Chapter 10

ASEM Cooperation on Clean Energy

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Introduction

ASEAN and European Cooperation on energy fields is mentioned in the ASEAN–EU Plan of Action (2018–2022) in which the cooperation included the sharing of best practices on promoting energy access, energy security, energy efficiency and conservation (EEC), renewables and clean energy technologies and measures to support a competitive energy market.

The global energy demand has increased by 10 times since 1999, and it keeps increasing (IEA, 2020). The gravity of energy demand has shifted to Asia, and emerging economies account for half of the global growth in gas demand. While many Organisation for Economic Co-operation and Development (OECD) countries will see a peak in energy demand and some will experience negative growth due to energy efficiency and other factors, such as population growth and industrial structures, Association of Southeast Asian Nations (ASEAN) countries will be the opposite as they will need more energy to steer their economic growth. In the medium-to-long term, two major factors, sustained economic growth and increasing populations in the ASEAN region, are the major drivers responsible for the doubling of energy demand in our model prediction for 2015–2040. The Southeast Asia as well as other developing countries in Asia currently face paramount challenges in matching energy demand with sustainable energy supply given the transition to a lower carbon economy. This implicates the heightened need of transition towards development and deployment of greener energy sources. The growing energy demand will be met by appropriate energy supply in which renewables and other clean energy alterative such as renewables, hydrogen, and clean technologies will need to be accelerated.

ERIA conducted a study on hydrogen demand potential based on three scenarios of hydrogen penetration in various sectors. There are two types of hydrogen production. Hydrogen can be produced either by the reforming and gasification of fossil fuels, such as natural gas and coal, or applying water electrolysis using electricity generated by renewable energy, such as hydro/geothermal, solar/PV, and wind. The study projected the potential growth of hydrogen adaptation and usage in all sectors by 2040, with the cost of hydrogen decreasing from US$0.90/$Nm^3$ (normal cubic metre) currently to US$0.30–US$0.40/Nm^3 in 2040, which is competitive with the target price for gasoline. The projected increase of energy demand in ASEAN shows a threat to energy security

and the effort to curb CO_2 emissions. These common energy challenges will need to be addressed through concerted efforts, including collective measures and actions to rapidly develop and deploy energy efficiency and saving, high-efficiency and low-emission coal-fired power plant technology, and nuclear safety, and to double the share of renewable energy in the overall energy mix for inclusive and sustainable development.

The rapid economic growth in ASEAN has led to marked increases in energy demand in the region. The energy outlook and energy saving potential in the East Asia region show that primary energy demand is expected to grow at an average annual rate of 3.6% between 2015 and 2040. In absolute terms, it will increase from 666.61 million tons of oil equivalent (Mtoe) in 2015 to 1623.63 Mtoe in 2040. By energy source, oil is the dominant and largest energy source, with a share of 50.5% in 2040, a slight increase from 50.1% in 2015. Coal is the second-largest energy source, projected to have a 43.3% share in 2040, a large increase from 26.9% in 2015. Natural gas is projected to have a share of 27.3%, a slight drop from 31.4% in 2015 due to the policy directions of ASEAN countries. The share of hydropower is expected to drop slightly from 2.4% in 2015 to 1.4% in 2040 as the resource has been fully developed. The remaining share of about 25% in 2015 was from renewables, such as geothermal, wind, solar and biomass, and this share in 2040 is likely to increase to 31%.

The shares of final energy consumption by fuel source point to oil as the dominant energy source, with shares of 41.3% in 2015 and 45.4% in 2040, followed by electricity with shares of 16.1% in 2015 and 19.4% in 2040, coal with shares of 8.9% in 2015 and 12.3% in 2040, natural gas with shares of 10.3% in 2015 and 11.3% in 2040, with the remaining as heat and others. The dominant share of oil use in the final energy consumption is due to the increased oil use in the transport sector. Total power generation is projected to grow at 6.3% per year on average from 2015 (equivalent to 32.9 terawatt-hours [TWh]) to 2040 (equivalent to 53 TWh). The share of coal-fired generation is projected to be the largest, at 53% in 2040, a significant increase from 32.9% in 2015. The share of natural gas is projected to drop from 46.6% in 2015 to 34.1% in 2040, while the share of hydropower will also fall from 13.6% in 2015 to 7.4% in 2040. The share of geothermal will decrease from 2.2% in 2015 to 1.5% in 2040. The remaining share (wind, solar, biomass) of 1.6% in 2015 is projected to be 3.1% in 2040.

