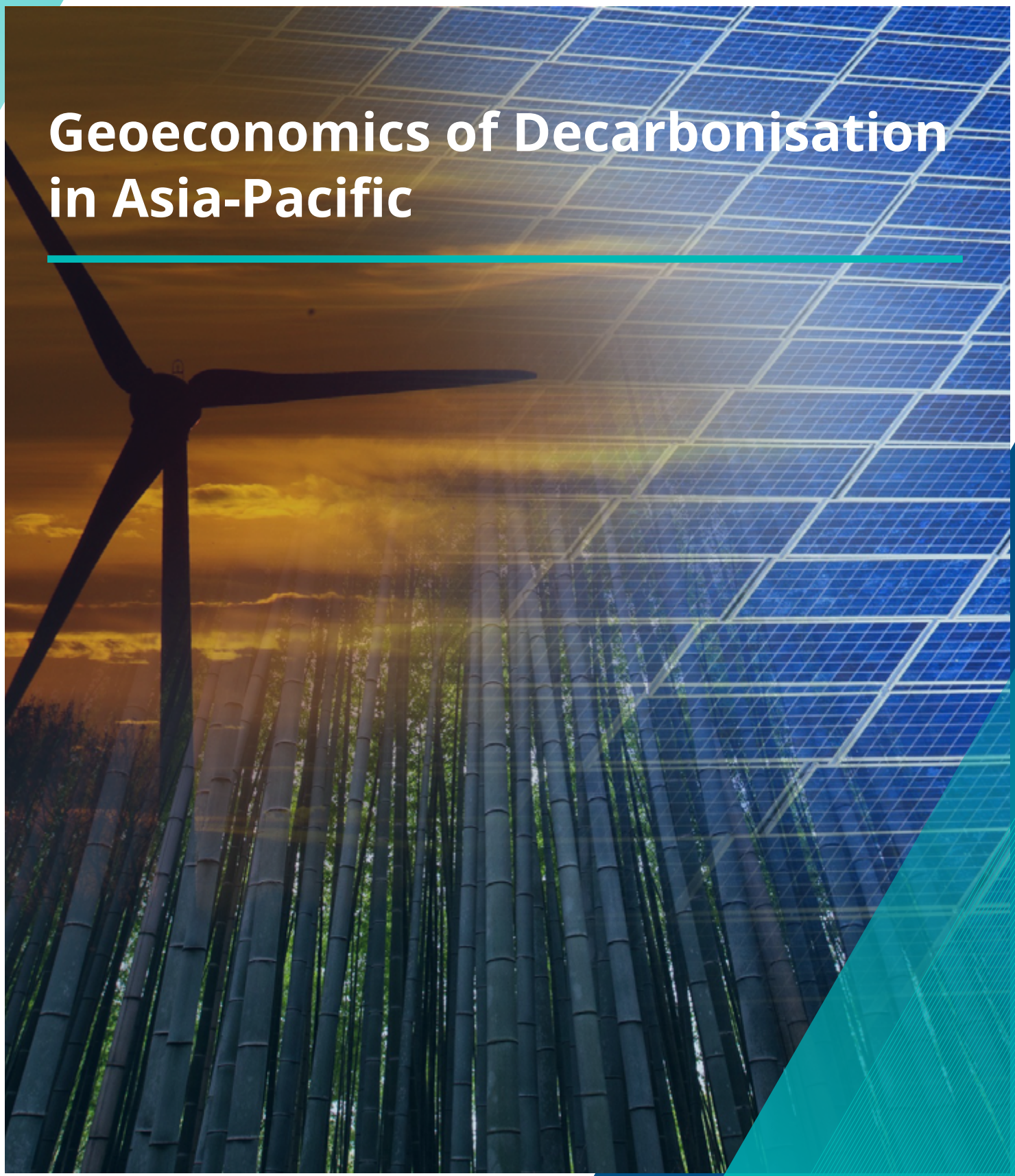
KONRAD ADENAUER STIFTUNG

Geoeconomics of Decarbonisation in Asia-Pacific



Geoeconomics of Decarbonisation in Asia-Pacific

Foreword

Dear readers,

Russia's attack on Ukraine has, amongst others, clearly shown the complex interactions between major geopolitical developments and geo-economic dependencies in the energy sector.

For Germany, this situation is particularly challenging due to the decarbonisation policy taking place at the same time. In the short term, Germany needs fossil fuels to secure its energy supply during the gradual decarbonisation process. The currently available renewable energies are not yet sufficient to compensate for sudden energy import shortfalls. In the medium to long term, however, dependencies on fossil energy sources will decrease with decarbonisation.

But even then, Germany will remain confronted with resource policy issues. It is already foreseeable that decarbonisation will result in new raw material import dependencies. The demand for critical minerals such as lithium, cobalt or rare earths, which are necessary for the large-scale use of renewable energy technologies, therefore require a foreign policy focus on raw material security with strategic foresight. As decarbonisation is being pursued all over the world and increasingly also by emerging economies, competition for the corresponding raw materials will increase significantly. These developments will change the previous patterns of resource policy and the dependency relationships known in this context. A new economic policy map with winners and losers of decarbonisation will emerge.

Moreover, decarbonisation is not purely a resource policy issue. It also includes questions about the future of the fossil energy industry, cross-border electricity grids, sustainability taxonomies, CO_2 pricing that shapes global trade or new transport routes for hydrogen as an energy carrier. All of these policy areas will have an impact on the extent to which decarbonisation can be achieved in a resource-safe manner.

For the European Union and Germany in particular, the consequence is that we need to look at other regions of the world to learn more about the geopolitical implications arising from decarbonisation. Especially amidst the confrontation with Russia, for Germany and the European Union it is a matter of strengthening their resilience. This brings the challenge of reducing vulnerability without creating new — potentially even stronger — dependencies. As it is nowhere near being only about resources and energy — it is also a matter of a new competition between different systems. This publication on the geo-economic challenges of decarbonisation in the Asia and Pacific region provides exciting insights and perspectives.

I hope you will find the publication interesting.

Dr. Gerhard Wahlers
Deputy Secretary General and Head
Division European and International Cooperation
Konrad-Adenauer-Stiftung e.V

Table of Contents

Introduction

The policy framework for decarbonisation in the Asia and Pacific region is directly shaped by the aftermath of the pandemic and increasingly important climate policies. The economic slumps in the wake of the lockdowns are currently being followed by a rapid economic recovery, which is causing energy demand and energy prices to rise. Energy bottlenecks in China and India, among others, were already observable consequences. This is followed by supply chain problems that are opening up raw material supply gaps not only in Asia but worldwide. At the global climate negotiations in Glasgow last year, it became apparent that international climate policy could make progress despite the economic upheavals caused by the pandemic. The USA returned to the world stage with a claim to climate policy leadership and met a China that also sent climate policy signals with its CO_2 neutrality target for 2060, the introduction of the world's largest emissions trading scheme and the announcement that it would no longer build coal-fired power plants abroad. The European Union presented its comprehensive Green Deal, which forms the economic basis for its 2050 climate neutrality target.

In the Asia and Pacific region, China is not alone in its ambitious climate agenda. Numerous countries now have climate neutrality targets. Among them are Japan and South Korea for 2050, India for 2070 and Indonesia and Kazakhstan for 2060. Many countries in Asia took their time in setting climate neutrality targets until shortly before the climate negotiations last year, often choosing later years rather than 2050. This circumstance has been criticised by observers in view of the impacts of climate change that are already taking place. On the other hand, the binding commitment to a climate neutrality target can in itself be seen as a climate policy trend reversal in many emerging and developing countries in Asia. For many countries, decarbonisation is a major political and economic hurdle in terms of security of energy supplies, affordability and domestic reserves of fossil fuels.

Asian energy and climate policy is characterised by a high degree of heterogeneity. For example, the largest expansion rates for renewable energies worldwide are currently found in China and India, which are also among the largest producers and consumers of coal. Australia is one of the world's largest coal exporters, but will also export hydrogen to Japan and, in the future, pipe solar energy to Southeast Asia via underwater power cables. The cost of renewable energy in Asia is now no higher than that of fossil fuels, which is increasingly encouraging investors to invest in sustainable energy systems. Against this backdrop, Asian decarbonisation, if it can be generalised at all, is characterised by economic pragmatism. The development of new, more sustainable energy supply systems does not always necessarily take the form of CO_2-neutral first best solutions, but also gives technologies a chance to develop their potential later. For example, it is already evident that many Asian countries are experimenting with CO_2-separating technologies in order to use domestic coal deposits in a climate-neutral way in the medium term. Or, in order to build up a hydrogen industry, they are initially using fossil energy sources for hydrogen production. These approaches also serve to provide a future for the existing energy industry, which represents a central labour market in many countries.

The decarbonisation strategies currently being observed in the Asia and Pacific region are also very different. What they all have in common, however, is that they are accompanied by significant economic changes, which in turn have a formative geo-economic impact. For example, the demand for fossil fuels will decline in the future due to decarbonisation, with countries that have these resources losing revenue. Countries that have energy transition raw materials such as lithium, cobalt or rare earths, which in turn are increasingly in demand for the production of wind turbines, solar panels or batteries, can look forward

to new sources of income. Hydrogen has become the central energy carrier for decarbonisation. Against this background, the emergence of new global trade relations around the production, transport and purchase of hydrogen is to be expected. The increased use of renewable energies leads to an expansion of the electrification of the economy, which in turn requires large cross-border electricity transmission networks. However, at the same time it must also accommodate small-scale decentralised and highly complex interactions between electricity consumers and electricity producers. In addition, CO_2 pricing is being continuously expanded worldwide with consequences for international trade. The financial sector is also adjusting to a climate policy framework that is defined in detail by state sustainability taxonomies and delimited in case of doubt.

All of this is currently taking place in the Asia and Pacific region. The following chapters provide examples of how these challenges can present themselves in detail. An exciting and challenging picture for decarbonisation policy is revealed. The analyzes refer to the situation before the Russia-Ukraine war, so possible consequences for the decarbonization in Asia are not included.

Dr. Christian Hübner
Director of Regional Project Energy Security and Climate Change Asia-Pacific (RECAP)
Konrad Adenauer Stiftung e.V.

Critical Minerals Strategy of Asia-Pacific Countries: Diversification, Circular Economy and Multilateral Initiatives

Dr. Kaho YU

Abstract

The fast-growing trend of energy transition has made the geopolitics of critical minerals, particularly securing mineral supply from Asia-Pacific, a global strategic agenda. While critical minerals are indispensable inputs for clean technology, their markets are characterised by high levels of monopoly, growing competition, trade disruptions and supply chain risks for end-users. A confluence of the COVID-19 pandemic and US-China trade war has further exposed the fragility in the global supply chains for some critical minerals. Aware of the economic importance and supply risks of critical minerals, many countries in Asia-Pacific, from China to Australia, India, Indonesia, Japan, South Korea and Vietnam, have rolled out strategies and/or joint initiatives to develop dependable supply sources and attract investment. Against this background, this study seeks to analyse the critical material strategies of the above countries and provide an outlook for critical materials in Asia-Pacific.

Key Findings

- While the monopolised nature of the critical mineral market makes the supply chain highly vulnerable to geopolitical risks and regulatory restrictions, recent trade tensions, the pandemic and supplier instability serve to highlight these concerns.
- While short-term restrictive export regulations and competing behaviour of stockpiling could result in market distortion, supply chain diversification and R&D are longer-term strategies for APAC countries.
- Both big consumers and suppliers of critical minerals are attempting to play a bigger role in the global supply chain especially in the downstream sector.
- Resource-poor countries have started to incorporate the circular economy into their resource security policy, where material recovery, substitution and recycling play a key role.
- Major producers and consumers are taking a more strategic approach to establishing joint initiatives as a way to enhance collaboration in relation to critical minerals.
- Given the rapid rise in projected mineral demand for energy transition, additional production is needed both within and outside China and has to be conducted under high ESG standards.

Introduction

The increasing pace of decarbonisation around the world has far-reaching consequences for the security of critical minerals. While these materials are the key component minerals in clean energy technologies, from electric vehicles (EV) batteries to storage applications, its market is highly unbalanced and China-focused. Therefore, the supply of critical minerals has become a strategic issue since it determines a country's pace of energy transition and triggers resource competition among big powers. The need to strengthen the security of critical minerals is not only a pressing issue for climate leaders like the EU and the US but has also raised the concerns of Asian consumers with high mineral import dependency, such as Japan and Korea, as well as (potential) producers, such as Australia, India, Indonesia and Mongolia, who want to benefit from the growing demand for the minerals. Against this background, the study aims to analyse the strategies of major critical mineral consumers and producers in Asia-Pacific. It examines their resource security, with a focus on their efforts to either reduce the dependence on China's supply or benefit from the growing decarbonisation trend.

The Market of Critical Minerals

Critical minerals play a central role in the deployment of many clean energy technologies,[1] and the growing risks from climate change will only drive their demand. According to a World Bank study, the demand for component minerals for electric storage batteries — such as aluminium, cobalt, lithium, manganese, and nickel — could rise by more than 450 per cent by 2050 if clean energy technology is deployed at a level consistent with the Paris Climate Agreement goal of keeping the rise in atmospheric temperature to no more than 2 degrees Celsius. The growing demand for these materials could be even more pressing for climate leaders like the EU; the European Commission Vice President Maroš Šefčovič pointed out that the EU needs to "ensure a secure and sustainable supply of raw materials to meet the needs of the clean and digital technologies".[2] By 2050, the EU will need almost 60 times more lithium and 15 times more cobalt to cover the need for the mobility and energy storage sectors.[3] In the same period, the demand for rare earth elements used in permanent magnets, a critical component of products like wind generators, could increase ten-fold.[4] Amid the growing competition for these critical materials, major consumers are attempting to secure their supplies, which could be undermined by trade tensions, price volatility and pandemic disruption.

High Level of Monopoly: China

In comparison with fossil fuel supply, the supply chain for critical minerals needed in the deployment of clean technologies has been long concentrated in a small number of countries, particularly China. According to the US Geological Survey, China has an estimated 44 million metric tons of rare earth minerals, which account for 36.7 per cent of the world's reserves (see chart below).[5] In 2020, China's rare earth mineral production reached over an estimated 140,000 metric tons, accounting for 58 per cent of the world's production.[6] China is also a key refiner of lithium and cobalt, accounting for over 60 per cent and 70 per cent of the global share, respectively.[7] China has also demonstrated leading production capacity in EV battery components, such as cathodes (52%), anodes (78%) and electrolytes (62%).[8]

Recognising the strategic value of critical minerals and their industrial application, China has been prioritising the development of this sector for three national economic and security goals. The Chinese government has identified "new materials" as one of the ten strategic sectors in its "Made in China 2025", an initiative aiming at reducing its economy's reliance on imported technologies and upgrading China's manufacturing capacity by 2025. The government also considers these materials the key to the development of EVs and EV batteries, which is in turn a primary means of reducing air pollution and achieving its goal of peak emissions before 2030 and carbon neutrality by 2060. Moreover, China has been looking to shift its position from a raw commodity producer/exporter to a producer of high-value end products.[9] China is eager to develop its manufacturing base of critical rare earth materials and related products (such as EV batteries) to narrow its technology gap with the West and export these high-value products.

THE MARKET OF CRITICAL MINERALS

The increasing pace of decarbonisation around the world has far-reaching consequences for the security of critical minerals.

By 2050, the EU will need almost 60 times more lithium and 15 times more cobalt to cover the need for the mobility and energy storage sector.

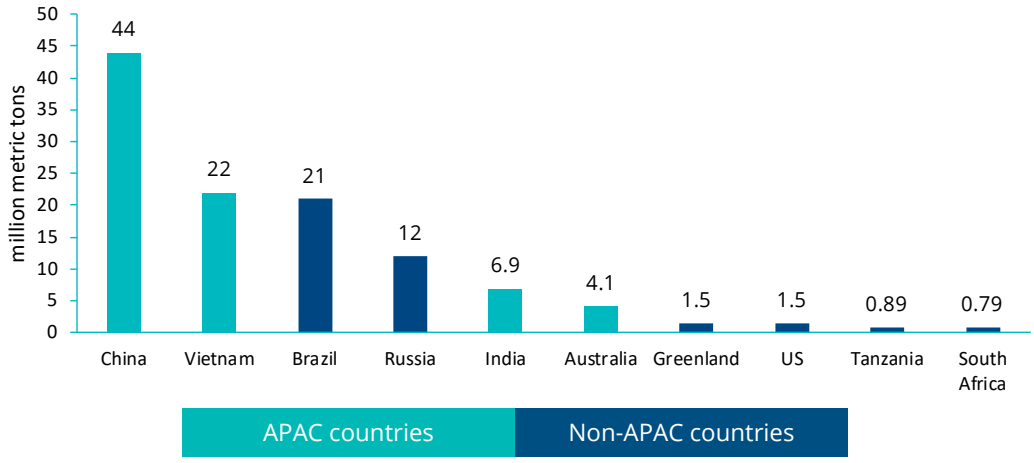
Critical minerals play a central role in the deployment of many clean energy technologies and the growing risks from climate change will only drive their demand.

According to a World Bank study, the demand for component minerals for electric storage batteries could rise by more than **450%** by 2050.

According to the European Commission Vice President, the EU needs to ensure a secure and sustainable supply of raw materials to meet the needs of clean and digital technologies.

The supply of critical minerals has become a strategic issue since it determines a country's pace of energy transition and triggers resource competition among big powers.

Figure 1: Estimated Rare Earth Reserves by Country in 2020 (million metric tons)



Source: Statista (2021)[10]

Other than its natural advantage of vast mineral deposits, China's monopoly of the global production and supply of critical minerals is driven by a combination of nationalistic industrial policies, production and export restrictions, overseas investment, lower labour costs and more flexible environmental standards.[11]

Nationalistic industrial policy: In the early 1990s, China started to restrict foreign investment, especially in the upstream sector from mineral exploration to smelting.[12] Foreign miners can only take part in China's supply chain in the form of joint ventures with Chinese state-owned companies. In the 2010s, the government continued to step up policy support to boost the upstream and downstream development of critical minerals. In particular, it attempted to strengthen its industrial control over mining capacity, encourage innovation and applications, promote higher environmental standards, create an industrial structure led by dominant firms and tackle illegal mining.[13] In 2016, the Chinese government consolidated all official mining and separation companies in the rare earths sector into six state-owned enterprises (SOEs): Northern Rare Earth (Group) Hi-Tech (including Baotou), Aluminum Corporation of China (Chinalco), China Minmetals Corporation, Xiamen Tungsten Corporation, China Southern Rare Earth Group and Guangdong Rare Earth Industry Group.[14] China's National Mineral Resource Plan for 2016–2020 further called for establishing a warning mechanism for the rare-earth industry to safeguard its supply chains against various causes of potential disruptions.[15] During these periods, most miners were merged with larger corporations, and new licences were strictly controlled as a means to keep mining activities and supply in check.

Production and export restrictions: Since the late 1990s, China has been imposing substantial restrictions on the production and export of critical raw materials that have a direct impact on the supply chain. A key policy is the export quota which China introduced in 1999 to control domestic production and illegal exports.[16] To further boost domestic development, in 2005, the government cancelled the export tax reimbursement for rare earth ores, metals and oxides.[17] From 2007, China started to levy export taxes on all rare earth metals and increased them to 15–25 per cent for different critical ores, oxides and products.[18] Another key policy was the production quota on rare earth concentrates introduced in 2006,[19] which was further converged and allocated to the six state-owned rare earth groups in 2016.[20] More recently, in October 2020, China passed an export-control law that would restrict exports of controlled items, potentially including critical raw materials, to protect China's national interests and security.[21] In early 2021, China introduced draft legislation to "reinforce the protection of its rare earth resources" and "strengthen full industrial chain regulation" by tightening the approval process of rare earth mining and trade.[22] These restrictions were aimed at incentivising the downstream mining sector and protecting domestic reserves.

Overseas investment: Other than supporting domestic production, China has been expanding its overseas asset portfolio, particularly the minerals it lacks, while protecting domestic reserves. It is undertaking mergers and acquisitions (M&A) globally to maintain its strong hold over the supply chain. In late 1990s, the Going-Out Strategy encouraged Chinese companies to invest in foreign rare earth assets/companies and tap on global reserves. Chinese SOEs purchasing a majority stake in Magnequench in 1995 were one of the first few cases of Chinese miners investing abroad as a means to penetrate global reserves.[23] The Belt and Road Initiative, launched in 2015, has further advanced China's global quest for critical rare earth materials. The Chinese government has been supporting Chinese SOEs with discounted loans to invest in upstream and downstream mineral sectors globally. This allows China to increase the proportion of Chinese-owned resources in its total imports. China has also been climbing up the global value chain from merely importing minerals to taking part in the midstream and downstream sectors overseas. For example, while almost 60 per cent of the global cobalt ore supply comes from DRC, China has heavily invested in cobalt mines and smelting projects in DRC, accounting for over 70 per cent of the global cobalt refining capacity.[24]

Lower labour costs and more flexible environmental standards: China is not the only country which owns these mineral reserves, but competitors from elsewhere have failed to sustain their production and have had to terminate it eventually in the face of the competitive Chinese industry. For example, the US once had a leading role in the industry of rare earth elements with Mountain Pass Mine being its biggest mine following the discovery of rare earth elements in America in the late 1940s. However, the US industry suffered from high operation costs because mining rare earths could cause serious environmental problems which a US mining company cannot put aside. Mountain Pass Mine failed to sustain operations and was eventually closed. In contrast, the Chinese metal industry had fewer regulatory burdens of similar kinds. As a result, the American rare earth metal industry started to decline in the late 1980s, and China overtook the US's leading role in the industry. China became a major producer of rare earth metals and dominated the market. Following the innovation of new energy and military technology, China's dominant position pushed the development of its rare earth industry even faster.

Emerging Risks: The Need to Seek an Alternative Supply Chain

The monopolised nature of the critical mineral market makes the supply chain highly vulnerable to geopolitical risks and regulatory restrictions. Recent trade tensions, the pandemic and supplier instability serve to highlight these concerns.

Trade Tensions

Given the monopolised nature of the critical mineral market, supplier stability and the resilience of supply chains have been growing concerns for major importers. Observers have pointed out that China appears to recognise the strength of its critical mineral supply chain as geopolitical leverage over the last decade.[25] Considering the increasing global demand for critical minerals, China's dominance of the global mineral supply chain will increase the world's economic reliance on the Chinese market. This could allow China to avoid supply disruptions and use import/export as leverage during geopolitical conflicts.

As early as in 2010, the Chinese government restricted rare earth exports to Japan due to an incident near the contested Diaoyu islands in the East China Sea.[26] Although these quotas were lifted in 2014 following a World Trade Organization ruling, the rare earth crisis of 2010 provided proof of China's control over the production and export of rare earth materials. More recently, during the heightened phases of the US-China trade war in 2019, Beijing raised tariffs to 25 per cent on rare earth exports to the US.[27] Although China did not ban rare earth material sales to the US, a Chinese state newspaper strongly implied that rare earths could become a counter weapon for China to hit back against US pressure.[28] Amid escalating trade tensions and the pandemic disruption, in 2020, President Xi further called for the need to strengthen global supply chain dependence on China and "develop powerful retaliation and deterrence capabilities against supply cut-offs by foreign parties".[29]

Although China is unlikely to bluntly weaponise its critical mineral trade, the above developments have already reinforced growing concerns in Western countries about their vulnerability to mineral supply chain disruption, particularly in the event of a clash between China and the West. As a response, the European Commission announced the creation of the European Raw Materials Alliance to seek to reduce its dependence on Chinese supply. The US has also explored rare earth co-operation with non-Chinese partners. Due to the vulnerable situation of the critical mineral supply chains, reducing the Chinese share of critical mineral supplies has been on the EU's policy agenda.

Pandemic Disruption

The COVID-19 pandemic is another incident that has exposed the vulnerability of the global supply chain of critical minerals, which heavily relies on supplies from China. In 2020, the COVID-19 pandemic hit global trade and industrial activities at an unprecedented speed and scale, resulting in significant disruption to refinery output of critical materials. Most of the affected regions in China are major manufacturing hubs of raw materials, products and equipment.

The mineral market first faced a supply shock due to closures of facilities, transport disruption and labour shortages in China in Q1. Then, a demand shock hit the global market due to containment measures. Delays to shipments of products to consumers both in China and internationally resulted in some shortages in raw materials and finished products. International buyers, who require quick delivery from China and do not have alternative supply options, are among the most impacted. The supply shortage could be worse if domestic consumers are preferentially supplied over international consumers under certain agreements. Many of them failed to secure alternative suppliers and were forced to reduce or halt production.

The growing need for diversification as a "de-risking" strategy has become one of the main lessons of the pandemic crisis. In recent years, there have been growing efforts to diversify supply chains outside China due to increasing labour costs and rent in the "world factory". Some multilateral corporations have attempted to vertically integrate their supply chain outside China to ensure more control over raw material prices, quality and supplies. Some governments also encourage their corporations to bring production home as a way to strengthen domestic production capacity. The COVID-19 pandemic has accelerated these efforts.

Supplier Instability

More recently, the military coup in Myanmar in February 2021 alongside pandemic containment measures have raised concerns over decreased supply of Myanmar rare earths. While Myanmar has rich deposits of critical minerals, political instability since the coup has appeared to fuel a surge in prices and disrupt mineral trade with China. According to USGS, Myanmar was the third-largest rare earth producer after China and the US in 2020, accounting for 12.5 per cent of the global volume.[30] It accounted for around 50 per cent of China's heavy earth concentrate supply in 2020. Myanmar was also the world's third-largest tin miner in 2020 and accounted for more than 95 per cent of China's tin imports. Myanmar also has rich deposits of dysprosium and terbium, which are crucial to advanced technology used in high-strength permanent magnets for EV motors and wind power generators. While mining activities are active throughout the country, there are over 100 rare earth mines in Kachin state in northern Myanmar, which is close to China's Yunnan province.[31]

Although the rare earth mines in Kachin state have close ties to the military government, disruption to the transportation of minerals and border closures during the pandemic still cause delays to Myanmar's mineral trade with China. Escalating tensions between the military government and the local armed forces could also interrupt rare earth production. Processors and manufacturers in southern China reportedly faced supply chain issues due to disruption to the supply of rare earth ores, concentrates and semi-processed products between the two countries.[32] Moreover, illegal mining has reportedly surged since the coup and further complicated the supply chain, resulting in environmental devastation. Despite the economic contribution of the mining sector, Myanmar lacks effective governance and oversight of illegal activities in the industry, which in turn results in resource exploitation.

Another inconvenient truth about the supply chain is the international sanction on the military government and military-owned companies and industries. Future sanctions could target revenues from the extractive sector, forcing some international companies to suspend dividends to military-linked companies. While sanctions make it more difficult for international corporations to keep their supply chain away from Myanmar, they will also create investment room for Chinese companies and local partners. This means that despite its effort to diversify its export portfolio, Myanmar will likely remain trade-dependent on China in the foreseeable future.

Alternative Supply Chains and Critical Material Strategies in APAC

Supply disruption and growing mineral demand for energy transition over the last decade have triggered many countries, such as Japan and

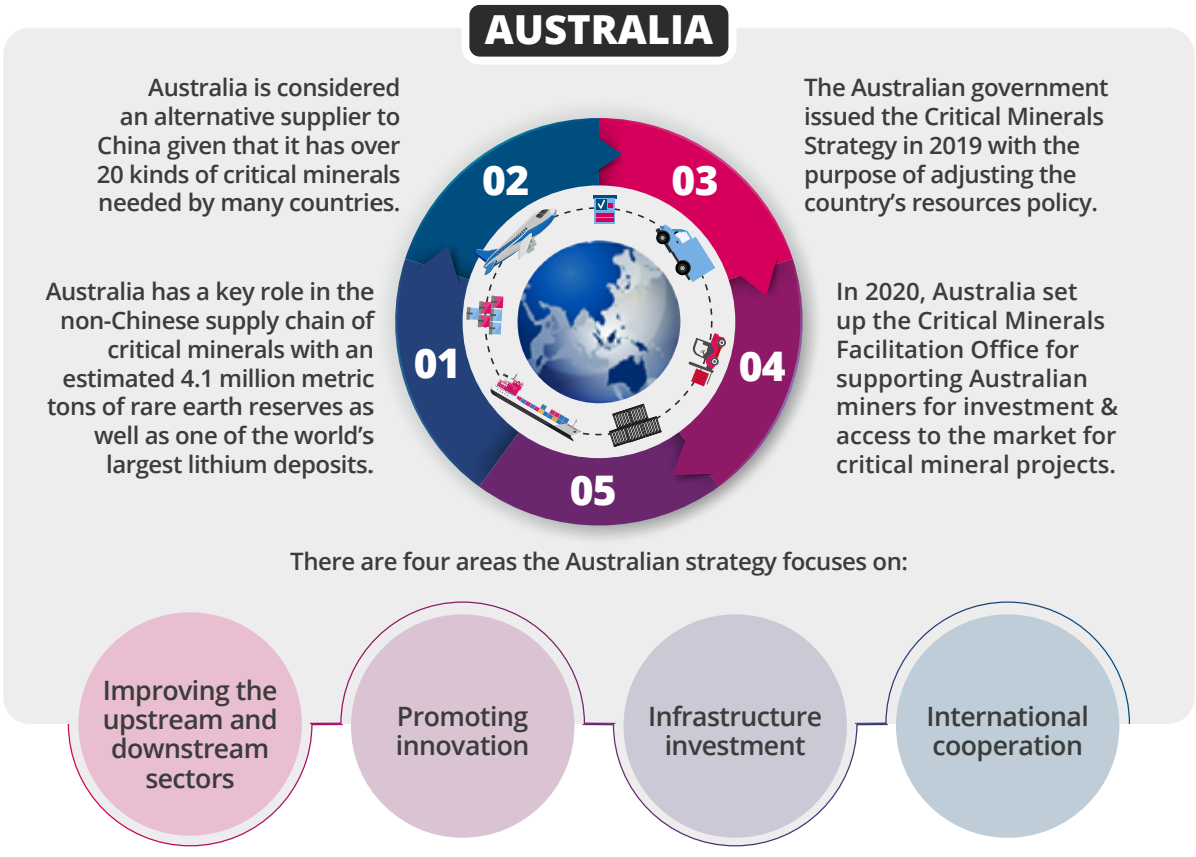
South Korea, to consider options to diversify their sources of production and processing products. Countries with rich resources, such as Australia, Indonesia, India and Vietnam, are also attempting to grab this resource opportunity to benefit their own economies.

Australia

Due to its large reserves, Australia has a key role in the non-Chinese supply chain of critical minerals. It has an estimated 4.1 million metric tons of rare earth reserves as well as one of the world's largest lithium deposits.[33] Australia is considered an alternative supplier to China given that it has over 20 kinds of critical minerals needed by many countries. However, high environmental and financial costs of the production of these critical minerals have hindered their development.

In 2019, the Australian government issued its Critical Minerals Strategy, which aims at adjusting the country's resource policy as a way to enhance its competitiveness in the global resource market.[34] It outlines various national actions to match Australia's rich resource potential with the growing demand for critical raw and refined materials. In 2020, Australia set up the Critical Minerals Facilitation Office, which aims at supporting Australian miners to secure investment and market access for critical mineral projects.[35] Projects considered to have the potential for advancing Australia's critical mineral sector will be eligible for financial support through Export Finance Australia or EFA, including the Defence Export Facility. Overall, Australia's strategy focuses on strengthening four areas of its critical mineral sector: upstream and downstream capacity, innovation, infrastructure and international cooperation.

Improving the upstream and downstream sector: The Australian government is attempting to attract more foreign investment to its resource sector to strengthen its upstream exploration and downstream processing capabilities. The government is expected to play an active role in



connecting potential greenfield investors with domestic opportunities, identifying investors and investment opportunities, enhancing the creation/advancement of the downstream value chain (e.g. batteries and battery components) and promotion of Australian resource companies overseas. This strategy also includes various initiatives, such as lithium-ion battery value chain, and the Australian critical mineral prospectus and supplier matching programme. This would allow Australian companies to secure markets for critical mineral products.

Promoting innovation: The Australian government has been supporting the development of mining technologies as a way to reduce the environmental and financial costs of extracting and processing critical raw materials. This includes energy-saving and resource expanding technology that allows miners to process low-grade ores in a more economical and environmentally friendly way. The government has invested in two major initiatives, including the $100.5 million Exploring for the Future (2016–2020) initiative and the $218 million MinEx Cooperative Research Centre. Both initiatives aim at making sure that Australia's mineral sector is employing leading techniques. The Research Centre is the world's largest government-industry-academia collaboration focusing on mineral exploration. The government has also set up other research programmes, such as the Cooperative Research Centre Projects and Optimising Resource Extraction, and has allocated millions of dollars of funds for projects with a focus on critical minerals.

Infrastructure investment: The Australian government has identified infrastructure development as a key way to boost its sector of critical minerals. Australia needs large-scale infrastructure to effectively connect its resources to the market. Infrastructure, from processing facilities to roads and harbours, is crucial for enhancing productivity, reducing business costs and connecting markets. For example, the government's decision to upgrade various sections of the Great Northern Highway could improve the transport of minerals to and from Wyndham Port.

International cooperation: The Australian government has been strengthening links with other major buyers of critical minerals as a way to stay informed of market development and to match market opportunities. For example, in February 2018, Australia and the US agreed to strengthen cooperation over critical minerals. Both countries expressed the intention to commit to Geoscience Australia and the US Geopolitical Survey to collaborate on critical mineral issues. More recently, in February 2021, Australian miner Lynas was awarded a second contract to develop a rare earth processing facility in Texas. These collaborations will allow scientists and companies from Australia and the US to have a better understanding of their critical mineral reserves and how to match the potentials. Australia is also seeking collaboration on rare earth issues with other suppliers and buyers, such as Vietnam and Japan.

India

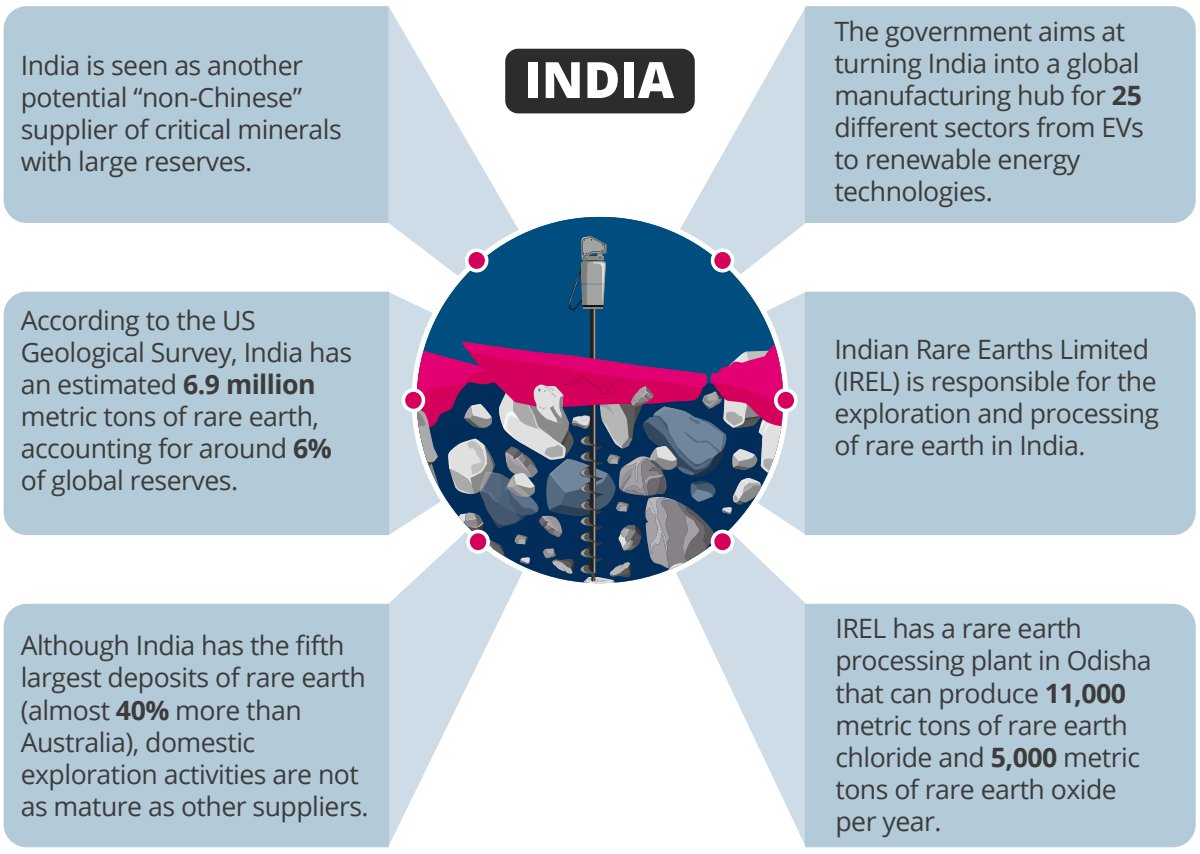
India has a unique position in the global supply chain of critical minerals because of its high resource potential but also high import dependency at the same time. First, India is seen as another potential "non-Chinese" supplier of critical minerals with large reserves, including the mineral sands along the Indian Ocean coastline. According to the US Geological Survey, India has an estimated 6.9 million metric tons of rare earths, accounting for around six per cent of global reserves. Although India has the fifth-largest deposits of rare earths (almost 40 per cent more than Australia), domestic exploration activities are not as mature as those of other suppliers. Only a few private miners, such as Beach Minerals Co., Cochin Minerals, Resine Ltd. and Rutile Ltd., are active in this sector. India consumes limited rare earths at the moment, although it uses many materials and end-products from these minerals. India's demand for these materials is mainly catered for through imports.

