

Energy-Related Research



1. **Securing Resilience of Nuclear Infrastructure Against Severe Natural Disasters**

Many natural disasters hit Asian countries each year, some causing serious damage. A huge typhoon hit the Philippines in September 2018, while a 7.5-magnitude earthquake in Sulawesi, Indonesia killed many and caused economic loss in October 2018.

Several Asian countries are considering building nuclear power plants to meet rapidly increasing energy demand. If nuclear facilities are damaged by natural disasters, there is a high risk of more serious damage – the release of radioactive material – than at other types of power plants. It is therefore extremely important to share information in order to prepare for the impact of natural disasters on Asian nuclear facilities. Information sharing will allow countries to build best practices for securing safety

and resilience, not only in countries that develop nuclear power, but also for their neighbours.

The US, which has the largest nuclear power capacity in the world, and western European countries, have accumulated abundant knowledge and experience on preparing for and responding to natural disasters. Most of this information is accessible at the library of the Nuclear Energy Agency (NEA) within the OECD. This includes documents produced by the OECD/NEA Working Group on External Events, which focuses on external hazards of common interest to NEA member countries.

Japan, Asia's first OECD member, brought in nuclear technology from the US in the early 1960s, and has learnt from Europe and the US about the preparedness of nuclear facilities against natural disasters. It would be useful for non-OECD Asian countries to gain knowledge, experience, and lessons from the experience of others.

2. Nuclear Public Acceptance Improvement Project

Across countries and continents, public acceptance of nuclear power is crucial for establishing a governmental nuclear energy programme. Therefore, understanding the determinants of public acceptance of nuclear power is important. This study examines the effects of knowledge, trust, risk, and benefit-related factors on public acceptance of nuclear power in Europe, the US, and Japan. Through field visits and interactive workshops, this study has identified different levels of public acceptance and related communication

strategies to effect changes. Through public consultation, the effective communication role that subregional authorities and non-governmental organisations could play has also been identified. The following recommendations were proposed based on the workshop's findings: (i) to build trust, nuclear communications need to include integrity, competence, and benevolence; (ii) talking about the need for nuclear power, rather than describing the technology using technical jargon, is crucially important and effective; (iii) what works best is to share personal stories, be open, honestly admit mistakes, and apologise when necessary; (iv) the involvement of local stakeholders should be led by locals employed where nuclear facilities are located; (v) new opportunities can be created by promoting confidence to secure public and private investment, and delivering projects and programmes to secure an ambitious economic legacy; (vi) the role of media and how to provide information to media should be reconsidered; and (vii) media, including social media, can and should build public opinion and can often amplify trends.

This project published its findings in a report titled *Public Acceptance of Nuclear Power Plants in Hosting Communities: A Multilevel System Analysis*. The report stated that problems with public acceptance have resulted in significant setbacks for nuclear power plant projects in ASEAN and East Asia. Trust within the communities that host the nuclear facilities is one of the key factors expected to enhance public acceptance of nuclear energy. However, in countries with a multilevel governance system, the concept of public acceptance needs to be specified and reinforced through open communication. By employing both a multinomial opinion leader path and direct communication

models – as evolved in Japan, Finland, France, the US, and the United Kingdom – this report shows that public acceptance can be positively influenced by energy authorities and local governments.

3. The Influence on 3Es by Electric Vehicles Penetration in ASEAN

ASEAN is a growth centre in Asia, and demand for passenger and freight transportation is strong, with cars and trucks convenient and proliferating. Today, we see the adverse effects – such as traffic congestion, traffic accidents, and air pollution – especially in urban areas. As demand for petroleum for fuel has increased, the oil self-sufficiency rate in the region has declined sharply, while carbon dioxide (CO₂) emissions have increased. The use of cars and trucks is expected to continue to grow in line with economic growth, increasing concerns for energy security and the environment.

To tackle these issues, ASEAN countries have announced policies to promote electric vehicles and the development of associated infrastructure. For example, Indonesia intends to ban the sale of fuel combustion engine vehicles by 2040. Malaysia plans to raise the number of electric passenger cars operating in the country to 100,000 by 2030 and establish 125,000 charging sites. Thailand announced an electric vehicle investment incentive and plans to convert all 22,000 tuk-tuk (three-wheeled taxis) to electric engines by 2025.

The move to electric vehicles will reduce oil consumption and air pollution, but nations must consider how to deal with increasing electricity demand. Further, there remains the possibility that energy self-sufficiency and environmental problems may not improve – this will depend on the features of an individual nation's power generation sector, including the generation mix, and input fuels.