The increasing energy demand in ASEAN reflects an overall trend for developing Asia. This is worrisome due to the challenge of securing the energy needed at an appropriate price and supply stability. The OECD may be in the best position to assist ASEAN for its energy transition towards clean energy use by having more renewables and clean energy technologies in its energy system. Therefore, the appropriate energy policies for energy security and energy affordability will need to be flexible considering the role of fossil fuel in the energy transition, as noted in the case of ASEAN. It is also important to mention that meeting the growing energy demand will need the appropriate energy policies and energy infrastructure investments to ensure sustainable energy use and economic growth.

Managing Energy Transition and Energy Reality

The world is undergoing an energy transformation, from a system based on fossil fuels to a system based on cleaner energy use, including renewables and the cleaner use of fossil fuels, in order to reduce global greenhouse gas emissions and avoid the most serious impacts as a result of climate change. Addressing the energy transition towards a cleaner energy system has been a common goal as reflected in the global agreement of the United Nations Climate Change Conference, COP21, where global leaders agreed to set the goal of limiting global warming to well below 2 degrees Celsius compared to the pre-industrial level.

Although agreement on a common goal has been reached, the policy measures and actions undertaken in each county have varied, reflecting the differences in their socioeconomic, political, and geographical contexts. To be explicit, the energy transition is an economic problem, since the present financial system tends to look only toward immediate profit, discounting the medium- and long-term advantages. In this way, new and clean technology seems more expensive than the conventional fossil fuel-based energy system. So, an appropriate energy policy to allocate economic resources for the energy transition is vital to ensure equitable and affordable access to energy for everyone.

According to ERIA's Energy Outlook (Kimura and Han, ed., 2019), the fossil fuel (oil, coal, and natural gas) demand in the ASEAN region will almost triple from 507 Mtoe in 2015 to 1393 Mtoe in 2040 under the Business as Usual (BAU) Scenario, driven mainly by the objectives of ensuring energy security, fuel supply stability, and affordability. Even under the Advanced Policy Scenario (APS) assuming more aggressive energy efficiency and the higher penetration of non-fossil fuels, fossil fuel demand in 2040 is projected to be 1,027 Mtoe, double the value in 2015. Notwithstanding ongoing efforts in the East Asia Summit (EAS) region to promote energy efficiency and renewable energy sources, it is obvious that fossil fuels will play a crucial role in the energy mix in the ASEAN region. Managing the energy transition in ASEAN will require stress on the presence of fossil fuels (coal, oil, and natural gas) in the short and medium-term energy system, and what matters is how to explore ways to use fossil fuels in an environmentally sustainable manner to act as a bridge to a carbon-free energy future, rather than simply ruling them out completely. For the successful implementation of energy transition and climate change policy objectives, policymakers will need to balance the other equally important policy objectives of energy security, energy access, and affordability, for instance, policy blind of banning public financing on Clean Coal Technology (CCT) could be counterproductive in terms of climate mitigation since the lack of finance for high-efficiency but more expensive CCT would simply result in the deployment of cheaper and less-efficient technologies, such as critical or sub-critical technologies and higher CO_2 emissions.

The energy transition and its shift towards a cleaner energy system will have fundamental impacts for ASEAN and the global economy. The pace at which countries adopt policies has seen drastic change in the energy system, where more renewables have penetrated the electrical grid. One of the greatest challenges that the energy transition presents is the cost and associated knowhow for technology, and infrastructure and the related costs to obtain a higher share of renewables in the energy system. Equally important is the shift in the geopolitical landscape, where fossil fuel-producing countries will need to shift at a similar pace to adopt a new, diversified economic model to cope with the changes. It is important to note that the shift and pace of energy transition will involve costs and investments in all energy-related infrastructure and will have a huge impact on energy affordability. Bridging from the current energy system to a future cleaner energy system requires consideration of the cleaner use of fossil fuels and innovative technologies that can reduce CO_2 and greenhouse gas (GHG) emissions. Therefore, urgent steps are needed to decarbonise the energy sector through pathways to a low-carbon economy, which will require the rapid deployment of the clean use of fossil fuel technologies, renewable energy development, and a doubling of energy efficiency, given that the energy sector accounts for two-thirds of global GHG emissions.