However, self-sufficiency of these critical minerals is becoming a pressing issue because India is also an emerging consumer of critical minerals due to its national plan — Make in India initiative. The government aims at turning India into a global

manufacturing hub for 25 different sectors from EVs to renewable energy technologies. While there is a global trend for EV production, the Indian government is also committed to producing EV. India is expected to see a rapid growth in domestic demand for materials, especially battery and magnet components,[36] when the value chains of electric vehicles are established in the country.

The Indian government has been making efforts to make India more self-reliant by boosting domestic production and manufacturing capacity. Indian Rare Earths Limited (IREL), which is responsible for the exploration and processing of rare earths in India, has rolled out various plans to support the industry. For example, the IREL is setting up a rare earth permanent magnet plant at Visakhapatnam to produce samarium-cobalt magnets used in the defence and space sector. It also has plans to build a rare earth and titanium park in Bhopal that aims at attracting entrepreneurs who focus on the development of rare earth technologies and value chains. IREL also has a rare earth processing plant in Odisha that can produce 11,000 tonnes of rare earth chloride and 5,000 tonnes of rare earth oxide per year.

Despite this, India has yet to develop an overarching rare earth strategy. India will take years to reach full capacity in regard to the above projects. However, they indicate India's efforts towards creating an indigenous supply chain for critical minerals and diversifying from China, especially in the event of a geopolitical incident. In view of this, in 2019, India's National Institution for Transforming India (NITI) constituted an expert committee to develop a roadmap to address growing uncertainties in the trade of critical minerals as well as undeveloped domestic reserve potentials.



Indonesia

As the world's largest nickel producer, Indonesia is home to 21 million metric tons of nickel reserves, accounting for 22 per cent of the world's reserves. It's production of nickel reached 760,000 tonnes in 2020.[37] Indonesian miner Aneka Tambang is one of the leading players in developing the country's nickel reserves. The Indonesian government aims at turning global demand for nickel, an essential component of EV batteries, into a driver of Indonesia's economic development. It hopes to match its nickel potential to support the domestic EV and EV battery market.

Although mineral export is a key contribution to Indonesia's economy, the Indonesian government has been moving up its export ban on nickel ore since 2014 as a way to support the domestic economy through higher-value exports. The government first rolled out an export ban on nickel ore, hoping to divert exported raw materials to the value-added downstream sector in Indonesia. The government once relaxed the export ban on nickel ore in 2017 partly due to the rapid development of nickel-processing capacity in Indonesia. However, it decided to reinstate it beginning in January 2020 to conserve ore for the domestic processing industry. In May 2020, the government passed another regulation to motivate downstream development by making it easier for miners with smelting capacity to extend mining licences.

Rapidly changing regulations of Indonesian nickel ore exports since 2014 have undermined the profitability of this sector. An export ban alone is not sufficient for Indonesia to increase its smelting capacity, which requires massive investment in the downstream sector. Although the export ban has driven some firms to invest in Indonesia's downstream sector, the pandemic has resulted in delays in some of the nickel smelting projects. Moreover, the export ban left domestic miners more exposed to fluctuating commodity prices.

Japan

Japan is one of the world's largest consumers of critical minerals. With limited resource deposits at home, Japan heavily relies on imported critical minerals for its production of electronics and automobiles. Japan considers its supply chain of designated 34 critical minerals, such as rare earths, lithium and cobalt, to be exposed to external vulnerability from geopolitical instability due to pandemic disruptions.

Since the 2000s, the Japanese government has rolled out a strategy to secure its supply of critical minerals. In 2007, the Ministry of Economy, Trade and Industry (METI) formulated its resource diplomacy that underscored the strategy to enhance access to overseas mineral assets by the use of foreign aid, public finance and trade insurance.[38] The rare earth disputes between China and Japan in 2010 further drove Japan to step up measures to secure its supply chain of critical minerals and to reduce its reliance on Chinese supplies. A combination of efforts to seek non-Chinese suppliers and to reuse materials helped Japan to reduce its reliance on Chinese rare earth supplies from over 90 per cent to 58 per cent within a decade.[39] Currently, Japan's official target is to reduce this reliance to below 50 per cent by 2025.[40]

A combination of pandemic disruption and trade tensions has driven Japan to further protect its supply chain of critical minerals. In March 2020, Japan released the New International Resource Strategy, which highlighted the rising critical resource competition with big powers such as the US, China, Europe and other emerging economies. As a response to the pandemic's impact on critical mineral supply, the government passed several budgets for 2020, totalling 5.45 billion U.S. dollars. It aimed to aid Japanese manufacturers who are exposed to supply chain disruptions (such as rare earths) that could lead to significant damage to the Japanese economy. It also encouraged these Japanese manufacturers to reshore to Japan or to relocate their operations elsewhere with a lower risk of supply disruptions. In August 2021, Japan's finance ministry and METI attempted to tighten its regulations to protect the rare earth sector from foreign takeovers to ensure national security.[41]

Japan's critical mineral strategy focuses on four areas: securing supplies overseas, stockpiling, recycling and research and development.

Securing supplies overseas: The Japan Oil, Gas and Metals National Corporation (JOGMEC), a state-backed company governed by METI, is the centre of Japan's global quest for critical minerals. A key strategy of JOGMEC is to diversify Japan's supply by investing in and partnering with mining companies overseas. Through JOGMEC, Japan directs government funds to support mining projects and secure access to rare earth assets overseas. Japanese miners have developed mining projects overseas, such as the Mount Weld project in Australia, the Don Pao project in Vietnam, and the Indian Rare Earth project in India. Other than locking in a certain amount of critical mineral supply over a designated timeframe, it also allows Japan to stabilise the price of these materials, which is crucial to downstream manufacturers that rely on them.

Stockpiling: Since the early 1980s, Japan has been stockpiling critical minerals for industrial use via both national and private means. In the wake of the pandemic disruption, METI reportedly proposed to take full control of strategic rare metals by stepping up stockpiling levels.

Recycling: Japan has been supporting efforts to recycle rare earths as a way to reduce import dependency and to meet its growing demand for use in EVs. METI plans to set up a domestic facility to recycle critical minerals procured both inside and outside the country.[42]

Research and development: The Japanese government is committed to technological innovation in critical minerals, especially substitutes of rare earth minerals that Japan lacks. METI also plans to subsidise research to recycle rare earth minerals.[43] Besides, in the early 2010s, Japan identified large reserves of rare earth elements off its coast and has also been developing technology for deep sea exploration.[44]

JAPAN

Japan heavily relies on imported critical minerals for its production of electronics and automobiles.

In 2007, the Ministry of Economy, Trade, and Industry (METI) formulated its resource diplomacy that underscored strategy to enhance access to overseas mineral assets.

Japan reduced its reliance on Chinese rare-earth supplies from over 90% to 58% within a decade.

As a response to the pandemic's impact on critical mineral supply, the government passed several budgets for 2020, totaling USD 5.45 billion.

The rare earth disputes between China and Japan in 2010 further drove Japan to step up measures to secure its supply chain of critical minerals and to reduce reliance on Chinese supplies.

Japan is one of the world's largest consumers of critical minerals.

Japan aims to reduce its reliance below 50% by 2025.

Japan's critical mineral strategy focuses on four areas:

- Securing supplies overseas
- Stockpiling
- Recycling
- Research and development

SOUTH KOREA

South Korea has limited domestic deposits of critical minerals, such as lithium, cobalt, titanium, tungsten, vanadium, and molybdenum that are crucial to new industries.

The Korean government has prioritized mitigating uncertainties surrounding volatile supply chains of critical minerals.

As a resource-poor country, South Korea is heavily dependent on imported critical minerals.

South Korea has yet to publish an official list of critical minerals but is fully aware of the importance of these strategic resources and has categorized them as legal, strategic, and rare.

The South Korean government attempts to enhance its resource security by:

1. Securing import & stockpiling reserves and
2. Advancing resource recycling as part of its circular economy

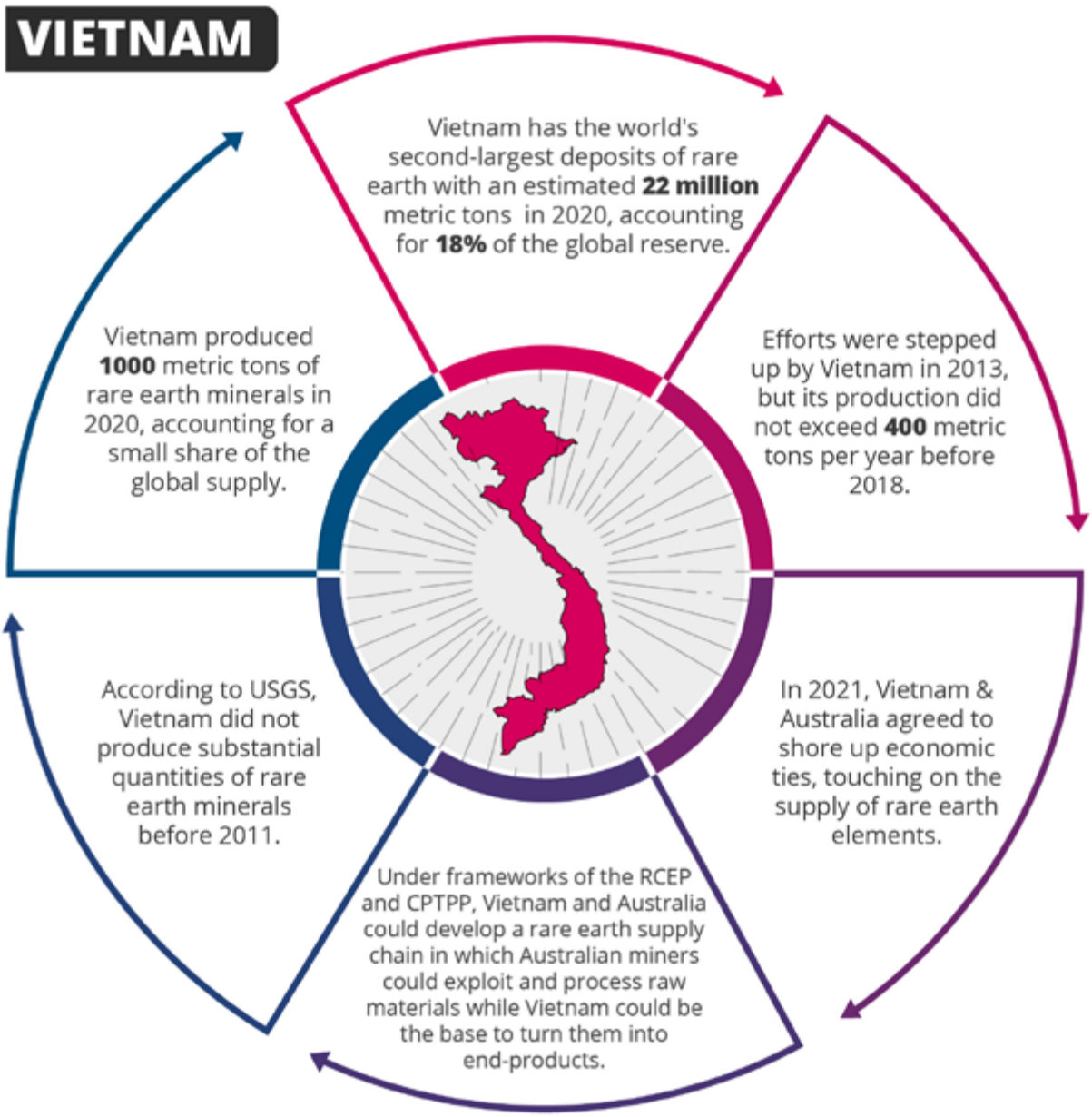
South Korea

As a resource-poor country, South Korea is heavily dependent on imported critical minerals, especially when the country is speeding up decarbonisation of its economy and building its EV industry. South Korea has limited domestic deposits of critical minerals, such as lithium, cobalt, titanium, tungsten, vanadium and molybdenum that are crucial to new industries. Therefore, the South Korean government has prioritised the need to mitigate the uncertainties surrounding volatile supply chains of critical minerals.

In contrast to the EU, the US and Australia, South Korea has yet to publish an official list of critical minerals but is fully aware of the importance of these strategic resources and has categorised them as legal, strategic and rare. Considering its heavy import dependency and vulnerability to growing uncertainties in the global resource trade, the South Korean government is attempting to enhance its resource security by 1) securing import and stockpiling reserves and 2) advancing resource recycling as part of its circular economy.

Securing import and stockpiling reserves: The National Program on Overseas Resource Development closely monitors the dynamics of national demand for critical minerals and formulates strategies to secure supplies for new industries.[45] While it attempts to ensure stable access to critical minerals overseas, it also creates a comprehensive roadmap for stockpiling these critical minerals, particularly lithium, cobalt, nickel and rare earths, for domestic consumption in key new industries such as EV batteries and renewable energy. Meanwhile, the Ministry of Trade, Industry and Energy (MOTIE), which is responsible for South Korea's mineral policy and law setting, leads the state reserve management and stockpiling of critical minerals. In August 2021, MOTIE set a target to increase its stockpiles of critical minerals to cover 100 days of consumption. It did not give a target date.[46] Under MOTIE's guidance, the state-owned Korea Resources Corporation will manage the stockpile and build new storage facilities. It will also develop resource strategies and expand South Korea's overseas investment in critical minerals.[47]

Advancing resource recycling as part of its circular economy: In 2018, the South Korean government enforced the "Framework Act on Resource Circulation" and established the Basic Plan on Resource Circulation (2018–2027) to set the mid- to long-term policy of recycling raw materials for sustainable raw material security.[48] It laid out the roadmap for moving towards a sustainable circular economy, which focuses on establishing a resource cycle from production to consumption to recycling. It promotes the recycling of high-quality waste materials and strengthens the governance of waste management in the critical mineral sector.



Vietnam

Vietnam has the world's second-largest deposits of rare earths with an estimated 22 million metric tons in 2020, accounting for 18 per cent of global reserves.[49] While it has approximately one half of China's rare earth reserves, Vietnam produces a limited volume of rare earth minerals. Vietnam produced 1000 metric tons of rare earth minerals in 2020, accounting for a small share of the global supply.[50] However, according to USGS, Vietnam did not produce substantial quantities of rare earth minerals before 2011. Although Vietnam has stepped up its efforts to exploit rare earth minerals in the northern provinces since 2013, its production did not exceed 400 metric tons per year before 2018. Vietnam has had a successful experience in diversifying exports through GVCs.

Vietnam's rich rare earth mineral potential has attracted investor interest, especially during periods of disruption. In 2010, several Japanese firms, including Toyota, announced investment in REE mining in Vietnam, as part of their global quest for rare earths.[51] In the same year, Showa Denko Rare Earth Vietnam also announced the construction of a new rare metal facility to produce dysprosium for use in neodymium magnets.[52] Although this early interest did not translate into substantial REE production, increased interest in diversification of supply may elevate interest in building Vietnamese REE capacity.

In recent years, due to supply chain disruption caused by trade tensions and the pandemic, companies have turned to Vietnam to maintain product flows. In 2021, Vietnam and Australia

agreed to shore up economic ties, touching on the supply of rare earth elements.[53] An observer pointed out that under frameworks of the RCEP and CPTPP, Vietnam and Australia could develop a rare earth supply chain in which Australian miners could exploit and process raw materials while Vietnam could be the base to turn them into end-products.[54] This is in line with Vietnam's strategy to explore its comparative advantage in the value chain of value-added products and has attracted FDI to support the development of domestic industries.

Critical Mineral Strategy of Asia-Pacific Countries

As seen from the above cases, to protect their own industry and supply of critical minerals, some countries have chosen to impose restrictions on exports of these materials and have started stockpiling them. Restrictive regulations can be seen as a short- to mid-term strategy of countries that lack good governance of and investment in their mineral sector. For example, China's restriction on the export and production of rare earths was partly driven by the need to tackle illegal exploration and export of these materials. Indonesia has been using export restrictions on nickel to drive foreign miners to invest in its downstream sector. Stockpiling is particularly important for counties such as Japan and South Korea which lack national resources at home. However, both restrictive regulations and competitive behaviour of stockpiling are not seen as long-term solutions, given the potential of market distortion and price volatility that they could lead to. A lack of regulatory efficacy could discourage investment as well.

Countries with longer-term strategies in regard to critical minerals normally focus on building or strengthening their own industrial capacity with more R&D efforts. However, since this process could take decades and reserves are geographically uneven, most governments have started developing strategies to diversify the supply chain.

Diversification of upstream supply: Supply disruption has driven both big consumers and suppliers of critical minerals to take assertive diversification strategies. To secure a stable supply of mineral resources, private miners together with their governments quickly diversify their supplies through a combination of diplomacy and overseas joint ventures. Although building a supply chain independent from China is not easy, Japan presented a successful case that managed to reduce its dependency on Chinese supply by around 30 per cent within a decade. Critical mineral suppliers like Australia are also trying to expand their export portfolio in order to capture the economic benefit driven by the growing need to diversify away from China. The Australian government has been actively reaching out to major consumers to match market opportunities for Australian miners.

Being part of the global supply chain: Other than exploring their own resources, both big consumers and suppliers of critical minerals are trying to play a bigger role in the global supply chain, especially in the downstream sector. Currently, many international miners ship their raw minerals to China for separation and processing, where their key facilities and research centres are also located. Therefore, the need to diversify from China is not only about the supply of critical minerals but also the processed products. However, supply chain disruption has driven some of these miners to look for alternative destinations for separation and processing. Countries like Vietnam are trying to attract international miners to invest in their downstream sector and relocate some of the operations there. Even countries with limited resources are investing in overseas downstream projects to capture new supply chain opportunities. While this could allow these countries to move up the global value chain, it could also help mitigate some of the supply chain risks in the region.

Circular economy: There is a growing trend that critical mineral consumers with limited resources at home, such as Japan and South Korea, have started to incorporate circular economies into their resource security policy. Many of these countries have implemented medium- and long-term policies towards a sustainable circular economy, where the role of material recovery, substitution and recycling are specifically addressed. Circular economies have become an alternative option to diversify supply

for these countries, and heavily depend on imports of critical minerals and are vulnerable to changes in external economic circumstances. These policies are particularly important because many of these high-tech products, such as the recycling and recovery of critical minerals from industrial waste and products, particularly electronic devices, modules, solar PV and EV batteries, are efficient means for strengthening resource security with secondary materials. They also aim at utilising the real commercial recycling potential of these critical minerals to make their supply chain more economically sustainable. However, it will take decades for these countries to establish a fully funded circular economy for critical minerals because of the technological complexity of recycling.

Multilateral initiatives: Major producers and consumers of critical minerals are taking a more strategic approach to establishing joint initiatives as a way to ensure a stable supply chain of these materials. Other than bilateral trade agreements, some of them have been seeking ways to improve the supply chains of these critical materials via multilateral partnerships. For example, in their first summit in September 2021, Members of the Quadrilateral Security Dialogue (Quad) discussed ways to ensure stable supply of rare earths, semiconductors and materials and reportedly agreed on a partnership to secure critical infrastructure.[55] Offering non-Chinese supplies, Australia plans to match its raw minerals with manufacturing and processing capacities and end-users in the US, Japan and India. The EU has also set up the European Raw Materials Alliance to establish a partner network of companies in the areas of primary raw materials, advanced materials, final products and recycling capabilities. It aims at diversifying sourcing from third countries and removing distortions to international trade.[56] Beyond strategic implications, these initiatives are expected to enhance the geological and market data collaboration, assessment of potential vulnerabilities in the supply chains, collective response to mitigate risks, and research and development.

Outlook and Challenges Ahead

Although new investments have been picking up and could boost near-term supply, a report by the International Energy Agency argued that they are not yet ready to meet the rising demand driven by the accelerated energy transition across the world.[57] In a mixed picture of future supply, battery-grade nickel and rare earths such as neodymium and dysprosium will likely face tight supply. Despite efforts to diversify supply, development of new mining projects from discovery to production and construction of new processing facilities could take over 15 years and up to 4–5 years, respectively.[58] Long project lead times could undermine the industry's ability to commence new projects and exacerbate the risk of failing to meet the demand.

Another emerging risk is whether new investments in critical mineral projects can fully address growing stakeholder and regulatory pressure around ESG (environmental, social and governance). In recent years, the mining and metal sector has been under growing pressure to address the high carbon emission and social issues related to mining and processing activities. There are growing numbers of stakeholders and governments requesting miners to follow global best practices, such as the Taskforce on Climate-related Financial Disclosures (TFGC) and the Responsible Minerals Assurance Process (RMAP). Miners are required to ensure that only responsibly sourced minerals exist in their supply chains and disclose their performance, targets and plans on these ESG issues.

However, the very nature of the mining sector means that it is difficult for mining companies to completely negate the ESG risks. The mining, processing and even recycling activities of critical minerals are often highly polluting and labour-intensive. Some projects are exposed to natural disasters, biodiversity risks, water shortage and indigenous people issues. Financial backers of these industries and projects are also increasingly likely to be targeted by regulators and civil society over their ESG performance or to be a potential object of litigation. Miners have to demonstrate comprehensive due diligence and reporting capacity across their supply chain as a

OUTLOOK AND CHALLENGES AHEAD

A report by the International Energy Agency argued that Asia Pacific countries are not yet ready for meeting the rising demand driven by the accelerated energy transition across the world.

The mining, processing, and even recycling activities of critical minerals are often highly polluting and labor-intensive.

Financial backers of these industries and projects are also increasingly likely to be targeted by regulators and civil society over their ESG performance.

The supply chain of critical minerals will likely remain vulnerable to geopolitical risks, regulatory restrictions, and supplier instability.

An emerging risk is whether new investments in critical mineral projects could fully address growing stakeholder and regulatory pressure around ESG (environmental, social, and governance).

Despite efforts to diversify supply, the development of new mining projects from discovery to production and construction of new processing facilities could take over 15 years and up to 4-5 years, respectively.

The very nature of the mining sectors means that it is difficult for mining companies to completely negate the ESG risks.

Some projects are exposed to natural disasters, biodiversity risks, water shortage, and indigenous people issues.

With the rise in demand for energy transition, additional production is needed both within and outside China and has to be conducted using ESG standards.

way to ensure compliance with ESG requirements. However, the tightening scrutiny of ESG issues could alter the investment incentive in critical mineral projects and have an impact on the costs and supply prospects of these materials.

Given the rapid rise in projected mineral demand for energy transition, additional production is needed both within and outside China and has to be conducted under high ESG standards. The production and processing operations of these minerals will likely continue to be concentrated in a small number of countries. Severe competition for these critical minerals will continue in the foreseeable future. Efforts to diversify supplies via investing in overseas mining and processing projects could help mitigate some of these risks, but this process could take decades. While major consumers and projects have launched a number of projects at varying stages of development, they are exposed to the possibility of price cycles and tightening regulations. The supply chain of critical minerals will likely remain vulnerable to geopolitical risks, regulatory restrictions and supplier instability.

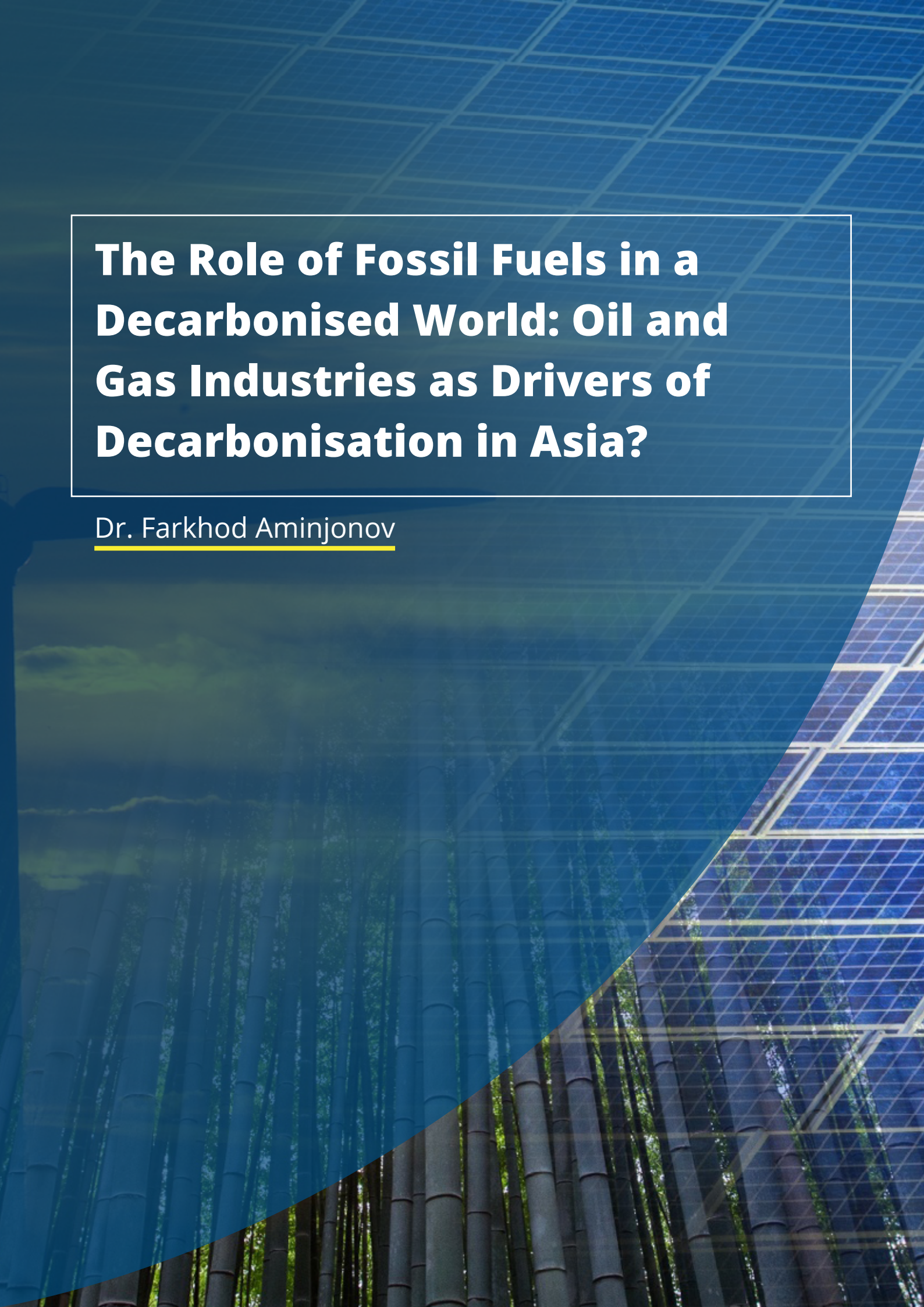
Dr. Kaho Yu is a Principal Analyst (Asia Politics & Energy) at Verisk Maplecroft and a non-resident fellow at the London Asia-Pacific Centre for Social Science and the European Centre for Climate, Energy and Resource Security (EUCERS) at King's College London. The opinions expressed in this article are the author's own and do not reflect the view of his employer or affiliated organisations.

1 Such as electric vehicles (motors and batteries), wind turbines, energy-efficient lights.
2 Šefčovič, Maroš 2020: Speech by Maroš Šefčovič at the Press Conference on critical mineral resilience in the EU.
3 European Commission 2021: In-depth reviews of strategic areas for Europe's interests, in: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy/depth-reviews-strategic-areas-europes-interests_en/ [11 Oct 2021].
4 Šefčovič, Maroš 2020: Speech by Maroš Šefčovič at the Press Conference on critical mineral resilience in the EU.
5 US Geological Survey 2021: Rare Earths 2021.
6 Ibid.
7 Ladislaw, Sarah et al. 2021: Industrial Policy, Trade, and Clean Energy Supply Chains, Center for Strategic and International Studies.
8 Ibid.
9 Kalantzakos, S. 2020: The Race for Critical Minerals in an Era of Geopolitical Realignments, The International Spectator, 55:3, p. 1-16.
10 Statista 2021, Rare earth reserves worldwide as of 2020, by country, Feb 2021, in: Rare earth reserves worldwide as of 2020, by country [28 Oct 2021].
11 Hurst, C. 2010: China's Rare Earth Elements Industry: What Can the West Learn?, Institute for the Analysis of Global Security.
12 RE-office / CST / MFERT. 1990: Notice on regulation of Rare Earth Foreign cooperation and technology exportation.
13 State Council Information Office 2012: Situation and policies of China's rare earth industry; State-Council 2011: Several opinions of the State Council on promoting the sustainable and healthy development of the rare earth industry.
14 European Commission 2020: The Role of Rare Earth Elements in Wind Energy and Electric Mobility: An analysis of future supply/demand balances.
15 State Council 2016: China's National Mineral Resource Plan for 2016-2020.
16 MFTEC 1999: Provisions on export quota bidding with compensation.
17 MoF / SAT 2005: Notice on adjusting the export tax refund rates of certain products.
18 MoF 2012: Tariff Execution Plan 2012.
19 MLR 2006: Notice on Issuing Total Mining Quota of Tungsten and Rare Earths of 2006.
20 MIIT 2016: Notice on issuing the 1-round of general control plan of rare earth production of 2016.
21 Xie, Jun / Li, Xuanmin 2020: Export control law to affect rare earths, UAVs, Global Times, 30 November 2020, in: https://www.globaltimes.cn/page/202011/1208529.shtml [11 Oct 2021].
22 Liu, Zhihua / Liu, Yukun 2021: China to step up protection of rare earth resources, China Daily, 16 January 2021, in: https://global.chinadaily.com.cn/a/202101/16/WS60023d3aa31024ad0baa3039.html [11 Oct 2021].
23 de la Bruyere, Emily / Picarsic, Nathan 2020: Absolute Competitive Advantage: Rare Earth Elements in China's Strategic Planning, Actionable Geopolitical Insight, Horizon Advisory.
24 Reportlinker 2019: Global and China Cobalt Industry Report, 2018-2023, PR Newswire, in: https://www.prnewswire.com/news-releases/global-and-china-cobalt-industry-report-2018-2023-300818715.html [11 Oct 2021].
25 Nakano, J. 2020: The Geopolitics of Critical Minerals Supply Chains.
26 Bradsher, Keith 2010: Amid Tension, China Blocks Vital Exports to Japan, The New York Times, 22 September 2010, in: https://nyti.ms/2HOinnx [11 Oct 2021].
27 Ibid.
28 Reuters 2019: China ready to hit back at U.S. with rare earths: newspapers, Reuters, 29 May 2019, in: https://www.reuters.com/article/us-usa-trade-china-rareearth/china-ready-to-hit-back-at-u-s-with-rare-earths-newspapers-idUSKCN1SZ07V [11 Oct 2021].
29 Xi, Jinping 2020: Certain major issues for our national medium- and long-term economic and social development strategy, Qiushi Journal.
30 United States Geological Survey 2021: Rare Earths 2021.
31 Bangkok Post 2021: Illegal rare-earth mining surges in Myanmar, Bangkok Post, 8 May 2021, in: https://www.bangkokpost.com/world/2112407/illegal-rare-earth-mining-surges-in-myanmar [11 Oct 2021].
32 Reuters 2021: China's rare earth imports from Myanmar dry up after border closure, Reuters, 20 September 2021, in: https://www.reuters.com/article/china-economy-trade-rareearths-idUSKBN2GG16X [11 Oct 2021].
33 USITC 2021: Rare earths and the US electronics Sector: Supply chain developments and trends.
34 Australian Government 2019: Australia's critical minerals strategy, in: https://www.industry.gov.au/sites/default/files/2019-03/australias-critical-minerals-strategy-2019.pdf [11 Oct 2021].
35 Australian Government 2020: Critical Minerals Facilitation Office, in: https://www.industry.gov.au/policies-and-initiatives/critical-minerals-facilitation-office [11 Oct 2021].
36 Such as neodymium, praseodymium and dysprosium.
37 USGS 2020: Mineral commodity summaries 2020.
38 Nakano, J. 2020: The Geopolitics of Critical Minerals Supply Chains.
39 Nakano, J. 2020: The Geopolitics of Critical Minerals Supply Chains; METI 2020: Critical Non-China Supply Chain in the Age of Green Innovation.
40 Ryosuke, Hanafusa 2020: Japan to pour investment into non-China rare-earth projects, Reuters, 15 February 2020, in: https://asia.nikkei.com/Politics/International-relations/Japan-to-pour-investment-into-non-China-rare-earth-projects [11 Oct 2021].
41 Argus 2021: Japan to cap foreign investment in rare metals sector, in: https://www.argusmedia.com/en/news/2245744-japan-to-cap-foreign-investment-in-rare-metals-sector [11 Oct 2021]
42 Kyodo News 2021: Japan eyes recycling rare metals to reduce reliance on China, others, Kyodo News, 29 March 2021, in: https://english.kyodonews.net/news/2021/03/09e968f24402-japan-eyes-setting-up-site-to-recycle-rare-metals.html [11 Oct 2021].
43 Ibid.

44 Nature 2020: Japan pioneers extracting rare-earth elements from the deep sea, in: https://www.nature.com/articles/d42473-020-00524-y [11 Oct 2021].
45 MOTIE 2014: The Fifth National Program on Overseas Resource Development.
46 Argus 2021: South Korea to increase stockpiles of rare metals, in: https://www.argusmedia.com/en/news/2241424-south-korea-to-increase-stockpiles-of-rare-metals [11 Oct 2021]
47 Ibid.
48 South Korea Ministry of Environment 2019: Comprehensive Measure of Waste Recycling, Korea Environmental Policy Bulletin, 14:1.
49 U.S. Geological Survey: Rare Earths 2021.
50 Ibid.
51 Yuasa, Shino 2010: Japan to Mine Rare Earths in Vietnam, Manufacturing.net, 22 October 2010.
52 SDK 2010: Ensuring Stable Supply of High-Performance Magnetic Alloys.
53 VNS 2021: Vietnam, Australia eye closer ties in economy, trade, investment, Vietnam News, 13 July.
54 VNA 2021: Australia prioritises economic ties with Vietnam: Expert, Vietnam News Agency, 14 July.
55 Pollard, Jim 2021: Quad Nations to Cooperate On Rare Earths, Chips and Tech Supply Chains, Asia Financial, 26 September 2021, in: https://www.asiafinancial.com/quad-nations-to-cooperate-on-rare-earths-chips-and-key-tech-supply-chains [11 Oct 2021].
56 ERMA 2020: European Raw Materials Alliance, in: https://erma.eu/about-us/ [11 Oct 2021].
57 IEA 2021: The Role of Critical Minerals in Clean Energy Transitions.
58 Ibid.

The Role of Fossil Fuels in a Decarbonised World: Oil and Gas Industries as Drivers of Decarbonisation in Asia?

Dr. Farkhod Aminjonov



Abstract

Asia, being the world's biggest emitter, is expected to make a significant contribution to climate change mitigation efforts. As energy accounts for about two-thirds of the greenhouse gas emissions, energy transition is often placed at the core of the region's response to climate change — reducing carbon dioxide and other greenhouse gases emissions from fossil fuels. There is a difference between fossil fuels as they are versus as they could be. The study derives from the understanding that the ultimate goal of sustainable development is not to entirely exclude fossil fuels, which would be a technologically, financially and politically difficult task to accomplish in the foreseeable future, but to turn them into part of the solution to the problem. Coal is the dirtiest of fossil fuels and is set for rapid replacement with less environmentally damaging sources of energy. But the world has not yet found a good substitute for oil and gas in terms of its availability and fitness for purpose. This chapter provides a comprehensive cross-regional comparative analysis of East Asian, Southeast Asian, South Asian and Central Asian countries' decarbonisation strategies and the role of the oil and gas companies in accelerating the transition towards a more sustainable future. Pathways for a low-carbon future presented in this chapter can become an integral part of the Asian countries' decarbonisation strategies.

