The Philippines has not declared carbon neutrality.

Table 4.3. Summary of Climate Change Policies

Selected Countries	CN Target Year	2030 GHG Emissions Reduction Target (NDC)				Coal Fired Plant Phase out
		Type of Reduction Target	Target Unconditional	Target Conditional*1	Base Year	
Indonesia	2060	Emissions	29%	41%	BAU	YES*2
Malaysia	2050	Carbon Intensity	45%	NA	2005	YES*2
Philippines	NA	Emissions	2.71%	75%	BAU	YES*2
Viet Nam	2050	Emissions	9%	27%	BAU	YES

BAU = business as usual, GHG = greenhouse gas, NDC = nationally determined contribution.
Source: Author.
*1：Conditional targets depend on the availability of international financial support, technical assistance and human resource development.
*2：New plants will not be approved.

2) Coal-fired plant phase out and suspension of new coal-fired power construction

Additionally, as shown in Table 4.3, policies common amongst the countries include phase out from coal-fired power generation and halt of the construction of new coal-fired power plants.

PLN will not build any new coal-fired power plants in the future and will phase them out by 2056. Further, Indonesia disclosed its policy for announcing a roadmap toward early shutdown of coal-fired power plants on 16 August 2023. The roadmap will be developed within a framework of the Just Energy Transition Partnership (JETP), which was established under the initiative of Japan and the US as a policy for providing support for transition from coal-fired power generation to renewable energies. JETP is a framework that G7 established in 2022 with the aim of supporting emerging and developing countries for their decarbonisation. Indonesian JETP was announced to coincide with the G20 Summit, which was held in Bali in November 2022, and a group of 10 nations/regions, led by Japan and the US, will release $20 billion publicly and privately in the next 3 years.

Malaysia and the Philippines decided to halt the approval of new coal-fired power plant projects.

Viet Nam pledged at COP26 to abolish coal-fired power generation in stages by 2040.

3) Energy efficiency policy

Indonesia has set a goal of reducing energy intensity by 1% every year from 2014 to 2025.

NEEAP 2016–25 of Malaysia promotes energy audits of buildings and energy-efficient building design (green building), and the country plans to reduce the electricity demand growth by 8% from 2016 to 2025.

In the Philippines, the EEC Act came into effect in May 2019. The Act requires submission of an annual energy consumption report, and an energy audit report will be submitted. In addition, the Philippines utilises consulting on energy conservation using ESCOs.

In Viet Nam, a Law on Energy Efficiency and Conservation (Energy Conservation Law) came into force in January 2011. Plants and business operators designated for energy management are required to prepare and submit an annual plan for energy conservation, A Five-Year Plan, and report regularly, appoint an energy manager, and conduct an energy audit once every 3 years (Table 4.4).

Table 4.4. Summary of Energy Efficiency Policy

Country	Policy
Indonesia	To reduce energy elasticity to less than 1 by 2025 and to reduce the intensity of final energy by 1% per annum until 2025.
Malaysia	Reduce electricity demand growth by 8% from 2016 to 2025. Also, promotion of green building.
Philippines	Annual Energy Consumption Report, Energy Audit Report, ESCOs
Viet Nam	National energy conservation target is set for 2006–2010 as 3%–5%, and for 2010–2015 as 5%–8%. Annual plan, Five-Year Plan, preparation, and submission of regular reports on energy conservation, appointment of energy manager, energy audit once every 3 years.

Source: Author.

2. Proposal

2.1. Electricity Sector

The electricity and heat production sector accounts for the largest share of CO_2 emissions in all the four countries studied. The issues of the electricity and heat production sector is the fact that an increase of the coal-fired power generation has led to an increase of the CO_2 emissions.

Policies common amongst the four countries include phase-out of coal-fired power generation and halt of the construction of new coal-fired power plants. On the other hand, coal-fired electricity generation, which is inefficient, has increased; the CO_2 emissions resulting from the increase have also increased, implying that the countries have a dilemma where even though energy conservation progresses, the carbon intensity worsens.