ASEAN and EU Energy Policy Directions

The ASEAN Plan of Action for Energy Cooperation (APAEC) Phase 2, which is under preparation for endorsement by ASEAN Ministers on Energy Meeting (AMEM) within 2020, will set key energy policy targets and have energy policy implications for energy infrastructure-related investment in the region. Key targets include the revision of the new energy efficiency and conservation target from a 30% energy intensity reduction by 2025 (based on 2005 levels) to more ambitious levels – the likely new target of a 35%–40% reduction will involve the expansion of energy efficiency measures to transport and industries. It will also establish a new sub-target for the renewables share in installed power capacity that shall complement the existing target of a 23% share of renewables in the Total Primary Energy Supply (TPES) by 2025. APAEC Phase 2 will also include policy measures to pursue smart grids and renewable energy grid integration, and measures to address emerging and alternative technologies, such as hydrogen, energy storage, bioenergy, nuclear energy, climate change and decarbonisation, energy investment and financing and private sector participation, disasters-related vulnerability and resilience, capacity building requirements and other cross-sectoral issues. APAEC Phase 2 will maintain focus on energy connectivity and market integration but will add a sub-theme on energy transition and energy resilience on how the region will need to have a strategy to deal with fossil fuels and new technologies.

In the ASEAN region, there are wide gaps in economic development in terms of GDP, population growth, energy use, and technologies. However, each country is committed to doing the utmost to address the common climate change issue. The countries share their commitments through various policies, such as energy intensity targets or through the actual targets of the renewables share in the energy mix. Nevertheless, emerging countries face the issues of providing energy access and energy affordability, while promoting renewables and other clean energy technologies will remain expensive – although solar and wind module costs have dropped drastically, the system costs remain expensive when applied in developing countries. Making these clean and green technologies available to the developing countries in ASEAN will require policy attention, including regulations and financing mechanisms with support from developed countries.

The European Union (EU) aims to be climate neutral by 2050 (EU, 2020). Among other targets, the foreseeable 2030 climate and energy framework includes EU-wide targets and policy objectives for the period from 2021 to 2030. The key targets for 2030 include at least 40% cuts in GHG emissions from 1990 levels, at least a 32% share for renewable energy, and at least 32.5% improvement in energy efficiency. The cut in GHG emissions will enable the EU to move towards a climate-neutral economy and implement its commitments under the Paris Agreement. For renewables, the binding renewable energy target for the EU for 2030 of at least 32% of final energy consumption will include a review clause by 2023 for an upward revision of the EU-level target. For energy efficiency, the headline target of at least 32.5% for energy efficiency is to be achieved collectively by the EU in 2030, with an upward revision clause by 2023. To achieve effective implementation towards these targets, a transparent and dynamic governance process will help deliver on the 2030 climate and energy targets in an efficient and coherent manner. The EU has adopted integrated monitoring and reporting rules to ensure progress towards its 2030 climate and energy targets and its international commitments under the Paris Agreement.

Investments in Low-Carbon Energy Infrastructure

The rapid increase in the foreseeable energy demand in ASEAN will need coordinated and appropriate energy supply infrastructure and investments to ensure the region's energy sustainability, development, and environment. Investments in some of the new and renewable energy and clean technologies are still faced with instability and high energy supply costs. Thus, the energy policy targets and clean technologies' penetration into the energy system will need to be promoted. The investments in low-carbon technologies and renewables are seen as important for managing the energy transition towards the cleaner use of energy and addressing environmental issues. The OECD may not favour financing of coal-fired power plants globally, however, ASEAN will build more coal-fired power plants to meet the increasing energy demand in response to energy affordability and accessibility.

Based on this reality, perhaps, it is safe to ensure that coal use in ASEAN's energy transition is more environmentally friendly by using the best available technology to reduce pollutants and emissions, while at the same time gradually increasing the penetration of renewables. There are huge areas of cooperation in which the EU could assist ASEAN towards achieving a cleaner and lower-carbon economy through the transfer of technologies and investments.