Introduction

Asia, being the world's biggest emitter, is expected to make a significant contribution to climate change mitigation efforts. As energy accounts for about two-thirds of the greenhouse gas emissions, energy transition is often placed at the core of the region's response to climate change — reducing carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions from fossil fuels to prevent the worst effects of climate change with severe economic, social and political consequences. Most of the governments have even shown environmental consciousness by setting new energy-growth patterns with a focus on decarbonisation. Decarbonisation refers to the process of reducing the "carbon intensity" of primarily the energy and transport sectors. The need for action is pressing.

There is a difference between oil and gas as they are as opposite in nature as they could be. In this study, we derive from the understanding that the ultimate goal of sustainable development is not necessarily to entirely exclude hydrocarbons, which would be technologically, financially and politically extremely difficult task to accomplish in the foreseeable future, but to turn them into part of the solution to the problem.

This chapter provides a comprehensive cross-regional comparative analysis of the Asian countries with a focus on oil and gas industries as drivers of decarbonisation to accelerate progress towards a sustainable future.

Coal is the dirtiest of fossil fuels and is set for rapid replacement with less environmentally damaging sources of energy. But the world has not yet found a good substitute for oil and gas in terms of their availability and fitness for purpose. Thus, the chapter focuses on hydrocarbons to explore the possibility of the oil and gas industries becoming one of the drivers of decarbonisation and, through innovative technological and policy tools, drive the progress.

There seems to be a consensus on the necessity of the transition to sustainable energy systems. However, Asian countries are at different levels of economic development, and have uneven resource endowments and technological capacities. It is generally believed that decarbonisation could be within reach for advanced economies. Yet, decarbonising emerging economies may prove much harder due to expanding energy-intensive economies and population growth-driven energy demand. This chapter provides a cross-regional comparative analysis of East Asian, Southeast Asian, South Asian and Central Asian countries' decarbonisation efforts and the role of oil and gas companies in the transition.

This is a policy-relevant study aimed at developing pathways for low-carbon development throughout the Asian region. Asian countries need technological innovations coupled with a strong policy to move towards a low-carbon future. Pathways for a low-carbon future highlighted in this chapter could become an integral part of Asian countries' decarbonisation strategies.

The rest of the chapter is organised as follows. Section 1 discusses the global and regional trends towards a sustainable future, such as climate change initiatives, rationale for decarbonisation and Asia's commitments to transform the region's energy systems. Section 2 provides a comprehensive analysis of the role that the oil and gas industries play in decarbonising Asia. Section 3 explores the decarbonisation pathways for the oil and gas industries to build resilient and sustainable energy systems in Asia.

Global and Regional Trends in Sustainable Energy Transition: Decarbonising Asia

A transition to sustainable economies implies that energy security and hydrocarbon industry interests must now be aligned with the common interest of mitigating climate change.[1] Stakeholders are forced to mitigate climate change impact and governments must adopt stringent decarbonisation regulations. Having shaped the energy sector for a century and served as one of the key drivers of economic development, oil and gas companies are under serious pressure from customers, regulators and investors to reduce their carbon footprint and embrace energy sector decarbonisation.

The oil and gas era is not over yet. According to the IEA Sustainable Development Scenario, the oil and gas sector is forecast to contribute up to 50 per cent of global primary energy by 2040.[2] Asia will become the region driving energy demand, especially hydrocarbons. Energy consumption growth, however, will come at a certain cost. Climate change mitigation strategies will pose a serious threat to the oil and gas industry unless they start adopting strategies and introducing new business models that can secure them a place in a carbon-constrained world. The changing behaviour of the oil and gas industries, in turn, might trigger important effects on climate policies, energy prices, energy security and global oil/gas politics.[3] The predominant decarbonisation pathways focus on scaling up renewable energy (mainly solar and wind) and measures to improve energy (fossil fuels) use efficiency. The oil and gas industries are in a position to play a leading role in enhancing the efficiency of their operations and contributing to the clean energy transition.

Global Climate Change Mitigation Initiatives

The Paris Agreement requires all the signatories (196 countries) to limit global warming to less than 2 degrees Celsius by reducing their emissions of greenhouse gases. The Intergovernmental Panel on Climate Change indicated that to limit global warming to 1.5 degrees Celsius, the CO_2 emissions have to fall by 45 per cent from the 2010 level by 2030 and reach "net-zero" by 2050.[4] During the Paris Climate Conference (COP21) held in 2015, countries voluntarily set their own emissions targets in their national climate action plans — Nationally Determined Contributions or NDCs — to secure a lower carbon future. COP21 is the first universal, legally binding global climate change agreement, which has been adopted by nations all over the world since 22 April 2016.

Considering the fact that the energy sector accounts for two-thirds of all emissions, the climate change mitigation targets must commence by decarbonising the power, industry, transport and heat sectors.[5] In 2019, emissions from the combustion of fossil fuels (coal, oil and natural gas) amounted to 36.4 gigatons, representing 80 per cent of the total anthropogenic CO_2 emissions and 68 per cent of the total GHG emissions.[6] Without oil and gas companies taking the lead in the transition, only part of the energy system and the economy, in general, will be decarbonised.

Defining the Energy Transition

The "energy transition" implies moving away from fossil fuels to a more sustainable economy and clean energy systems. The transition is also about a shift from high carbon intensity to lower

carbon intensity as well as the transformation of the energy sector in which various elements (oil and gas, transport, heating, renewables, and so on) are increasingly integrated.[7] The energy transition, of course, encompasses all components of the energy sector, such as the production, conversion, delivery and use of energy. While the general discourse might imply that there is no room for fossil fuels at the end of the energy transition, this chapter focuses on the overall lowering of the emissions from energy sector-dependent fuel and technologies.[8] Climate mitigation measures will force countries to phase out the coal from their economies as much as they can. No economically viable alternative has been found, however, to the use of oil and gas sources.

Rationale for Decarbonisation

For a century, oil and gas industries were considered the driver of economic growth. In the 21st century, oil and gas companies are highly exposed to low-carbon transition risks but also to opportunities. With its considerable scientific, technical, economic and financial assets, these industries can drive the transition to a low-carbon economy. In the era of the energy transition, the oil and gas sector will continue to power up economic development, but not just through hydrocarbon exploration and production.

Oil and gas industries would want to adapt to the energy transition in a way that they do not simply support the decarbonisation of the energy system but play a leading role in it. There are three potential pathways for the industry:

a) continue with business as usual (BAU) and strengthen companies' current strategies of maximising the short-term profit;

b) enhance the efficiency of their operations by switching to low-carbon sources — natural gas, blue hydrogen and biofuels; and,

c) transition to renewable energy, such as solar, wind, electric vehicles (EV) and green hydrogen.[9]

Evidence presented in this chapter suggests that decarbonisation may not be successful or happen at all without oil and gas companies playing a major role in maintaining the shareholder investment return, mitigating emissions, and meeting changing consumer needs. Oil and gas companies have a wide range of instruments to accelerate decarbonisation. They can implement incentives to boost structural and behavioural changes for improved energy efficiency. Using their knowledge and expertise, they can transform the traditional carbon-intensive energy systems to low-carbon power systems. They can also promote electrification of the transport, industry and heating/cooling sectors.

Energy Demand Growth

The Institute of Energy Economics based in Japan predicts that primary energy demand in rich countries will drop eleven per cent by 2050 from current levels, while demand will rise by more than 50 per cent in emerging economies. As a result, the institute estimates that the global demand for oil will account for 36 per cent, while that for natural gas will climb up to 57 per cent by 2050, against the 2020 level.[10] Around 60 per cent of oil demand and 75 per cent of natural gas demand at mid-century will be met by fields that are yet to be developed.[11]

So, the end game for decarbonisation transition is not an energy system without oil and gas. Oil and gas industries are in a position to facilitate the transition to a lower-carbon economy and eventually a net-zero future. The new business value, however, will force the oil and gas industries to reinvent themselves. A new business model requires a clear vision of the change, which can be determined by responding to the following questions: How rapidly should they change? Could they be risking losing profits from their traditional business if they move too fast? How open should they be to transforming their behaviour in case the market forces or the government policies force them to make a rapid transition? How successful could they be in integrating new business models (energy efficiency, renewables and decentralisation) into their traditional operations?[12] Since Asia's developed and emerging economies will drive the global energy demand growth, the success of

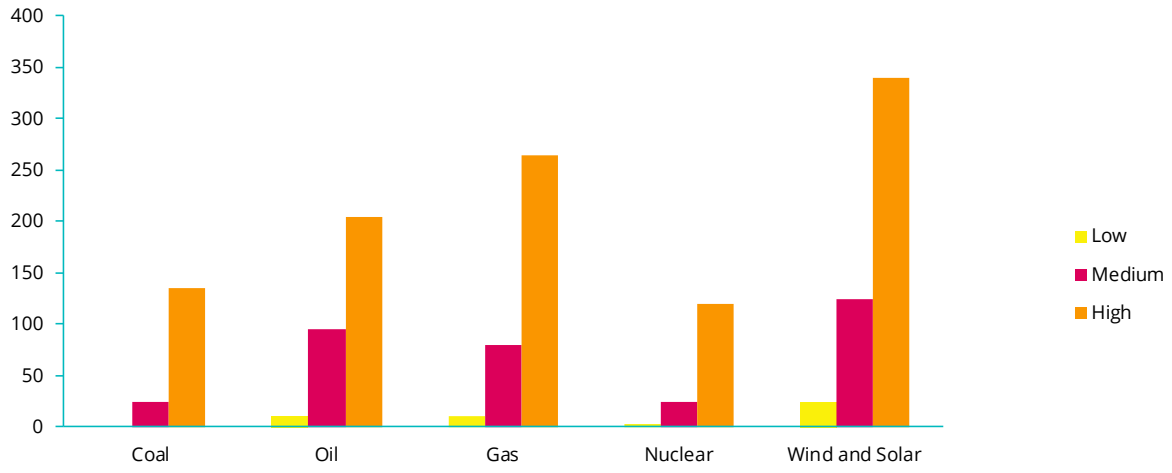
the decarbonisation initiatives in this region will determine the worldwide success of mitigating Climate Change impact.

Asia Shaping the Future Energy and Global Climate

Asia will play a decisive role in shaping future energy and consequently the global climate. Around half of the world's population live in Asia. More than 60 per cent of the world's largest cities are located in Asia and the region has been undergoing remarkable economic growth. Economic growth in the region, in turn, boosts energy demand. While some Asian countries pay a great deal of attention to the development of renewable energy sources as an attempt to address environmental risks and reduce their economies' carbon footprint, the region still heavily relies on fossil fuels. But the region cannot continue to depend on environmentally damaging fossil fuels in the BAU context. Over 45 per cent of the world's CO_2 emissions are already concentrated in Asia, and 93 out of the 100 most polluted cities are located in Asia.[13]

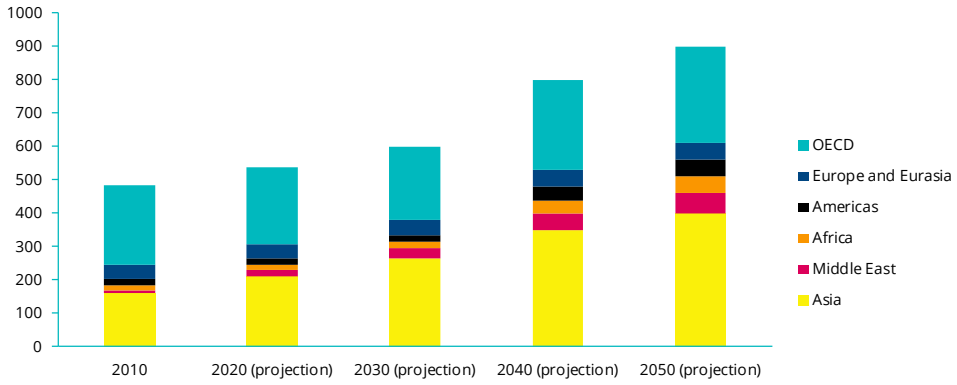
Climate change is having an uneven impact on countries. Consequently, the measures taken to mitigate the consequences of the impact vary across countries and regions. Asia is among the world's most vulnerable regions, with large and increasing populations exposed to high and often extreme climate risks. According to the EY Megatrend 2020 report, unless deep decarbonisation of the economies is successfully carried out, 252 million people in Asia will be displaced by coastal flooding by 2050.[14] Myanmar, the Philippines, Thailand, and Vietnam are already among the ten states in the world that have suffered the most in human and material terms from climate-related weather events over the past 20 years. As highlighted in the Global Climate Risk Index (2020), the Philippines was the second-most affected country by climate change-induced events that cost the economy 4.5 billion U.S. dollars in 2018 alone.[15] In an attempt to mitigate the Climate Change impact and secure a "net-zero" carbon future, all Asian countries have adopted NDCs.

Figure 2: The Range of Global Consumption of Primary Energy in 2050 from IPCC Scenarios



Source: James et al. (2021) [16]

Figure 3: Global Primary Energy Consumption by Region (2010–2050)



Source: Cohen (2021) [17]

Table 1: Asian Countries' Paris Agreement Commitments [18]

Central Asia		
Regions	**Ratified**	**Targets [19]**
Kazakhstan	6 Dec 2016	Unconditional target: 15% below the 1990 level by 2030 Conditional target: 25% below the 1990 level by 2030 Unconditional long-term target: 25% below the 1990 level by 2050
Kyrgyzstan	18 Feb 2020	11.49%–13.75% below BAU in 2030 (With international support: 29%–30.89% below BAU in 2030) 12.67%–15.69% below BAU in 2050 (With international support 35.06%–36.75% below BAU in 2050)
Tajikistan	22 March 2017	10%–20% (flexible target) below the 1990 level (25.5 million tonnes of CO_2 equivalent) 25%–35% below the 1990 level (under the condition that all programmes aimed at GHG emission reduction are successfully implemented) by 2030
Turkmenistan	20 Oct 2016	No concrete commitments and targets
Uzbekistan	9 Nov 2018	10% below the 2010 level GHG emission by 2030.

South Asia		
Regions	**Ratified**	**Targets [20]**
Afghanistan		13.6% reduction in GHG emissions by 2030 compared to business as usual (BAU); 2030 scenario, conditional on external support.
Pakistan	10 Nov 2016	20% reduction of its 2030 projected GHG emissions Subject to availability of international grants to meet the total abatement cost of about 40 billion U.S. dollars.
India	2 Oct 2016	450 GW renewables capacity by 2030 and 60% of total installed capacity being renewables by 2030 National Mission on Enhanced Energy Efficiency National Hydrogen Mission Draft LNG policy targets

Maldives	22 April 2016	Unconditional reduction of 10% of its Greenhouse Gases (below BAU) for the year 2030 Could be increased up to 24% in a conditional manner, in the context of sustainable development, supported and enabled by the availability of financial resources, technology transfer and capacity building
Nepal	5 Oct 2016	Achieve 80% electrification through renewable energy sources having an appropriate energy mix by 2050. Reduce its dependency on fossil fuels by 50%.
Sri Lanka	21 Sep 2016	NDCs for Mitigation intend to reduce GHG emissions against the BAU scenario by 20% in the energy sector (4% unconditionally and 16% conditionally) and; by 10% in other sectors (transport, industry, forests and waste) by 3% unconditionally and 7% conditionally by 2030.
Bhutan	19 Sep 2017	Bhutan intends to remain carbon neutral where emissions of greenhouse gases will not exceed carbon sequestration by forests, which is estimated at 6.3 million tonnes of CO_2 Bhutan will maintain a minimum of 60% of total land under forest cover for all time
Bangladesh	21 Sep 2016	Reduction of GHG emissions in the power, transport, and industry sectors by 12 $MtCO_2e$ by 2030 or 5% below BAU emissions for those sectors Reduction of GHG emissions in the power, transport, and industry sectors by 36 $MtCO_2e$ by 2030 or 15% below BAU emissions for those sectors

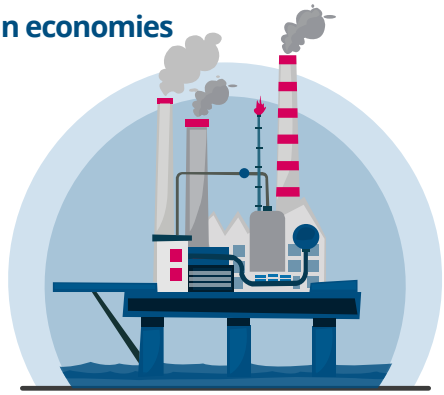
East Asia		
Regions	**Ratified**	**Targets** [21]
China	3 Sep 2016	"Made in China 2025" transition from heavy industry to higher value-added manufacturing; 14th Five-Year Plan: Reduce the CO_2 intensity of the economy by 18% from 2021 to 2025 Reduce the energy intensity of the economy by 13.5% from 2021 to 2025 20% non-fossil share of energy mix by 2025 25% non-fossil share of energy mix by 2030 Aim to peak CO_2 emissions before 2030 Lower CO_2 emissions per unit of GDP by 60% from 2005 levels.
Japan	8 Nov 2016 (Acceptance)	Post-2020 GHG emission reductions is at the level of a reduction of 26.0% by fiscal year 2030 compared to fiscal year 2013 25.4% reduction compared to fiscal year 2005 Achieve at least a 50% reduction of global GHG emissions by 2050
North Korea	1 August 2016	Reduction of GHG emissions by 8.0% compared to a BAU scenario, by 2030 with domestic resources Achieve the additional contribution equivalent to 32.25% of the GHG emission in the BAU scenario by 2030 if international support is received.
South Korea	3 Nov 2016	14th long-term natural gas supply and demand plan (2021–2034). Emission reduction by 37% from the BAU level by 2030
Mongolia	21 Sept 2016	Increase renewable electricity capacity from 7.62% in 2014 to 20% by 2020 and to 30% by 2030 as a share of total electricity generation capacity Reduce electricity transmission losses from 13.7% in 2014 to 10.8% by 2020 and to 7.8% by 2030 Reduce building heat loss by 20% by 2020 and by 40% by 2030, compared to 2014 levels

Southeast Asia		
Regions	**Ratified**	**Targets** [22]
Brunei	21 Sep 2016	Reduce its energy consumption by 63% by 2035 against the BAU scenario Achieve a 10% share of renewable energy in power generation by 2035 With regard to the transport sector, the target is to reduce CO_2 emissions by 40% from morning peak-hour vehicle use by 2035 compared with the BAU scenario
Cambodia	6 Feb 2017	Reduction of 3100 gigagrams of carbon dioxide equivalent ($GgCO_2eq$) by 2030 compared with 2010 baseline emissions of 11,600 $GgCO_2eq$
Indonesia	31 Oct 2016	Reduction of 29% of its emissions against the BAU scenario by 2030 in the unconditional scenario If there is additional international support, Indonesia intends to reduce an additional 12% of its emissions Indonesia: 23% share of renewable energy in primary energy supply by 2025 and 31% by 2050.
Laos	7 Sep 2016	The Laos electricity grid draws on renewable resources for almost 100% of output — implementing a renewable energy strategy that aims to increase the share of small-scale renewable energy to 30% of total energy consumption by 2030
Malaysia	16 Nov 2016	Reduction of its GHG emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005; this consists of 35% on an unconditional basis and a further 10% being conditional upon receipt of climate finance, technology transfer, and capacity building from developed countries
Myanmar	19 Sep 2017	Increase the share of renewables in rural electrification to 30% Increase hydropower capacity to 9.4 gigawatts, and distribute about 260,000 energy-efficient cooking stoves to rural areas Myanmar aims to achieve 20% electricity-saving potential of the forecast electricity consumption by 2030
The Philippines	23 March 2017	GHG emissions reduction of 70% by 2030 relative to its BAU scenario of 2000–2030. The mitigation contribution is conditioned on the extent of financial resources — including technology development and transfer
Singapore	21 Sep 2016	Reduction of CO_2 emissions unconditionally from 7–11% lower than its BAU level by 2020 (pledged in 2009) A further 16% reduction by 2020 after COP21 in Paris on 12 December 2015
Thailand	21 Sep 2016	Its GHG emissions to reach 555 million tonnes of carbon equivalent ($MtCO_2e$) by 2030 in the BAU case, with 76.8% mainly from the energy and transport sectors Reduction of GHG emissions by 20% of the BAU emissions in 2030
East Timor		Reduce the dependence on imported fuel Reduce the dependence on fossil fuels for cooking Promote the use of higher efficiency technologies
Vietnam	3 Nov 2016 (Approval)	Cut emissions by 25% from 2010 levels if international support is received through bilateral and multilateral cooperation GHG emissions reduction efforts during 2021–2030 aim to reduce its GHG emissions by 8% in 2030 compared with the BAU scenario, in which the emissions intensity per unit of GDP will decline by 20% from 2010 levels and forest coverage will increase by 45%

OIL AND GAS INDUSTRIES AS DRIVERS OF DECARBONIZATION

Decarbonization of the Asian economies can potentially enhance:

- The countries' energy security
- Access to affordable clean energy
- Minimize environmental degradation
- Trigger sustainable development



The key drivers of decarbonization are:

- Policy & government targets
- Technology and operational cost reduction
- Investor pressure
- The customers' demand

Oil and Gas Industries as Drivers of Decarbonisation

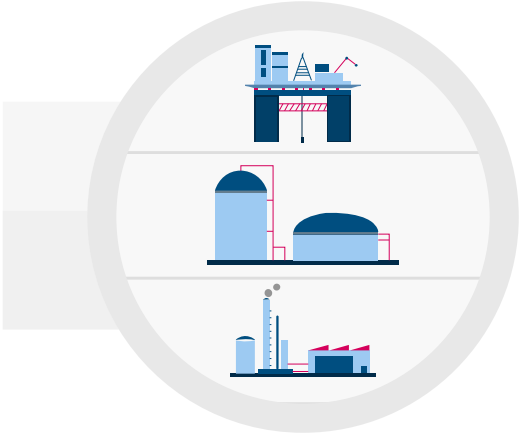
Decarbonisation of the Asian economies can potentially enhance countries' energy security, enable access to affordable clean energy, minimise environmental degradation and thus trigger sustainable development. The key drivers of decarbonisation include but are not limited to policy and government targets, technology and operational cost reduction, investor pressure and customer demand.[23] Oil and gas companies with environmental commitments will see much faster sales growth than those without sustainable initiatives.[24] Asian emerging economies are highly concerned about the cost of a sudden shift away from fossil fuels, especially in hydrocarbon extraction, downstream processing, fuel-driven power generation and manufacturing industries, such as petrochemicals, steel and cement. The following section provides a comprehensive analysis of the role of oil and gas industries in driving decarbonisation with a particular focus on Asia.

Transition Throughout the Entire Value Chain

The 2050 end game is not an energy system without fossil fuels. Rather, the objective for oil and gas companies is to play a central role in the decarbonisation of the energy system.[25] The oil and gas industries will play a key role in the transition throughout the entire value chain: a) upstream stage of the oil and gas industry development — hydrocarbon production is energy-intensive and accounts for 59 per cent of the GHG emissions of the oil and gas sector; b) midstream stage — transportation accounts for another 14 per cent of the GHG emissions; c) downstream stage — the remaining 28 per cent of GHG emissions come from oil and gas refining. [26] Oil and gas companies have a wide range of instruments to engage with decarbonisation efforts by enhancing the process of hydrocarbon production and transportation efficiency as well as the demand-side management. Thus, it comes as no surprise that the oil and gas industries will not merely try to survive the low-carbon energy transition but accelerate and lead the transition by building strategies for the low-carbon business models that would allow them to minimise their carbon intensity while remaining profitable.[27]

If, until recently, the competitiveness of the oil and gas companies was determined by its breakeven price, over the next couple of decades, environmental impact will also play an important role.[28] The majority of the oil and gas companies can potentially reduce their carbon emissions from 10 per cent to 20 per cent without having a negative impact on the companies' return on investment. Increasing the emission reduction by another 30 per cent to 40 per cent may still secure a positive internal rate of return. To reduce the remaining 30 per cent to 40 per cent of emissions — reaching net-zero emissions — will depend on the companies' ability to introduce new business models and diversify their portfolio.[29]

TRANSITION THROUGHOUT THE ENTIRE VALUE CHAIN



- The objective/2050 end game for oil and gas companies is to play a central role in the decarbonization of the energy system
- Transition throughout the entire value chain:

Upstream stage - Hydrocarbons production is energy-intensive and accounts for **59%** of the GHG emissions of the oil and gas sector

Midstream stage – Transportation accounts for another **14%** of the GHG emissions

Downstream stage – The remaining **28%** of GHG emissions come from oil and gas refining

Decarbonising Asia

Asia is the world's largest and fastest-growing consumer of energy as well as the largest emitter of CO_2.[30] Developing Asia, with 52 per cent of the world's total population (2019), contributes around 23 per cent of the world's economic output while consuming 36 per cent of the total primary energy, which accounts for 42 per cent of global CO_2 emissions.[31] Experts have already labelled the 21st century as the "Asian century", in which Asian countries will remain the largest energy-consuming region with an ever-growing demand for hydrocarbons.[32]

According to the International Energy Agency, oil demand in Asia is expected to increase up to 9 million barrels per day (mbd) by 2040, compared to 6.5 mbd currently. It is also projected that refineries' capacity throughout Asia will increase by 60 per cent between 2018 and 2050.[33] The largest increase, however, is projected in the gas sector. While gas demand is expected to decline sharply in Europe and North America, the pattern of demand will remain the same in Asia.[34] The demand for fossil fuels in Southeast Asia, for instance, has constantly been growing over the past couple of decades. Since 2000, the use of fossil fuels in the country has more than doubled (boosting the emissions) and currently accounts for around 80 per cent of primary energy demand in the region.[35] Fossil fuels will most likely continue to dominate the energy mix of the region with a slight increase by 2050 (82% from 78% in 2017). Oil will be the largest energy source in the primary energy mix, accounting for almost 40 per cent, with a projected share of natural gas of around 25 per cent.[36] At the same time, the region is frequently cited as being the most vulnerable to climate change impact and cannot undermine the importance of the energy transition.

Asia is not just a region that is behind the rest of the world in phasing out fossil fuels; it has become the biggest threat to reaching the "net-zero" goals. With current policies, it is improbable that Asian countries would achieve their NDCs. Yet, such dependence on fossil fuels, if managed appropriately, also creates opportunities.

The world's developed and developing regions will undergo the energy transition differently. For developed countries, the priority is lowering energy demand per capita and decarbonising energy demand, while for developing nations, affordable energy access remains a priority. The biggest challenge for Asian developing countries is to accelerate the energy transition while maintaining energy security and affordability. Asian oil and gas industries are expected to play a key role in maintaining such balance. Major national oil and gas companies in China, for instance, have secured 94 per cent of the country's oil and 96 per cent of gas outputs. While these companies are taking an active part in the decarbonisation of the economy, the country's energy security remains their key mandate.[37] The analysis in the sub-sections below focuses on the key factors at play that could influence the pace of energy transition in Asian markets over time. Having acknowledged the diversity in socio-economic development and political systems among the Asian nations themselves, the analysis in the chapter revolves around the recognition that they are all vulnerable to climate change impact, face similar existing and emerging energy security threats, and are under increasing pressure to transform their energy systems to sustain economic growth.

Immense Investments in the Energy Transition

The energy transition is labelled as the greatest challenge of our times, which requires unparalleled levels of investment. In 2020, the world countries allocated over 500 billion U.S. dollars to the energy transition, a 9 per cent increase compared to 2019.[38] This may not, however, be sufficient to reach "net-zero" carbon economies. It is estimated that over 1 trillion U.S. dollars must be allocated to financing the energy transition with an additional 600–800 billion U.S. dollars to be spent on oil and gas industries to secure a managed decline of traditional sources.[39] In total, the Asia Investor Group on Climate Change estimates that 26 trillion U.S. dollars (2 degrees Celsius scenario) to 37 trillion U.S. dollars (1.5°C scenario) must be invested until 2050 to achieve "net-zero" carbon economies.[40] Without oil and gas companies' financial resources securing energy, transition might be a difficult task to accomplish.

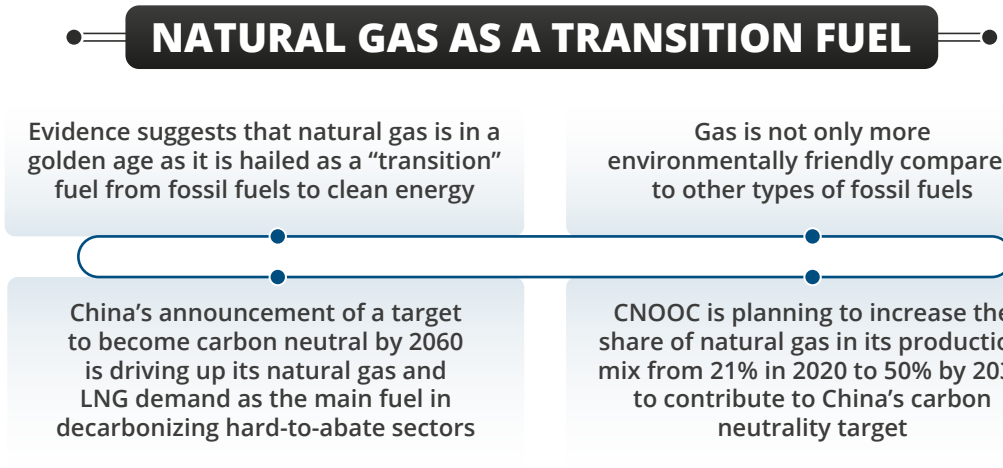
Natural Gas as a Transition Fuel

While there is a general discourse that fossil fuels are set for a dark age, evidence suggests that natural gas is in a golden age as it is hailed as a "transition" fuel from fossil fuels to clean energy, particularly in the Asian context. Gas is not only more environmentally friendly compared to other types of fossil fuels; it is also a global fuel available to external markets through international pipelines and liquified natural gas (LNG). Heavy industry is also turning into an attractive market for natural gas because the market for high-temperature heat has no compelling options that could displace gas. Thus, gas has become a central part of the decarbonisation narrative for oil and gas companies, particularly for Asian countries.

Table 2: Comparative Life Cycle Estimates of GHG Emissions per kW of Electricity Among Fossil Fuels

Natural Gas (Conventional)	Natural Gas (Fracking)	Natural Gas (LNG)	Fuel Cell	Diesel	Heavy oil	Coal
443	492	611	664	778	778	960–1050

Source: Sen et al. (2021) [41]



Natural Gas for Hard-To-Abate Sectors

China's announcement of a target to become carbon neutral by 2060 is driving up its natural gas and LNG demand as the main fuel in decarbonising hard-to-abate sectors — heavy industry, shipping and heavy-duty road transport.[42] Chief financial officer at CNOOC, Xie Weizhi, highlighting the importance of natural gas for China's climate policies, said that the company is planning to increase the share of natural gas in its production mix from 21 per cent in 2020 to 50 per cent by 2035 to contribute to China's carbon neutrality target.[43] The profile in India, Pakistan and Bangladesh is similar to that of China. Natural gas makes up 70 per cent of Bangladesh's energy mix. In India, with a projected share of natural gas of 18 per cent by 2050, Petronet (a government-owned oil and gas company) and GAIL (a government-owned natural gas processing and distribution corporation) are investing in existing and sanctioned LNG export-import and gas infrastructure.[44] Currently, more than 95 per cent of Singapore's energy is generated from natural gas.[45] Certain initiatives will be introduced to enhance the efficiency of gas production and consumption in Asia; however, gas will continue to play an important role in the system and beyond.

Natural Gas for Light-Duty Passenger Vehicles

The light-duty passenger vehicle sector currently accounts for roughly 10 per cent of global CO_2 emissions and 23 per cent of oil and gas demand.[46] Natural gas vehicles (NGVs) can become an integral part of oil and gas companies' sustainability initiatives. There are environmental benefits in terms of lower CO_2 emissions both directly from using NGVs and indirectly as a result of being able to transport vehicle fuel through its existing network of pipes as opposed to road tankers. It is also clearly of benefit to increase network sales and utilisation.[47] Air pollution in India, especially in cities, has already forced the government to change the public transport compressed natural gas in 2001 and taxis in 2015.[48]

Gas consumption in the transportation sector is unevenly distributed around the world, with seven countries accounting for 80 per cent of the gas in this sector. Asian countries clearly dominate the sector (China — 43%, India — 5%, Thailand — 4%, Pakistan — 4%).[49] Of Central Asian countries, Uzbekistan accounted for 40.8 per cent of total vehicle number in 2018.[50]

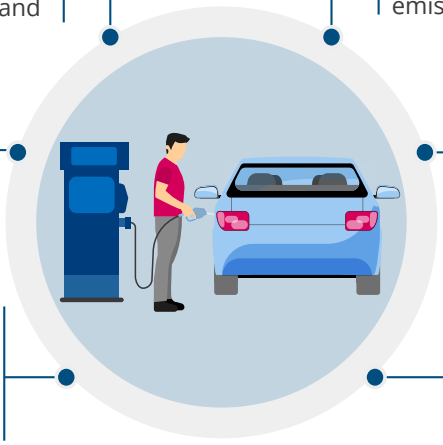
The future projections highlight that the demand for transportation will continue to grow, doubling the number of vehicles on the road to up to 3 billion from the current 1.3 billion.[51] Today oil dominates the fuel mix and meets the transport needs. Gasoline and diesel account for 96 per cent of total fuel consumption and 21 per cent of global carbon emissions.[52] Light-duty passenger vehicles, in turn, account for 23 per cent of the oil and gas demand.[53] Some Western developed nations have introduced policies to trigger the transition to electric vehicles powered primarily by clean energy sources. In emerging Asia, however, switching to gas, which is environmentally cleaner than oil, is perceived as one of the climate change mitigation options, at least in the transition period to sustainable economies and even beyond. The role of the oil and gas companies in securing this path should not be underestimated.

NATURAL GAS FOR LIGHT-DUTY PASSENGER VEHICLES

The light-duty passenger vehicle sector accounts for **10%** of global CO_2 emissions and **23%** of oil and gas demand

Gasoline and diesel account for **96%** of total fuel consumption and **21%** of global carbon emissions

In the Central Asian country—Uzbekistan accounted for **40.8%** of the total vehicle population in 2018



The light-duty passenger vehicles account for **23%** of the oil and gas demand

The demand for transportation will continue to grow, doubling the number of vehicles on the road up to 3 bln. from the current 1.3 bln

Gas consumption in the transportation sector is unevenly distributed around the world, with seven countries accounting for **80%** of the gas in this sector with Asian countries dominating:

China **43%**

India **5%**

Thailand **4%**

Pakistan **4%**

Natural Gas Addressing the Problem of Intermittency of Renewables

Asian nations, in line with their NDC goals, are planning to transform their energy systems by integrating renewable energy into their energy mix. Large-scale integration of intermittent renewable energy within a short timeframe into the existing fossil fuel-dominated energy systems can also be an obstacle. To put it differently, too much and too fast innovation might be too much for conventional and highly inflexible power systems. With the growing share of renewables in the energy system, the intermittent nature of sources is starting to compromise the reliability of the system's functioning and frequency control of the grid.[54]

Adding large-scale intermittent renewable energy sources to the existing grid system changes almost every aspect of the system's operation and management.[55] In Central Asia, for instance, Kazakhstan's power system was initially designed with limited electricity generation flexibility and excessive reliance on coal-based power generation. A feature of the power system of Kazakhstan is the high proportion of non-flexible coal-fired power plants. More than 70 per cent of the country's electricity is generated at coal-fired power plants. The flexibility of power transmission in countries with excessive dependence on coal and ambitions to integrate renewables on a large scale can be provided through gas-fired thermal power plants.[56] Oil and gas companies are without doubt in a good position to positively affect the transition by expanding their engagement in the power systems.

Natural Gas Triggering International Cooperation

Increasing demand for gas consumption in Asia will trigger international cooperation. Asia's two largest natural gas consumers, for instance, do not have sufficient local low-cost natural gas resources to switch away from coal. China has increased its natural gas imports by 30 per cent since 2010, mainly from Qatar, Australia, the US, Russia and Central Asia.[57] China imported 73 per cent of its oil and 43 per cent of its natural gas in 2020. By the mid-2020s, the Chinese projected dependence on imported oil is expected to range from 70 to 75 per cent, while its natural gas import dependence might fluctuate in the diapason of 34 to 66 per cent.[58] Even those countries, which are currently exporters of LNG — Malaysia (7% of global exports), Indonesia (4%) and Brunei Darussalam (2%) — being unable to meet rising domestic demand may turn into net importers.[59] An attempt to meet Asia's growing demand for gas will reshape the geopolitical context of the gas supply relations by boosting the dynamics both within the region and in relation to external actors. It will accelerate the construction of land-based gas supply infrastructure, such as the Turkmenistan-Afghanistan-Pakistan-India pipeline or the Iran-Pakistan-India pipeline. These changing dynamics will also turn Singapore or Sri Lanka into LNG trading hubs.[60] The success of the initiatives, for a large part, will depend on oil and gas companies.