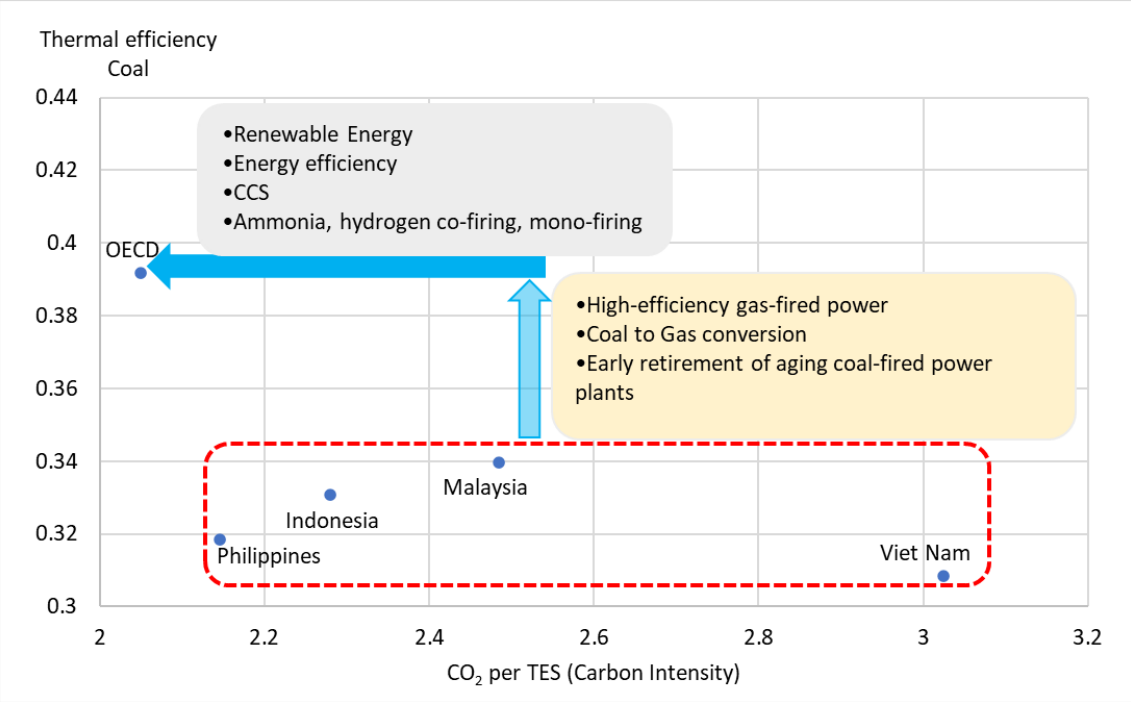
Figure 4.1 shows a matrix in which the horizontal axis represents the carbon intensity, and the vertical axis the efficiency of coal-fired electricity generation. The four countries have higher carbon intensities and lower efficiency of coal-fired electricity generation than OECD countries.

Possible means to raise the level to the OECD level may be divided into measures to increase the power generation efficiency and measures to improve the carbon intensity.

Measures to increase the power generation efficiency include: (a) early retirement of aging coal-fired power plants, and (b) high-efficiency gas-fired power generation.

Measures to improve the carbon intensity include: (c) ammonia, hydrogen co-firing, or mono-firing, and (d) introduction of CCS or renewable energies.

Figure 4.1. Improvement of Power Generation Efficiency and Carbon Intensity



TES = total energy supply, OECD = Organisation for Economic Co-operation and Development.
Source: Author.

Examples can provide international cooperation in coping with these issues include the following four cases.

A) ADB's Energy Transition Mechanism (ETM)

B) Efficiency improvement of coal-fired power generation and conversion to gas

C) Ammonia co-firing

D) CCS demonstration

A) ETM of ADB

ETM is a joint initiative with developing countries to accelerate the transition from fossil fuels to clean energy. Public-private investments from governments, multilateral banks, private investors, and others will fund country-specific ETM funds to phase out coal-fired power early. Under the ETM, ADB signed a memorandum of understanding with PT PLN, Indonesia's state-owned power company, to consider early retirement of Indonesia's Cirebon coal-fired power plant.

B) Efficiency improvement of coal-fired power and conversion to gas-fired plant

Improvement of the efficiency of coal-fired electricity generation requires equipment replacement as it relates to aging. From the aspects of power generation efficiency improvement and carbon intensity reduction, it is important to pursue not only the existing 'Ultra Super Critical' technology for pulverised coal firing, but also the development of new coal-gas firing technologies (Integrated Coal Gasification Combined Cycle, and Integrated Coal Gasification Fuel Cell Combined Cycle).

The CO_2 emissions by combustion of natural gas is less than half that of coal, and natural gas-fired power generation is generally more efficient than coal-fired power generation. Therefore, on the road to carbon neutrality, natural gas can play a transitional binder role until low-carbon technologies such as renewable energy and CCS are introduced on a large scale. Natural gas has the potential to be replaced by non-fossil fuels such as hydrogen in the future. For natural gas-producing countries such as Indonesia and Malaysia, infrastructure development costs such as tanks and piping to power generation facilities can be kept relatively low.

The share of renewable energy in the TES of the four studied countries is currently extremely small, so it is assumed that it will take some time for renewable energy to spread. To catch up with vigorous energy demand, switching to natural gas-fired power can be a highly effective measure.