A report of this study was published in August 2019, titled *Study on Electric Vehicle Penetrations' Influence on 3Es in ASEAN*. The study analysed the effects of electric vehicle deployment on the economy, energy, and the environment (3Es) in Indonesia, Malaysia, Thailand, and Viet Nam. In the scenario that assumes a continuation of historical trends, those countries may face challenges in the 3Es, especially in terms of increasing CO₂ emissions and decreasing energy self-sufficiency. The study reaches four main conclusions. First, the effect of electric battery electric vehicle penetration in terms of reducing CO₂ emissions is limited unless the power generation sector is decarbonised. Second, battery electric vehicle penetration requires investment funds and subsidies several times higher than that of hybrid electric vehicles, and large investments in low-carbon power supply are required. Third, charging infrastructure is a key requirement, but not the only one, for plug-in electric vehicles. Finally, introducing electric vehicles into ASEAN countries would fulfil various policy purposes, but their massive deployment might have negative economic side effects. Electric vehicle penetration, therefore, requires realistic and affordable policies.

4. Biomass and Coal Co-combustion in ASEAN Region (Phase III)

Biomass use is an important issue for the AMS, for which agriculture and forestry remain crucial industrial sectors. Residue is, however, treated as waste and disposed of either through incineration or landfill. The waste is varied in terms of type, grade, and characteristics, but quantities are sufficient for use in co-combustion. This biomass waste is one of the most promising renewable fuels for smaller-scale power generation – it addresses the need for CO₂ emissions reductions and the rural electrification that is crucial to rural development.

However, biomass is seasonal, while coal has better availability and can therefore complement biomass. Therefore, biomass can contribute lower CO₂ emissions that would not be achieved if a smaller-scale power plant operated on coal only.

The Phase I study proposed CO₂ emissions reductions and improved energy security for the ASEAN region through coal and biomass co-combustion in circulating fluidised bed boilers. Phase I formulated two models based on two AMS – Indonesia, a biomass-rich coal producer, and the Philippines, a biomass-rich coal importer. Both countries have the potential to develop co-combustion. The phase I study designed a policy proposal covering co-combustion methods and measures for dissemination with necessary policy instruments. It is expected that the Phase I co-combustion policy proposal will help ASEAN and EAS nations to reduce CO₂ emissions and tighten their energy security.

Phase I highlighted the particular interests and concerns of ASEAN nations in biomass use and co-combustion, while Phase II identifies the measures ASEAN nations need to take to facilitate biomass use. In Phase II, we draw up best practice guidelines for ASEAN. It has identified examples of best practice, including the Phase I research, and will formulate guidelines for an optimal policy framework for ASEAN to facilitate biomass use, with a focus on co-combustion. Phase II analyses the measures to be taken and the role to be played by co-combustion in addressing the looming issue of grid fluctuation, which arises from the large-scale introduction of renewables.

The study published an ERIA research project report titled *Study on the Biomass and Coal Co-Combustion in the ASEAN Region* in December 2019. The report explained that co-combustion of agricultural waste and coal could make a very significant contribution to reducing CO₂ emissions compared with simple coal combustion for power generation. Since the AMS are generally rich in biomass resources, the co-combustion of biomass and coal could play an important role in combating climate change. For this study, we compared two cases: case 1 focuses on Indonesia as a biomass-rich and coal-producing country; and case 2 focuses on the Philippines as a biomass-rich and coal-importing country. It calculated the levelised cost of electricity to check whether the electricity cost produced from the co-combustion of biomass and coal is economically feasible, compared with the electricity cost produced from coal-fired power generation only. The results show that biomass and coal co-combustion is not feasible under the current tariff situation; it will require putting into place incentives such as a feed-in tariff. In the Phase II

study, therefore, further consideration shall be given to identifying tailor-made country-specific models with optimal capacity and technologies as well as appropriate incentives.

5. Study on Demand and Supply Potential of Hydrogen Energy in East Asia (Phase II)

Energy demand in Asia has been increasing continuously due to economic growth.

Consequently, CO₂ emissions have also been increasing significantly, because this region largely depends on coal. Many governments in the region have developed renewable energy, including solar photovoltaic. However, progress has not been significant because of the disadvantages of renewable energy – plants are often small-scale, energy sources are intermittent and seasonal, and prices are high. Hydrogen is possible as a renewable energy source, and the Phase II study focuses on deeper research on its demand, production, and transport costs. It also looks to share knowledge on the hydrogen supply chain through a new hydrogen working group.

The report, published in May 2019, stated that although hydrogen is used for industrial activities such as ammonia production or refining, it has great potential to become one of the clean energies of the future. Energy uses of hydrogen are (i) fuel for fuel cell vehicles in the road transport sector, (ii) fuel for power generation (starting from a mixture with natural gas and shifting gradually to 100% hydrogen), and (iii) heating fuel for boilers and furnaces in the industrial sector.