NATURAL GAS ADDRESSING THE PROBLEM OF INTERMITTENCY OF THE RENEWABLES

Asian nations are planning to transform their energy systems by integrating renewable energy into their energy mix

More than **70%** of Kazakhstan's electricity is generated at coal-fired power plants

Too much and too fast innovation might be too much for conventional and highly inflexible power systems

The flexibility of power transmission can be provided through gas-fired thermal power plants

NATURAL GAS TRIGGERING INTERNATIONAL COOPERATION

Asia's two largest natural gas consumers do not have sufficient local low-cost natural gas resources to switch away from coal

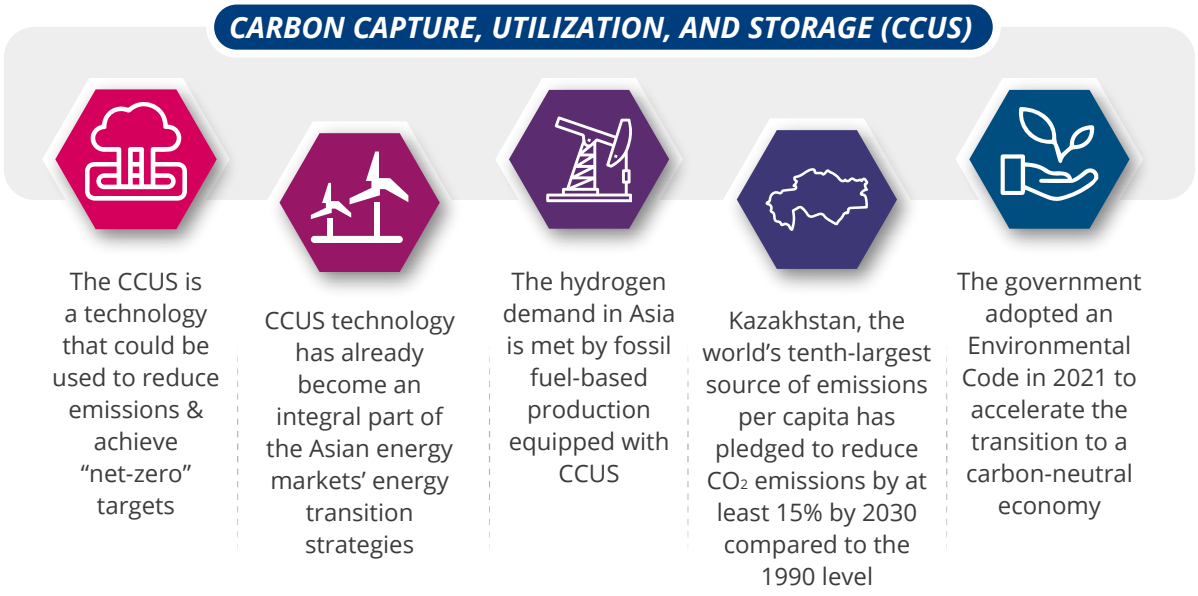
China's natural gas import dependence might fluctuate in the diapason of **34** to **66%**

Increasing demand for gas consumption in Asia will trigger international cooperation

China has increased its natural gas import by **30%** since 2010, mainly from Qatar, Australia, the US, Russia, and Central Asia

China imported **73%** of its oil and **43%** of its natural gas in 2020

By the mid-2020s, the Chinese projected dependence on imported oil is expected to range between **70** to **75%**



Introducing Innovative Technologies

Natural gas is the cleanest form of fossil fuel, but it is still a fossil fuel nonetheless. Further cleaning and greening of natural gas must be integrated into strategies aimed at building lower-carbon societies. Deployment of carbon capture and storage facilities as well as promoting "blue hydrogen" seem to be viable options.

Carbon Capture, Utilisation and Storage (CCUS)

Since oil and gas will remain a significant part of the future energy mix, the industry is seriously considering the deployment of CCUS as a climate mitigation action tool that allows companies to continue to monetise their reserves more sustainably. The CCUS is a technology that could be used to reduce emissions and achieve "net-zero" targets.[61] While most of the investments in CCUS have been concentrated in developed economies, in the future, government policies could encourage or even force the expansion of this technology in developing Asian nations. In fact, despite its cost, CCUS technology has already become an integral part of the Asian energy markets' energy transition strategies. The hydrogen demand in Asia is met by fossil fuel-based production equipped with CCUS.[62]

Kazakhstan, the world's tenth-largest source of emissions per capita, has pledged to reduce CO_2 emissions by at least 15 per cent by 2030 compared to the 1990 level.[63] The problem, however, is that Kazakhstan's carbon-heavy energy industry is outdated and highly inefficient. The government adopted an Environmental Code in 2021 to accelerate the transition to a carbon-neutral economy. The main principle of the new Environmental Code is "the polluter pays and fixes". Authorities decided to introduce a twofold increase in penalties for environmental damage hoping that such measures would expedite the transition to carbon neutrality.[64] These policy changes imply that CCUS must become a critical component of the country's energy transition initiative.

Building a Hydrogen-Based Society

The transition to a lower-carbon energy system will also require expansion of the share of clean gases/fuels — hydrogen. Hydrogen is not an energy source. It is an energy carrier, which is for now mainly produced from natural gas — "grey hydrogen" and coal — "black hydrogen". Only a small part of it is equipped with carbon capture technologies to make it "blue hydrogen".

The emerging global hydrogen market requires the creation of new value chains. Today's hydrogen value chains are dominated by fossil fuels. In a decarbonised world, however, there is only a place for "blue" and "green" hydrogen. Blue hydrogen, in turn, supports natural gas extraction, transport and processing and the CCUS industry. Not surprisingly, the oil and gas industries have shown interest in hydrogen, which also needs to be produced, transported and distributed. Being quite familiar with the process, those companies are on the way to re-purposing part of the existing gas infrastructure for hydrogen production and transportation.[65]

Global demand for hydrogen is expected to increase from the current level of 75 MtH2/year to more than 500 MtH2/year in 2050.[66] With the projected energy demand growth, Asia will certainly play its part in expanding the use of hydrogen. Japan has been implementing a comprehensive plan to "become the first country in the world to realize a hydrogen-based society".[67] Japan's commitment to hydrogen can be seen in its prominent role at the Tokyo 2020 Olympics, with 500 hydrogen fuel cell vehicles being used during the Olympics. Japan is aiming to build 1,000 hydrogen refuelling stations for fuel-cell vehicles across the country by 2030.[68] South Korean President Moon Jae-in has also outlined a vision for developing a hydrogen-based economy in the country.[69] Such national oil companies as Petronas (Malaysia), Pertamina (Indonesia) and PTT (Thailand) have also made commitments to explore the commercial production of hydrogen in Southeast Asia.[70] Sinopec Group seeks to leverage its network of more than 30,000 retail stations to become a leading supplier of hydrogen fuel across China.[71]

Downstream Stage of Oil and Gas Industry Development

The downstream stage of the oil and gas industry accounts for 28 per cent of GHG emissions.[72] Asian nations are home to the world's largest refineries, which take crude oil and transform it into refined products, such as gasoline and diesel or jet fuel. A decline is expected in demand for refined products since they are to be taxed, consumers are switching to electric vehicles and biofuel is displacing refined products.[73] This process, however, will take decades to complete, with liquid fuels remaining as the main energy source for Asia's transport sector. The refining industry in India and China grew by 68 per cent and 53 per cent, respectively, between 2010 and 2017. Successful decarbonisation of the oil and gas refining segment will require reconfiguration of the major refineries with global assets valued at nearly 1 trillion U.S. dollars,[74] which would be difficult to carry on without active engagement of the oil and gas companies. Major refiners across Asia, including Petronas, SK Innovation, S-Oil, ENEOS, PTT and CPC Taiwan, are already expected to drive the transition.[75]

Integrated Energy Systems: Promoting Renewables

Both international and national oil companies have the potential to extend their business and operating models into the wider energy system. As part of the new business model, oil and gas industries are reducing the footprint of their operations by cutting the share of hydrocarbons in favour of renewables. Some companies are diversifying their current roles, monetising their assets and using their expertise to explore the rapidly expanding clean energy sector. China National Offshore Oil Corporation (CNOOC), which closed its renewable energy development unit in 2014, revived its activities in offshore wind power after five years.[76] The company launched its first project last year with the installment of a 300 megawatts wind farm in eastern China.[77] Indonesia is planning to convert its diesel plants (5,200 in total) to renewable energy facilities to potentially reduce its carbon emissions by up to 0.7 million tonnes.[78] Reliance Industries, the operator of the world's biggest refining complex at Jamnagar in western India, announced the investment of 10.1 billion U.S. dollars in clean energy over the next three years in the pursuit of becoming a "net-zero" carbon company by 2035.[79]

Exploring Oil and Gas Industries' Decarbonisation Pathways for Asia

As discussed in the previous section, oil and gas industries are already performing the role of the drivers of decarbonisation and transition to a sustainable economy. However, emerging energy and climate risks are posing a serious threat to Asian countries' energy security and economic sustainability. The priority is to accelerate the transformation of the economy at scales envisioned by countries' NDCs in all sectors (energy, transportation, industry and residential areas).[80] To continue their operations, oil and gas companies will come under even greater pressure to prove that no other technology can deliver the same energy service at an equivalent economic cost and to demonstrate alignment with targets to attain carbon neutrality by 2050.[81] This section provides a set of recommendations to trigger deep decarbonisation of the energy sector and mitigate the risks for the oil and gas industries in Asia.

Engaging All Stakeholders

Attempts to decarbonise the hydrocarbon sector will require policymakers, oil and gas industry operators, the scientific community and even regular consumers to take an active part in not just financing the decarbonisation initiatives but also sustaining the best practices.[82]

To incentivise investments in new technologies such as CCUS or hydrogen, government policies should be adopted that encourage distribution of the costs across the entire supply chain. This could ease the financial burden of the transition for the oil and gas industries and encourage them to be part of the solutions to the emerging climate risks through utilising their own expertise.

Technology leaders with deep R&D will emerge at the forefront of the sustainable energy system. It is recommended that cross-sector R&D teams work together to identify potential uses for hydrogen in aviation or heavy industry. Oil and gas companies can also merge their efforts with utility companies to enhance mobility as a service solution.[83]

Promote a Circular Economy

A circular economy is about the shift from linear to circular supply chains within the oil and gas industry to facilitate the decoupling of economic growth from the excessive dependence on fossil fuels. Circularity implies the reduction, reuse and recycling of equipment and waste, which will become a prominent feature of the future business models pursued by the oil and gas industries. Particularly for the emerging and developing Asian countries that forecast continuous growth in the consumption of hydrocarbon products and services, thereby generating emissions throughout the supply chain, the linear decarbonisation model will prove ineffective. In the absence of a rapid decline in the use of hydrocarbons, a circular economy offers undeniable prospects.[84] The circular economy has four main pillars[85]:

Reduce	This includes steps towards energy efficiency, zero routine flaring, methane leakage minimisation, renewable electricity integration and switching to low-carbon fuels.
Reuse	This includes CO_2-enhanced oil recovery and supercritical CO_2 applications.
Recycle	This includes the use of carbon in synthetic fuels, fertilisers/urea, methanol, polymers, and other chemicals and concrete.
Remove	This includes efforts to enhance natural sinks through reforestation, produce bioenergy with carbon capture utilisation and storage, direct air capture and storage as well as other forms of carbon capture, utilisation and storage.

The circular economy approach will allow Asian nations to lower the emissions that would have been generated when the oil and gas products end their life and the energy intensity required to create new products.

Re-Purposing The Infrastructure

With gas turning into the "transitional fuel", the oil and gas companies may need to partially or completely re-purpose the existing infrastructure for a decarbonised world. The integration of the power and gas grids could be one potential solution to ensuring the efficient provision of secure and economic energy to a wide range of consumers. Using existing oil and gas transportation and refining facilities for the development of hydrogen or renewable energy sources can accelerate the sustainable transition in Asia.

The Shift to Small Businesses

In the oil era, the target end consumers for oil and gas companies have been the states and large industries. For those companies to adjust to the realities of sustainable transition within the integrated energy systems, the target must shift from primarily large businesses and also include small businesses, business-to-companies' operators and even directly to individual consumers such as households.[86]

Hydrocarbon Demand Management

Different from the supply-centric approach to the existing energy system, the future energy system will be a consumer-centric one. For the sustainable transition to be successful, changes have to be introduced not just on the supply side but also on the demand side of the value chain, particularly in the region that is home to half of the world's population. A large part of the demand for oil and gas comes down to individual consumer choices and consumption patterns. Oil and gas companies can secure the demand for hydrocarbons over a longer period of time with higher returns by aligning incentives with downstream customers. To perform deep decarbonisation of the industry, oil and gas companies need the help of their customers, particularly those that are heavily dependent on hydrocarbons and associated sectors.[87] Oil and gas companies can help their customers adapt to the energy transition by boosting demand for low-carbon impact products. Total, for instance, has made a decision to stop selling fuel oil for power generation in France after 2025 and by this is encouraging French customers to switch to clean electricity and natural gas.[88] Similar practices must be seriously considered by the companies operating in the Asian market.

Emissions from the use of oil and gas products are the largest contributor to the energy sector's carbon footprint. Lowering the carbon intensity of the sector may require extensive and direct collaboration between the industry and its customers. According to "The Southeast Asia Climate Outlook: 2021 Survey Report", the vast majority of respondents across all countries in the region recognise the importance of climate change. Vietnamese and Filipino respondents displayed the greatest urgency, with 80 per cent and 77.9 per cent respectively finding it a "serious and immediate threat" to their countries. Unfortunately, evidence presented in this chapter highlights that the region is still excessively dependent on fossil fuels and the overall level of confidence among the respondents in the region's transition to renewable energy is quite low.[89] Despite citizens' support for climate change actions, when customers are asked about concrete changes that might alter their living standards, the questions of economics, convenience, and cost tend to come to the fore.[90] Thus, helping consumers contribute to emissions reduction must become one of the key functions of integrated energy service companies that most of the oil and gas industries might soon transform into.

Greening the Hydrogen

Currently, 99 per cent of all hydrogen used still comes from fossil fuels[91] without any CCS implemented, leaving an extensive carbon footprint[92] — limited contribution to the sustainable economic transition. Particularly in the Asian context, where the demand for energy is expected to rise rapidly, incentives must be introduced, aiming not only for hydrogen to be used over fossil fuels but promoting "blue hydrogen" and "green hydrogen" as viable solutions.[93]

While experts primarily focus on the technical and cost hurdles to be overcome to achieve a full-scale hydrogen economy, a large-scale integration of hydrogen into the Asian economies will have an

important effect on the geopolitical landscape of energy supply relations. International maritime hydrogen trade will most likely redraw the geography of the future energy trade thereby reshaping the geopolitical relations between suppliers and consumers. Hydrogen trade — particularly "green hydrogen", differently from traditional oil and gas, creates less asymmetrical relations between suppliers and consumers. In fact, hydrogen creates a new prosumer category (both producers and consumers of hydrogen) since it is technically possible to produce it anywhere in the world. Such a shift will make it difficult to weaponise hydrogen to influence the decisions of the world's largest energy importers — Asian emerging and developed nations. Currently, hydrogen is a very localised industry, with 85 per cent produced and consumed on-site.[94] This trend will most likely continue in a decarbonised world with the expansion of the share of "green" and "blue" hydrogen in the energy mix. Energy security and geopolitical benefits of "clean" hydrogen will incentivise Asian authorities to once again refer to the oil and gas industries' expertise and resources.

Cross-Sectoral Growth

Best practices developed by the oil and gas companies during the process of decarbonisation should be reapplied to drive new growth opportunities across other industries. For instance, the CCUS technology pioneered in the upstream stage of oil and gas sector development (extraction and production) can be successfully leveraged in the downstream stage (heavy industry).[95] Oil and gas companies can speed up the diversification of their business portfolios by focusing on what until recently has been considered non-core business activities for the industry — from establishing power utility companies to investing in electric vehicles. For instance, oil and gas industries with extensive knowledge and experience in offshore operation can share that knowledge with the offshore wind industry.[96] Taking advantage of oil and gas expertise through cross-sectoral collaboration offers prospects for Asian economies.

Leveraging Digitalisation

Tracking emissions is both difficult and critical, particularly around methane, but it is essential for the industry's decarbonisation initiatives.[97] Digitalisation will allow companies to track their operations at every stage in a timely manner. Digitalisation is already contributing to the reduction of the carbon footprint of internal operations and lowering the operation cost through robotic process automation, data-driven decisions supported by artificial intelligence and blockchain technology.[98] Yet, Asian nations, particularly developing countries, lack digitalisation of the energy sector. To ensure the sector's connectivity within the integrated energy systems, efficiency and sustainability, oil and gas companies must accelerate the digitalisation of their operations.

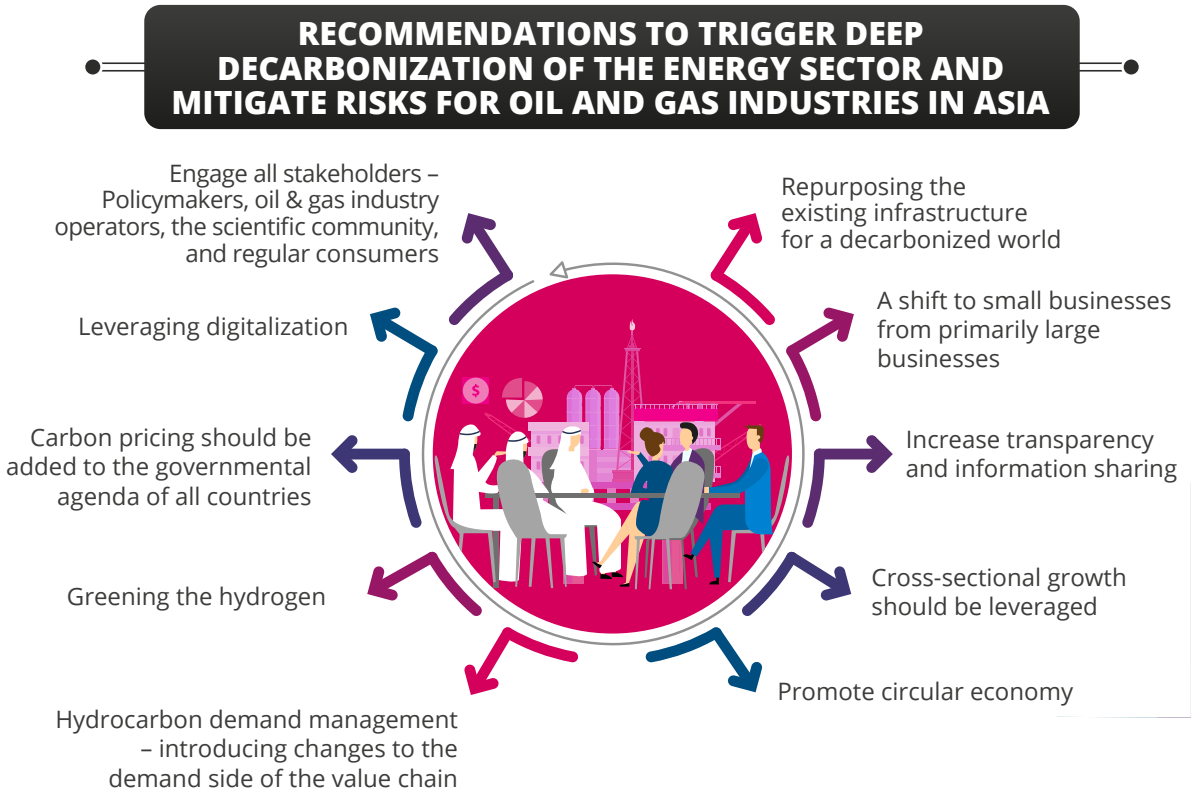
Increasing Transparency and Information Sharing

Oil and gas field equipment and services companies need to increase the transparency of their emissions-reduction efforts and demonstrate a clear pathway to reducing the emissions intensity of their activities. These companies have already accumulated an enormous amount of data on oil and gas deposits, extraction, transportation and refining processes. Sharing information among oil and gas companies and with governmental agencies may accelerate the energy transition, particularly in developing Asian countries.[99]

Carbon Pricing

Considering the fact that climate change impact discourse and the transition to sustainable energy are now shaping purchasing decisions as well as investments in the energy sector, the question of carbon pricing will be added to the governmental agenda of all countries, most likely sooner than later. Carbon pricing is supposed to play a central role in driving the shift towards a low-carbon economy by changing the behaviour of energy producers, consumers, investors and even regular customers.[100] Among Asian nations, however, this mechanism is not popular. In those few countries where carbon prices have been introduced, they

are too low to spur investments in low-carbon technologies needed for the energy transition. In Singapore, for instance, carbon taxes are charged at five U.S. dollars per tonne of emissions and are only applied to high emissions companies with GHG emissions of over 2000 tCO_2e annually. The analysis of the existing carbon pricing in different parts of the world suggests that a price range from 50–80 U.S. dollars per tonne of emissions can trigger a transition to sustainable energy.[101] The wider applicability of carbon pricing may soon become a reality that Asian nations are no longer able to ignore.



Conclusion

Paradoxically, Asia, being highly vulnerable to environmental risks, is also behind the growth in global fossil fuel demand — the leading cause of global climate change. So, the pace of worldwide decarbonisation in the future will be determined, to a large extent, by the success of the low-carbon initiatives implemented in Asia. Evidence presented in the chapter highlights that the oil and gas industries are in a position to trigger change in areas under the oil and gas companies' direct control and accelerate the decrease of external emissions caused by downstream users. Thus, the importance of the oil and gas industries, as drivers of decarbonisation — playing a pivotal role in reshaping the environmental policies, leading the innovation in pursuit of new opportunities across the energy system (process efficiency and demand management, an expanded portfolio of decarbonised and electricity-based solutions) and enabling other sectors to manage an effective transition to the sustainable economy — should not be underestimated.

Dr. Farkhod Aminjonov is Assistant Professor of College of Humanities and Social Sciences at Zayed University.

1 Van de Graaf, Thijs / Overland, Indra / Scholten, Daniel / Westphal, Kirsten 2020: The new oil? The geopolitics and international governance of hydrogen, Energy Research & Social Science 70.
2 Peszko, Grzegorz / Van der Mensbrugghe, Dominique / Golub, Alexander 2020: Diversification and Cooperation in a Decarbonizing World, The World Bank Group, Policy Research Working Paper 9315, Jul 2020, in: https://openknowledge.worldbank.org/bitstream/handle/10986/34056/Diversification-and-Cooperation-Strategies-in-a-Decarbonizing-World.pdf?sequence=4&isAllowed=y [28 Oct 2021].
3 Van de Graaf, Thijs / Verbruggen, Aviel 2015: The Oil Endgame: Strategies of Oil Exporters in a Carbon-Constrained World, Environmental Science and Policy 54 (2015), pp. 456-462.
4 IPCC 2018: Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments, IPCC Report, 8 Oct 2018, in: https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/ [28 Oct 2021].
5 Phoumin, Han / Kimura, Fukunari / Arima 2021: ASEAN's Energy Transition towards Cleaner Energy System: Energy Modelling Scenarios and Policy Implications, Sustainability 13(5), 06/2021, p. 4.
6 Asian Development Bank 2021: Energy Policy Supporting Low Carbon Transition in Asia and the Pacific, May 2021, p. 3, in: https://www.adb.org/sites/default/files/institutional-document/699206/energy-policy-draft-consultation.pdf [28 Oct 2021].
7 Net Zero Pathways 2021: Energy Transition: The Evolving Role of Oil and Gas Companies in a Net-Zero Future, Net Zero Pathways, Jun 2021, 3, in: https://www.euractiv.com/wp-content/uploads/sites/2/2021/06/Energy-Transition_The-evolving-role-of-oil-and-gas-companies-in-a-net-zero-future.pdf [28 Oct 2021].
8 Johnston, Robert / Blakemore, Reed / Bell, Randolph 2020: The Role of Oil and Gas Companies in the Energy Transition, Atlantic Council, 9 Jan 2020, in: https://www.atlanticcouncil.org/in-depth-research-reports/report/the-role-of-oil-and-gas-companies-in-the-energy-transition/ [28 Oct 2021].
9 Asmelash, Elisa / Gorini, Ricardo 2021: International Oil Companies and the Energy Transition, International Renewable Energy Agency, 2021, in: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Feb/IRENA_Oil_Companies_Energy_Transition_2021.pdf [28 Oct 2021].
10 Hanafusa, Ryosuke / Kibe, Hidemitsu 2021: Global Energy Shortage Looms as Investment in Fossil Fuels Slides, Nikkei Asia, 21 Sept 2021, in: https://asia.nikkei.com/Spotlight/Datawatch/Global-energy-shortage-looms-as-investment-in-fossil-fuels-slides [28 Oct 2021].
11 Copenhagen Economics 2017: The Future of Fossil Fuels: How to Steer Fossil Fuel Use in a Transition to a Low-Carbon Energy System, Jan 2017, p. 6, in: https://www.copenhageneconomics.com/dyn/resources/Publication/publicationPDF/6/386/1485851778/copenhagen-economics-2017-the-future-of-fossil-fuels.pdf [28 Oct 2021].
12 Henderson, James / Sen, Anupama 2021: The Energy Transition: Key challenges for incumbent and new players in the global energy system, OIES Paper, Sept 2021, p. 16, in: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/09/Energy-Transition-Key-challenges-for-incumbent-players-in-the-global-energy-system-ET01.pdf [28 Oct 2021].
13 REN21 2020: Renewables in Asia: A Tough Race against Fossil Fuels, 27 Jul 2020, https://www.ren21.net/renewables-in-asia/ [28 Oct 2021].
14 Winter, Patrick / Bell, Matthew 2020: Why Decarbonization Should Top Asia-Pacific Board Agendas, Ernst & Young, 20 Nov 2020, https://www.ey.com/en_gl/board-matters/why-decarbonization-should-top-asia-pacific-board-agendas [28 Oct 2021].
15 Overland, Indra / Sagbakken, Haakon Fossum / Chan, Hoy-Yen / Merdekawati, Monika / Suryadi, Beni / Utama, Nuki Agya / Vakulchuk, Roman 2021: The ASEAN Climate and Energy Paradox, Energy and Climate Change 2, p. 1.
16 Henderson 2021, n. 12.
17 Cohen, Ariel 2021: Why The Green Transition Can't Happen Without Natural Gas, Forbes, 8 Jul 2021, in: https://www.forbes.com/sites/arielcohen/2021/07/08/how-natural-gas-can-help-fuel-the-green-revolution/amp/?fbclid=IwAR0hvELnUuKMKge9L2fJbCDZJtafmeU477WBhIko0Hlk8DzVQOSNJjIDycA [28 Oct 2021].
18 United Nations n.d.: United Nations Treaty Collection: Paris Agreement, in: https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en#EndDec [28 Oct 2021].
19 For detailed references on NDCs in Asia see the United Nations Framework Convention on Climate Change website - https://unfccc.int/; Phoumin, Han/Kimura, Fukunari/Arima, Jun 2021: ASEAN's Energy Transition towards Cleaner Energy System: Energy Modelling Scenarios and Policy Implications, Sustainability 13(5) pp. 6-7; International Energy Agency 2021: Global Energy Outlook – 2021, in: https://iea.blob.core.windows.net/assets/88dec0c7-3a11-4d3b-99dc-8323ebfb388b/WorldEnergyOutlook2021.pdf [28 Oct 2021].
20 Ibid.
21 Ibid.
22 Ibid.
23 Deloitte 2020: The 2030 Decarbonization Challenge: The Path to the Future of Energy, in: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-eri-oil-and-gas-decarbonization.pdf [28 Oct 2021].
24 Grushevenko, Ekaterina et al. 2021: Decarbonization of Oil and Gas: International Experience and Russian Priorities, Skolkovo Moscow School of Management, Mar 2021, p.15, in: https://energy.skolkovo.ru/downloads/documents/SEneC/Research/SKOLKOVO_EneC_Decarbonization_of_oil_and_gas_EN_22032021.pdf [28 Oct 2021].
25 Accenture 2020: Decarbonizing Energy: From A to Zero, in: https://www.accenture.com/_acnmedia/PDF-135/Accenture-Decarbonizing-Energy-Exec-Sum-LDM.pdf [28 Oct 2021].
26 Grushevenko et al., 2021, n. 24, pp. 22-23.

27 Johnston, Robert / Blakemore, Reed / Bell, Randolph 2020: The Role of Oil and Gas Companies in the Energy Transition, Atlantic Council, 9 Jan 2020.
28 Accenture, 2020 n. 25, p.67.
29 Baker, Thomas / Kharisov, Ilshat / Seturathinam, Ramya 2020: A Decarbonization Roadmap for Upstream Oil and Gas, Boston Consulting Group, 12 Jun 2020, in: https://www.bcg.com/industries/energy/oil-gas/decarbonization-roadmap-for-upstream-oil-gas [28 Oct 2021].
30 Tachev, Victor 2021: The Oil and Gas Industry in Asia – Current State and What Lies Ahead, Energy Tracker Asia, 21 Jul 2021, in: https://energytracker.asia/the-oil-and-gas-industry-in-asia-current-state-and-what-lies-ahead/ [28 Oct 2021].
31 Zhou, Wenji et al. 2020: Decarbonization Pathways and Energy Investment Needs for Developing Asia in Line with 'Well Below' 2°C, Climate Policy 20(2), 2020, p. 235.
32 ENI n.d.: Asia Pacific, in: https://www.eni.com/en-IT/eni-worldwide/asia-pacific.html [28 Oct 2021].
33 Tachev, 2021, n. 30.
34 Fulwood, Mike 2021: Energy Transition: Modelling the Impact on Natural Gas, OIES Paper: NG 169, Jul 2021, p.6, in: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/07/Energy-Transition-Modelling-the-Impact-on-Natural-Gas-NG-169.pdf [28 Oct 2021].
35 International Energy Agency (IEA) 2021: Carbon Capture, Utilisation and Storage: The Opportunity in Southeast Asia, Jun 2021, p. 12, in: https://iea.blob.core.windows.net/assets/2c510792-7de5-458c-bc5c-95c7e2560738/CarbonCaptureUtilisationandStorage_TheOpportunityinSoutheastAsia.pdf [28 Oct 2021].
36 Phoumin, Han / Kimura, Fukunari / Arima 2021: ASEAN's Energy Transition towards Cleaner Energy System: Energy Modelling Scenarios and Policy Implications, Sustainability, Jun 2021, 13(5), p. 2. [28 Oct 2021].
37 Meliksetian, Vanand 2021: China's Big Oil To Exploit Core Strengths In Decarbonization, OilPrice, 23 Aug 2021, in: https://oilprice.com/Energy/Energy-General/Chinas-Big-Oil-To-Exploit-Core-Strengths-In-Decarbonization.html [28 Oct 2021].
38 Feder, Judy 2021: Who Is Winning in the Energy Transition? Journal of Petroleum Technology, 1 Jun 2021, in: https://jpt.spe.org/who-is-winning-in-energy-transition [28 Oct 2021].
39 Henderson, 2021, n. 12, p. 12.
40 Asia Investor Group on Climate Change 2021: Asia's Net Zero Energy Investment Potential, March 2021, in: https://www.aigcc.net/wp-content/uploads/2021/03/March-2021_-Asias-Net-Zero-Energy-Investment-Potential-English.pdf [28 Oct 2021].
41 Sen, Anupama / Meini, Luca 2021: Beyond Energy: Incentivizing Decarbonization through the Circular Economy, OIES Paper, Apr 2021, in: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/04/Beyond-Energy-Incentivizing-Decarbonization-through-the-Circular-Economy-EL-44.pdf [28 Oct 2021].
42 Pathak, Kalpana 2021: Asia to Drive 75% of LNG Demand Growth by 2040: Shell LNG Outlook, MINT, 25 Feb 2021, in: https://www.livemint.com/companies/news/asia-to-drive-75-of-lng-demand-growth-by-2040-shell-lng-outlook-11614264747233.html [28 Oct 2021].
43 Chen, Aizhu 2020: China CNOOC Says to Raise Gas' Share to Half of Output by 2035, Reuters, 22 Oct 2020, in: https://www.reuters.com/article/us-china-cnooc-results/china-cnooc-says-to-raise-gas-share-to-half-of-output-by-2035-idUSKBN27719W [28 Oct 2021].
44 Gunasekara, Shiyana 2021: Perspectives on Low-Carbon Transitions in South Asia, The National Bureau of Asian Research, 14 Sept 2021, in: https://www.nbr.org/publication/perspectives-on-low-carbon-transitions-in-south-asia/ [28 Oct 2021].
45 Singapore Government Agency Website 2021: Singapore Exploring Hydrogen, Carbon Capture Technologies in Decarbonization, 28 Jun 2021, in: https://www.edb.gov.sg/en/business-insights/insights/singapore-exploring-hydrogen-carbon-capture-technologies-in-decarbonisation.html?cid=soc-li-news_ccus-bau-corp-202106-sg-pt:ec:na:na:at:na:sy&utm_medium=soc&utm_source=linkedin&utm_campaign=bau_edb_corporate_news_ccus_singapore_202106&utm_content=photo-energy&chemicals-notapplicable-notapplicable-article-notapplicable-syndicated [28 Oct 2021].
46 Accenture, 2020, n.25, p.86.
47 Le Fevre, Chris 2019: A Review of Prospects for Natural Gas as a Fuel in Road Transport, OIES, 21 Apr 2019, p. 21, in: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/04/A-review-of-prospects-for-natural-gas-as-a-fuel-in-road-transport-Insight-50.pdf [28 Oct 2021].
48 Le Fevre, 2019, n.47, p. 20.
49 Tsafos, Nikos 2020: How Will Natural Gas Fare in the Energy Transition?, Center for Strategic and International Studies, 14 Jan 2020, https://www.csis.org/analysis/how-will-natural-gas-fare-energy-transition [28 Oct 2021].
50 Le Fevre, 2019, n.47, p. 3.
51 Accenture, 2020, n.25, p.86.
52 Hydrogen Council 2017: How hydrogen empowers the energy transition, Jan 2017, p. 9, in: https://hydrogencouncil.com/wp-content/uploads/2017/06/Hydrogen-Council-Vision-Document.pdf [28 Oct 2021].
53 Accenture, 2020, n.25, p.86.
54 Destro, Nicola / Korpås, Magnus / Sauterleute, Julian F. 2016: Smoothing of Offshore Wind Power Variations with Norwegian Pumped Hydro: Case Study, Energy Procedia 87(62).
55 Umbach, Frank 2018: Energy Security in a Digitalised World and Its Geostrategic Implications, Umbach, 1 Sept 2018, p. 40, in: https://www.kas.de/en/web/recap/single-title/-/content/energy-security-in-a-digitalised-world-and-its-geostrategic-implications [28 Oct 2021].
56 Abisheva, Saule 2020: UNDP and DAMU Stimulate Investment in Small-Scale RES Facilities, QazaqSolar Report Issue 2: New Prospects and Opportunities for the RES Development in Kazakhstan, 2020, p. 25, in: https://spaq.kz/images/Qazaq-Solar4.pdf [28 Oct 2021].
57 Johnston, Robert / Blakemore, Reed / Bell, Randolph 2020: The Role of Oil and Gas Companies in the Energy Transition, Atlantic Council, 9 Jan 2020.