C) Green/ Blue Ammonia co-firing

The biggest advantage of green/blue ammonia as a fuel is that it is carbon-free. Ammonia does not emit CO_2 when combusted. Ammonia also has the advantage of being easy to transport and inexpensive. The disadvantage of ammonia is that nitrogen oxides are generated during combustion.

When ammonia is co-firing in a boiler for thermal power generation, it can be handled simply by changing the burner. In the case of ammonia co-firing, new equipment and initial investment can be minimised, and there is no need to decommission a thermal power plant. Many of the coal-fired power plants in the four studied countries are relatively new, and this is an effective means of avoiding stranded assets without decommissioning them.

The following are examples of ammonia co-firing demonstrations.

In 2021, JERA power generation company in Japan commenced a demonstration of small-scale coal-ammonia co-firing in collaboration with IHI in Hekinan, Aichi Prefecture, Japan (Figure 4.2). JERA will also commence large-scale fuel ammonia co-firing (heat volume ratio: 20%) in fiscal 2023, a year ahead of schedule (Figure 4.3). In addition, JERA plans to achieve a percentage of

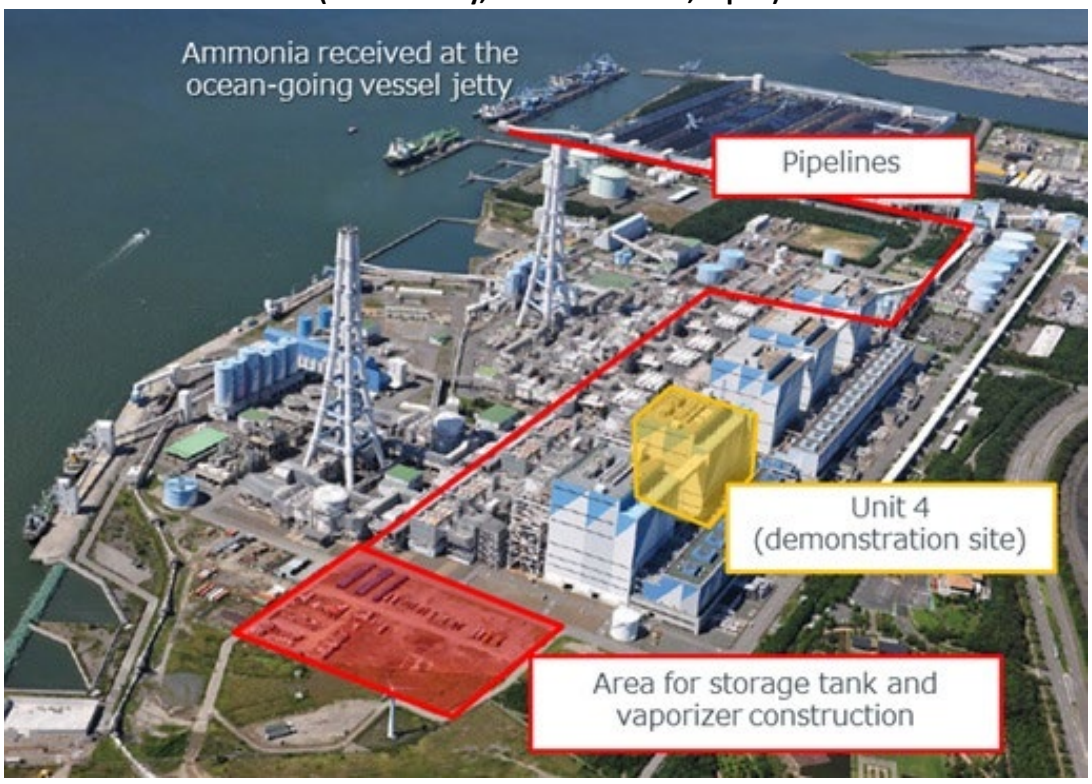
ammonia in co-firing at 50% in/after 2030, and 100% ammonia only in/after 2035.

Advantages of ammonia include the fact that existing technology and equipment can be used. Ammonia co-firing can be achieved by slightly improving the burner in the boiler. Although a tank for storing ammonia and a pipeline would separately be required, it would be almost unnecessary to alter any other power generation facilities or the transmission line.

Many of the coal-fired power plants in the four countries studied went on stream relatively recently. Ammonia co-firing can serve as an effective means to advance decarbonisation at low cost and speedily by utilising such existing equipment.