The world's cumulative demand in energy infrastructure investment is projected to be US$60 trillion in 2014–2040 (IEA, 2016). This also means that energy investment of US$2.7 trillion per year is needed by 2040. For Southeast Asia alone, about US$1.7 trillion in cumulative investment in energy supply infrastructure to 2035 is required, with 60 % of the total in the power sector (IEA and ERIA, 2013). While IEA and ERIA (2013) predicted the required investment needed in energy infrastructure, including the actual situation and the extent of investment needed, the current investment deficit in the energy sector is yet to be done, which encompasses the extraction, generation, and distribution of traditional fossil fuels as well as renewable sources. So, funding the gap in the required energy investment is a key issue for ASEAN countries. Energy infrastructure and clean technologies are costly and require large investment and involvement from different stakeholders. When it comes to financing clean energy-related infrastructure projects, the words bankable, financeable, and investable are always discussed amongst different stakeholders, as each stakeholder will look at the project from a different perspective in terms of how much they will get in return from their investments. For example, each investor, such as a bank, government, or developer, will have a different idea of what a project's risk/return profile should be. By and large, a bankable project is a project that a bank is willing to finance. But bank financing is only one component of the capital investment structure, and most private investors seek much higher returns on their investment. So, the term 'financeable and investable' is used if the green project looks like a strong project with stable revenue, a suite of credit guarantees, and political risk insurance, with expected single-digit or mid-teen returns. This is far below the hurdle rates for risk-adjusted equity investors for frontier market projects. Normally, green projects are subjected to many risks unless the projects are guaranteed by the government.

Energy infrastructure project finance requires a mix of investors (either developers and/or private equity firms or corporate investors) and debt providers provided by commercial banks or public-sector funding. Within a particular capital structure, for example, a project may receive equity investment from a private equity firm or group of investors, with an insurance wrap from Development Financial Institutes (DFIs) like the Multilateral Investment Guarantee Agency (MIGA), the Overseas Private Investment Corporation (OPIC), the International Finance Corporation (IFC), the World Bank, or the Asian Development Bank, and pledged debt from a bank, such as Standard Bank. Institutional investors may participate either directly or through a private equity allocation or the purchase of other financing options, such as a government infrastructure bond. Currently, most infrastructure investment is financed by the public sector, public–private partnerships (PPPs), or external official development assistance

for emerging ASEAN countries. For PPPs, the ASEAN Member States have different levels of infrastructure policy, financing methods, and financial capacity. PPP programmes have been significantly developed and utilised in Malaysia, Indonesia, Thailand, and the Philippines, and also recently in Singapore. Whilst Cambodia and Viet Nam are yet to formalise PPPs, private sector participation has become increasingly important in infrastructure development. The Lao PDR and Myanmar have potential, but they are facing multiple challenges, from a lack of fiscal resources to fiscal sustainability. PPPs still have a less significant role in Brunei Darussalam, which has abundant public financial resources to build infrastructure.

How to Deal with Coal Use in the Energy Transition in ASEAN

Coal, as the most abundant and reliable energy resource, will continue to be the dominant energy source in power generation to meet the fast-growing electricity demand in the ASEAN region and for emerging economies around the world, even though its use has been drastically reduced in OECD countries and the developed world due to the role of gas, renewables, and advanced technologies. In 2015, ASEAN's share of coal use in power generation was 32%, and its share will increase to 42% by 2040; while the share of gas in power generation was 42% in 2015, and its share will drop to 37% in 2040 (Kimura and Phoumin, 2019). The increase in coal use for power generation in ASEAN countries will lead to the widespread construction of coal-fired power plants, which without the employment of the best available clean-coal technology (CCT), will result in increased GHG and CO_2 emissions. Meanwhile, the climate narrative at COP25 and the coming COP26 will likely enforce the banning of public coal financing, not limited to OECD countries but throughout the globe The efforts of developed economies to ban coal financing have their merits, but the countries need to understand the unintended impacts that could arise from such policies. It should be noted that technological developments in CCTs have been fast achieved in developed nations, while the transfer and diffusion of know-how technology of the CCTs to the developing world has been slow. The actions taken to abate CO_2 and GHG emissions have gained momentum in the developed world, especially amongst OECD countries, while developing nations lack the means to afford the available technologies to reduce CO_2 and GHG emissions. Further, China is leading the financing of coal-fired power plants around the developing world as it is not bound to the OECD's rules and obligations to ban coal financing.

It is a real concern that if not paired with the proliferation of more sustainable energy development, increasing coal use in emerging Asia will have negative effects on the region's environmental security. With the projected increase in coal-fired generation capacity, both local pollutants – CO_2 and GHG emissions – will become major issues in the future.