58 Downs, Erica 2021: Green Giants? China's National Oil Companies Prepare for the Energy Transition, Energy Policy, 29 Sept 2021, in: https://www.energypolicy.columbia.edu/research/report/green-giants-china-s-national-oil-companies-prepare-energy-transition [28 Oct 2021].
59 IEA, 2021, n. 35, p. 12.
60 Gupta, Sanjeev / Tekchandani, Praveen 2021: Commentary: Oil and Gas is Not the Sunset Industry You Think It Is, Channel News Asia, 6 May 2021, in: https://www.channelnewsasia.com/commentary/oil-gas-zero-carbon-emission-climate-change-renewable-energy-1346966 [28 Oct 2021].
61 Heidug, Wolf / Zakkour, Paul 2021:Transitioning to Net-Zero: CCUS and the Role of Oil and Gas Producing Countries, OIES, June 2021, p. 2, in: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/06/Insight-90-Transitioning-to-Net-Zero-CCUS-and-the-Role-of-Oil-and-Gas-Producing-Countries-.pdf [28 Oct 2021].
62 IEA, 2021, n. 35, p. 24.
63 Eurasianet 2021: Kazakhstan Unlikely to Meet Paris Commitments, 22 Jun 2021, in: https://eurasianet.org/kazakhstan-unlikely-to-meet-paris-commitments [28 Oct 2021].
64 Satubaldina, Assel 2020: Kazakhstan to Double Penalties for Environmental Damage, The Astana Times, 11 Sept 2020, in: https://astanatimes.com/2020/09/kazakhstan-to-double-penalties-for-environmental-damage/ [28 Oct 2021].
65 Van de Graaf et al., 2020, n.1.
66 IEA, 2021, n. 35, p. 24.
67 Kosturjak, Anthony / Dey, Tania / Young, Michael D. / Whetton, Steve 2019: Advancing Hydrogen: Learning from 19 plans to advance hydrogen from across the globe, Future Fuels CRC, July 2019, in: https://www.energynetworks.com.au/resources/reports/advancing-hydrogen-learning-from-19-plans-to-advance-hydrogen-from-across-the-globe-ffcrc/ [28 Oct 2021].
68 Greening, Paul / Strachan, Euan 2021: Energy in ASEAN: Hydrogen in Asia Pacific, Akin Gump, 24 Aug 2021, in: https://www.akingump.com/en/experience/industries/energy/speaking-energy/energy-in-asean-hydrogen-in-asia-pacific.html [28 Oct 2021].
69 Kosturjak et al., 2019, n.67.
70 Greening et al., 2021, n.68.
71 Downs, Erica 2021: Green Giants? China's National Oil Companies Prepare for the Energy Transition, Energy Policy, 29 Sept 2021.
72 Grushevenko, Ekaterina et al. 2021: Decarbonization of Oil and Gas: International Experience and Russian Priorities, Skolkovo Moscow School of Management, Mar 2021, 15, pp. 22-23.
73 Peszko, Grzegorz / van der Mensbrugghe, Dominique / Golub, Alexander 2020: Diversification and Cooperation in a Decarbonizing World, The World Bank Group, Policy Research Working Paper 9315, Jul 2020.
74 Gordon, Deborah / Acharya, Madhav 2018: Oil Shake-up: Refining Transitions in a Low-Carbon Economy, Carnegie Endowment for International Peace, Apr 2018, p.5, in: https://carnegieendowment.org/files/Gordon_DrivingChange_Article_April2018_final.pdf [28 Oct 2021].
75 Sahu, Surabhi / Vahn, Gawoon Philip 2021: Malaysia's Petronas Hastens Decarbonization Push, but Oil Business Still Vital, S&P Global, 7 Sept 2021, in: https://www.spglobal.com/platts/en/market-insights/latest-news/energy-transition/090721-malaysias-petronas-hastens-decarbonization-push-but-oil-business-still-vital [28 Oct 2021].
76 Asmelash, Elisa / Gorini, Ricardo 2021: International Oil Companies and the Energy Transition, International Renewable Energy Agency [28 Oct 2021].
77 Meliksetian, Vanand 2021: China's Big Oil To Exploit Core Strengths In Decarbonization, OilPrice, 23 Aug 2021 [28 Oct 2021].
78 Siemens Energy 2021: Asia Pacific Energy Leaders Identify Seven Key Trends for a Sustainable Energy Future, 11 Mar 2021, in: https://press.siemens-energy.com/global/en/pressrelease/asia-pacific-energy-leaders-identify-seven-key-trends-sustainable-energy-future [28 Oct 2021].
79 Hydrocarbon Processing 2021: Indian Refining Giant Unveils $10 B Green Energy Plan, 24 Jun 2021, in: https://www.hydrocarbonprocessing.com/news/2021/06/indian-refining-giant-unveils-10-b-green-energy-plan [28 Oct 2021].
80 Hydrogen Council 2017: How hydrogen empowers the energy transition, Jan 2017, p. 9.
81 Zheng, Cecillia / Khoo, Choon Gek 2021: Southeast Asia Decarbonization Updates, Q2 2021, IHS Markit, 6 Aug 2021, in: https://ihsmarkit.com/research-analysis/southeast-asia-decarbonization-updates-q2-2021.html [28 Oct 2021].
82 Accenture, 2020 n. 25, p.36.
83 Accenture, 2020 n. 25, p.136.
84 Sen, Anupama / Meini, Luca 2021: Beyond Energy: Incentivizing Decarbonization through the Circular Economy, OIES Paper, 2021, p. 5.
85 Khowaiter, Ahmad O. Al/Mufti Yasser M. 2020: An Alternative Energy Transition Pathway Enabled by Oil and Gas industry, in Decarbonization Pathways for Oil and Gas, OIES Paper 121, Mar 2020, in: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2020/03/OEF121.pdf [28 Oct 2021].
86 Accenture, 2020 n. 25, p.22.
87 Accenture, 2020 n. 25, p.64.
88 Net Zero Pathways, 2021, n. 7.
89 Seah, Sharon / Martinus, Melinda / Jiahui, Qiu 2021: The Southeast Asia Climate Outlook: 2021 Survey Report, ISEAS - Yusof Ishak Institute, 2021, p. 12, in: https://www.iseas.edu.sg/wp-content/uploads/2021/09/Southeast-Asia-Climate-Outlook-2021-Survey-Report.pdf [28 Oct 2021].
90 Nagashima, Monica 2018: Japan's Hydrogen Strategy and Its Economic and Geopolitical Implications, ifri Center for Energy, Oct 2018, p. 29, in: https://www.ifri.org/sites/default/files/atoms/files/nagashima_japan_hydrogen_2018_.pdf [28 Oct 2021].
91 Van de Graaf et al., 2020, n. 1, p. 1.
92 Nagashima, 2018, n. 90.
93 Briault, Thomas n.d.: Could Hydrogen be Southeast Asia's Key to the Energy Transition?, ARUP, in: https://www.arup.com/perspectives/could-hydrogen-be-southeast-asias-key-

to-the-energy-transition [28 Oct 2021].

94 Van de Graaf et al., 2020, n. 1.

95 Accenture, 2020 n. 25, p.74.

96 Asmelash, Elisa / Gorini, Ricardo 2021: International Oil Companies and the Energy Transition, International Renewable Energy Agency, 2021

97 Agosta, Alessandro / Boccara, Gillian / Brecciani, Giorgio / Heringa, Berend / Browne, Nickolas 2021: The Impact of Decarbonization on the Gas and LNG Industry, Mckinsey, 30 Jun 2021, in: https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-impact-of-decarbonization-on-the-gas-and-lng-industry [28 Oct 2021].

98 Net Zero Pathways, 2021, n. 7, p. 26-28.

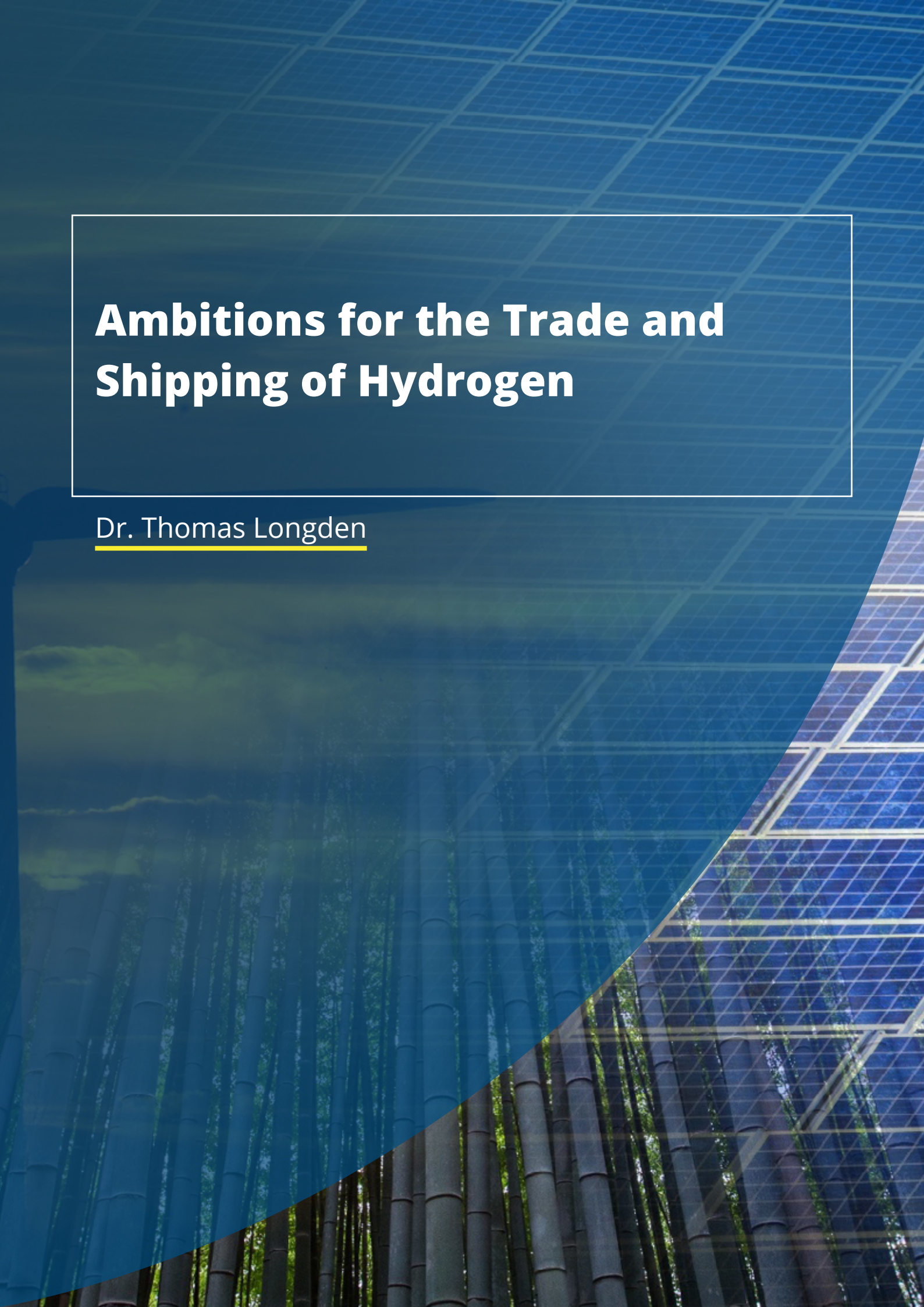
99 IEA, 2021, n. 30, p. 35.

100 Blazquez, Jorge / Dale, Spencer / Jefferiss, Paul 2020: The Role of Carbon Pricing in the Energy Transition, in Decarbonization Pathways for Oil and Gas, OIES Paper 121, Mar 2020, p. 3.

101 Sivaprasad, Dave 2021: Commentary: Singapore's Oil and Gas Sector Should Embrace Transition to a Green Future With Confidence, Channel News Asia, 6 Feb 2021, in: https://www.channelnewsasia.com/commentary/singapore-clean-energy-oil-gas-shell-keppel-carbon-tax-climate-1882976 [28 Oct 2021].

Ambitions for the Trade and Shipping of Hydrogen

Dr. Thomas Longden



Abstract

There are a range of countries in the Asia-Pacific region that have aspirations to set up a hydrogen industry. Part of this industry would involve the trade and shipping of hydrogen and ammonia. There are a range of strategies and demonstration projects that reflect these ambitions. While the technology will develop over the next decade, the links being made now are likely to reflect future trading relationships. This article will provide an overview of the current connections being made between countries in the Asia-Pacific. This will include a review of hydrogen strategies and other policy documents for the discussion of trade (or shipping) between countries, which will reflect ambitions to establish supply-chains, a review of demonstration projects in the region and outline whether cross-national parties were involved in operating or setting up these projects, and a review of existing fuel trade between key players. Together, this will provide an idea of where the momentum is heading and where supply routes may emerge. It will allow for an assessment of whether future supply routes are more/less likely to develop.

Ambitions for the Trade and Shipping of Hydrogen

There are a range of countries in Asia-Pacific that are aspiring to set up a hydrogen industry that involves the trade of a hydrogen-based carrier and shipping between countries. This is reflected in the numerous hydrogen strategies that specifically mention the export or import of hydrogen. There are also numerous demonstration projects and scoping studies with collaborators from multiple countries. Some companies are investing in projects in other countries that have the potential for hydrogen trade. These aspirations, studies and projects are resulting in new or reinforced connections between countries in Asia-Pacific and beyond.

This trade and shipping could be established using hydrogen (compressed or liquefied), ammonia or methylcyclohexane. There are demonstration projects and scoping studies aimed at verifying the technical and financial viability of these carriers (refer to Box 1 for details). While many of the projects utilise (or assess the use of) renewable energy to create "green hydrogen", coal and natural gas-based hydrogen have recently been shipped between countries. Fossil fuel-based hydrogen can be called "grey hydrogen" (if no carbon capture and storage are used) or "blue hydrogen" (when carbon capture and storage are used). "Clean hydrogen" is a term often applied to both renewables-based hydrogen and "blue hydrogen".

While shipping and storage technologies need to develop further, the connections being formed now are likely to reflect future trading relationships. This review focuses on the connections between countries by assessing hydrogen strategies, demonstration projects and feasibility studies, and existing fuel trade between the key players. This provides a snapshot of whether links are being made with existing trading partners and whether new connections are being made. In many ways, Japan is leading the way with numerous projects aiming to establish the trade of hydrogen in Asia-Pacific. Other countries have stated their ambitions in this area, but have less links established or made less investment in hydrogen export projects. Some of the major players (including China and India) are developing hydrogen strategies (refer to Box 2 for details).

Overview of Connections Between Potential Exporters and Importers in Asia-Pacific

Table 3 provides an overview of the types of connections that have been made between countries. These connections have been identified based on the development of new hydrogen strategies and projects. Some of the connections between countries are multidimensional (with multiple links made) and others are relatively immature (with fewer links). And some are strong connections (with notable investment). Weaker connections are identified when there is only a feasibility study or it is a case where one country mentions another but there is no reciprocal mention in national documents.

Many of the links between countries are amongst those with existing trading relationships. These include Japan building connections with Australia, Canada, Saudi Arabia and the United Arab Emirates. Some of these connections stand out as they involve projects that include shipping hydrogen between these countries (refer to Box 3 for details). There are a few new connections that have been established or are being sought after. These are between Japan and Brunei, as well as Chile aspiring to trade with Japan and South Korea.

This analysis provides an indication of where the momentum is heading and where supply routes may emerge (if the technological barriers are overcome). There are major fuel exporters that haven't made their plans or intentions known. For example, the United States has released a hydrogen strategy that mentions export but does not identify potential trading partners. Whether additional demonstration projects or feasibility studies include the US will be something to watch over the coming years. China and India are developing hydrogen strategies (refer to Box 2 for details).

Table 3: Key Connections Between Potential Exporters and Importers in Asia-Pacific

Potential Hydrogen Trading Partners		Mentioned In Hydrogen Strategy	Established A Demonstration Project Or Feasibility Study	Existing Trading Partners (Major Or Minor)
Exporter	**Importer**			
Australia	**Japan**	Yes — reciprocal mention in national documents.	Yes — multiple projects that involve shipping hydrogen between these countries.	Yes — major trading partners in fuels.
Australia	**South Korea**	Yes — but only by one country (Australia).	Yes — feasibility study.	Yes — major trading partners in fuels.
Australia	**Germany**	No	Yes — feasibility study.	Yes — but minor partners.
Brunei	**Japan**	No	Yes — a project that has involved shipping hydrogen between these countries.	Yes — but only major for Brunei.
Canada	**Japan**	Yes — but only by one country (Canada).	Yes — a project that will involve shipping hydrogen between these countries.	Yes — Canada is one of the top 4 OECD trading partners for fuels.
Chile	**Japan/ Korea**	Yes — but only by one country (Chile).	No	No
Saudi Arabia	**Japan**	No	Yes — a project that has involved shipping hydrogen between these countries.	Yes — major trading partners in crude oil.
United Arab Emirates	**Japan**	No	Yes — feasibility study.	Yes — major trading partners in crude oil.

Note: green shading denotes the strongest connection, yellow shading denotes a connection with some potential, and grey shading denotes cases with no evidence of a connection.

Box 1: Shipping Technologies

Liquefied hydrogen carrier: The SUISO FRONTIER has been developed by Kawasaki Heavy Industries, Ltd. and is part of technology demonstration projects between Japan and Australia. This includes the Hydrogen Energy Supply Chain (HESC) project, which will demonstrate that hydrogen can be produced using coal and transported to Japan.[1] [2] It will be able to transport about 1,250 m^3 of liquefied hydrogen.[3] COVID-19 has delayed the commissioning of the ship, but it is scheduled to arrive in Australia in the second half of the 2021 Japanese fiscal year (which is October 2021–March 2022).[4]

Notable scale up needs to occur for cost-competitive liquefied hydrogen transport. The ship is small in comparison to a LNG ship. Boil-off losses are higher and the energy density is lower.[5] Even so, it is impressive to see that the ship is almost ready for the first trip transporting hydrogen from Australia to Japan.

Source: Nature portfolio (n.d.)[6]

Ammonia as a carrier: Today there is international shipping of ammonia but using this carrier would probably limit the types of final uses. There is discussion of extracting hydrogen at the point of use, but this will be costly and incur an energy penalty.[7] It is possible to co-burn ammonia in coal-fired power stations and reduce emissions.[8] And a pilot project in Japan that has been announced aims to achieve a co-firing rate of 20 per cent in a 1GW unit.[9] [10]

Ammonia and hydrogen as a marine fuel: Ammonia can also be used as a fuel in engines, so ammonia fuel cells could be used in shipping vessels. Existing boats tend to be small hybrid passenger vehicles. But ambitions are great, as reflected by the International Maritime Organization (IMO), aiming to halve emissions by 2050.[11] [12]

Hydrogen Strategies with Ambitions for Trade

There have been a range of national documents released since Japan published its hydrogen strategy in 2017 (Table 4). Almost all of them mention exporting or importing hydrogen and identify a potential trading partner. While the German and European Union (EU) documents mention trade with certain regions, other documents signal an intent to establish a connection with a specific country. These strategies provide an indication of how countries hope hydrogen trade will develop across Asia-Pacific and beyond.

Key strategies identify countries that aim to be importers and those that hope to be exporters (dot points below).

Reciprocal mentions of countries are rare and this is likely to be due to the timing of the release of each strategy. Both the Japanese (importer) and Australian (exporter) strategies mention a trading relationship with each other.

Some strategies mention a country after that party released a strategy and this is included in the analysis. It implies that those countries have signalled an interest in making a connection with another country. The strategies that mention a country after the other released a strategy include:

- New Zealand's strategy (exporter) identifies Japan (importer)
- Canadian strategy (exporter) identifies Japan (importer)
- Chilean strategy (exporter) identifies Japan and South Korea (importer)
- Norwegian strategy (exporter) identifies the European Union (importer)
- British strategy (exporter) identifies the European Union (importer)

Some strategies also mention an ambition to provide technological assistance or to collaborate in developing hydrogen projects in other countries. The strategies that specifically mention the dissemination of related technologies or a cross-national collaboration are:

- Japan mentioning Australia and Brunei
- Germany mentioning partner countries, North Sea countries and southern Europe, and Global dissemination
- Norway mentioning collaboration with other Nordic countries
- The UK mentioning Europe and Southeast Asia

The ambitions laid out in these strategies are only part of the story. Establishing a national strategy or plan is only an initial step. Those countries with strong ambitions for establishing hydrogen trade are likely to be those that are also involved in demonstration projects or scoping studies. This is the focus of the next section.

The strategies that specifically mention the dissemination of related technologies or a cross-national techonological collaboration are:

Table 4: Key Hydrogen Strategies that Mention Trade and Dissemination of Technology

Country	Year	Type of document	Mentions imports or exports	Mentions potential trading partner	H2 trading partner/ route	Dissemination of related technology
Japan [13]	2017	National hydrogen strategy	Yes	Yes	Australia to Japan	Australia; Brunei
Australia [14]	2019	National hydrogen strategy	Yes	Yes	Australia to Asian partners; Australia to Japan and South Korea	
New Zealand [15]	2019	National hydrogen strategy	Yes	Yes	Japan; South Korea	
South Korea [16]	2019	Hydrogen Economy Roadmap	Yes	No		Overseas
Canada [17]	2020	National hydrogen strategy	Yes	Yes	The USA (particularly California and the Eastern US); Japan; South Korea; China; European Union	
Chile [18]	2020	National hydrogen strategy	Yes	Yes	Europe; China; Japan; Korea; USA; Latin America	
Germany [19]	2020	National hydrogen strategy	Yes	Yes	Other European Member States, particularly North and Baltic Sea; Partner countries; International trade	Partner countries; North Sea countries and southern Europe; Global
European Union [20]	2020	Intergovernmental hydrogen strategy	Yes	Yes	North Africa; International trade, in particular with the EU's neighbouring countries in Eastern Europe and in the Southern and Eastern Mediterranean countries	
Norway [21]	2020	National hydrogen strategy	Yes	Yes	Norway to Europe via pipeline	Nordic countries (Norway, Sweden, Denmark, Finland and Iceland);
United States [22]	2020	National hydrogen strategy	Yes	No		
United Kingdom [23]	2021	National hydrogen strategy	Yes	Yes	Scotland to the EU; The UK to Belgium, Netherlands and Ireland; North Sea trade	The UK to Europe/SE Asia

Demonstration Projects Related to the Trade and Shipping of Hydrogen

While the development of a national strategy or plan is an important signal of an ambition to establish a new hydrogen industry, establishing demonstration projects or scoping studies reinforces this ambition. A review of online materials found 38 demonstration/pilot projects and feasibility studies that clearly identify cross-country collaboration/ investments and specifically mention exporting some form of hydrogen.

Table 5 presents these projects and studies by country of origin and provides details of the source of the energy feedstock, carrier, trading partner or funder/investor, and whether a shipping method is identified. This is not an exhaustive list of projects or studies. They are those that the author identified as having relevance to the trade and shipping of hydrogen (during a review that concluded on 12 September, 2021).

While most projects and studies focus on green hydrogen, natural gas and coal are being used as feedstocks in multiple countries (i.e., Australia, Brunei, Canada, Lithuania, Norway, Saudi Arabia, and the United Arab Emirates). Some projects (and strategies) use the term "green hydrogen" to indicate that the focus is on the use of electrolysers driven by renewable electricity. Others use the terms "blue hydrogen" or "clean hydrogen" to indicate the use of fossil fuels and the incorporation of carbon capture and storage (CCS).

Australia has multiple demonstration/pilot projects and feasibility studies with organisations from Japan, Germany, South Korea, the Netherlands, France and elsewhere. These include the use (or study of) renewables, coal and natural gas-based hydrogen.

Japan has multiple demonstration/pilot projects that include shipping with Australia, Brunei, Canada, Saudi Arabia and the United Arab Emirates (refer to both Table 5 and Box 3). These include the use (or study of) renewables, coal and natural gas-based hydrogen. They include multiple carriers for transporting hydrogen-based fuels.

There is a Memorandum of Understanding between Egypt and Germany to develop a hydrogen-based industry with export capability. It focuses on renewables-based hydrogen.

Chile is a country without a strong history as an energy exporter. But it has multiple initiatives with organisations from France, the Netherlands and Singapore. Chile has a focus on renewables-based hydrogen.

One major country that did not have a lot of projects or studies identified during this review was the United States. It will be interesting to see whether this is still the case in a few years as the US hydrogen strategy was released in mid-2020.

Note that China and India are developing hydrogen strategies (refer to Box 2 for details).

This analysis can be compared to the "possible trade routes" that were identified by IRENA in a recent report (Figure 4). Similar patterns for emerging trade routes are found.

Box 2: Large Countries Without Hydrogen Strategies

China: As of October 2021, there is no Chinese national hydrogen strategy. However, China's 14th Five-Year Plan (2021–2025) discusses hydrogen as one of six industries of the future. It mentions that hydrogen is a "frontier" area that the country pledges to advance. Demonstration projects are planned with 1.7 billion yuan as a fiscal bonus for local governments that can meet specific targets. [24]

There are reports of a Chinese strategy being developed by the National Development and Reform Commission. But the timing of this is unclear. However, it is common that documents are developed for the specific industries mentioned in five-year plans. [25]

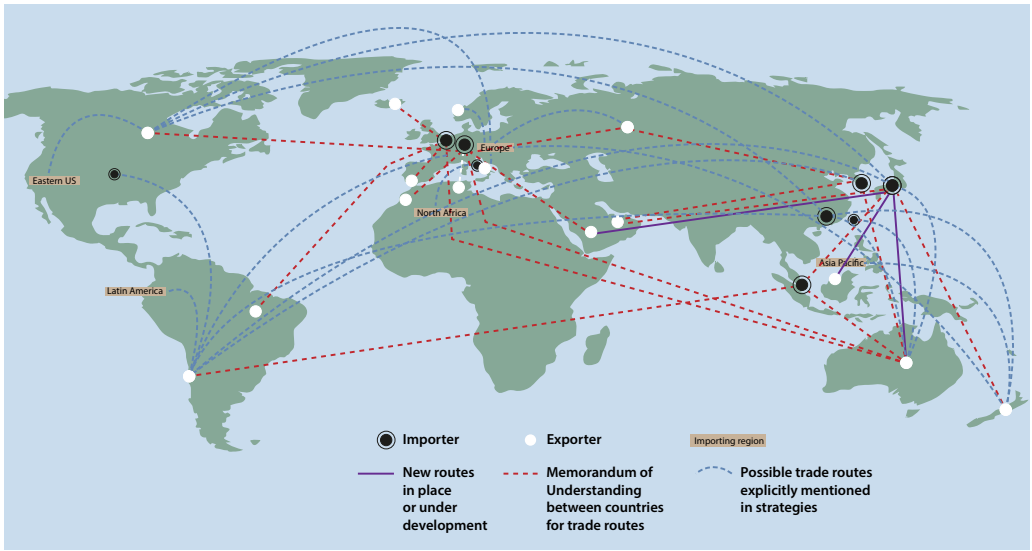
Even without a national strategy, ambitions are high. This is reflected by the recent announcement that Inner Mongolia's Energy Administration has approved a green hydrogen project that aims to "use 1.85 gigawatts of solar and 370 megawatts of wind to produce 66,900 tons of green hydrogen a year". [26]

The Beijing-Tianjin-Hebei municipal bureau of economy and information technology has announced a plan for a hydrogen industry that would be "valued at more than 100 billion yuan (15.4 billion U.S. dollars) and reduce carbon emissions by 2 million metric tons". [27]

India: Recently, Prime Minister Modi announced a National Hydrogen Mission that would see India become a "global hub for green hydrogen production and exports". [28]

Details of the Mission are limited and the "budget did not specify the details of the scheme and what India's ambitions were towards it". The Ministry of New and Renewable Energy (MNRE) has allocated more than 3 million U.S. dollars for research and development in hydrogen. [29]

Figure 4: Possible Trade Routes (As Summarised by IRENA)



Source: IRENA (2021) [30]

Table 5: Selected Demonstration Projects or Feasibility Studies Mentioning Export

Country Producing Hydrogen	Energy Feedstock	Type of Carrier	Other Country Involved (Incl. Tech. Companies and Investors)	Description	Export Mentioned	Type of Shipping Selected
Australia	Renewables — solar and wind	Ammonia	Denmark, China and India	Asian Renewable Hub project focused on exporting green ammonia [31]	Yes	Yes
	Renewables	Unclear	Germany	Australia-Germany Hydrogen Accord [32]	Yes	Unclear
	Renewables	Multiple	Germany	HySupply: a joint Australian-German Hydrogen feasibility study [33]	Yes	Yes
	Renewables	Ammonia	Germany	MOU with the aim of transporting ammonia from Australia to Germany [34]	Yes	Yes
	Renewables — solar and wind	Compressed hydrogen	France	Feasibility study into hydrogen production facilities [35] [36] [37]	Yes	Yes
	Renewables — solar	Liquefied hydrogen	Japan	Export-scale liquid hydrogen project with a liquefaction facility and liquid hydrogen carriers (ships) [38] [39]	Yes	Yes
	Natural gas; renewables	Ammonia	Japan	Feasibility study of the large-scale export of hydrogen as ammonia for use in decarbonising coal-fired power generation [40]	Yes	Yes
	Renewables — solar and wind	Methylcyclohexane	Japan	Feasibility study of the export of hydrogen to Japan using MCH for storage and transport [41]	Yes	Yes
	Renewables	Unclear	Japan	MOU to "explore opportunities to develop a hydrogen ecosystem" that will initially pursue domestic uses before moving to enable large-scale export [42] [43]	Yes	Unclear
	Renewables — mainly hydro	Ammonia	Japan	MOU to assess the feasibility of supplying and transporting green ammonia to Japan for blending into existing power generation [44]	Yes	Yes
	Renewables	Unclear	Japan	MOU to undertake a study into the potential production, storage and export of renewable hydrogen [45]	Yes	Unclear
	Renewables — solar	Methylcyclohexane	Japan	Technical verification of producing, transporting and dehydrogenation of MCH [46]	Yes	Yes
	Renewables — solar and wind	Ammonia	Japan	Capital investment in H2U Investments, including The Hydrogen Utility (H2U) — an Australian developer of green hydrogen and green ammonia projects [47]	Yes	Yes
	Coal	Liquefied hydrogen	Japan	Pilot project where hydrogen is made using coal, which is then shipped to Japan using the SUISO FRONTIER [48] [49]	Yes	Yes
	Renewables — solar and wind	Unclear	Netherlands	Feasibility study with the Port of Rotterdam [50]	Yes	Unclear
	Renewables — solar	Ammonia	South Korea	Feasibility study of "transport-focused" hydrogen facilities with export facilities at a port [51]	Yes	Yes
	Renewables — solar and wind	Unclear	Unclear	Renewable hydrogen production facility that is aiming to supply the domestic and export market [52]	Yes	Unclear
	Renewables — solar and wind	Liquefied hydrogen	South Korea	Joint feasibility study on hydrogen export supply chains [53]	Yes	Yes

Brazil	Renewables — solar and wind	Unclear	Multiple regions	MOU to set up a hydrogen facility in a strategic location with access to major international markets [54]	Yes	Unclear
Brunei	Natural gas	Methylcyclohexane	Japan	Demonstration project producing and shipping hydrogen from Brunei to Japan [55] [56] [57]	Yes	Yes
Canada	Natural gas	Ammonia	Japan	MOU related to the production of low-carbon hydrogen through the use of natural gas with carbon capture and storage (CCS) with export to Japan [58]	Yes	Yes
Chile	Renewables — solar	Ammonia	France	Project that aims to produce green ammonia for mining applications [59] [60]	No	No
	Renewables	Unclear	Netherlands	Feasibility study with the Port of Rotterdam [61]	Yes	Unclear
	Unclear	Unclear	Singapore	MOU for collaboration on low-carbon hydrogen technologies [62]	No	Unclear
Egypt	Renewables	Unclear	Germany	MOU to develop a hydrogen-based industry in Egypt with export capability [63]	Yes	Unclear
Iceland	Renewables — hydro, geothermal and wind	Multiple	Netherlands	Pre-feasibility study about exporting green hydrogen from Iceland to the Port of Rotterdam [64]	Yes	Yes
Lithuania	Natural gas	N/A	Japan	Feasibility study for a blue hydrogen project with shipping of liquefied CO_2 [65]	No	N/A
Mauritania	Renewables — solar and wind	Unclear	Luxembourg	MOU to develop a "power-to-X" project with the aim of exporting green hydrogen and its derivatives to global markets [66]	Yes	Unclear
MENA	Unclear	Unclear	Germany and others	MENA Hydrogen Alliance set up to advise or promote pilot projects [67]	Yes	Unclear
Netherlands	Renewables — wind	Use of existing natural gas pipelines mentioned	Germany, Norway	Project that will complete a feasibility study on producing green hydrogen in the Netherlands and exporting it to Northwest Europe [68]	Yes	Yes
Norway	Natural gas	Pipeline	Germany	Project aims to supply hydrogen to Germany for use in steel making [69]	Yes	Yes
	Renewables — hydro and wind	Unclear	United Kingdom	MOU to create a "commercial pathway to export green hydrogen from Norway into the UK energy market" [70]	Yes	Unclear
Saudi Arabia	Natural gas	Ammonia	Japan	Demonstration project of the production and shipment of ammonia from Saudi Arabia to Japan [71]	Yes	Yes
	Natural gas	Ammonia and MCH	Japan	MOU to investigate opportunities for establishing blue hydrogen and blue ammonia supply chains [72]	Yes	Yes
	Renewables — solar and wind	Ammonia	United States	Project that will produce ammonia and mentions exporting it [73]	Yes	Yes
United Arab Emirates	Natural gas	Ammonia	Japan	Joint study to explore the potential of blue ammonia production in the UAE and export potential is implied with discussion of the current trading relationship [74]	Implied	Implied
United States	Renewables — solar	Unclear	Unclear	MOU to investigate the potential for a combined solar and electrolyser project at the Corpus Christi port [75]	Yes	Unclear
Uruguay	Renewables	Multiple	Netherlands	Feasibility study with the Port of Rotterdam [76]	Yes	Yes

DEMONSTRATION PROJECTS

There are 38 demonstration/pilot projects and feasibility studies that identify cross-country collaboration and exporting some form of hydrogen.

Australia has multiple demonstration/pilot projects and feasibility studies with organizations from Japan, Germany, South Korea, the Netherlands, France, and elsewhere.

Japan has multiple demonstration/pilot projects that include shipping with Australia, Brunei, Canada, Saudi Arabia, and the United Arab Emirates.

There is a Memorandum of Understanding between Egypt and Germany to develop a hydrogen-based industry with export capability.

Chile is a country without a strong history as an energy exporter but it has multiple initiatives with organizations from France, the Netherlands, and Singapore.

Japan has a diverse interest in hydrogen with 3 major pilot and demonstration projects with Australia, Saudi Arabia, and Brunei.

The Australia-Japan pilot is led by HySTRA.

The Saudi Arabia demonstration project is led by Aramco.

Brunei-Japan pilot project with a list of partner organizations, including Chiyoda Corporation, Mitsubishi Corporation, and many other partners.

Box 3: Japan's Diverse Interests in Hydrogen

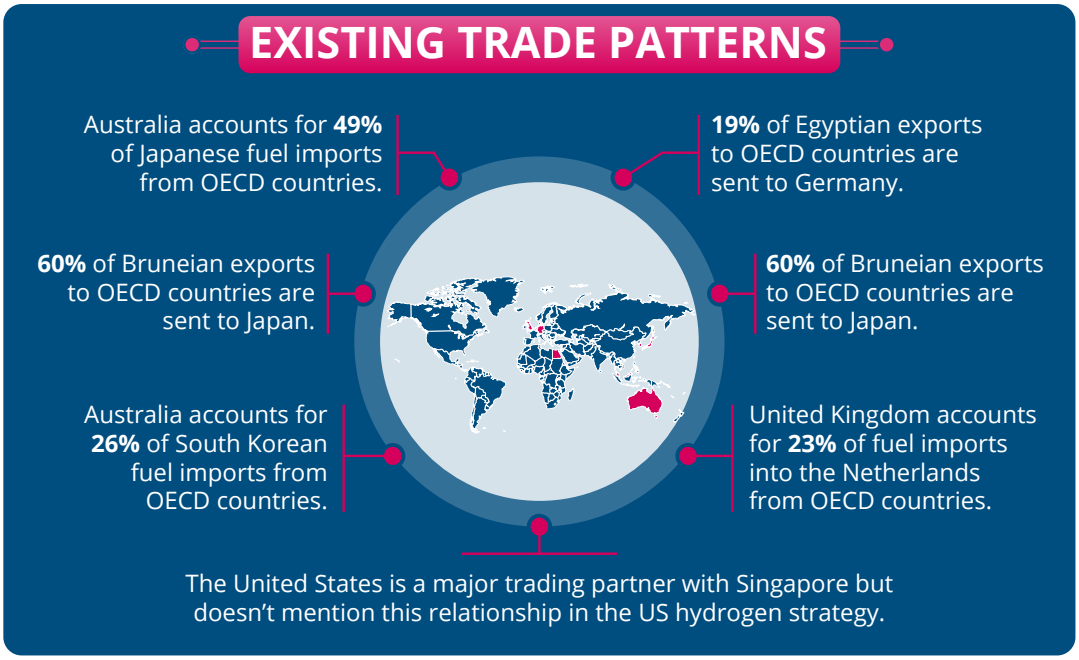
Three major pilot and demonstration projects with Australia, Saudi Arabia and Brunei: There are three projects that involve shipping hydrogen between these four countries (i.e. from Australia or Saudi Arabia or Brunei to Japan).

These are:

- Australia-Japan pilot led by HySTRA, which is a consortium that includes J-POWER, Shell Japan, Iwatani Corp., Kawasaki Heavy Industries Ltd., Marubeni Corp. ENEOS Corp. and K Line. This project will use brown coal to make hydrogen and then liquefy it at the Port of Hastings before transporting it to Japan (Port of Kobe) via a Liquefied Hydrogen Carrier. [77]
- Saudi Arabia demonstration project led by Aramco. This project focuses on the production of ammonia from crude oil and has already shipped 40 tonnes from Saudi Arabia to Japan. [78]
- Brunei-Japan pilot project with a list of partner organisations, including Chiyoda Corporation, Mitsubishi Corporation, Mitsui & Co., Ltd., Nippon Yusen Kabushiki Kaisha, the Advanced Hydrogen Energy Chain Association for Technology Development and ENEOS Corporation. This project involves shipping methylcyclohexane, which is an organic compound, to Japan. [79] After hydrogen is extracted, toluene is transported back to Brunei for repeated use. [80]
- Other: There are a range of other connections that Japan has established with Norway, New Zealand and Australia.