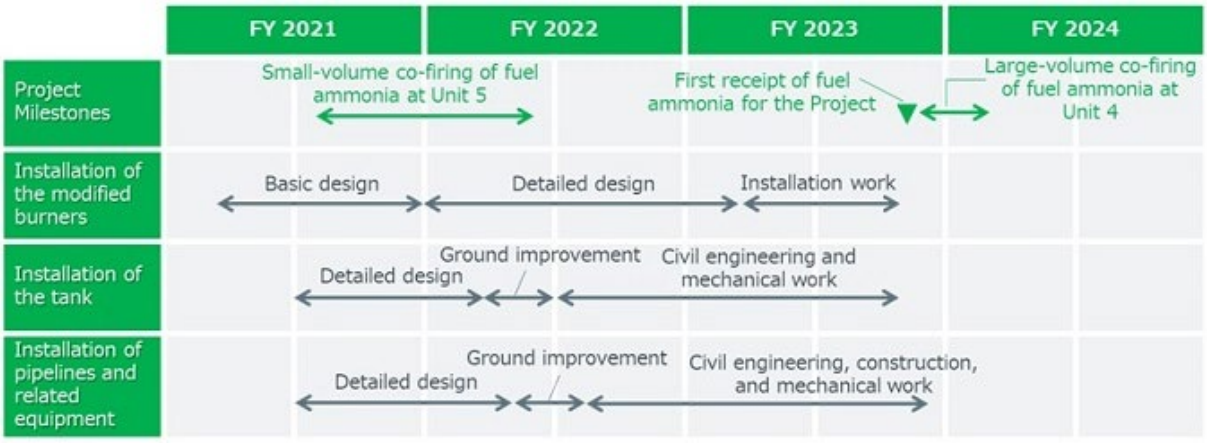
Although it faces challenges in supply chain building, such as joint procurement of ammonia, development of large ammonia carriers, and construction of a safe transport structure, the ammonia co-firing approach is a realistic measure to prevent the existing equipment from becoming a stranded asset.

Figure 4.2. Project Site at the Hekinan Thermal Power Station (Hekinan City, Aichi Prefecture, Japan)



Source: JERA Press Release, 31 May 2022.
https://www.jera.co.jp/en/news/information/20220531_917 (accessed 11 May 2023).

Figure 4.3. Project Schedule at Hekinan



Source: JERA Press Release, 31 May 2022.

Biomass is another co-firing material besides ammonia. Biomass can be co-combusted with coal-fired power and has advantages such as virtually zero CO_2 emissions and the ability to utilise existing facilities. It is a method of generating electricity by combusting and gasifying biological resources such as wood, and the principle is the same as thermal power generation and ammonia power generation. CO_2 is emitted when it is combusted, but biomass fuel absorbs CO_2 during the growth process, so when viewed as a whole, it does not increase the amount of CO_2 in the atmosphere. Since it is not affected by the weather, it can also serve as a backup power source for renewable energy power generation. The four countries studied are rich in biomass resources. Co-firing wood chips, palm stalks, wood pellets, etc. is a practical and fast-acting method.

D) CCS demonstration

The advantage of CCS is that it can significantly reduce CO_2. It is possible to recycle CO_2. CO_2 from the atmosphere can also be captured and stored. Disadvantages include cost reduction at each stage of CO_2 separation, capture, transportation, and storage, construction of a CO_2 value chain, and development of laws.

CCS can be introduced in any field that emits large amounts of CO_2, such as thermal power generation, steel plants, cement production, and waste incineration. The potential for CCS in the four countries studied is high because there are many oil and gas fields.