Our hydrogen demand forecast suggests that, in an optimistic scenario, 2% of fossil fuels will have been replaced by hydrogen in 2040. This is equivalent to 104.7 Mtoe of demand for hydrogen in energy use, and CO₂ emissions are expected to fall by 2.7%.

This study forecasts that the cost of local supply chains will fall to \$0.40–\$0.50/Nm³ on average at dispensing stations by 2040. This will be close to the target for hydrogen becoming competitive against gasoline, at \$0.30–\$0.40/Nm³.

If ground-breaking technological developments in fuel cell vehicles, hydrogen power generation, and hydrogen supply were achieved, costs are expected to go down, resulting in the further benefits of an expansion of the hydrogen market and learning effects. Aggressive and environmentally friendly policies will certainly help to expedite the arrival of hydrogen as an important component in the transition to clean energy.

6. Preparation of Energy Outlook and Analysis of Energy Saving Potential in East Asia Region

Energy demand in the East Asia region is expected to grow rapidly due to ongoing economic growth. Energy saving is one of the options to mitigate the growing energy demand. EAS countries have set voluntary energy saving goals and action plans. Quantitative analysis is needed to understand energy saving and renewable energy potential through the energy outlook approach, applying EAS countries' energy saving goals.

In FY2019, ERIA published energy demand and supply reports for three countries –Cambodia, the Lao PDR, and Myanmar.

The Cambodia report was prepared as an update to *Cambodia Energy Statistics 2018*. Cambodia's energy supply has been increasing due to the country's high economic development. Its economic growth will continue for at least another 5 years, according to international economic organisations such as the International Monetary Fund. Thus, Cambodia faces the following challenges, which need to be met with appropriate government policies. First, energy demand is fully linked to economic growth (elasticity is near 1). Second, to continue to secure the energy supply, Cambodia should maximise its domestic energy capacity, such as hydropower and biomass. Third, the use of liquefied petroleum gas (LPG) by the three-wheeled tuk-tuk transport mode has increased significantly due to the low price of LPG. Countries in the region mostly use LPG in the residential and commercial sectors, but Cambodia differs from neighbours such as Thailand and Viet Nam, and needs to update its LPG consumption survey results to verify this finding.

The Lao PDR report was prepared as an update to *the Lao PDR Energy Statistics 2019*, which covered 2010–2018. The key findings are as follows: (i) the total final energy consumption (TFEC) increased by 2.7% per year over 2010–2018; (ii) net power production in 2018 was 34,664.5 gigawatt-hours (GWh), power exports were 26,708 GWh, power imports were 300.50 GWh, and the total electricity supply was 8,257 GWh – creating an imbalance of power supply since the power demand was 5,416.60 GWh; (iii) the total primary energy supply (TPES) increased by 10.7% per year over 2010–2018, with

coal becoming dominant, as its share increased sharply from 3.9% in 2010 to 39% in 2018, followed by hydropower, whose share reached 20.8% in 2018; (iv) the TPES as a share of GDP (energy intensity) increased at an average growth rate of 4.2% per year from 2014 to 2017 from 323.7 to 507.3 tons of oil equivalent (toe) per \$1 million (in constant 2010 US dollars); (v) the TFEC as a share of GDP (energy intensity) has been decreasing at an average annual growth rate of 4.4% per year, from 349.59 to 244.76 toe/million US\$ (in constant 2010 US dollars); (vi) the combustion of fossil fuels, particularly coal, was the main contributing factor in the increase in CO₂ emissions in the Lao PDR after 2015; and (vii) although coal use has increased CO₂ emissions, import dependency improved from 22% in 2010 to 13% in 2018.

The Myanmar report was prepared as an update to *the Myanmar Energy Statistics 2017*, which covered 2000–2016. The key findings are as follows: (i) the TFEC and TPES for 2010–2017 grew by 3.8% per year and 4.6% per year, respectively; (ii) natural gas produced from both onshore and offshore sites increased by 6.5% per year, whilst its exports increased by 5.5% per year from 2010 to 2017; (iii) mainly used in gas-fired turbines, the natural gas supply in the TPES increased by 10.5% per year from 2010 to 2017, while the final energy consumption of natural gas declined annually by 6.2% from 2010 to 2017; (iv) CO₂ emissions from the combustion of fossil fuel energy increased to around 28% CO₂ million tons in 2017 from 12% CO₂ million tons in 2010; (v) hydropower generation is clean in terms of CO₂ emissions, but faces seasonal fluctuation and environmental issues; and (vi) energy intensity, defined as TPES/GDP, increased by 85% in 2010–2017.