These include:

- Feasibility study between NEL Norway, Stiftelsen for industriell og teknisk forskning (SINTEF), Statoil, Linde Kryotechnik, Mitsubishi Corporation, Kawasaki Heavy Industries, Norwegian University of Science and Technology (NTNU) and the Institute of Applied Energy. This study investigated the potential for large-scale hydrogen production in Norway with liquefied hydrogen exports to European and Japanese markets. [81]
- Japan-New Zealand memorandum of co-operation between the Ministry of economy, trade and industry of Japan and the Ministry of business, innovation and employment of New Zealand. [82] [83]
- Mitsubishi Heavy Industries, Ltd. made a 180 million U.S. dollars investment in the Australian hydrogen energy infrastructure developer H2U. This is related to a South Australian project that plans to build a 75megawatts electrolyser plant to produce about 40,000 tonnes of ammonia per year. Export is mentioned as an aim of this project. [84] [85]
- Australia-Japan consortium conducting a feasibility study for hydrogen exports from Gladstone port in Queensland. Lead organisations are Queensland's state-owned energy company Stanwell and Iwatani Corporation. They have recently been joined by Kawasaki Heavy Industries, Kansai Electric Power Co., Marubeni Corp, and the Australian company APA Group. The Australian Renewable Energy Agency (ARENA) also announced that it would provide funding for the study. METI has also provided funding for the study. [86] [87]
- Australia-Japan pilot hydrogen plant that will be fuelled by solar and coupled to batteries. It is expected to be commissioned in early 2023. This is a joint venture between the Queensland state-controlled utility CS Energy and the Japanese engineering firm IHI Corporation. [88]



Existing Trade Patterns

This section focuses on whether the key countries identified in previous sections have an existing trading relationship. It focuses on OECD data for the import and export of mineral fuels, lubricants and related materials between 2015 and 2020. As they are OECD data, they exclude the Organization of the Petroleum Exporting Countries (OPEC). But this should not impact the validity of the analysis as the demonstration project data have already identified links to Saudi Arabia and the United Arab Emirates. The omission from these data is accounted for in the summary of the key findings.

This comparison shows that many of the connections being made are with existing trading partners. These existing links can be summarised as follows:

- Australia accounts for 49 per cent of Japanese fuel imports from OECD countries (Table 6)
- Norway and the Netherlands account for 61 per cent of German fuel imports from OECD countries (Table 7)
- Australia accounts for 26 per cent of South Korean fuel imports from OECD countries (Table 8)
- The United Kingdom accounts for 23 per cent of fuel imports into the Netherlands from OECD countries (Table 9)
- The United States is a major trading partner with Singapore but does not mention this relationship in the US hydrogen strategy (Table 10)
- 60 per cent of Bruneian exports to OECD countries are sent to Japan (Table 11)
- 19 per cent of Egyptian exports to OECD countries are sent to Germany (Table 12)

In contrast to these examples, some links are new (or immature). Chile is currently a net importer of fuels and becoming a major trading partner with Japan and other countries would be a new trading relationship (in terms of fuels). Morocco trades with Spain, but other partnerships (with Germany for example) would be new (Table 13).

The United States is a country that trades in fuels with many key countries (i.e. Japan, South Korea, the Netherlands and Singapore) but has not made their ambitions for exporting hydrogen clear. In many ways, it could be a sleeping giant, especially as the US is a resource-rich country with numerous ports and is a major player in LNG (Figure 5). Note that comparisons between hydrogen trade/demand and LNG have been made in previous reports. [89] [90] [91] [92] [93]

Table 6: Major Trading Partners of Japan

Trading partner	Percentage of fuel imports from OECD countries*
Australia	49%
United States	26%
Korea	16%
Canada	5%

Source: OECD Stat 2021 [94]

Table 7: Major Trading Partners of Germany

Trading partner	Percentage of fuel imports from OECD countries*
Norway	32%
Netherlands	29%
Belgium	10%
United Kingdom	9%

Source: OECD Stat 2021 [95]

Table 8: Major Trading Partners of South Korea

Trading partner	Percentage of fuel imports from OECD countries*
United States	35%
Australia	26%
Japan	13%
United Kingdom	9%

Source: OECD Stat 2021 [96]

Table 9: Major Trading Partners of the Netherlands

Trading partner	Percentage of fuel imports from OECD countries*
United Kingdom	23%
United States	17%
Belgium	15%
Norway	15%

Source: OECD Stat 2021 [97]

Table 10: Major Trading Partners of Singapore

Trading partner	Percentage of fuel imports from OECD countries*
United States	39%
Japan	17%
Australia	15%
Norway	4%

Source: OECD Stat 2021 [98]

Table 11: Major Trading Partners of Brunei

Trading partner	Percentage of fuel exports to OECD countries*
Japan	60%
Korea	18%
Australia	16%
New Zealand	5%

Source: OECD Stat 2021 [99]

Table 12: Major Trading Partners of Egypt

Trading partner	Percentage of fuel exports to OECD countries*
Italy	23%
Germany	19%
Greece	14%
United States	14%

Source: OECD Stat 2021 [100]

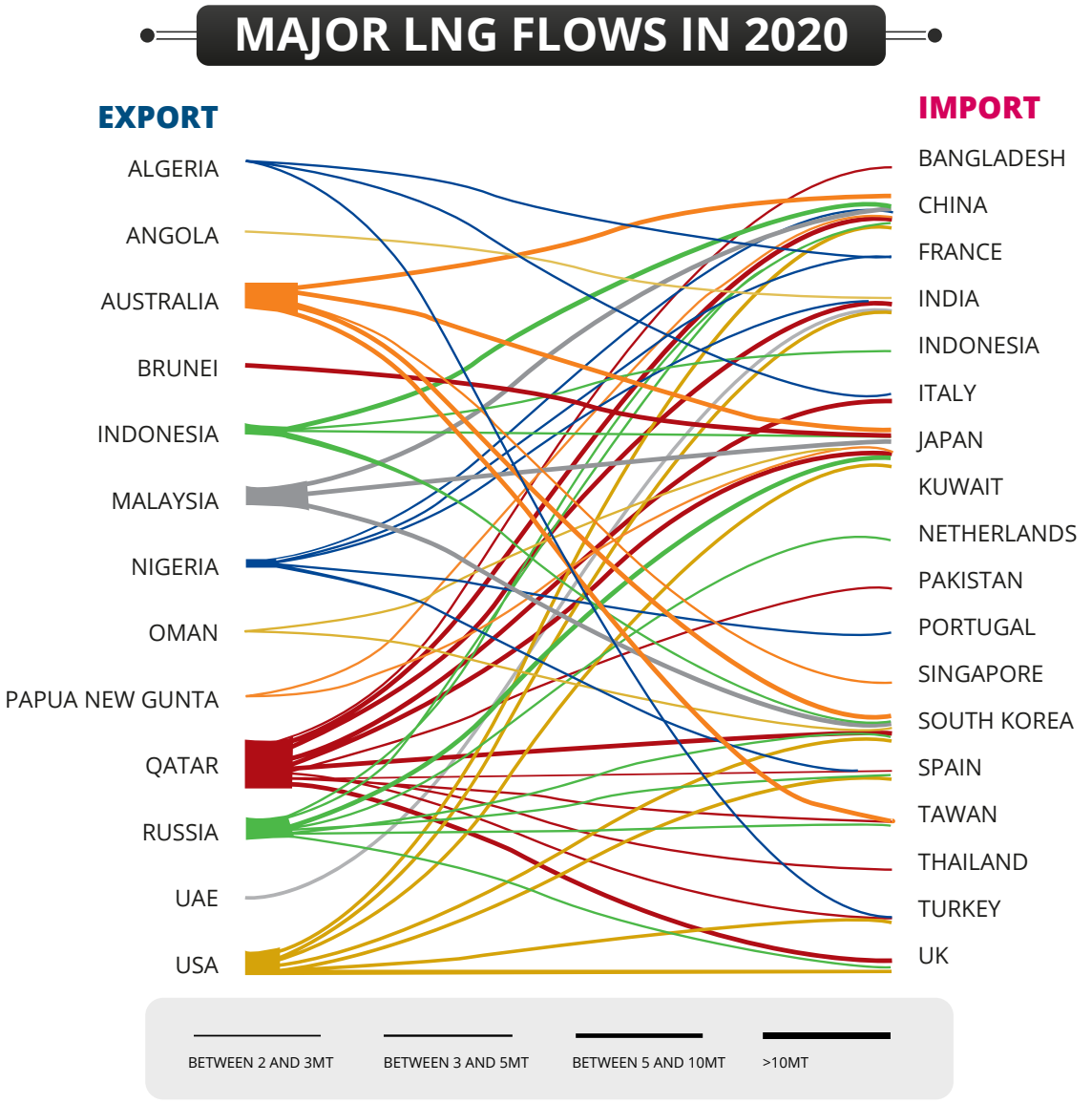
Table 13: Major Trading Partners of Morocco

Trading partner	Percentage of fuel exports to OECD countries*
Spain	89%
Belgium	3%
United Kingdom	3%
France	3%

Source: OECD Stat 2021 [101]

*Percentage of imports of mineral fuels, lubricants and related Materials from OECD countries (by value for 2015–2020)

Figure 5: Present Day Liquefied Natural Gas (LNG) Trade Between Key Countries in 2020



Source: GIIGNL 2021[102]

Overview

Aspirations to build new hydrogen supply chains are resulting in new or strengthened connections between countries in Asia-Pacific and beyond. While the technology needs to develop further (and many feasibility studies are underway), the links being formed now are likely to reflect future trading relationships. This analysis focused on a range of hydrogen strategies, demonstration projects or feasibility studies, and existing fuel trade to highlight the current interactions between key players. This may provide an indication for the establishment of future trade routes.

Many of the links being made between countries with ambitions to establish a hydrogen industry are amongst those with existing connections and trading relationships (specifically for fuels). These include Japan establishing hydrogen-based projects with Australia, Canada, Saudi Arabia and the United Arab Emirates.

But there are also a few connections that have been newly established or would need to be expanded. These are between Japan and Brunei. And Chile is aspiring to trade with Japan and South Korea.

The lack of action by the United States means that it could be viewed as a sleeping giant. The US hydrogen strategy was released in mid-2020, so this could be one reason for the lack of feasibility studies and projects aimed at export trade. The US is a major player in LNG and has many ports, which seems to be a precursor for ambitions to establish ship-based hydrogen exports.

Other countries to pay attention to over the next year are China and India, which are developing hydrogen strategies (refer to Box 2 for details).

While there is uncertainty about how (and whether) technological barriers can be overcome, there are notable ambitions to establish the trade of hydrogen amongst key countries in Asia-Pacific. This analysis provides an indication of where the momentum is heading and where supply routes may emerge. Greater weight has been given to those connections that involve shipping hydrogen between these countries and for major trading partners (based on recent trade in fuels). Based on this, Japan has shown the greatest ambition for establishing hydrogen trade and has identified a range of potential trading partners (specifically Australia, Brunei, Saudi Arabia and the United Arab Emirates).

Aspirations to build new hydrogen supply chains are resulting in new or strengthened connections between countries in the Asia Pacific and beyond

'Clean hydrogen' refers to both renewable-based hydrogen and 'blue hydrogen'.

Japan is leading the way with numerous projects aiming to establish the trade of hydrogen in the Asia-Pacific. China and India are developing strategies.

To establish the trade of hydrogen, technological barriers need to be overcome.

Conclusions

Existing trading relationships are being built upon with the development of new hydrogen pilot projects or scoping studies. In a range of strategies, countries have identified themselves as potential hydrogen importers and exporters. Sometimes they have also identified a potential trading partner. Many of these links are between those with existing trading relationships. So the development of hydrogen trade is likely to be built by reinforcing existing relationships based on fuel trade (especially the trade of LNG), rather than forging new trading relationships.

How these projects develop and which trading routes emerge is unknown. But Japan is leading the way by developing shipping technologies and establishing demonstration projects with Australia, Canada, Saudi Arabia and the United Arab Emirates. They are building on current relationships with projects that have actually transported hydrogen. But this was at a small scale. Even the planned transport of liquefied hydrogen using SUISO FRONTIER is small compared to a typical LNG carrier. But they have established these links and are emerging as a front-runner in the race towards shipping hydrogen. It is impressive to see that the liquefied hydrogen ship is almost ready for the first trip transporting hydrogen from Australia to Japan.

Other connections are being made across Asia-Pacific. But they tend to be scoping studies of a smaller scale and have less technical solutions being offered. New links may be made and a range of Asia-Pacific countries have ambitions for hydrogen trade. For example, South Korea's strategy mentioned hydrogen trade but does not provide much detail on how this will evolve and who the trading partners could be. Some countries are focused on technological innovations in end-use technologies or domestic supply/demand.

The lack of export-based demonstration projects in China, India and the United States is interesting. Recent announcements in India show how quickly this could change.

Nevertheless, the technological barriers are real and a breakthrough is needed to establish cost-competitive trade of hydrogen, ammonia and other carriers. At this point, it is not clear which type of carrier will become viable.

Dr. Thomas Longden is Fellow of Crawford School of Public Policy and the Zero-Carbon Energy for the Asia-Pacific (ZCEAP) Grand Challenge at Australian National University.

1 Hydrogen Energy Supply Chain (HESC) Project 2020: A close look at the world's first liquid hydrogen carrier | Hydrogen Energy Supply Chain, 26 Aug 2020, in: https://hydrogenenergysupplychain.com/a-close-look-at-the-worlds-first-liquid-hydrogen-carrier/ [13 Sept 2021].

2 Hydrogen Energy Supply Chain (HESC) Project 2020: About HESC | Hydrogen Energy Supply Chain, in: https://hydrogenenergysupplychain.com/about-hesc/ [13 Sept 2021].

3 Kawasaki Heavy Industries 2019: World's First Liquefied Hydrogen Carrier SUISO FRONTIER Launches Building an International Hydrogen Energy Supply Chain Aimed at Carbon-free Society, 11 Dec 2019, in: https://global.kawasaki.com/en/corp/newsroom/news/detail/?f=20191211_3487 [21 Oct 2021].

4 Hydrogen Energy Supply Chain 2021: Suiso Frontier arriving in Australia in the second half of the 2021 Japanese fiscal year, 20 May 2021, in: https://hydrogenenergysupplychain.com/suiso-frontier-arriving-in-australia-in-the-second-half-of-the-2021-japanese-fiscal-year/ [21 Oct 2021].

5 Sparling, Steven C. / Tan, Lian Yok / Cachia, Clive / Spry, Joshua 2020: Takeaways for Liquid Hydrogen From the Global Liquefied Natural Gas Trade, Bloomberg Law, 2 Dec 2020, in: https://news.bloomberglaw.com/environment-and-energy/takeaways-for-liquid-hydrogen-from-the-global-liquefied-natural-gas-trade [21 Oct 2021].

6 Nature portfolio n.d.: A seamless hydrogen supply chain, in: https://www.nature.com/articles/d42473-020-00544-8 [21 Oct 2021].

7 CSIRO 2018: National Hydrogen Roadmap, Commonwealth Scientific and Industrial Research Organisation (CSIRO), CSIRO; 2018.

8 Stocks, Matt / Fazeli, Reza / Hughes, Llewelyn / Beck, Fiona Jean 2020: Global emissions implications from co-burning ammonia in coal fired power stations: an analysis of the Japan-Australia supply chain, Nov 2020.

9 Obayashi, Yuka 2021: Japan's JERA aims to use 20% ammonia at coal power plant in 2024, Reuters, 24 Mar 2021, in: https://www.reuters.com/business/energy/japans-jera-aims-use-20-ammonia-coal-power-plant-2024-2021-05-24/ [22 Oct 2021].

10 Hill, Joshua S 2021: Japan to use ammonia at coal plant in boost for Australia's biggest wind and solar project, RenewEconomy, 25 May 2021, in: https://reneweconomy.com.au/japan-to-use-ammonia-at-coal-plant-in-boost-for-australias-biggest-wind-and-solar-project/ [22 Oct 2021].

11 Timperley, Jocelyn 2020: The fuel that could transform shipping, BBC Future, 30 Nov 2020, in: https://www.bbc.com/future/article/20201127-how-hydrogen-fuel-could-decarbonise-shipping [22 Oct 2021].

12 Murray, Adrienne 2020: The foul-smelling fuel that could power big ships, BBC News, 6 Nov 2020, in: https://www.bbc.com/news/business-54511743 [22 Oct 2021].

13 Ministry of Economy Trade and Industry (METI) 2017: Basic Hydrogen Strategy, 2017.

14 Commonwealth of Australia 2019: Australia's National Hydrogen Strategy, 2019.

15 New Zealand Government 2019: A vision for hydrogen in New Zealand: Green Paper (National Strategy), Sept 2019, in: https://www.mbie.govt.nz/assets/a-vision-for-hydrogen-in-new-zealand-green-paper.pdf [13 Sept 2021].

16 Government of Korea 2019: Hydrogen Economy Roadmap of Korea, 2019.

17 Natural Resources Canada 2020: Hydrogen Strategy for Canada — Seizing the opportunities for hydrogen, 2020.

18 Ministry of Energy Government of Chile 2020: National Green Hydrogen Strategy, 2020.

19 Germany Federal Ministry for Economic Affairs and Energy 2020: The National Hydrogen Strategy, 2020.

20 European Commission 2020: A hydrogen strategy for a climate-neutral Europe, 2020.

21 Ministry of Petroleum and Energy 2020: The Norwegian hydrogen strategy 2020.

22 Office of Fossil Energy US Department of Energy 2020: Hydrogen Strategy: Enabling A Low-Carbon Economy, 2020.

23 UK Government 2021: UK Hydrogen Strategy, 2021.

24 Bai, Yujie / Liu, Yukun / Wen, Simin / Jia, Denise / Caxin 2021: China's hydrogen roadmap: 4 things to know, Nikkei Asia, 21 Jun 2021, in: https://asia.nikkei.com/Spotlight/Caixin/China-s-hydrogen-roadmap-4-things-to-know [21 Oct 2021].

25 Bloomberg 2021: China is formulating a hydrogen plan but its timing is uncertain, JWN Energy, 23 Apr 2021, in: https://www.jwnenergy.com/article/2021/4/23/china-is-formulating-a-hydrogen-plan-but-its-timin/ [21 Oct 2021].

26 Murtaugh, Dan 2021: China Approves Renewable Mega-Project for Green Hydrogen, Bloomberg Green, in: https://www.bloomberg.com/news/articles/2021-08-18/china-approves-renewable-mega-project-focused-on-green-hydrogen [21 Oct 2021].

27 The State Council 2021: Beijing releases plan on hydrogen energy industry development, in: http://english.www.gov.cn/news/topnews/202108/17/content_WS611bbd06c6d0df57f98de93f.html [21 Oct 2021].

28 Kumar, Sanjay 2021: India pushes renewables and green hydrogen, Chemistry World, 21 Sept 2021, in: https://www.chemistryworld.com/news/india-pushes-renewables-and-green-hydrogen/4014426.article [21 Oct 2021].

29 Jacob, Shine 2021: National Hydrogen Mission: All you need to know about India's plans and potential, Money Control, 10 Feb 2021, in: https://www.moneycontrol.com/news/business/economy/national-hydrogen-mission-all-you-need-to-know-about-indias-plans-and-potential-6486731.html [21 Oct 2021].

30 International Renewable Energy Agency 2021: Green Hydrogen Supply: A Guide to Policy Making, May 2021, in: https://irena.org/publications/2021/May/Green-Hydrogen-Supply-A-Guide-To-Policy-Making [13 Sept 2021].

31 Mazengarb, Michael 2020: Massive Asian Renewable Energy Hub grows to 26GW of wind and solar | RenewEconomy, Renew Economy, 16 Oct 2020, in: https://reneweconomy.com.au/massive-asian-renewable-energy-hub-grows-to-26gw-of-wind-and-solar-49343 [13 Sept 2021].

32 Australian Embassy Germany 2020: Hydrogen: the energy resource of the future, in: https://germany.embassy.gov.au/beln/hydrogen.html [13 Sept 2021].

33 Minister for Trade Tourism and Investment 2020: Exploring Australia's hydrogen future with Germany, 19 Nov 2020, in: https://www.trademinister.gov.au/minister/simon-birmingham/media-release/exploring-australias-hydrogen-future-germany [13 Sept 2021].

34 Matich, Blake 2021: Companies and ports lined up for Australian green hydrogen export to Germany, pv magazine Australia, 16 Apr 2021: https://www.pv-magazine-australia.com/2021/04/16/companies-and-ports-lined-up-for-australian-green-hydrogen-export-to-germany/ [13 Sept 2021].

35 Global Energy Ventures 2021: GEV SIGNS MOU WITH THE HYENERGY PROJECT, 2021.

36 Province Resources Limited 2021: Compressed Hydrogen Shipping Memorandum of Understanding, 2021.

37 Mazengrab, Michael 2021: French giant Total Eren signs on to massive 8GW green hydrogen project in WA, Renew Economy, 19 Apr 2021: https://reneweconomy.com.au/french-giant-total-eren-signs-on-to-massive-8gw-green-hydrogen-project-in-wa/ [13 Sept 2021].

38 Hartmann, Imogen 2021: MOU signed for Origin hydrogen project, Energy Magazine, 15 Apr 2021, in: https://www.energymagazine.com.au/mou-signed-for-origin-hydrogen-project/ [13 Sept 2021].

39 Origin Energy 2021: Green hydrogen project signs port MOU, 14 Apr 2021, in: https://www.originenergy.com.au/about/investors-media/media-centre/green_hydrogen_project_signs_port_mou.html [13 Sept 2021].

40 Woodside 2020: Woodside joins Japanese consortium to study exporting carbon-neutral hydrogen, 6 Apr 2020, in: https://files.woodside/docs/default-source/media-releases/woodside-joins-japanese-consortium-to-study-exporting-carbon-neutral-hydrogen.pdf?sfvrsn=a10aae6d_2 [13 Sept 2021].

41 Premier of South Australia 2021: Companies unite to develop a Japan-Australia CO_2-free hydrogen supply chain in South Australia, 3 Aug 2021, in: https://www.premier.sa.gov.au/news/media-releases/news/companies-unite-to-develop-a-japan-australia-CO_2-free-hydrogen-supply-chain-in-south-australia [13 Sept 2021].

42 Gladstone Regional Council: MOU signing sparks commencement of Gladstone Hydrogen Ecosystem Project, 17 Mar 2021, in: https://www.gladstone.qld.gov.au/news/article/410/mou-signing-sparks-commencement-of-gladstone-hydrogen-ecosystem-project [13 Sept 2021].

43 Gladstone Regional Council 2021: JOINT MEDIA RELEASE: MOU SIGNING SPARKS COMMENCEMENT OF GLADSTONE HYDROGEN ECOSYSTEM PROJECT, 17 Mar 2021.

44 Fortescue Metals Group Ltd 2021: Fortescue Future Industries investigating green ammonia supply chain between Australia and Japan, 20 May 2021, in: https://www.fmgl.com.au/in-the-news/media-releases/2021/05/20/fortescue-future-industries-investigating-green-ammonia-supply-chain-between-australia-and-japan [13 Sept 2021].

45 Hamid, Tara 2021: QLD Gov explores hydrogen export from Port of Hay Point, Roads & Infrastructure Magazine, 19 Aug 2021, in: https://roadsonline.com.au/qld-gov-explores-hydrogen-export-from-port-of-hay-point/ [13 Sept 2021].

46 Research Center for Advanced Science and Technology at the University of Tokyo 2019: Succeeded in the world's first technical verification to produce "CO_2-free hydrogen" at low cost-Trial of hydrogen supply chain establishment and hydrogen based society, 15 Mar 2019, in: https://www.rcast.u-tokyo.ac.jp/en/news/release/20190315.html [13 Sept 2021].

47 Mitsubishi Heavy Industries Ltd 2020: MHI to Invest in Green Hydrogen & Green Ammonia in South Australia, 27 Nov 2020, in: https://mhiaa.com.au/mhi-to-invest-in-green-hydrogen-green-ammonia-south-australia/ [13 Sept 2021].

48 HESC, 2020, n.1.

49 HESC, 2020, n.2.

50 Premier of South Australia 2021: Feasibility study on export of SA green hydrogen to Rotterdam, 23 Mar 2021, in: https://www.portofrotterdam.com/en/news-and-press-releases/feasibility-study-export-south-australian-green-hydrogen-rotterdam [13 Sept 2021].

51 Varrath, Sophine 2021: Port of Townsville signs MOU to export green hydrogen to South Korea, Renew Economy, 7 Sept 2021, in: https://reneweconomy.com.au/townsville-gains-ground-in-green-hydrogen-export-race-with-korea-zinc-mou/ [13 Sept 2021].

52 Mazengarb, Michael 2019: Massive 5,000MW solar and wind projects set to fuel WA's hydrogen expansion, Renew Economy, 8 Oct 2019, in: https://reneweconomy.com.au/massive-5000mw-solar-and-wind-projects-set-to-fuel-was-hydrogen-expansion-91993/ [13 Sept 2021].

53 Australia-Korea Business Council 2021: Mapping the Australia-Korea Hydrogen Intersections, 2021.

54 World Construction Network 2021: Enegix Energy to build $5.4bn Base One green hydrogen project in Brazil, 2 Mar 2021, in: https://www.worldconstructionnetwork.com/news/enegix-energy-to-build-54bn-base-one-green-hydrogen-project-in-brazil/ [13 Sept 2021].

55 Fuel Cells Works 2020: World's First International Transport Of Hydrogen From Brunei To Japan, 4 Mar 2020, in: https://fuelcellsworks.com/news/worlds-first-international-transport-of-hydrogen-from-brunei-to-japan/ [13 Sept 2021].

56 Wong, Aaron 2019: World's first global hydrogen supply project begins shipment from Brunei to Japan, Biz Brunei, 2 Dec 2019, in: https://www.bizbrunei.com/2019/12/worlds-first-global-hydrogen-supply-project-begins-shipment-from-brunei-to-japan/ [13 Sept 2021].

57 Advanced Hydrogen Energy Chain Association for Technology Development 2021: The Advanced Hydrogen Energy Chain Association for Technology Development (AHEAD) website, 2021, in: https://www.ahead.or.jp/en/ [13 Sept 2021].

58 Mitsubishi Corporation 2021: Mitsubishi Corporation and Shell sign MoU to collaborate on hydrogen plans in Alberta, 8 Sept 2021, in: https://www.mitsubishicorp.com/jp/en/pr/archive/2021/html/0000047710.html [13 Sept 2021].

59 Tractebel Engie n.d.: Green Ammonia Production - HyEx Project, in: https://tractebel-engie.com/en/references/green-ammonia-production-hyex-project [13 Sept 2021].

60 Argus Media 2021: Engie ushering green H2 into Chile's

mining patch, 9 Apr 2021, in: https://www.argusmedia.com/en/news/2203821-engie-ushering-green-h2-into-chiles-mining-patch [13 Sept 2021].

61 Chile reports 2021: Chile signs green hydrogen export memorandum of understanding with Europe's largest port, 19 Mar 2021, in: https://chilereports.cl/en/news/2021/03/19/chile-signs-green-hydrogen-export-memorandum-of-understanding-with-europe-s-largest-port [13 Sept 2021].

62 Singapore Ministry of Trade and Industry 2021: SINGAPORE AND CHILE SIGN MEMORANDUM OF UNDERSTANDING FOR COLLABORATION ON LOW-CARBON HYDROGEN TECHNOLOGIES, 16 Feb 2021, in: https://www.mti.gov.sg/-/media/MTI/Newsroom/Press-Releases/2021/02/Press-Release--Singapore-and-Chile-sign-MOU-for-collaboration-on-lowcarbon-hydrogen-technologies-on.pdf [13 Sept 2021].

63 Siemens Energy 2021: Siemens Energy supports Egypt to develop Green Hydrogen Industry, 24 Aug 2021, in: https://press.siemens-energy.com/mea/en/pressrelease/siemens-energy-supports-egypt-develop-green-hydrogen-industry [13 Sept 2021].

64 Business Wire 2021: Study Shows Shipping Green Hydrogen From Iceland to Rotterdam to be Realistic Before 2030, 22 Jun 2021, in: https://www.businesswire.com/news/home/20210622005796/en/Study-Shows-Shipping-Green-Hydrogen-From-Iceland-to-Rotterdam-to-be-Realistic-Before-2030 [13 Sept 2021].

65 Klaipedos nafta / Larvik Shipping / Mitsui O.S.K. 2021: Lines will carry out a feasibility study for liquefied CO_2 and hydrogen project in Klaipeda, Lithuania, 27 May 2021, in: https://www.mol.co.jp/en/pr/2021/img/21045.pdf?__hstc=222471108.4db3215171f87a9098dd39ee8a37a22b.1631350253308.1631350253308.1631350253308.1&__hssc=222471108.1.1631350253309&__hsfp=260249815 [13 Sept 2021].

66 Aerospace Central Europe 2021: CWP and Mauritania sign MoU for the development of a US$40 billion green hydrogen project - Aerospace, 30 May 2021, in: https://aero-space.eu/2021/05/30/cwp-and-mauritania-sign-mou-for-the-development-of-a-us40-billion-gree-hydrogen-project/ [13 Sept 2021].

67 Dii Desertenergy n.d.: MENA Hydrogen Alliance, in: https://dii-desertenergy.org/mena-hydrogen-alliance/ [13 Sept 2021].

68 Energy Industry Review 2020: Europe's Largest Green Hydrogen Project: NorthH2, 7 Dec 2020, in: https://energyindustryreview.com/renewables/europes-largest-green-hydrogen-project-north2/ [13 Sept 2021].

69 Open Grid Europe GmbH n.d: H2morrow – act today to be greenhouse gas neutral by 2050, in: https://oge.net/en/us/projects/our-hydrogen-projects/h2morrow [13 Sept 2021].

70 Gen2 Energy 2021: A breakthrough agreement for export of green hydrogen from Norway, 25 May 2021, in: https://gen2energy.com/a-breakthrough-agreement-for-export-of-green-hydrogen-from-norway/ [13 Sept 2021].

71 Aramco 2020: Conceptual Flow Diagram of "Blue Ammonia" Supply Chain Demonstration (Duration: August 2020 – October 2020), 2020, in: https://www.aramco.com/-/media/news/2020/sep/blue-ammonia-supply-chain-flow-diagram-web.pdf?la=en&hash=6FFE2FC0FF076E1BA65B957B1B22405BF817281A [13 Sept 2021].

72 ENEOS 2021: ENEOS signs MoU with Aramco for blue hydrogen and blue ammonia collaboration, 25 Mar 2021, in: https://www.eneos.co.jp/english/newsrelease/2020/pdf/20210325_01.pdf [13 Sept 2021].

73 Air Products: Air Products, ACWA Power and NEOM Sign Agreement for $5 Billion Production Facility in NEOM Powered by Renewable Energy for Production and Export of Green Hydrogen to Global Markets, 7 Jul 2020, in: https://www.airproducts.com/news-center/2020/07/0707-air-products-agreement-for-green-ammonia-production-facility-for-export-to-hydrogen-market [13 Sept 2021].

74 Abu Dhabi National Oil Company 2021: ADNOC and Three Japanese Companies to Explore Hydrogen and Blue Ammonia Opportunities, in: https://www.adnoc.ae/en/news-and-media/press-releases/2021/adnoc-and-three-japanese-companies-to-explore-hydrogen-and-blue-ammonia-opportunities [13 Sept 2021].

75 Evans, Caroline 2021: Corpus Christi Port Partnering with Ares on Green Hydrogen Project - Natural Gas Intelligence, Natural Gas Intelligence, 13 May 2021, in: https://www.naturalgasintel.com/corpus-christi-port-partnering-with-ares-on-green-hydrogen-project/ [13 Sept 2021].

76 Ministeriode Industria Energíay Minería 2021: URUGUAY-PORT OF ROTTERDAM HYDROGEN SUPPLY CHAIN, in: https://www.gub.uy/ministerio-industria-energia-mineria/sites/ministerio-industria-energia-mineria/files/documentos/noticias/Hydrogen - Uruguay %26 Port of Rotterdam.pdf [13 Sept 2021].

77 CO_2-free Hydrogen Energy Supply-chain Technology Research Association (HySTRA) 2021: HYDROGEN SUPPLY CHAIN, in: http://www.hystra.or.jp/en/project/ [22 Oct 2021].

78 Brown, Trevor 2020: Saudi Arabia ships low-carbon ammonia to Japan, Ammonia Energy Association, 8 Oct 2020, in: https://www.ammoniaenergy.org/articles/saudi-arabia-ships-low-carbon-ammonia-to-japan/ [22 Oct 2021].

79 MITSUI & CO. 2021: AHEAD to Support Decarbonization at Petroleum Refineries Through MCH Hydrogen Supply Chain from Brunei, 10 Aug 2021, in: https://www.mitsui.com/jp/en/topics/2021/1241738_12171.html [22 Oct 2021].

80 International Renewable Energy Agency, 2021, n. 30.

81 Nel Hydrogen 2016: Initiates feasibility partner study for large-scale hydrogen production in Norway, 13 Apr 2015, in: https://nelhydrogen.com/press-release/nel-asa-initiates-feasibility-partner-study-for-large-scale-hydrogen-production-in-norway/ [23 Oct 2021].

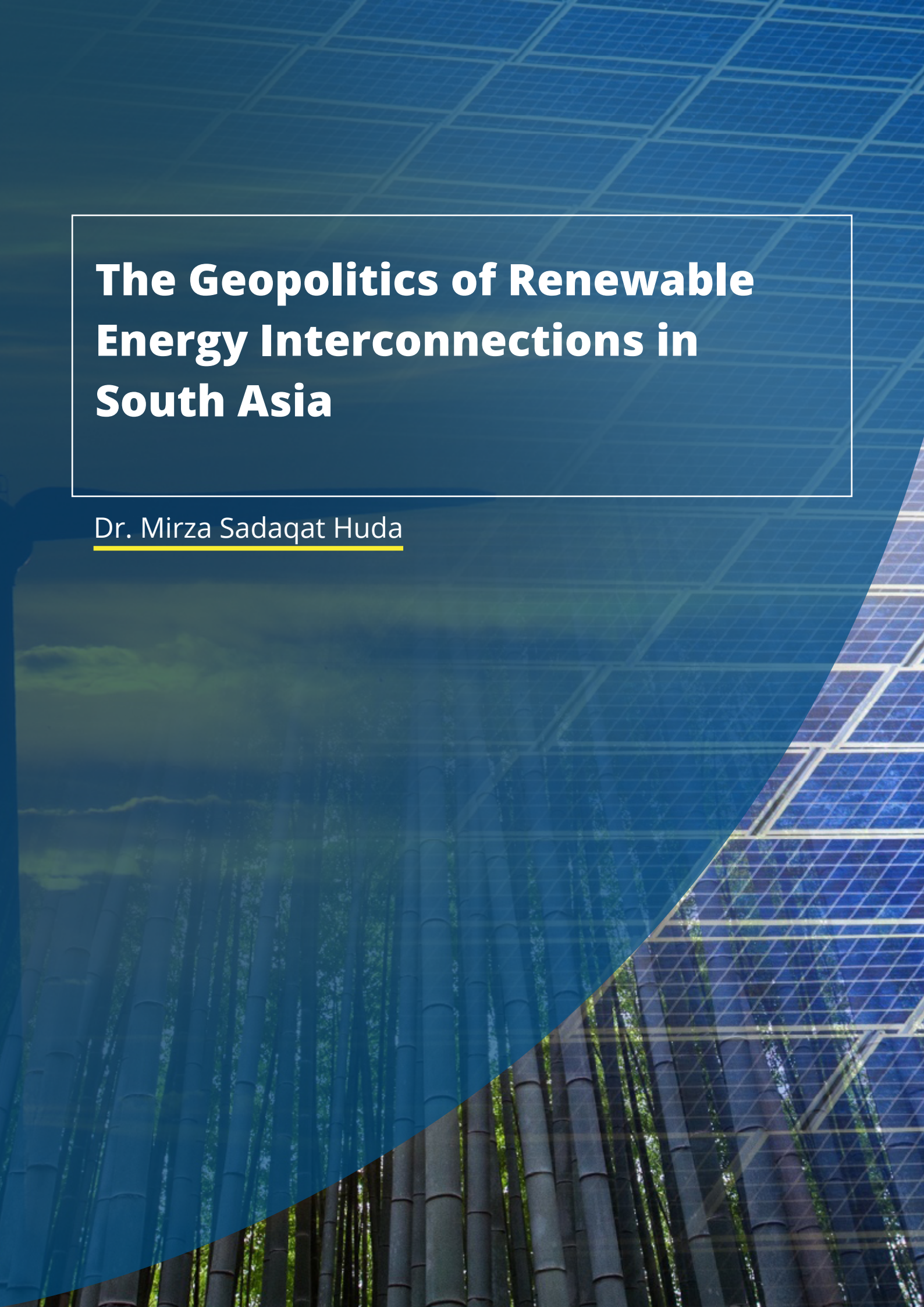
82 New Zealand Government 2018: New Zealand signs hydrogen agreement with Japan, 23 Oct 2018, in: https://www.beehive.govt.nz/release/new-zealand-signs-hydrogen-agreement-japan [23 Oct 2021].