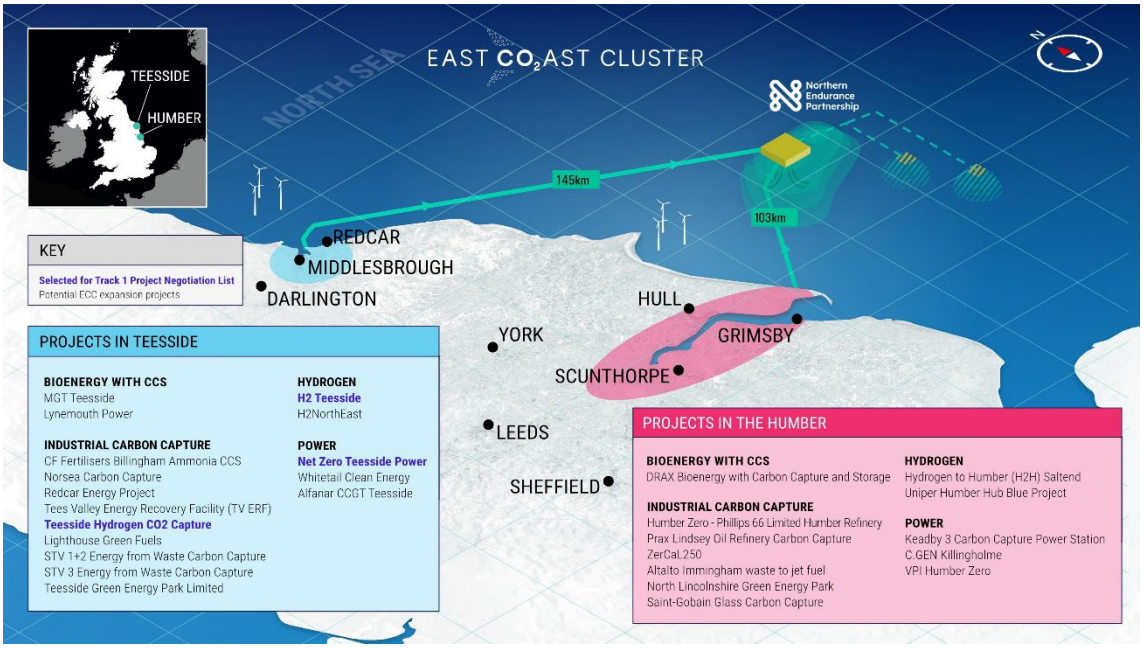
CO_2 is relatively easy to liquefy under high pressure and can be transported. As of September 2022, there are 196 CCS projects in the world. The issue of CCS is the cost, but it is expected that this will be resolved as the number of CCS projects increases and commercialisation progresses.

Regarding CCS, in the US, the Inflation Reduction Act tax credit, which was enacted in 2022, has been expanded to $85 per tonne of CO_2 storage. In Europe, oil- and gas-producing countries along the North Sea (the UK, Norway, and the Netherlands) are taking the lead in promoting CCS. The UK has set a target of 10 million tonnes per year by 2030.

- UK CCS case study: – East Coast Cluster

The East Coast Cluster is a CCS project in an industrial cluster in the eastern part of the UK (Teesside, Humber). The project cuts 50% of its CO_2 emissions for UK industrial clusters. Joint transportation and storage businesses include Net Zero Teesside and Zero Carbon Humber. BP, Eni, Equinor, National Grid, Shell and TotalEnergies set up a storage entity, i.e. the Northern Endurance Partnership (NEP), developing an aquifer in the southern North Sea as a storage site. Planned annual average collection amount is 23Mt/year in 2035. The project is scheduled to start operation in 2027 (Figure 4.4).

Figure 4.4. East Coast Cluster



Source: East coast cluster, https://eastcoastcluster.co.uk/ (accessed 4 June 2023).

- Canada CCS case study: – Quest CCS

Quest CCS in Alberta, Canada started operation in 2015 and captured 7 million tonnes of CO_2 in 7 years until 2022. Quest CCS will capture approximately 1 million tonnes of CO_2 annually from oil sands operations and store the CO_2 in sandstone reservoirs at depths of more than 2 km underground. Quest CCS is the world's first commercial-scale CCS facility applied to an oil sands business. The Quest CCS facility is operated by Shell Canada on behalf of the Athabasca Oil Sands Project. The respective ownership interests of the Project's assets in aggregate, directly and indirectly, are 70% Canadian Natural Resources Limited and an affiliate, 20% Chevron Canada Limited, and 10% Shell Canada Limited through certain subsidiaries (Figure 4.5).

Figure 4.5. Quest Carbon Capture and Storage

Source: Shell Canada Quest Carbon Capture and Storage, https://www.shell.ca/en_ca/about-us/projects-and-sites/quest-carbon-capture-and-storage-project.html (accessed 4 June 2023).

2.2. Iron and Steel Sector

In Indonesia and Viet Nam, the industry sector represents the second-largest CO_2 emissions source behind the electricity and heat production sector. Amongst the industry subsectors, iron and steel shows an especially high increase in coal consumption, and in line with it, the CO_2 emissions are also increasing. This is a result of the industrial policy.

The iron and steel subsector is one of the subsectors facing difficulty in reducing the carbon intensity. To improve the carbon intensity and achieve carbon neutrality in the iron and steel subsector, parallel efforts such as hydrogen reduction using the blast furnace method, expansion of the electric furnace method, and adoption of the direct hydrogen reduction technology would be required.

2.3. Road Transport

In Malaysia and the Philippines, the transport sector's share in CO_2 emissions is the second largest after the electricity and heat production sector. Especially, the CO_2 emissions in the road transport sector account for a large percentage.

As one of the measures to reduce CO_2 emissions in the road transport sector, a shift from vehicles using fossil fuels such as gasoline and diesel oil to next-generation automobiles such as electric vehicles is drawing attention. However, the penetration rate of electric vehicles is currently low in most countries. For example, in the Philippines, of approximately 11.80 million registered cars owned as of 2020, approximately 9.30 million cars are gasoline-powered, and approximately 2.48 million cars are diesel-powered. By contrast, the number of electric vehicles is only 464 (Table 4.5).