7. Hydrogen Potential Study in Asia Region

Hydrogen (H₂) is typically not produced from the natural environment, such as direct mining from earth. However, it can be produced artificially using various physical and chemical processes. The production processes typically consume energy in various forms. When hydrogen (high purity) is consumed for the purpose of acquiring energy (especially through the application of fuel cell technologies), it is considered an energy carrier. As the typical exhaust substance generated from the consumption of hydrogen as an energy carrier is pure water (H₂O), it is considered a clean energy. This is especially true if hydrogen is produced from renewable energy-based pathways. Hydrogen thus has the potential to become a fundamental solution to cure our dependence on fossil fuels and mitigate concerns regarding greenhouse gas emissions created by energy consumption. However, the application of hydrogen as an energy carrier has barely been commercialised due to challenges such as the high initial capital cost, high production cost of hydrogen, and substantial requirement for infrastructure development. In Asia, we are investigating if the deployment of hydrogen-based powertrains – fuel cell electric vehicles – could be justified for application in ASEAN countries' passenger car, bus, and truck fleets, with current and future technologies. If not, we would like to understand how big the gaps are in terms of the economics of hydrogen supply chains, and which parts of the supply chain drive them. This will help us identify what areas to target and prioritise for fuel cell electric vehicle application, as they are most likely to become competitive in the near future. Policy implications will be drawn accordingly.

8. LNG Market Development in Asia

Based on the findings of a 2018 study, and bearing in mind the ongoing development of the international natural gas and liquefied natural gas (LNG) market, this research aims to achieve the following: (i) consider the measures needed to establish a transparent, liquid, and stable LNG market in Asia; (ii) identify the areas from which new natural gas demand is expected; and (iii) activate upstream investments and enhance the cost competitiveness of the LNG supply.

Under (i), we review the status and issues pertaining to the development of the Asian LNG market, and explore measures to reduce the price volatility that increases as the global LNG market expands. Under (ii), we focus on the use of LNG in the transport sector and discuss the policy support needed to facilitate this. Under item (iii), we give an overview of the current upstream investment projects and examine efforts by industry and government to enhance the cost competitiveness of LNG. We focus on LNG from the US because it is expected to play a significant role in the development of the Asian LNG market.

The report was published in August 2019, with several key findings on the dynamics of the LNG market in this region. First, transparent and active spot markets are essential for identifying a price that reflects the fundamentals of supply and demand. Second, China and India have become a source of substantial new LNG demand. Because both are large, even small shifts in demand patterns contribute to uncertainty and volatility in LNG prices. Third, in most Asian countries, companies and governments have little direct experience of the operation and

construction of LNG re-gasification facilities and connection to electric power plants and distribution networks. Relevant laws and regulations have not been fully developed, leading to delayed decision making and project implementation. Fourth, as LNG bunkering advances globally, there is the potential for bunker fuel markets to become fragmented. For LNG bunkering to succeed, intergovernmental coordination is necessary. Fifth, traditional patterns of risk allocation in financing new LNG export capacity are not adequate to meet recent market trends. Supportive government policies and new risk-sharing strategies are needed for more projects to reach final investment decisions. Last, the Panama Canal Authority recognises its critical role as a transit point and potential bottleneck in the movement of US LNG exports to Asia; and has eliminated unfair practices and physical limitations in its arrangements for the passage of LNG cargo.

9. Energy Policy Road Map of Greater Mekong Subregion

The Greater Mekong Subregion (GMS) integrated into the global economic system in the late 1990s, but still faces many energy development challenges. Such challenges and opportunities are the focus of this study, which has the functional objectives of (i) quantitative scenario analysis of the major factors of rural electrification, including future electricity demand forecasts, the amount of power generation capacity needed in off-grid areas, and the costs required for rural electrification; (ii) qualitative analysis of obstacles to power development, particularly in border areas; and (iii) human resources development in policymaking/implementation for energy policymakers and researchers.

Shaping Energy Policies to Achieve the Sustainable Development Goals in Myanmar and the Greater Mekong Subregion, published in September 2019, stated that increases in access to electricity in the poorest countries have begun to accelerate, energy efficiency continues to improve, and renewable energy is making gains in the electricity sector. Despite such progress, some 100 million people in the GMS remain without electricity while access to clean cooking fuels and technologies needs dedicated attention. Moreover, if Sustainable Development Goals 7 and 13 and related goals are to be met, much higher levels of ambition and effective energy policies are required in countries such as Myanmar.

This report analysed the barriers to overcoming rural electrification challenges in the GMS in general and in Myanmar in particular, from the perspective of the Sustainable Development Goals, and presented innovative solutions. The report focused on the following three themes: electricity connectivity, barrier analysis of mini-grids, and energy for sustainable development. It was also found that energy issues are tied to many other important national security issues such as conflict resolution, peace building, and national unity. The report recommended an integrated energy policy and a new planning body to implement the required reforms.