83 METI 2018: METI and New Zealand Government Sign Memorandum of Cooperation on Hydrogen, 23 Oct 2018, in: https://www.meti.go.jp/english/press/2018/1023_006.html [23 Oct 2021].

84 Mitsubishi Heavy Industries Ltd. 2020: MHI to Invest in Green Hydrogen & Green Ammonia in South Australia: To Deliver Project Engineering, Hydrogen Gas Turbines and Compressors to Decarbonize Local Industries, Targeting Green Hydrogen and Ammonia Exports to Japan and Other Countries Going Forward, 26 Nov 2020, in: https://www.mhi.com/news/201126.html [23 Oct 2021].
85 Vorrath, Sophine 2020: Japan giant buys into Australian green hydrogen pioneer and big South Australia project, RenewEconomy, 26 Nov 2020, in: https://reneweconomy.com.au/japan-giant-buys-into-australian-green-hydrogen-pioneer-and-big-south-australia-project-16512/ [23 Oct 2021].
86 Out-law news 2021: Australia-Japan consortium explores hydrogen supply chain, Pinsent Masons, 30 Sept 2021, in: https://www.pinsentmasons.com/out-law/news/australia-japan-consortium-explores-hydrogen-supply-chain [23 Oct 2021].
87 Shrestha, Priyanka: Australia power firm granted $2.17m to assess green hydrogen export to Japan, Energy Live News, 29 Sept 2021, in: https://www.energylivenews.com/2021/09/29/australia-power-firm-granted-2-17m-to-assess-green-hydrogen-export-to-japan/ [23 Oct 2021].
88 Argus Media 2021: Australian CS Energy, Japan IHI to build hydrogen plant, 12 Oct 2021, in: https://www.argusmedia.com/en/news/2262638-australian-cs-energy-japan-ihi-to-build-hydrogen-plant [23 Oct 2021].
89 Commonwealth of Australia, 2019, n.14.
90 International Energy Agency 2019: The Future of Hydrogen, Jun 2019, in: https://www.iea.org/reports/the-future-of-hydrogen [13 Sept 2021].
91 Deloitte 2019: Australian and Global Hydrogen Demand Growth Scenario Analysis: report for COAG Energy Council – National Hydrogen Strategy Taskforce, Nov 2019, in: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/future-of-cities/deloitte-au-australian-global-hydrogen-demand-growth-scenario-analysis-091219.pdf [13 Sept 2021].
92 Hydrogen Council 2020: Path to hydrogen competitiveness: A cost perspective, 20 Jan 2020, in: https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf [13 Sept 2021].
93 ACIL Allen Consulting 2018: OPPORTUNITIES FOR AUSTRALIA FROM HYDROGEN EXPORTS ACIL ALLEN CONSULTING FOR ARENA, Aug 2018, in: https://arena.gov.au/assets/2018/08/opportunities-for-australia-from-hydrogen-exports.pdf [13 Sept 2021].
94 Organisation for Economic Cooperation and Development 2021: OECD iLibrary International Trade by Commodity Statistics SITC Revision 3, in: https://www.oecd-ilibrary.org/trade/data/international-trade-by-commodity-statistics/sitc-revision-3_data-00054-en [13 Sept 2021].
95 Ibid.
96 Ibid.
97 Ibid.
98 Ibid.
99 Ibid.
100 Ibid.
101 Ibid.
102 The International Group of Liquefied Natural Gas Importers n.d.: LNG MARKETS & TRADE, in: https://giignl.org/lng-markets-trade-0 [13 Sept 2021].

The Geopolitics of Renewable Energy Interconnections in South Asia

Dr. Mirza Sadaqat Huda



Abstract

The eight countries of South Asia are currently at the heart of the debate on the nexus between energy, the environment and sustainable development. South Asia is one of the most energy insecure regions in the world as well as being extremely vulnerable to the effects of climate change. In recent years, the need to address growing energy demand while reducing carbon emissions has created some political momentum towards the development of renewable energy resources in the region. However, the contribution of renewables in the energy mix of Pakistan and India, the 4th and 17th largest greenhouse gas contributors in the world, needs to be developed at a faster rate in order to achieve net zero global emissions by 2050/2070. In addition, regional grid interconnections that play an important role in exploiting comparative advantages and addressing the variance of renewables are few in number. In this context, this chapter will examine the opportunities and challenges of grid interconnections in South Asia. The chapter contextualises South Asia within the burgeoning literature on the geopolitics of energy transition. It advances knowledge on geopolitical issues related to cybersecurity, critical minerals and "electricity weapons" that constrain renewable energy interconnections in South Asia.

Introduction

South Asia today is one of the most energy-insecure regions in the world. Chronic energy shortages, dependence on costly imported hydrocarbons that increase the threat of climate change and constraints to renewable energy due to financial, behavioural and technical limitations combine to create a set of complex and interlinked problems that need to be urgently addressed in order for the region to continue to grow while pervasive poverty is addressed.[1] The demand for energy in South Asia has been driven mostly by economic growth and demographic expansion. Despite the economic impact of the COVID-19 pandemic, South Asia's average annual growth is forecast to be 3.4 per cent over 2020–23.[2] Another demand-side issue is demographic growth. South Asia has almost 1.8 billion people and is growing at an annual rate of 1.15 per cent,[3] although growth rates vary considerably among countries.[4]

To meet their energy needs, South Asian countries have mostly depended on expensive imports of oil and gas from outside the region, which has exacerbated balance of payments issues while not making any progress towards sustainable, long-term energy security.[5] [6] In recent years, South Asian countries have undertaken some cooperation on gas,[7] [8] hydroelectric dams,[9] [10] [11] and coal-fired power plants.[12] Contemporary progress has been driven by India's renewed emphasis on developing ties with neighbouring states to counter growing Chinese influence in South Asia. Yet, the number of projects being developed is very low in comparison to the enormous potential of cross-border energy cooperation. In addition, with the exception of hydroelectricity, cross-border energy projects are mostly based on the use of fossil fuels. While India has made enormous progress in enhancing the share of renewables in its domestic energy market, it has not undertaken cooperation on solar or wind energy projects with neighbouring states.

Enhancing cooperation between South Asian countries on renewable energy is important from a regional and a global perspective. From a regional perspective, cooperation on renewable energy can reduce costly imports of fossil fuels, decrease greenhouse gas emissions and enhance energy security. Cooperation on sustainable energy can also increase regional interdependence and peacebuilding.[13] [14] From a global perspective, the reduction of emissions due to the pandemic is expected to have an insignificant impact on mitigation efforts. Therefore, post-pandemic economic recovery efforts should be powered by renewable energy, which will require greater levels of international cooperation. Examining the challenges and opportunities of renewable energy interconnections in South Asia is therefore of critical importance.

This chapter proceeds in four parts. The first section provides an overview of the geopolitics of South Asia. This is followed by an analysis of how South Asia is likely to be affected by the

geopolitics of energy transition. The third section undertakes analysis of potential renewable energy interconnections in two geographic areas: Eastern South Asia comprising India, Bangladesh, Bhutan and Nepal; and Western South Asia comprising India and Pakistan. The fourth section provides a conclusion and policy recommendations.

The Geopolitics of South Asia

The geopolitics of South Asia have traditionally been underpinned by five regional realities:

1. internal issues of civil war, ethno-religious violence and separatism;
2. military conflict between India and Pakistan; and
3. political conflicts between India and the smaller states of Bangladesh, Nepal and Sri Lanka.[15]

In the last decade, the geopolitics of South Asia have been influenced by two other developments:

1. increasing influence of China in South Asia and New Delhi's territorial conflicts with Beijing and
2. rise of ethno-nationalistic populism in multiple countries of the region.

The term "South Asia" is a geographic expression that encompasses the eight diverse and sovereign states of Afghanistan, Bangladesh, Pakistan, India, Burma, Nepal, Sri Lanka, and the Maldives. The territorial, religious and ethnic disputes in South Asia are rooted in the tumultuous years before and after the end of almost three centuries of British colonisation.[16] [17] At the end of the colonial period in 1947, the subcontinent was divided along religious lines into Hindu-majority India and Muslim-majority East and West Pakistan. The Partition was one of the largest mass migrations in history and resulted in the death of almost one million people from religious violence. The hasty retreat by colonial forces led to the enduring conflict over Kashmir, which has been the focus of three wars between India and Pakistan. In 1971, supported by India, East Pakistan seceded to become Bangladesh after a six-month war, during which a large number of Bangladeshis were killed by the Pakistani army.[18]

These historical grievances have defined almost all interactions between the countries of the subcontinent, including energy cooperation. The low level of energy integration in South Asia today is significantly attributable to the tendency of domestic political parties to try to draw legitimacy through perpetuating hatred and animosity towards a neighbouring state by exploiting the tragedies of 1947 and 1971. Analysts have traditionally attributed the failure of regional cooperation in South Asia to the tensions between nuclear-armed Pakistan and India and the inability of the leaders of these two countries to overcome decades of mistrust and conflict. However, regional energy cooperation in South Asia hinges not only on India's relationship with Pakistan but on India's relationship with all other countries in the region, and how these relationships have influenced bilateral relationships between each of the smaller nations.[19]

For decades, India's policies have been detrimental to multilateral cooperation. Two dynamics of India's foreign policy have stagnated multilateralism: the first is India's approach to the South Asian Association for Regional Cooperation (SAARC) and the second is its policies on dealing with neighbouring countries in regard to regional concerns such as water and energy. During the inception of SAARC, India insisted on the principle of unanimity in decision-making, and the exclusion of all bilateral and contentious issues from deliberations. These two provisions have constrained the decision-making powers of the SAARC and effectively eschewed the discussion of critical bilateral issues, thereby perpetuating conflicts which in turn have impinged on regional cooperation. Prior to 2014, India's preference for bilateralism over multilateralism or even subregional initiatives related to water, energy and other issues has been a significant constraint on regional cooperation.[20]

Within this context, recent political developments at the regional and national levels have enhanced the prospects for the realisation of regional energy projects. Since coming to power in 2014, the Hindu nationalist Bharatiya Janata Party (BJP) government in India has undertaken a range of policies that were

aimed to reverse India's resistance to multilateral cooperation, removing one of the biggest obstacles to energy integration. In the last seven years, New Delhi's "Neighbourhood First" policy has attempted to manifest the long-awaited political will that has eluded regional cooperation initiatives in South Asia.

In 2014, India and Nepal signed a Power Trading Agreement, followed by agreements on developing two hydroelectric projects, the Upper Karnali and Arun III in 2015. In the same year, the members of the South Asian Association for Regional Cooperation (SAARC) signed the "SAARC Framework Agreement for Energy Cooperation (Electricity)" which gave further impetus to energy cooperation. In addition to bilateral engagements, New Delhi has agreed to allow cross-border trade of electricity between Bangladesh, Bhutan and Nepal through Indian territory, raising the prospects of multilateral collaboration on energy infrastructure. In 2018, the Ministry of Power of India released guidelines for the export and import of electricity that will facilitate trilateral collaboration in relation to electricity, a marked change from previous doctrines that only recognised bilateral cooperation.

Yet, progress in regard to regional energy cooperation has been met by a dichotomous increase in ethno-nationalistic populism. In India, the Hindu nationalist Bharatiya Janata Party (BJP) government, which won consecutive elections in 2014 and 2018, has pursued exclusionist and majoritarian policies, leading to the denigration of India's secular and inclusive culture. In Pakistan, religious extremists have pursued the creation of a homogeneous Sunni Muslim identity with little or no resistance from the government.[21] In Bangladesh, the Awami League has come under increasing criticism for its authoritarian measures and undemocratic practices. The rise of ethno-nationalistic populism in South Asia has exacerbated the deep divisions of the Partition. Currently, relations between India and Pakistan are particularly volatile. In early 2019, a suicide car bombing in Indian-administered Kashmir resulted in the two nuclear-armed rivals undertaking air strikes on each other's territory. While India has a very strong relationship with the ruling elites in Dhaka, the BJP does not share the same affinity with the people of Muslim-majority Bangladesh — one senior party leader referred to Bangladeshi migrants in India as "termites".[22]

Further complicating energy cooperation in South Asia is India's territorial conflict with China. New Delhi has traditionally perceived China's economic and military cooperation with South Asian countries with suspicion. India has refused to participate in China's Belt and Road initiative and has collaborated with the United States, Australia, and Japan under the auspices of the Quadrilateral Security Dialogue to deter Chinese influence in Asia-Pacific. In 2020 and 2021 India and China engaged in a series of violent clashes at disputed borders near the ecologically sensitive Himalayas.

Geopolitics of Energy Transition

In the coming decades, South Asia's volatile political landscape is likely to be impacted by the geopolitics of energy transition, which can either exacerbate existing tensions or lead to the development of mutually beneficial cooperation. Energy transition involves the replacement of fossil fuels with renewable energy sources, which will have an enormous impact on global energy trade and geopolitics. The impact of energy transition on geopolitics has been elucidated by Professor Carlos Lopes, Member of the Global Commission on the Geopolitics of Energy Transformation, IRENA who mentioned in a recent interview that "We are moving from a world that defines energy in form of stocks, to one that defines it in form of flow".[23] The prevailing geopolitics of energy are therefore likely to be determined not by access to resources but by distribution and infrastructure management.

Traditionally, energy geopolitics have been determined by stocks of fossil fuels, maritime chokepoints and intense strategic competition. Contemporary academic literature[24] [25] as well as reports by the International Renewable Energy Agency (IRENA)[26] propose that the geopolitics of renewable energy will be markedly different from that of fossil fuels.

Some academics argue that energy transition will lead to reduced political conflicts. This is because unlike oil, gas or coal, renewable energy is not

constrained to particular geographic areas but is available globally, which makes it difficult to manipulate for geopolitical purposes. Due to the ubiquitous nature of renewable energy sources, states will not be motivated to start conflicts to control them.[27] In addition, renewable energy is also expected to increase independence, thereby contributing to "energy democracy", which can increase stability and reduce geopolitical conflicts.[28]

Other academics argue that energy transition can lead to increased geopolitical tensions through technological competition, unsustainable use of raw materials, and disproportionate costs paid by vulnerable countries and communities.[29] [30] In such a scenario, renewable energy technology will replace oil and gas as the driver of geopolitical tensions.[31] Some scholars also argue that while renewables can reduce petroleum wars, they can lead to economic conflicts and trade wars, which will have important implications for geopolitics.[32]

The issues highlighted above have important implications for South Asia. In the sections below, I examine how some of the key geopolitical challenges of energy transition can affect existing political tensions as well as prospects for energy cooperation in South Asia.

Competition over Critical Materials

Energy transition will require the extraction, processing, and trade of a number of metals and mines that are important to the development of renewable energy technologies. There is a growing perception among policymakers that critical materials related to energy transition can be used as a geopolitical tool by countries that control deposits and production. The number of critical materials vary by study and there is no consensus on their composition, apart from their importance to the production of renewable energy technologies.[33] The 17 rare earth minerals which are important components in the magnets used in wind turbines are considered particularly important to energy transition.[34]

In South Asia, Chinese control of rare earth minerals is a significant concern for India. Currently, China provides more than 85 per cent of the world's rare earths and is home to about two-thirds of the global supply of rare metals and minerals (Seah & Joshi 2021). In addition, China has not hesitated to utilise its control of rare earth minerals for geopolitical purposes. For example, in 2010, Beijing stopped exports of rare earths to Japan following a maritime dispute, which created significant concerns among all countries dependent on Chinese supplies. The ongoing territorial dispute between China and India can lead to disruptions in supplies, which will negatively impact India's renewable energy projects.

Some academics provide a more nuanced perception of critical minerals, arguing that these resources are more abundant than is often stated and can be replaced and replenished through technological advancements and recycling.[35] [36] Given that China and India are two of Asia's largest markets for renewable energy, there is great potential for cooperation between these two countries over the sustainable utilisation of metals important for energy transition. Some areas of cooperation include joint exploration, extraction, and refining of minerals, as well as the development of rules-based and well-regulated markets for these resources. Cooperation between China and India over rare earths is likely to enhance collaborative approaches to rare earth minerals in the broader South Asian region.

Cybersecurity

The global deployment of renewables will be matched by the increasing digitalisation of energy infrastructure. Digitalised grids that connect multiple countries and continents may be subject to cyber attacks by hostile state and non-state actors. Some analysts claim that these threats are highly likely and can have devastating consequences for national and international security.[37] In recent years, governments in Australia, Germany and Belgium have prevented Chinese companies from investing in energy infrastructure, citing concerns about cyber espionage.[38] Reusswig et al.[39] argue that the core issue that prevents international cooperation on high-tech grids is the lack of trust between major powers.

Cybersecurity is a critical cause for concern in South Asia due to the vulnerability of existing systems and plethora of political conflicts between neighbouring states. Given the existing conflicts between India and Pakistan and India and China and the increasing prominence of digital technology in espionage and warfare, the likelihood of energy infrastructure being subject to cyber attacks cannot be ignored. In 2020 India banned 59 Chinese apps from operating in the country, a reflection of New Delhi's apprehensions about China's political use of digital technologies. In addition to state actors, non-state actors involved in the large number of insurgencies and intrastate conflicts in South Asia may also have interests in undertaking cyber attacks against energy infrastructure.

Some academics argue that cyber threats are exaggerated and should be perceived in the context of broader issues related to cyber-crime, which is likely to be countered by increasingly more resilient technological systems and processes.[40] [41] Within this context, cyber threats to energy infrastructure is a common threat that will affect all countries of South Asia as well as China and will require collaborative responses. Under the 2016 "Framework for the U.S.-India Cyber Relationship", Washington and New Delhi have undertaken a series of exchanges on cybersecurity issues and this arrangement can be expanded to include multiple countries of South Asia. Joint training between energy officials of South Asian countries on cybersecurity and state-level agreements on codes of conduct in the digital sphere can do much to reduce geopolitical apprehension about the vulnerability of energy infrastructure to cyber attacks.

The Electricity Weapon

To achieve net-zero carbon by 2050, the proportion of electricity within global energy consumption will need to increase from the current level of 21 per cent to 51 per cent.[42] This will mean that the most important segments of societies, such as transport and manufacturing, will be powered by electricity. This electricity dependence has led to concerns about cross-border electricity interconnections being vulnerable to the "electricity weapon", a concept that gained prominence after Russia halted gas and electricity supplies to Ukraine and Georgia following geopolitical conflicts in 2006.[43]

There is some concern among policymakers that powerful countries that are leading the energy transition process will utilise their control of transnational electricity grids and technological expertise to oppress and control weaker states.[44] This geopolitical challenge is particularly relevant for the conflict prone borders of South Asia. The India-Pakistan border is one of the most militarised regions of the world and is subject to repeated cross-border violence. While the governments of India and Bangladesh have a stable bilateral relationship, a large number of Bangladeshi civilians are arbitrarily killed or injured every year by Indian security forces at the international border. In 2015, a bilateral dispute between Nepal and India led New Delhi to implement an official blockade at the border between the two countries, leading to acute fuel shortages, and brought the country to a virtual standstill. As a result of border conflicts and other political disputes, existing electricity trade between India and the smaller countries of Nepal, Bangladesh and Bhutan are insignificant in relation to potential, as demonstrated in Table 15. Currently, there is no electricity interconnection between India and Pakistan. Therefore, in a regional context where borders are the epicentres of conflict and instruments of hegemonic oppression, the fear of the "electricity weapon" is an important geopolitical challenge to transnational energy interconnections.

Some scholars argue that deliberate disruptions of electricity supplies are extremely rare and such threats are mitigated by increasing levels of energy independence and multiple supply options offered by renewables.[45] Scholten and Bosman[46] put forth the concept of "grid communities" which envisions renewable energy interconnections as mechanisms that facilitate interdependence between countries and thereby disincentivise deliberate disruptions. South Asian countries can engage in technical and diplomatic processes to address the threat of deliberate disruptions of cross-border electricity grids. This can be in the form of agreements on codes of conduct regarding cross-border energy trade and technical designs that enhance interdependence and increase the cost of deliberate disruptions.

Renewable Energy Potential in South Asia

Energy experts argue that cross-border electricity grids powered by solar, wind, and other sources between neighbouring countries and at the intercontinental level can maximise comparative advantages and address the variable nature of renewables.[47] As seen in Table 14, currently South Asian countries are highly dependent on fossil fuels for electricity generation. Domestic coal dominates the energy mix of India's power generation while Bangladesh is highly dependent on gas and Pakistan uses substantial amounts of both gas and oil to generate electricity. South Asia's reliance on fossil fuels has continued for decades despite substantial potential for the development of renewable energy sources. As seen in Table 15, South Asia has abundant solar, wind and hydroelectric resources, which can be harnessed through regional cooperation. In the next sections, I discuss some existing cooperation over energy interconnections as well as future opportunities.

Table 14: Electricity Mix of South Asian Countries[48]

Country	Electricity production (kWh billion)	Coal (% of total)	Natural gas (% of total)	Oil (% of total)	Hydropower (% of total)	Renewable energy (% of total)	Nuclear power (% of total)
India	1052.3	67.9	10.3	1.2	12.4	5	3.2
Sri Lanka	11.6	8.9	0	50.2	39.7	1.2	0
Pakistan	95.3	0.1	29	35.4	29.9	0	5.5
Afghanistan	–	–	–	–	–	–	–
Bangladesh	44.1	1.8	91.5	4.8	2	0	0
Nepal	3.3	0	0	0.1	99.9	0	0

Table 15: Renewable Energy Potential in South Asia[49] [50]

Country	Solar power potential (kWh/m2/day)	Hydropower potential (MW)	Wind power potential (MW)
India	5.0	150,000	102,778
Sri Lanka	5.0	2,000	24,000
Pakistan	5.3	59,000	131,800
Afghanistan	6.5	25,000	158,000
Bangladesh	5.0	330	–
Nepal	4.0	83,000	–
Bhutan	2. 7	41,000	760

Renewable Energy Interconnections Between India, Bangladesh, Bhutan and Nepal

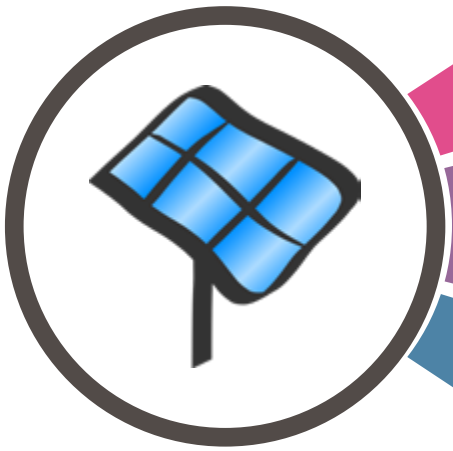
As shown in Table 16, energy interconnections in South Asia exist only at the bilateral level, between India and the countries of Nepal, Bhutan, and Bangladesh. However, in recent years, significant progress has been made towards the development of multilateral transmission lines under the auspices of regional organisations such as the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) and sub-regional frameworks such as the Bangladesh, Bhutan, India, Nepal (BBIN) Initiative. The BIMSTEC regional power grid envisions cross-border interconnections between the electricity grids of Sri Lanka, India, Nepal, Bangladesh, Bhutan, Myanmar and Thailand. These interconnections between multiple countries of South and Southeast Asia can have environmental benefits by facilitating trade in electricity generated through hydroelectric dams and solar farms and also enhance economic growth by generating foreign exchange revenues and access to cheap energy.[51]

The BBIN Initiative envisions trade in hydroelectricity through grid interconnections between the countries of Eastern South Asia. Under this framework, India and Bangladesh will import electricity from hydropower dams in Bhutan and Nepal, which can have the added benefit of incentivising multilateral cooperation over the integrated river basin management of the Ganges-Brahmaputra-Meghna Basin.[52] Currently, two regional hydroelectric dams are being developed through multilateral cooperation, i.e., the 900 megawatts Upper Karnali Dam in Nepal and the 1,125 megawatts Dorjilung Dam in Bhutan.

Table 16: Existing Electricity Interconnections in South Asia[53]

Countries	Electricity Interconnections
India Nepal	Multiple lines at 400 KV, 132 KV, and lower voltages connected under synchronous mode. These include: » 400 KV D/c Dhalkebar-Muzzafarpur line » 132 KV lines: Kataiya-Duhabi, Raxaul-Parwanipur, Kataiya-Kushaha, Gandak East-Gandak/Surajpura, Tanakpur-Mahendranagar
India Bangladesh	Connected through two major lines: » 400 KV Bheramara- Baharampur » 400 KV Surjyamaninagar – South Comilla
India Bhutan	Multiple lines at 400 KV, 220 KV, 132 KV, and lower voltages connected under synchronous mode. These include: » 400 kV Tala HEP-Siliguri » 220 KV Chukha HEP-Birpara » 132 kV – Geylephu-Salakati » 132 kV – Deothang-Rangia

RENEWABLE ENERGY INTERCONNECTIONS BETWEEN INDIA, BANGLADESH, BHUTAN, AND NEPAL



Interconnections in South Asia exist only at the bilateral level, between India and the countries of Nepal, Bhutan, and Bangladesh.

One such regional organization is the Bay of Bengal Initiative for Multi-Sectoral Technical & Economic Cooperation (BIMSTEC) and sub-regional frameworks such as the Bangladesh, Bhutan, India, Nepal (BBIN) Initiative.

In recent years, significant progress has been made towards the development of multilateral transmission lines under the auspices of regional organizations.

Renewable Energy Interconnections Between India and Pakistan

High-level military conflict between India and Pakistan has prevented the development of energy interconnections between the two countries. However, plans by India and Pakistan to construct solar and wind farms near each other's territory provide an opportunity for technical cooperation that can complement the current momentum towards energy integration. Both countries are planning to install solar panels and wind turbines near the shared Thar Desert, an ecologically diverse landscape that falls in between the international border of the two countries. Currently, the Indian states of Rajasthan and Gujarat that share borders with Pakistan have solar and wind energy capacities of 4,046 megawatts and 9,760 megawatts respectively. Indian projects include the Charanka Solar Park, the largest solar park in Asia which is located just 50 kilometers from the border with Pakistan. In October 2019 it was reported that land close to the international border with Pakistan was being considered for the setting up of 30 GW and 25 GW of solar and wind energy plants in Gujarat and Rajasthan, respectively. In Pakistan, the 100 megawatts Quaid-e-Azam Solar Park in Punjab is located approximately 100 kilometers from the Indian border. Similar to India, Pakistan is planning to capitalise on its energy and wind resources, and is considering proposals for a 400 megawatts solar plant and a 640 megawatts wind farm in Sindh.[54]

India and Pakistan's individual efforts to develop clean energy resources in close proximity to their shared border have created substantial opportunities for collaboration. In July 2013, it was reported that a delegation of Pakistani experts visited India to study the use of solar plants in irrigation, a mere six months after one of the worst border skirmishes between the two countries. This suggests that geopolitical issues, no matter how intractable, may not necessarily derail collaboration in relation to energy diversification and transition. Despite the volatility of the current relations between India and Pakistan, the two countries may consider facilitating cross-border exchanges between scientists and engineers on renewable energy technology. This can include field visits to solar and wind farms, joint conferences, and collaborative research projects. In 2030, when the cost of solar power in India will fall to as low as 0.02 U.S. dollars per kilowatt hour and storage expenses will decrease by 70 per cent, technical cooperation can give way to energy trade between India and Pakistan.[55]

Geopolitical Challenges to Renewable Energy Interconnections in South Asia

Electricity interconnections facilitated through BIMSTEC and BBIN and India-Pakistan cooperation can enhance energy security and facilitate interdependence and regional integration. However, these projects also face certain geopolitical challenges. One of the most pressing impediments to peace and development in Asia is New Delhi's ongoing border conflict with China and Pakistan. Due to the political rhetoric from all sides, India views China's cooperation with South Asian countries with a great deal of suspicion. While such myopic perceptions undermine economic development and connectivity, it is unlikely to impact proposed electricity interconnection projects. First, China's domination of rare earth supplies is unlikely to impact energy cooperation in Eastern South Asia, as energy integration in this region is focused to a large extent on hydroelectric dams that are not dependent on these minerals. Second, while rare earths are required for the development of solar, wind, and other technologies, China's interests in maintaining good relations with Pakistan, Bangladesh, Nepal, and Bhutan is likely to discourage Beijing from using rare earth supplies to extract geopolitical concessions from India.

A greater threat to energy interconnections comes from within South Asia. As mentioned in the previous sections, the contemporary rise in ethno-nationalistic populism has exacerbated intra-state as well as inter-state conflicts in the region. Increased tensions between communities and countries can increase the cybersecurity risks of renewable energy infrastructure and also enhance the threat of deliberate disruptions of electricity supplies.

During territorial or political tensions, countries that are excluded from participating or benefiting from energy interconnections may be incentivised to undertake physical and cyber attacks against regional grids. Ensuring energy interconnections between India and her neighbours to the east as well as the west can reduce the risk of physical and cyber threats to energy infrastructure by the facilitation of region-wide energy interdependence.

Non-state actors have become increasingly involved in instigating conflicts even between states that have strong bilateral relationships. For example, following communal riots in Bangladesh in October 2021, Hindu extremists unleashed mass violence on Muslim minorities in the Indian state of Tripura. While the BJP has tried to place itself as the vanguard of Hindu interests globally, its official response to the crisis in Bangladesh was measured as it did not want to risk losing influence in Dhaka, which further angered Hindu extremists. Even if energy interdependence disincentivises state-level actors to target the energy infrastructure of neighbouring states, non-state actors who are instigated by political rhetoric, fake news and propaganda can be inspired to undertake cyber or physical attacks. Pandering to extremists for narrow political gains at the national level can thus have repercussions for regional energy integration.

India's use of its economic and military strength to intervene in the domestic affairs of Nepal and Bangladesh creates significant concerns regarding the use of deliberate disruptions. The interdependence created by a regional grid can reduce New Delhi's incentives to instigate deliberate disruptions of electricity in neighbouring states. Yet, as demonstrated by the blockade of Nepal's borders in 2015, India has the resources and political clout to absorb any costs associated with cutting off one of its neighbours from essential supplies. Given New Delhi's increasing paranoia about Nepal and Bangladesh's cooperation with China, India may use deliberate disruptions of electricity supplies for geopolitical gains. In the case of interconnections between India and Pakistan, either country can disrupt electricity supplies as a response to conflicts. The two countries have regularly cancelled economic, sporting, and cultural exchanges as a result of geopolitical conflicts and thus the continuation of energy trade is highly likely to be dependent on the political relationship between the two countries.

Another challenge to regional energy cooperation is the environmental impacts of renewable energy, which can impact geopolitics. The development of hydroelectric dams can have devastating impacts on the communities and environments

of multiple countries. The development of dams at the national level in South Asian countries has resulted in domestic as well as international conflicts.[56] A multilateral approach to managing the environmental impacts of hydroelectric dams is impeded by agreements regarding transnational rivers that have perpetuated the establishment of sovereign rights to water and focused on dividing rather than sharing natural resources. In addition, policymakers in countries that export hydroelectricity are concerned about the environmental impact of regional dams, while such issues receive little recognition in countries that might import this resource.[57]

Solar and wind farms can also undermine the environment in South Asia. The Thar desert, where multiple renewable energy projects are being developed by India and Pakistan, is home to critically endangered species, and six areas within the desert have been reserved for ecological conservation by India and Pakistan. It is also one of the most densely populated deserts in the world, home to 1.2 million people, from multiple religious and ethnic backgrounds, who face grave socioeconomic challenges.[58] Large-scale development of renewable energy projects in the Thar and surrounding areas has resulted in resettlement, disruptions of traditional livelihoods, and undermined food security.[59] If the societal and environmental challenges of renewable energy projects are not addressed, they can lead to political opposition against such initiatives, which can undermine the potential of energy interconnections between India and Pakistan.

Energy interconnections in South Asia are also impeded by the way the costs and benefits of cooperation are perceived by politicians. The inherent link between energy and electoral politics in South Asia has created the acceptance of energy as a political good rather than an economic one, which has in turn impinged on creating consensus on the opportunity cost of non-cooperation. In South Asia, resource nationalism is a fundamental challenge to regional energy cooperation. The root cause of the rise of resource nationalism in South Asian countries is the fallacy of the way in which the costs and benefits of resources are conceptualised by politicians. Leaders of the region often focus solely on the total amount of hydrocarbon deposits or hydroelectric potential in their jurisdiction, rather than attempt to create public consensus on the accumulated benefits of resource utilisation. This confined perception was apparent among certain political leaders in Bangladesh when Indian companies signed production-sharing contracts with Dhaka to explore hydrocarbons in the Bay of Bengal in early 2014. Political rhetoric expounded by leaders with regard to the total value of renewable energy potential in individual countries will perpetuate the perception of energy resources as a strategic asset that needs to be controlled rather than one that should be utilised for the betterment of mankind.[60]

Conclusion

Energy interconnections in South Asia can have benefits for energy security, the environment and regional peacebuilding. Due to the challenges outlined above, policymakers in South Asian countries must invest in sustained collaboration when designing the modalities of cross-border electricity grids. This can include agreements and protocols on cross-border energy infrastructure that oblige parties to facilitate uninterrupted energy supplies. Such agreements can be based on the Transit Protocol of the Energy Charter. South Asian countries can also engage in regional non-binding agreements on cybersecurity that oblige countries to refrain from undertaking cyber attacks against the energy infrastructure of neighbouring states. In developing renewable energy projects, regional countries should implement best practices alongside social and environmental safeguards such as the International Finance Corporation's Environmental and Social Performance Standards to ensure that energy transition does not undermine the environment and the interests of vulnerable people. Political leaders in South Asia must also contribute towards changing perceptions around energy utilisation and resource nationalism.

Yet, renewable energy is only one element of the broader push towards energy transition. At the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow in 2021, India made a pledge

to achieve net-zero carbon by 2070. To reach this target India and the other countries of South Asia will need to undertake cooperation over multiple aspects of energy. As demonstrated by Van de Graaf et al.,[61] this includes a decrease in investment in fossil fuels and an increase in international trade in renewable energy technology and goods such as solar panels, wind turbines, and batteries. Technology transfer related to the engineering, maintenance and installation of renewable energy infrastructure will need to gain momentum in the coming decades.[62] Increases in the production and trade in hydrogen and biofuels such as methane and methanol will play an important role in the reduction of fossil fuel in transport, which will require international investment in regional hubs for the production of these resources.[63] Progress in these critical nodes of cooperation will determine the momentum of renewable deployment and the timeline of the energy transition process.

In the current geopolitical climate, energy interconnections between the eastern and western parts of South Asia will evolve at different paces. The momentum towards establishing multilateral energy interconnections between India, Bangladesh, Bhutan, and Nepal have been delayed due to the COVID-19 pandemic as well as various bureaucratic and political issues. The status of cross-border energy projects is also not regularly updated and thus the general populations of South Asia and various non-government organisations are not involved in the discourse on regional energy cooperation. The four countries should engage in ensuring continuous progress towards energy projects and provide regular briefings to stakeholders on current statuses of cross-border projects. Lastly, the establishment of the long-awaited BIMSTEC Energy Centre should be expedited.

India and Pakistan can benefit from technical cooperation such as study exchanges and joint research and experimentation on solar and wind energy technology. Regional educational institutions such as the South Asian University should consider developing courses on energy and water security in arid regions, which can enhance interactions on resource governance between Pakistani and Indian students. Efforts towards policy and tariff harmonisation and investment in cross-border infrastructure can perhaps one day lead to renewable energy trade between the two countries.