Table 4.5. Number of Motor Vehicles Registered by Type and Fuel Used (Philippines)

Year	Grand Total*						
	Gas	Diesel	Compressed Natural Gas (CNG)	Liquified Petroleum Gas (LPG)	Light Electric Vehicles (LEV)	Others	Total
2020	9,312,619	2,478,156	349	34	464	3	11,791,625

Source: Land Transportation Office, Philippines.

As analysed in Chapter 3, the four studied countries have a coal-fired power generation share of more than 50%. It is necessary to consider the popularisation of electric vehicles and the decarbonisation of power sources as a set. If the fuel mix for power generation is mainly fossil fuels, especially if the ratio of coal is high, even if there are no GHG emissions during electric vehicle driving, it will emit GHGs during power generation. Therefore, it is necessary to shift to clean power sources such as renewable energy. Decarbonisation of the road transport is closely linked to decarbonisation of the power generation sector.

In addition, there are two types of decarbonisation regulations for automobiles: regulations on fuel economy and promotion of lower emissions vehicle. The government can impose more stringent standards on fuel economy of new car sales to reduce oil consumption and resulting CO_2 emissions. The latter is to promote the dissemination of new types of vehicles including hybrid vehicles, plug-in hybrid vehicles, and battery electric vehicles that have lower carbon footprints. Supply of these new vehicles are now rapidly growing in the world and ASEAN member countries can enjoy environmental benefits attained by such technologies. In addition, biofuel may be another choice for those countries where supply can be anticipated.

To comprehensively decarbonise road transport, not only the decarbonisation of vehicles, but also the reduction of GHG emissions due to traffic congestion and the improvement of inefficient transportation (single-seat passenger cars), are issues. It is also important to develop urban infrastructure and transform society, such as expanding public transportation, improving road networks, and reducing travel needs due to closer proximity to work and home.

Electrification of automobiles into, for example, electric vehicles not only serve as an environmental and energy measure, but also is intended to create next-generation industries. The electrification aims for decarbonisation where GHG emissions are reduced to net zero through electric vehicle penetration and have the implication of promoting the production of automobiles centering on electric vehicles, the attraction of investments in related parts, and the development of industries. In particular, Indonesia aims at becoming an electric vehicle hub within the ASEAN region and is pursuing electrification and zero-emissions in automobile production.

2.4. Residential Sector

As for the residential sector, while traditional fuels are decreasing, modern energies such as electricity and LPG are increasing, in Indonesia and Viet Nam. Electricity consumption is increasing also in Malaysia and the Philippines.

Energies used at residences are mainly for electricity by appliances such as lightings, air conditioners, TVs and refrigerators, and heat consumptions in hot-water supply and cooking.

As for lighting, energy conservation measures include replacement to light-emitting diode lights, use of illuminance sensors, and replacement of lighting fixtures with controllable illuminance.

For air conditioning, energy conservation measures may include replacement to energy-saving air conditioners, and cleaning of filters. However, top priority should be given to the improvement of the insulation and airtightness performance of residence windows. With residences having good window insulation and airtightness, the air cooled by air conditioning is hard to leak, the air conditioner's cooling temperature can be set higher, number of air conditioners would be reduced and the operating time is shorter. Institutionalising the display of the energy conservation performance of residences is important also from the viewpoint of forming a stock of high-quality residences. In addition, if a photovoltaic generation system is installed in a residence with high window insulation and airtightness performance, the cool air will be effectively used without leakage.

As for home appliances, it is important to indicate their performance in a manner easy-to-understand for consumers, such as 5-Star Rated Alliances of Malaysia.

The Vauban district (population of about 5,500) in the city of Freiburg (population of about 200,000) in southwestern Germany is an example of the comprehensive development and transformation of the transport and residential sectors. The Vauban district is a natural recycling eco-city completed in 2007. The Vauban district has realised greening, district heating, energy-saving housing, and carport-free (parking lots cannot be built in subdivisions). Specifically, trees that are 1 metre above the ground and have a trunk circumference of more than 80 centimetres cannot be felled. Rooftop greening is obligatory on flat roofs with an angle of 10 degrees or less, and light rail transit tracks are also greened to reduce the heat island effect and reduce the burden of sewage treatment due to rainwater seepage. Heat is supplied to the district using a cogeneration system as an energy source. Buildings also use roofs, walls, and glass with high thermal insulation performance, which reduces energy loss. The collective housing shares a boundary wall, making it difficult for heat to escape from the wall surface. Passive construction, energy-plus construction and the use of solar technology are standard. Private cars are parked in several multi-storey car parks in the district and then walked or cycled to their homes. The Vauban district and the center of Freiburg are connected in about 15 minutes by light rail or bus (Figure 4.6).