Based on Green House Gas Emission Data,[1] emissions from fossil fuel combustion and industrial processes contributed to about 78% of the GHG emissions increase from 1970 to 2011. China, the United States, Europe, and India were the largest emitters, contributing 30%, 15%, 9%, and 6% of global GHG emissions, respectively. With substantial new generation capacity required to generate power, unabated coal-fired power generation plants are increasingly being constructed in developing Asia. These trends bring forward the urgent need to address the environmental sustainability of powering emerging Asia's economic development and the need for clean coal technology deployment.

How to Scale-up Renewables Penetration

While economic growth has increased the affordability of renewable energy (RE) around the world, many emerging economies are still in the early stages of development. For ASEAN members who can afford greater investment in RE, an important concern is the need for electricity storage and smart grids to support higher RE penetration levels in the electricity sector. Smart grid technologies are already making significant contributions to electricity grids in some developed countries of the OECD. However, these technologies are still undergoing continual refinement and improvement and, hence, are vulnerable to potential technical and non-technical risks. RE growth will thus be constrained by infrastructure development as well as by the evolution of technology. These also include capacities in assessing and predicting the availability of renewable energy sources. These capacities offer additional benefits, notably the promise of higher reliability and overall electricity system efficiency.

In the climate narrative, RE provides a bright prospect for the world's energy sector. ASEAN countries will have to follow the same trend as the rest of the world and expand their RE industries. Due to technological advances, the great growth potential of RE in the future will come from wind, solar, and biofuel power, which will compete with traditional fossil fuels. Among the ASEAN economies, there is also ample scope for growth in hydroelectricity, particularly in relatively less-developed economies, such as Cambodia, Myanmar, and the Lao PDR. In several ASEAN countries, there is also the potential for growth in geothermal energy. Therefore, the largest reduction in CO_2 emissions is expected in the power sector, by introducing renewable energy as much as possible. To have a high penetration of renewables in the power system, there needs to be a huge investment in power system integration to enable the coordination the interplays of distributed generation (wind power plants, mega-solar photovoltaic (PV) plants, rooftop solar PV systems on buildings), market system, demand response technologies and information technology (IT, i.e. data acquisition

[1] EPA, *Global Greenhouse Gas Emissions Data,* available at http://www.epa.gov/climatechange/ghgemissions/global.html (accessed 10 February 2015).

and communication). This coordinated power system integration by using the Internet of Things (IoT) is known as the smart grid system. As the EU has achieved a high penetration of renewables using IoT or the smart grid system, ASEAN can learn much from the EU. As a smart grid system involves a complex arrangement of infrastructure whose functions depend on many interconnected elements, investment in smart grid system components will have huge potential for future electrical system demand.

The Future Clean Energy Potential of Hydrogen

Hydrogen is the most abundant element in the universe, and it has the potential to fuel the economy while emitting little or no emissions. Hydrogen can be used as a clean energy for vehicles, heating, electricity generation, industrial processes, and energy storage.

In the EU's ambition to make Europe the first climate-neutral continent in the world by 2050, hydrogen fuel will play a large role as an enabler for achieving carbon neutrality. Hydrogen is likely to be on the EU's agenda as there is an overwhelming agreement amongst players on the importance of hydrogen in a carbon-neutral Europe (McKenna, 2020). The EU plans to launch the Innovation Fund, which is a promising tool to support hydrogen applications in hard-to-abate sectors, such as steel manufacturing. For the past 10 years, the focus was on power generation and how to decarbonise it. But now, EU policy is looking at sectors that are more difficult to decarbonise. There is a big focus on steel, but the EU is also looking at refineries, the chemical sector, and transport, including heavy-duty and maritime transport. Europe's focus is on accelerating the production of green hydrogen from renewable sources, but there is still a long way to go, and most likely this will not happen at scale until 2030. In the meantime, it will have to rely on large-scale conventional production methods combined with carbon capture technology – otherwise known as blue hydrogen.

ERIA's research in hydrogen energy in the past two years has identified the significant potential of hydrogen energy supply and demand in the EAS region. ERIA's study projected the potential growth of hydrogen adaptation and usage in all sectors to 2040, with the cost of hydrogen falling from US$0.90/$Nm^3$ (normal cubic metre) currently in Japan to US$0.30–US$40/Nm^3 in 2040, which is competitive with the target price for gasoline. China is one of the biggest potential producers and consumers of hydrogen energy in the near future. China aims to get one million fuel-cell vehicles on its roads by 2029, and by 2023 it will have invested more than $17 billion in hydrogen. Japan is actively promoting the global adoption of hydrogen for vehicles, power plants, and other potential uses. What we knew is that the use of hydrogen is expanding in the transport sector, and its adoption is gaining momentum. For example, the Tokyo Metropolitan Government will increase the number of hydrogen buses to 100 by 2020, and Sarawak Local Government will start to operate hydrogen buses soon.

In June 2019, ahead of the G20 summit in Osaka, the International Energy Agency (IEA) recommended that the world must 'tap into hydrogen's potential to play a key role in a clean, secure, and affordable energy future'. While challenges remain, the cost of producing hydrogen from renewable sources is expected to decrease by 30% over the next decade.

While countries around the globe, especially the OECD countries and China, try to promote the introduction of hydrogen fuels, there are various costs and institutional barriers. Experts have shared two major barriers to developing green or clean hydrogen energy in China. First, there is a lack of comprehensive and valid feasibility studies on potential renewable or clean energy hydrogen projects, as well as the associated energy infrastructure networks for transportation and distribution. Second, there are institutional and regulatory barriers to enabling the hydrogen projects. For example, current regulations on power grid companies have no capacity to transmit the curtailed renewables as well as nuclear energy to hydrogen production facilities near the demand market, and neither do they have the incentive to build dedicated new lines for such purposes. Furthermore, the current power sector regulations do not allow the onsite production of hydrogen at renewable power stations using the curtailed electricity.

Conclusion and Policy Implications

ASEAN's economic, social, and political dynamics have made it one of the fastest-growing regions. However, the challenges of growing energy demand, energy security, and energy affordability to steer the growth is true for all of developing Asia, not just ASEAN. While OECD countries have achieved a fast reduction of GHG emissions in response to the climate commitments of COP21, developing Asia has still some way to go to achieve a balance of economic growth, energy affordability, and availability. Much of the future energy mix of emerging ASEAN countries will rely on coal use for power generation. In case of ASEAN, many member states are locked into coal use for many years as the contracts for coal-fired power plants locked for 20–35 years. Thus, ignoring the coal use in ASEAN means ignoring the reality and emissions from coal use. Treating coal use as part of the energy transition in ASEAN is most important for addressing the priority of energy affordability and climate change. Thus, the deployment of clean coal technology will be urgent and crucial in the region. Although ASEAN's energy targets have been set to bring in more renewables, ASEAN faces challenges in the implementation for the targets as renewables remain expensive in terms of system cost, and the high penetration will be obstructed by the traditional grids, which cannot manage the higher penetration of renewables. Thus, smart grids using IoT will be a new and green investment infrastructure to allow the greater penetration of renewables but will need a lot of investment, such as in hard grids, applications, data management, and human resources. Hydrogen fuel has future clean energy potential due to its versatility in many sectors.

The promotion and adoption of hydrogen fuel will be key for a future clean society. The EU and developed world are leading the hydrogen research and development, and ASEAN will need to catch up, learn, and adopt the application and uses of hydrogen in the economy. Below are key policy recommendations prompted for leaders' attention:

Clean Use of Coal

Assisting developing Asia and ASEAN towards realising a clean energy future will require dealing with the current and future substantial new generation capacity of coal required to generate power. Unabated coal-fired power generation plants are increasingly being constructed in developing Asia, and this trend brings forward the urgent need to address the environmental sustainability of powering emerging Asia's economic development and the need for clean coal technology deployment. Below are the key policy recommendations.