It is thought that urban development that integrates the design of transportation and housing infrastructure can be realised in an environment suitable for each country even in the studied countries.

Figure 4.6. Vauban, Freiburg, Germany

Source: Freiburg city HP Quartier Vauban,
https://visit.freiburg.de/en/attractions/quartier-vauban (accessed 6 June 2023).

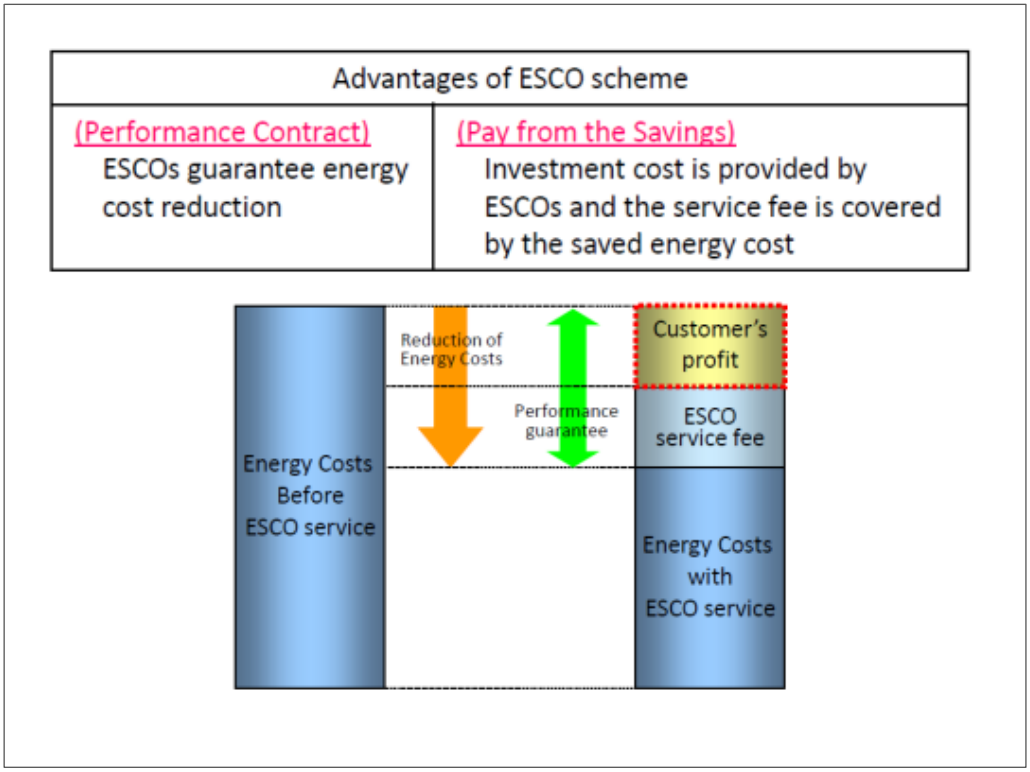
2.5. Energy Efficiency Policy

1) ESCOs

In the Philippines, an ESCO service was effective in power saving through energy conservation consulting. The ESCO service is a project intended to secure all investments and customer benefits with the reduction of utility costs achieved through energy-conserving renovation works, and provides comprehensive services including energy conservation diagnosis, design, execution, operation, management, and funding. The service is characterised by a 'Performance Agreement,' under which the energy conservation effect is guaranteed by the ESCO business operator, and if no effect is obtained, the ESCO business operator will make repayment (Figure 4.6).

The energy conservation consulting service with ESCO will be also effective for countries where energy consumptions are expected to increase in the future, such as Cambodia and the Lao People's Democratic Republic, though they are not amongst the countries studied for this report.

Figure 4.7. ESCO Scheme



ESCO = energy services company.
Source: Japan Association of Energy Service Companies

2) Energy Audit

The energy conservation measures common amongst the four countries include an energy audit. An energy audit is a policy instrument that is adopted in many countries and regions with the aim of improving the energy consumption efficiency of the audited facility/equipment and reducing the GHG emissions. In addition, an energy audit contributes to improving the energy efficiency.

ISO 50001 (energy management system) would help achieve systematic energy management, and support energy conservation and decarbonisation activities. It can also be utilised for the improvement of energy performance in energy conservation, etc., and medium- to long-term energy strategies aimed for CO_2 emissions reduction, etc. The ISO 50001 standard has focused on the improvement of energy performance since its issuance and enables the visualisation of energy performance in energy consumption intensity, energy efficiency, energy consumption (total amount), and energy-derived CO_2 emissions, etc., and the conduct of an analysis using data as an energy review.