- The current climate narrative and policy approach of banning coal use shall be reviewed to assist emerging Asia to afford CCTs, providing that there are less available alternative energy options for emerging Asia in the medium term to meet energy demand. Treating CCT as a technology solution in the energy transition will be a win-win solution.
- Developing Asia will rely on whatever CCTs are available in the market with an affordable price. The upfront costs of such ultra-supercritical (USC) technology or advanced ultra-supercritical (A-USC) technology are higher compared to Supercritical (SC) and sub-critical (C) technologies. Thus, it is necessary to lower the upfront cost of A-USC or USC through policies, such as attractive financial/loan schemes for USC technologies, or a strong political institution to deliver public financing for CCTs to developing Asia.
- A policy framework should clearly state the corporate social responsibilities of developed and developing nations, respectively, by highlighting the near- and long-term policy measures towards the coal industry and coal-fired power generation, with the speedy acceleration of the research and development (R&D) of carbon capture sequestration, utilisation and storage (CCUS) for commercialisation sooner or later in the near future. A business model will need to be developed around the CCUS.
- There is a need for public consultation or local participation on the potential impacts of any selected coal technologies. However, for developing Asia, institutions may not emphasise such local participation. Thus, an active organisation is needed to disseminate information on the potential harm resulting from less-efficient coal-fired power plants.
- China, the leader in public financing on coal-fired power plants to Asia, may consider to embed the environmental standard into the funding mechanism to ensure that the deployment of coal-fired power plants is at least using USC Chinese technologies for developing Asia.

Penetration of RE through Smart Grids and IoT

The EU's assistance and cooperation will be key to pushing ASEAN into a high level of RE through smart grid investment and cooperation. These include:

- Investment in 'hard' infrastructure, which includes the physical component of the grid within the country and for the ASEAN Power Grid Connectivity, power generation, transmission, and the distribution network as well as energy storage facilities to balance the load fluctuations as the result of higher RE penetration.
- Investment in telecommunications, which represents the telecommunication services that monitor, protect, and control the grid. These include wide area networks, field area networks, home area networks, and local area networks.
- Investment in data management, which ensures proper data mining and utilisation to facilitate smart grid applications.
- Investment in tools and software technologies that use and process collected information from the grid to monitor, protect, and control the hard infrastructure layer and reinforce the grid to allow the integration of renewable energy.

The Future Clean Energy of Hydrogen Fuel

Hydrogen energy-related industries will be a huge investment in the foreseeable future. However, the large scale and adoption of hydrogen use policy will need to be considered. Below are key policy directions for investments in hydrogen.

- There is a huge potential for investments in hydrogen production from renewables and nuclear energy. Further, curtailed electricity from RE is suitable for hydrogen production, but there needs to be clear policy and regulations to promote such hydrogen production.
- For hydrogen vehicles to be widely adopted, hydrogen refuelling stations and hydrogen transportation and storage facilities will need to be developed.
- Public awareness and willingness to pay together with public financing on the hydrogen production and supply chain will be key to promote the investment.
- Governments will need to establish targets for hydrogen penetration/use in all sectors. Energy policy and targets to promote hydrogen use will encourage the investment of the supply chain.

The ASEM Summit in 2021 will deliberate the future of Asia–Europe cooperation for a sustainable development programme that addresses the future concerns of the two regions. The recommendations above will help ASEM to develop the roadmap for cooperation in the field of clean energy for Asia and Europe.

REFERENCES

European Union (2020), EU Action: 2050 Long-term Strategy. https://ec.europa.eu/clima/policies/strategies/2050 (accessed 27 April 2020).

International Energy Agency (IEA) (2016), World Energy Outlook 2016. Downloadable at https://www.iea.org/reports/world-energy-outlook-2016 (accessed 12 March 2020).

IEA (2020), Global Energy Prospects and Their Implications for Energy Security and Sustainable Development. http://www.oecd.org/parliamentarians/meetings/gpn-meeting-february-2020/Faith-Birol-Global-energy-prospects.pdf (accessed 28 April 2020).

IEA and ERIA (2013), WEO-2013 Special Report: Southeast Asia Energy Outlook. Downloadable at https://webstore.iea.org/weo-2013-special-report-southeast-asia-energy-outlook (accessed 12 March 2020).

Kimura, S. and P. Han (eds.) (2019), Energy Outlook and Energy Saving Potential in East Asia 2019. Downloadable at https://www.eria.org/publications/energy-outlook-and-energy-saving-potential-in-east-asia-2019/ (accessed 12 March 2020).

Kimura, S. and H. Phoumin (2019), *Energy Outlook and Saving Potential in the East Asia*. Jakarta: ERIA.

McKenna, J. (2020), Europe's New Love Affairs with Hydrogen. https://spectra.mhi.com/europes-new-love-affair-with-hydrogen?gclid=EAIaIQobChMI-NS1xoaI6QIVlg4rCh1qMAPqEAAYASAAEgJf6vD_BwE (accessed 27 April 2020).