2.6. International Cooperation

Representative examples of international cooperation with the countries studied include Asia Zero Emission Community (AZEC). The Japanese government announced an AZEC initiative aimed at encouraging Asian countries to cooperate in decarbonisation and energy transition in January 2022, and held an AZEC cabinet meeting in March 2023. AZEC has conducted activities

such as hydrogen, ammonia and CCS demonstration projects, Asia zero-emissions thermal project, project financing, and Asia CCS network.

3. Summary

ASEAN countries are promoting energy efficiency policies to cope with the increase in energy consumption associated with economic development. However, over the 20-year period from 2000 to 2020, countries with large populations and economies, such as Indonesia, Malaysia, the Philippines, and Viet Nam, steadily increased their energy efficiency while their carbon intensity worsened. That is, despite progress in energy conservation, CO_2 emissions are increasing.

In short, the cause of the carbon intensity worsening is coal. In the four countries studied, the electricity and heat production sector is a sector that accounts for the largest CO_2 emissions. In the electricity and heat production sector, the coal-fired electricity generation and the CO_2 emissions have both increased. The four countries studied commonly decided on policies such as phasing out coal-fired power generation and halting the construction of new coal-fired power plants. Measures to fill the gap between the current situation and the future goal include increasing the coal-fired power generation efficiency and improving the carbon intensity. Measures to increase the power generation efficiency include early shutdown of aging coal-fired power plants and conversion to high-efficiency gas-fired power plants. For the improvement of the carbon intensity, there are measures such as ammonia-hydrogen co-firing, ammonia-mono-firing, CCS, and introduction of renewable energies.

In Indonesia and Viet Nam, the manufacturing industries represent the second largest CO_2 emissions behind the electricity and heat production sector. The increase of the coal consumption in the iron and steel subsector is especially notable, and as a result, the CO_2 emissions have increased. In both countries, blast furnaces were put into operation in the 2010s. However, the world iron and steel industry has pursued the transition from the blast furnace method to the direct reduction method or the electric furnace method with the aim of achieving carbon neutral, and the ratio of electric furnaces is expected to grow in the future. Both countries also need to follow such a trend.

In Malaysia and the Philippines, the transport sector (road transport) accounts for the second-largest CO_2 emissions after the electricity and heat production sector. Electrification of automobiles into, for example, electric vehicles not only serve as an environmental and energy measure, but also is intended to create next-generation industries. Both countries are required to achieve conversion and sophistication of the industrial structure by pursuing the production of automobiles centering on electric vehicles, the attraction of investments in related parts, and the development of industries, in addition to aiming for decarbonisation where GHG emissions are reduced to net zero through electric vehicle penetration. Furthermore, Indonesia has abundant resources for batteries, such as nickel, cobalt, and manganese. The country is expected to achieve both decarbonisation and industrial development through electrification and zero-emissions in vehicle production, by aiming to become an electric vehicle hub in the ASEAN region, while ensuring security of such resources.

The CO_2 emissions in the residential sector are smaller than that of the other sector. However, in the Philippines, this sector accounts for the largest final energy consumption, and the third

largest in Indonesia and Viet Nam. It is important not only to shift to energy-saving devices, but also to improve the performances of the building frame and residence equipment, such as window insulation and airtightness performance of residences. These improvements would not only improve the energy conservation in this sector, but also contribute to reducing the CO_2 emissions. Installing a photovoltaic generation system in high-performance residences would increase the air conditioning efficiency and raise the energy self-sufficiency rate of residences.

ESCO and Energy Audit would help visualise various energy conditions and contribute to performance improvement in the short term and the long term. They can help achieve systematic energy management, and support energy conservation and decarbonisation activities in both public and private sectors.

To promote the upgrading of coal-fired power generation in ASEAN, decarbonisation of steel, and promotion of electric vehicles and zero-emissions vehicles, it is necessary to pursue not only stop-gap energy conservation policies intended to simply reduce the consumption of fossil fuel energies such as coal, but also energy conservation policies from a broad perspective, including efforts in fields different from those supervised by the Energy Ministry/ Department such as the energy transition financing, technology development, industrial structure transformation, housing performance improvement, and implementation of systematic energy management such as ESCOs and Energy Audit.

Except for the Philippines, the three countries studied have declared they will be carbon neutral in 2050 or 2060. Carbon neutrality must be maintained after it is achieved. These broad policies can help achieve long-term sustainable carbon neutrality. For ASEAN to realise a low-carbon society at an early stage, international cooperation in technology and finance will then be necessary.

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