South Asian countries can use cooperation over solar and wind energy to facilitate a regional water-energy nexus approach to climate change, with significant benefits for regional stability. An initiative by EcoPeace Middle East found that exploiting the synergies between Jordan's solar power potential and Israel's expertise in desalination can contribute towards climate goals and the Middle East peace process between Jordan, Israel, and Palestine. The project envisions Jordan as a regional hub for solar plants — exporting energy to Israel to power the desalination of water from the Mediterranean Sea. The clean water will be exported to Jordan and Palestine, thereby increasing the energy and water security of the region, and increasing interdependence. Such holistic projects are already being undertaken in Pakistan, where water pumps and purification facilities powered by solar panels have ensured safe drinking water for underprivileged populations.[64]

Lastly, South Asian collaboration in regard to renewable energy can benefit from innovative finance options that monetise not only renewable energy generation but social co-benefits such as peacebuilding. Peace Renewable Energy Credits (P-RECs) are a new variant of traditional RECs that denote the environmental, social, and peacebuilding attributes associated with renewable energy generation from projects located in fragile settings, including conflict affected areas and humanitarian missions. In South Asia several energy projects are being proposed in areas that are home to socio-economically challenged populations, several protected wildlife sanctuaries and national parks. These areas have seen perennial border disputes, such as water conflicts between India and Bangladesh over the tributaries of the GBM and territorial conflicts between India and Pakistan. The P-REC can help capture the non-power benefits of multilateral and bilateral collaborative renewable energy projects as they relate to poverty alleviation, ecological protection, and détente between India and Pakistan, and offer an additional way to monetise energy transition.[65]

In summary, while energy interconnections hold great potential for sustainable development and peacebuilding in South Asia, astute political leadership and sustained investment in planning are required to address the challenges and exploit the opportunities related to these projects. South Asian political leaders and energy experts should engage with international actors to implement best practices in the development of a region-wide renewable electricity grid.

Dr. Mirza Sadaqat Huda is Postdoctoral Research Fellow at Organization for Security and Co-operation in Europe (OSCE) Academy.

CONCLUSION/RECOMMENDATIONS

Energy interconnections in South Asia can have benefits for energy security, the environment, and regional peacebuilding.

Due to the challenges faced in the region, policymakers in South Asian countries must invest in sustained collaboration when designing the modalities of cross-border electricity grids.

South Asian countries can also engage in regional non-binding agreements on cybersecurity that oblige countries to refrain from undertaking cyber attacks against the energy infrastructure of neighboring states.

In developing renewable energy projects, regional countries should implement best practices alongside social and environmental safeguards.

Political leaders in South Asia must also contribute towards changing perceptions around energy utilization and resource nationalism.

India and the other countries of South Asia will need to undertake cooperation over multiple aspects of energy.

Increases in the production and trade in hydrogen and biofuels such as methane and methanol will play an important role in the reduction of fossil fuel in transport, which will require international investment in regional hubs for the production of these resources.

The four countries should engage in ensuring continuous progress towards energy projects and provide regular briefings to stakeholders on the current statuses of cross-border projects.

South Asian political leaders and energy experts should engage with international actors to implement best practices in the development of a region-wide renewable electricity grid.

While energy interconnections hold great potential for sustainable development and peacebuilding in South Asia, astute political leadership and sustained investment in planning are required to address the challenges and exploit the opportunities related to these projects.

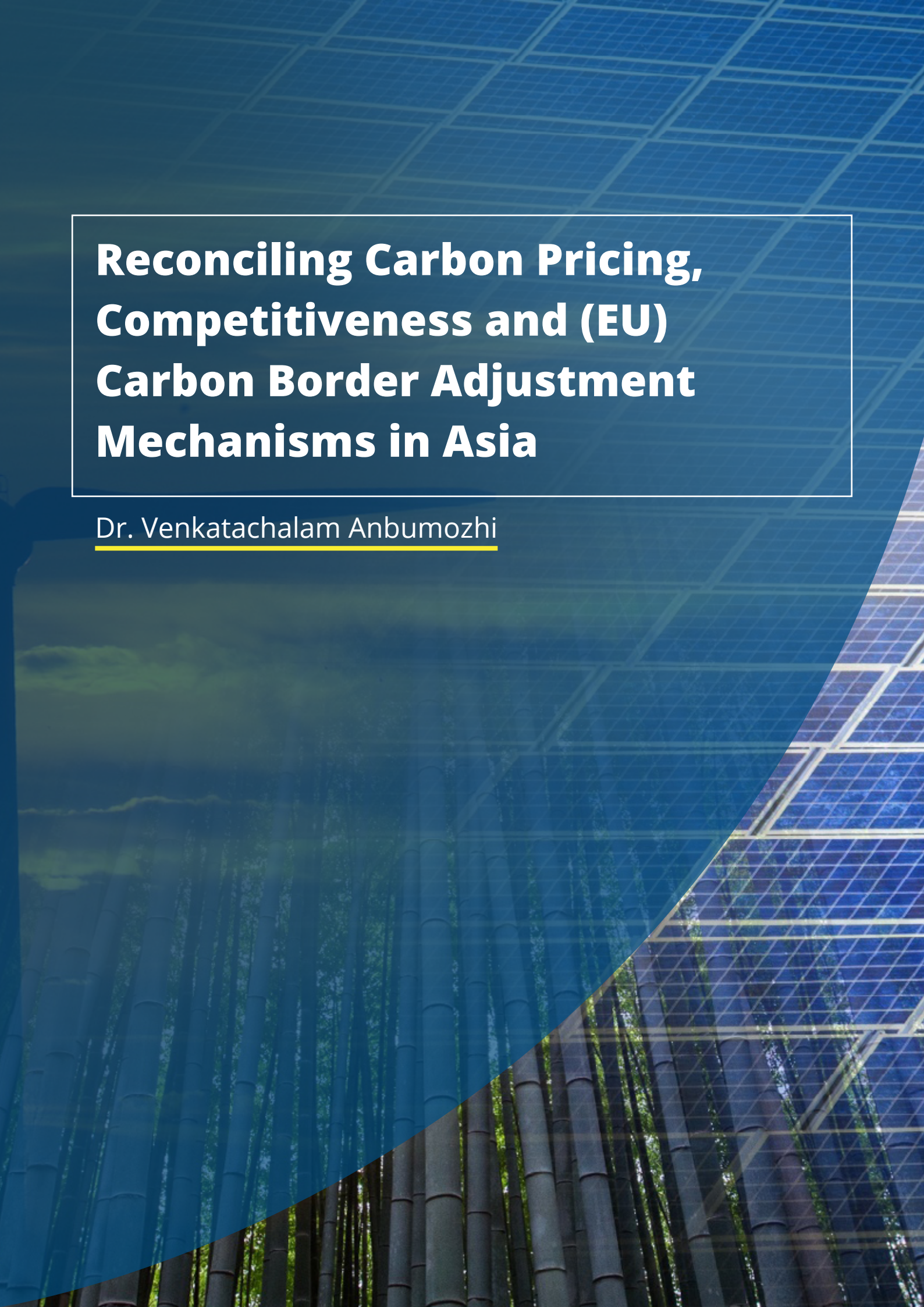
The establishment of the long-awaited BIMSTEC Energy Centre should be expedited.

1 Huda, Mirza Sadaqat 2020b: Energy Cooperation in South Asia: Utilizing Natural Resources for Peace and Sustainable Development, London: Routledge.
2 WB 2021a: Shifting Gears: Digitization and Services-Led Development, South Asia Economic Focus (October), World Bank: Washington.
3 WB 2021b: World Bank Indicators, World Bank: Washington.
4 Huda, 2020b, n. 1.
5 Huda, 2020b, n. 1.
6 Ebinger, Charles K. 2011: Energy and security in South Asia: cooperation or conflict, Washington, D.C: Brookings Institution Press.
7 Huda, Mirza Sadaqat / Ali, Saleem H. 2018: Environmental peacebuilding in South Asia: Establishing consensus on hydroelectric projects in the Ganges-Brahmaputra-Meghna (GBM) Basin. Geoforum, 96, pp. 160–171.
8 Nathan, H. S. K. / Kulkarni, S. S. / Ahuja, D. R. 2013: Pipeline politics-A study of India's proposed cross border gas projects, ENERGY POLICY, 62, pp. 145–56.
9 Huda et al., 2018, n.7.
10 Saklani, Udisha, et al. 2020: Hydro-energy cooperation in South Asia: Prospects for transboundary energy and water security, Environmental Science & Policy, 114, pp. 22-34.
11 Schulz, Christopher / Saklani, Udisha 2021: The future of hydropower development in Nepal: Views from the private sector, Renewable Energy, 179, pp. 1578-88.
12 Huda, Mirza Sadaqat / McDonald, Matt 2016: Regional cooperation on energy in South Asia: Unraveling the political challenges in implementing transnational pipelines and electricity grids. Energy Policy, 98, pp. 73-83.
13 Huda, Mirza Sadaqat / Ali, Saleem H. 2019: The Energy Politics of the Asia-Pacific Region, in Kathleen J. Hancock and Juliann Allison (eds.), The Oxford Handbook of Energy Politics, New York: Oxford University Press.
14 Saklani et al., 2020, n. 10.
15 Huda, Mirza Sadaqat 2021: An ecological response to ethno-nationalistic populism: grassroots environmental peacebuilding in south Asia. International Affairs, 97 (1), pp. 119-38.
16 Huda, Mirza Sadaqat 2019: Addressing Challenges to Regional Energy Cooperation in South Asia, in Narayan, S, Len, Christopher and Roshni, Kapur (ed.), Sustainable Energy Transition in South Asia: Challenges and Opportunities. World Scientific: Singapore, pp. 25-43.
17 Najam, Adil / Yusuf, Moeed 2013: South Asia 2060: envisioning regional futures, London: Anthem Press, An imprint of Wimbledon Publishing Company.
18 Huda, 2021, n. 15.
19 Huda, 2021, n. 15.
20 Huda, 2020b, n. 1.
21 Huda, 2021, n. 15.
22 Huda, 2021, n. 15.
23 Speech by Carlos Lopes at the Commission on the Geopolitics of Energy Transformation, at IRENA 9A, 23 Jan, 2019
24 Bazilian, Morgan, et al. 2020: Four scenarios of the energy transition: Drivers, consequences, and implications for geopolitics, WIREs Climate Change, 11 (2), e625.
25 Overland, Indra 2019: The geopolitics of renewable energy: Debunking four emerging myths, Energy Research & Social Science, 49, pp. 36-40.
26 Van de Graaf, Thijs / Bond, Kingsmill / Overland, Indra 2019: A New World: The Geopolitics of the Energy Transformation, Abu Dhabi: International Renewable Energy Agency.
27 Vakulchuk, Roman / Overland, Indra / Scholten, Daniel 2020: Renewable energy and geopolitics: A review, Renewable and Sustainable Energy Reviews, 122, 109547.
28 Szulecki, Kacper / Overland, Indra 2020: Energy democracy as a process, an outcome and a goal: A conceptual review, Energy Research & Social Science, 69, 101768.
29 Bazilian, Morgan, et al. 2019: Model and manage the changing geopolitics of energy, Nature, 569 (7754), pp. 29-31.
30 Scholten, Daniel / Bosman, Rick 2016: The geopolitics of renewables; exploring the political implications of renewable energy systems, Technological Forecasting and Social Change, 103, pp. 273-83.
31 Raman, Sujatha 2013: Fossilizing Renewable Energies, Science as Culture, 22 (2), pp. 172-80.
32 Vakulchuk et al., 2020, n. 27.
33 Vakulchuk et al., 2020, n. 27.
34 Van de Graaf et al., 2019, n.26.
35 Overland, 2019, n. 25.
36 Van de Graaf et al., 2019, n.26.
37 Scholten & Bosman 2016, n.30.
38 Van de Graaf et al., 2019, n.26.
39 Reusswig, Fritz / Komendantova, Nadejda / Battaglini, Antonella 2018: New Governance Challenges and Conflicts of the Energy Transition: Renewable Electricity Generation and Transmission as Contested Socio-technical Options, pp. 231-56.
40 Overland, 2019, n. 25.
41 Vakulchuk et al., 2020, n. 27.
42 IRENA 2021: World Energy Transitions Outlook: 1.5°C Pathway, Abu Dhabi: International Renewable Energy Agency.
43 Reusswig et al., 2018, n.39.
44 Lilliestam, Johan / Ellenbeck, Saskia 2011: Energy security and renewable electricity trade—Will Desertec make Europe vulnerable to the "energy weapon"?, Energy policy, 39 (6), pp. 3380-91.
45 Overland, 2019, n. 25.
46 Scholten & Bosman 2016, n.30.
47 Overland, 2019, n. 25.
48 Shukla, Akash Kumar / Sudhakar, K. / Baredar, Prashant 2017: Renewable energy resources in South Asian countries: Challenges, policy and recommendations. Resource-Efficient Technologies (3) 3, pp.342-346
49 Ibid.
50 IRENA 2019: Renewables Readiness Assessment: Kingdom of Bhutan, International Renewable Energy Agency, Abu Dhabi.
51 SARI / EI 2020: Prospects of Regional Energy Cooperation and Cross Border Energy Trade in the BIMSTEC region, South Asia Regional Initiative for Energy Integration: New Delhi.

52 Huda & Ali, 2018, n. 7.
53 SARI / EI, 2020, n. 51.
54 Huda, Mirza Sadaqat 2020a: Promoting peace in deserts of sun and wind: renewable energy cooperation between India and Pakistan, Energy Peace Partners: California.
55 Huda, 2020a, n. 54.
56 Huda, Mirza Sadaqat 2017: Envisioning the future of cooperation on common rivers in South Asia: a cooperative security approach by Bangladesh and India to the Tipaimukh Dam, Water International, 42 (1), pp. 54-72.
57 Huda & Ali, 2018, n. 7.
58 Huda, 2021, n. 15.
59 Yenneti, Komali / Day, Rosie / Golubchikov, Oleg 2016: Spatial justice and the land politics of renewables: Dispossessing vulnerable communities through solar energy mega-projects, Geoforum, 76, pp. 90-99.
60 Huda, 2021, n. 15.
61 Van de Graaf et al., 2019, n.26.
62 Sweijs T, et al. 2014: Time to wake up: The Geopolitics of EU 2030 Climate and Energy Policies, The Hague Centre for Strategic Studies.
63 Van de Graaf et al., 2019, n.26.
64 Huda, 2020a, n. 55.
65 Huda, 2020a, n. 55.

Reconciling Carbon Pricing, Competitiveness and (EU) Carbon Border Adjustment Mechanisms in Asia

Dr. Venkatachalam Anbumozhi



Abstract

This paper examines the application of carbon pricing mechanisms in Asia to identify the potential for regional cooperation. It offers extensive stock taking of current trends in carbon pricing initiatives at regional, national and city level and seeks to answer important questions in regard to policymaking, such as what would be the positive and negative externalities for economic competitiveness. Based on lessons learned from other international carbon pricing initiatives, it analyses the implications of the EU carbon border adjustment mechanism. Based on that it identifies the potential areas for regional/international cooperation for a gradual introduction of carbon policies in developing and emerging economies of ASEAN and APEC.

Background

Asia-Pacific, especially China, India and the Association of South East Asian Nations (ASEAN) is becoming a larger contributor to global carbon emissions, with the fastest economic growth in the world from 1990 to 2020. Higher energy use, an increase in transport fleets and deforestation have been driving most of the carbon emissions in the region to date accompanied with greater integration with the global economy through international supply chains and production networks. Moving away from the region's carbon-intensive development trajectory requires strong and coordinated actions.

Carbon pricing mechanisms as a policy tool present an opportunity for advanced countries of East Asia and the emerging market economies of ASEAN member states (AMSs) to deliver on the ambitious Nationally Determined Contribution (NDC) goals of the Paris Agreement and avoid the higher costs of carbon lock-ins. In the past years, several countries in Asia and AMSs have either adopted or are in the process of establishing a carbon price mechanism to reduce GHG emissions and to decarbonise electricity and industry sectors.

There are several paths that governments can take to price carbon, all leading to the same result. They begin to capture what are known as the external costs of carbon emissions — costs that the public pays for in other ways, such as damage to the climate, risks such as crops losses and healthcare costs from heat waves and droughts as well as damage to property due to flooding and sea level rises — and tie them to their sources through a price on carbon.

A price on carbon helps shift the burden for the damage back to those who are responsible for it, and who can reduce it. Instead of dictating who should reduce emissions where and how, a carbon price gives an economic signal and carbon polluters decide for themselves whether to discontinue their polluting activity, reduce emissions, or continue polluting and pay for it. In this way, the overall climate goal is achieved in the most flexible and least damaging way to the economy and society. Carbon pricing also stimulates clean energy technology and carbon market innovation, fuelling new, low-carbon drivers of economic growth.

There are two main types of carbon pricing: emissions trading systems (ETSs) and carbon taxes. An emissions trading system — sometimes referred to as a cap-and-trade system — caps the total level of greenhouse gas emissions and allows those industries with low emissions to sell their extra allowances to larger emitters. By creating supply and demand for emissions allowances, an ETS establishes a market price for greenhouse gas emissions. The cap helps ensure that the required emission reductions will take place to keep the emitters (in aggregate) within their pre-allocated carbon budget.

A carbon tax directly sets a price on carbon by defining a tax rate on greenhouse gas emissions or — more commonly — on the carbon content of fossil fuels. It is different from an ETS in that the emission reduction outcome of a carbon tax is not pre-defined, but the carbon price is.

The choice of the carbon pricing instrument will depend on the national and economic circumstances of ASEAN countries. Singapore is the first country in the region to introduce a carbon tax, which covers 80 per cent of the national GHG

emissions. Indonesian government regulations mandate the establishment of an ETS by 2024. Thailand and Vietnam are now piloting voluntary ETSs.

There are also more indirect ways of pricing carbon, such as through gasoline taxes, the removal of fossil fuel subsidies, and energy sector regulations or climate policies that may incorporate a "social cost of carbon". Greenhouse gas emissions can also be priced through payments for emission reductions. Private entities or governments can purchase emission reductions to compensate for their own emissions (so-called offsets) or to support mitigation activities through results-based finance.

At the global level, some 40 countries and more than 20 cities, states and provinces already use carbon pricing mechanisms, with more planning to implement them in the future. Together the carbon pricing schemes now in place cover about half of their emissions, which translates to about 13 per cent of annual global greenhouse gas emissions.

If carbon pricing is well designed, it can be one of the most equitable instruments of climate policy. In contrast to other low-carbon energy regulatory instruments like feed-in tariffs, financing of energy efficiency improvements, or green technology standards, carbon pricing generates revenues that permit compensation for the inequitable consequences of the policy. This holds true not only for carbon taxation, but also for emissions trading, as revenues can be raised by selling or auctioning permits.

In the longer term, with carbon pricing applied more widely across ASEAN, and the price of carbon rising, the revenue could be recycled for allocated spending on (i) complementary climate mitigation policies and (ii) cushioning the adverse impact of carbon pricing on competitiveness and improving the tax benefits as a whole. But revenue could also be used to reduce outstanding government debt or spent on social infrastructure such as health and education that have nothing to do with environmental policy.

Yet some argue that carbon pricing would increase the cost of living and poor households will be severely affected. Several economists also argue that in the short and medium term, it will affect the competitiveness of firms in export-oriented economies. The pros and cons of carbon pricing are likely to have different weights in different AMSs, and there are avenues for regional cooperation to avoid carbon leakages.

The European Union has committed to establishing an effective carbon pricing mechanism through ETS and is aiming for very significant emission cuts — 55 per cent on 1990 levels by 2030, and zero net emissions by 2050. To help it get there without too much disruption, the European Commission introduced a carbon tariff — known as the carbon border adjustment mechanism (CBAM). The CBAM is a tax on imports based on the carbon emissions involved in making them. Its purpose is to level the playing field with domestic EU producers who will be made to pay a carbon price based on their emissions. This may reduce the demand for Asian exports of coal and steel and other emissions-intensive export commodities and manufactured goods, thereby lowering volumes and increasing the prices for domestic consumers.

This paper examines the implications of carbon energy pricing in Asia-Pacific to identify the potentials for regional cooperation. It offers extensive stock taking of current trends in carbon pricing policies and seeks to answer important questions in regard to policymaking, such as what would be the positive and negative externalities of implementing them at full scale and unilateral enforcement of the CBAM. On the basis of lessons learned from other East Asian and European countries, it also identifies potential areas for international cooperation for a gradual introduction of carbon policies in AMSs.

Issues, Current Response Strategies, Challenges and Institutional Arrangements

Targets Related to Energy Use and Carbon Pricing Policies

Under the Paris climate agreement AMSs have made a voluntary pledge, termed as Nationally Determined Contributions (NDC), to reduce their carbon emissions. The NDCs show the willingness of them to work with the international community to combat climate change. Implementation of NDCs is not only a global commitment but an opportunity for these countries to take decisive, inclusive and coordinated actions to reshape the economy and achieve energy transition. The energy sector, accounting for some two-thirds of the region's GHG emissions today, is the centre pillar of NDC commitments. Table 17 shows the common but differentiated responsibilities of NDCs submitted by ASEAN and East Asian countries. Their targets for emission reductions differ greatly in terms of their ambition and the way they are expressed as sectoral actions. NDCs of Cambodia, Indonesia, the Philippines and Vietnam as well as China contain absolute targets, either for total emissions or for the year in which the emissions will peak. Others are expressed as a decrease in emissions against the business-as-usual base line. The commitments also take the form of a target for emissions intensity, or emissions per unit of GDP. Most of the NDCs come with a conditional or contingent component, meaning that further reduction in emissions will come with international technology and financial support. This clause of the Paris Agreement is important as ASEAN member states believes in Common but differentiated responsibilities (CBDR) that include international support for capacity building ASEAN implement their NDCs in a more ambitious way. For example, Indonesia intends to unconditionally reduce its GHG emissions by 29 per cent, while also pledging to reduce up to 41 per cent with bilateral and multilateral provisions of technology, finance and capacity building support. Thailand emphasises its intention to reduce carbon emissions by 20 per cent by 2020. Singapore has committed to unconditionally reducing its carbon emissions by 36 per cent. The Philippines' NDC lays out plans to reduce its carbon emissions by 70 per cent by 2030. This commitment is conditional on international support and will heavily rely on renewable energy, waste, transport and forestry sectors.

Table 17: Composition of NDCs in ASEAN and East Asian Countries

Country (Entry Into Force)	NDC Targets	Current Renewable Energy Targets	Scope of NDC Targets
Australia (9 Dec 2016)	Reduce emissions 26–28% by 2030 (reference: 2005)	33,000 GwH by 2020 23.5% of electricity generation in 2020	Targets include energy, industrial processes and product use, waste, agriculture, and the LULUCF sector
Brunei Darussalam (4 Nov 2016)	Reduce energy consumption by 63% by 2030 (reference BAU)	10% of power generation by 2035 Total power generation mix: 954,000 MWh by 2035	Reduce CO_2 emissions from morning peak hour vehicle use by 40% by 2035 Increase the total forest reserves to 55% of the total land area
Cambodia (8 Mar 2017)	Reduce emissions, conditional 27% by 2030 (reference: BAU) Reduction of 3,100 Gt CO_2 from a baseline of 11,600 Gt CO_2 by 2030	Hydro 32,500 MW by 2020	Emissions reduction by 2030: - Energy industries 16% - Manufacturing industries 7% - Transport 3% - Other 1% - Total savings 27%
China (4 Nov 2016)	Reduce emission intensity by 60–65% by 2030 (reference: 2005)	Increase the share of non-fossil fuels in primary energy consumption to around 20%	Increase forest stock volume by around 4.5 billion cubic metres on the 2005 level
India (4 Nov 2016)	Reduce emission intensity by 33–35% by 2030, conditional (reference: 2005)	40% of electric power installed capacity from non-fossil fuel by 2030	An additional carbon sink of 2.5 to 3 billion tonnes of CO_2e through additional forest and tree cover by 2030
Indonesia (30 Nov 2016)	Reduce emissions by 29% and 41% conditionally by 2030 (reference: BAU)	23% of energy to be from new and renewable energy (including nuclear) by 2025, at least 31% by 2050	12.7 million hectares of forest area has been designated for forest conservation
Japan (8 Dec 2016)	Reduction by 26% by 2030 (reference: 2013)	Renewables by 22%–24% by 2030	Removal target by LULUCF is 37 million tCO_2e
Lao PDR (4 Nov 2016)	Increase the share of small-scale renewable energy to 30% of energy consumption by 2030, estimated to reduce emissions by 1,468,000 kt CO_2 by 2025	Increase the share of renewable energy to 30%	Increase forest cover to 70% of land area by 2020
Malaysia (16 Dec 2016)	Reduce emissions intensity by 35% and conditional 45% by 2030 (reference: 2005)	Cumulative total RE (MW): - 2020: 2,065 (9%) - 2030: 3.484 (10%) - 2050: 11.544 (13%)	Targets include energy, industrial processes, waste, agriculture, and the LULUCF sector

Myanmar (17 Dec 2016)	By 2030, boost hydropower capacity by 9.4 gigawatts to achieve rural electrification using at least 30% renewable energy sources; expand forest area to 30% by 2030	Increase the share of hydroelectric generation to 9.4 GW by 2030	Reserved forest and protected public forest: 30% of total national land area Protected area systems: 10% of total national land area
New Zealand (4 Nov 2016)	Reduce emissions by 30% by 2030 (reference: 2005)	Increasing renewable generation to 90% by 2025	Continue to achieve a rate of energy intensity improvement of 1.3% per annum
Philippines (11 Mar 2017)	Conditional reductions up to 70% by 2030 (reference: BAU)	Capacity installation targets by 2012–2030: 8,902 MW	Targets cover all sectors including LULUCF
Republic of Korea (3 Dec 2016)	Reduce emissions by 37% by 2030 (reference: BAU)	22–29% of electricity generation to be from nuclear by 2035	Reduce energy intensity by 46% between 2007 and 2030
Singapore (4 Dec 2016)	Reduce emission intensity by 36% by 2030)reference: 2005)	Raise solar power in the energy system up to 350 MW by 2020	Energy intensity improvement (from 2005 levels) target of 35% by 2030
Thailand (4 Nov 2016)	Reduce emissions by 20%; conditional 25% by 2030 (reference: BAU)	Targeted renewable generation: 13,927 MW by 2021	Reduce energy intensity by 25% in 2030
Vietnam (3 Dec 2016)	Reduce emissions by 8% and conditional 30% by 2030 (reference: BAU)	Targeted capacity by 2030 - Wind power: 6,200 MW - Biomass power: 2,000 MW - Other renewables: 5,600 MW	Forest cover will increase to the level of 45%

Source: UNFCC, 2016

Cambodia intends to reduce its emissions by 27 per cent by 2030 on the condition of available international support. Vietnam promises to unconditionally lower its emissions by 8 per cent by 2030 and will reduce them a further 25 per cent with adequate support for renewable energy uptake, energy efficiency improvement and change in transport fuel use. A closer look at the NDCs reveals the fact that almost all of the countries aim to achieve their emission reduction targets by increasing the cumulative electrical power capacity from renewable energy sources as embedded in their national energy policy formulations. Some countries also pledged new energy-efficiency targets. Seven countries in the region, including Lao PDR and Myanmar, have forestry targets of maintaining or increasing their land area covered by forests.

Current Carbon Pricing Mechanisms and Indirect Carbon Pricing Instruments

Energy Subsidies and Carbon Pricing

With the energy mix dominated by fossil fuels, higher energy consumption is primarily responsible for the rapid increase in carbon emissions in ASEAN countries, rising more than 4 per cent a year in the region. In 2019, ASEAN accounted for 4.3 per cent of global carbon emissions excluding deforestation. The region's most populated country, Indonesia, is the main carbon emitter (34% of emissions) followed by other emerging economies: Thailand (17%), Vietnam (17%), Malaysia (16%) and the Philippines (9%). It should nevertheless be noted that owing to its net exports of manufactured goods, the region generates more carbon than it consumes.

According to several economic studies, there is no difference in the behavioural response expected from the imposition of carbon pricing through tax and the removal of fossil fuel subsidies (a negative carbon pricing mechanism). Fossil fuel subsidies, whether on consumption (price control, tax exemptions) or production (preferential tax rates, tax incentives for products), increase carbon intensive growth. They exist to enable low-income households to overcome energy poverty, but in several AMSs, they mostly benefit richer citizens who consume more energy. Although these subsidies could be channelled toward more efficient expenditure such as direct cash transfer to the poorest households, and expansion of low-carbon infrastructure, their elimination is still a political minefield.

This suggests that subsidy reform may have an important potential to help the introduction of carbon pricing in ASEAN and assist the low-carbon energy transition.

Table 18: Fossil Fuel Subsidies in AMSs (Billions of Nominal $)

Country		2007	2008	2009	2010	2011
Indonesia	Oil	11.30	14.28	8.99	10.15	15.72
	Electricity	1.87	4.74	5.31	5.79	5.56
	Natural gas	0.00	0.00	0.00	0.00	0.00
	Coal	0.00	0.00	0.00	0.00	0.00
	Total	**13.17**	**19.02**	**14.30**	**15.94**	**21.28**
Malaysia	Oil	2.69	4.61	1.58	3.89	5.35
	Electricity	0.49	2.20	1.71	0.81	0.94
	Natural gas	1.42	2.97	1.68	0.97	0.89
	Coal	0.00	0.00	0.00	0.00	0.00
	Total	**4.60**	**9.78**	**4.97**	**5.67**	**7.18**
Philippines	Oil	0.16	0.12	0.03	1.10	1.46
	Electricity	0.00	0.00	0.00	0.00	0.00
	Natural gas	0.00	0.00	0.00	0.00	0.00
	Coal	0.00	0.00	0.00	0.00	0.00
	Total	**0.16**	**0.12**	**0.03**	**1.10**	**1.46**
Thailand	Oil	1.55	2.08	1.20	2.11	3.29
	Electricity	0.88	4.16	4.23	5.44	5.67
	Natural gas	0.22	0.58	0.24	0.48	0.48
	Coal	0.17	0.56	0.50	0.44	0.85
	Total	**2.82**	**7.38**	**6.17**	**8.48**	**10.29**
Vietnam	Oil	0.32	1.09	0.00	0.00	1.02
	Electricity	1.68	2.25	2.10	2.69	2.92
	Natural gas	0.09	0.21	0.13	0.23	0.16
	Coal	0.01	0.01	0.01	0.01	0.02
	Total	**2.10**	**3.57**	**2.23**	**2.93**	**4.12**

Renewable Energy Pricing and Revenue Recycling

Carbon pricing and revenue recycling policies when combined together could accelerate the uptake of renewable energy in ASEAN countries. Table 19 shows a summary of various renewable energy pricing schemes in place in each AMS. All AMSs provide support in the form of tax incentives, which are regulated differently in their national energy policies, including tax exemption, VAT reduction, tax allowances as well as others. Tax incentives are seen as attractive support to create low-carbon investment; hence, most AMSs have made this available. Feed-in Tariffs (FiTs), auctions, self-consumption schemes, soft loans and other types of supporting schemes are implemented based on AMS policies and the level of market maturity for low-carbon energy uptake.

The purchase agreement through a FiT typically provides a specified price for every kilowatt-hour (kWh) of low-carbon renewable electricity generated and structured with a specific contract period and often differentiated based on the carbon content of technology type, size and location. FiTs are seen as effective schemes to create a carbon market in the beginning phase since they incentivise renewable energy generation costs to be competitive with other fossil fuel energy generation. In Indonesia, Malaysia, Philippines, Thailand and Vietnam, the increased capacity is strongly related to FiT Implementation as the main market driver.

Financing Schemes and Carbon Pricing Instruments for Enhanced Energy Efficiency

Energy efficiency projects offer higher carbon benefits and economic rates of return but remain unimplemented because of high investment risk, and unavailable information on incentive schemes and mechanisms. One of the crucial issues for AMSs in the realisation of potential energy savings is the energy efficiency investment delivery mechanism that is or can be adapted to the national and local economic environment.

In general, some of the identified barriers in energy efficiency pricing and financing include the insufficient financial and technical capacities from both the demand and supply side and the need for favourable policy frameworks that encourage investments in energy efficiency projects that have high carbon benefits. To address some of the barriers in financing energy efficiency in the region, some AMSs such as Singapore, Thailand, Malaysia, Indonesia and Vietnam have been able to develop more advanced frameworks by creating dedicated pricing and financing schemes as illustrated in Table 20.

A coherent, interrelated set of price discovery measures are needed to help AMSs. White certificate trading systems have been in place in many countries like India. The appeal of India Perform, Achieve and Trade (PAT) lies in bringing eco-efficiency benefits of market-based instruments and carbon, where carbon pricing policies have tended to be dominated by more traditional — and typically — costlier technology and performance standards. Although the targets for carbon performance in the first compliance phase were modest and trading in the market for certificates consequently thin, the substantial overachievement of targeted energy saving reflects the potential of the emission trading schemes as an instrument of climate and clean industrial policy.

Table 21 illustrates The Specific Energy Efficiency Pricing Policies In Industry, Transport And Building Sectors.

Table 19: Renewable Energy Pricing Policies in AMSs

AMS	RE Target	FiT	Self-Consumption	Competitive Bidding / Auction	Tax Incentives	Soft Loan	Capital Subsidy	Tradable RECs
Brunei	X				X			
Cambodia	X			X				
Indonesia	X	X	X	X	X	X		
Lao PDR	X				X			
Malaysia	X	X	X	X	X	X		
Myanmar	X				X			
Philippines	X	X	X		X			X
Singapore	X		X	X				
Thailand	X	X	X	X	X	X	X	
Vietnam	X	X	X		X			

Table 20: Energy Efficiency Pricing Schemes in AMSs

AMS	Dedicated Energy Efficiency Grants	Dedicated EE loans	Dedicated Equity	Dedicated debt guarantee	EPC
Brunei					
Cambodia					
Indonesia	X				
Lao PDR	X				
Malaysia	X	X		X	X
Myanmar	X	X		XX	
Philippines	X				
Singapore	X				X
Thailand	X	X	X		
Vietnam	X	X			

Table 21: The Specific Energy Efficiency Pricing Policies in Industry, Transport and Building Sectors.

	Cross-Sector		Industry	Transport	Buildings	
Countries	**National Strategy**	**ESCO**	**Energy Management**	**Fuel-Economy Standard**	**Building Code**	**MEPS and Labelling**
Indonesia	National Energy Conservation Master Plan	Partnership programme on Energy Conservation	Mandatory energy management (>6000 toe/y)	Fuel-economy standard under consideration	Voluntary codes (building envelope, air conditioning, lighting, energy auditing)	Mandatory labelling (CFLs)
Malaysia	The National Energy Efficiency Action Plan under consideration	Investment tax allowance; import duty and sales tax exemption	Mandatory energy management (>3 million kWh per 6 months)	Tax measures to promote hybrid cars	Voluntary codes (energy-efficiency, renewable energy)	Mandatory MEPS (refrigerators, lighting, AC, fans, television sets)
Philippines	The National Energy Efficiency and Conservation Program	ESCO certificate of accreditation	Energy audit service	None	Voluntary codes (energy-conserving design)	Mandatory MEPS (AC,CFLs, linear fluorescent lamps); Mandatory labelling (eight products: refrigerators, air conditioners CFLs, etc.)
Thailand	20-Year Energy Efficiency Development Plan 2011-2030	Tax exemption (maximum 8 years); ESCO fund; low interest loans; promotion activities	Mandatory energy management (<1,000 KW or 20 TJ/y).	Fuel-economy standard under consideration Tax measures to promote energy-efficient vehicles (51/100 km)	Mandatory codes (building envelope, lighting, air conditioning); voluntary labelling	Mandatory MEPS (refrigerators, air conditioners); Voluntary labelling (23 of products: refrigerators, air conditioners, rice cookers, etc.)
Vietnam	The National Target Program on Energy Efficiency and Conservation	Market development project	Mandatory energy management (over 1,000 toe/y) Mandatory MEPS for electric motors from July 2013	Mandatory fuel-economy labelling (applied only for vehicles under the 7-seater category) from January 2015	Voluntary codes (building envelope, lighting, air conditioning, ventilation)	Mandatory MEPS from January 2015; Mandatory labelling from July 2013 (eight products; air conditioners, fans, rice cookers, etc.)

RENEWABLE ENERGY PRICING AND REVENUE RECYCLING

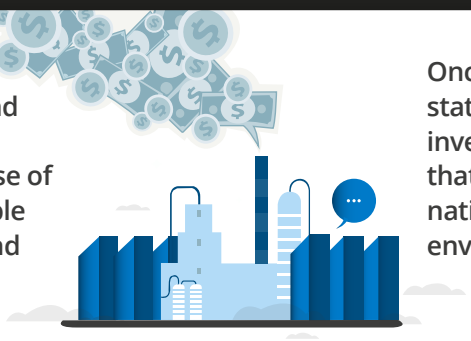
Carbon pricing and revenue recycling policies could accelerate the uptake of renewable energy in ASEAN countries

The renewable energy pricing policies in the ASEAN states are

- Feed-in-Tariff (FiT)
- Tax incentives
- Soft loans
- Tradable RECs
- Retarget
- Self-consumption scheme
- Competitive bidding or Auction
- Capital subsidy

FINANCING SCHEMES AND CARBON PRICING INSTRUMENTS FOR ENHANCED ENERGY EFFICIENCY

Energy efficiency projects offer higher carbon benefits and economic rates of return but remain unimplemented because of high investment risk, unavailable information on the schemes and mechanism .



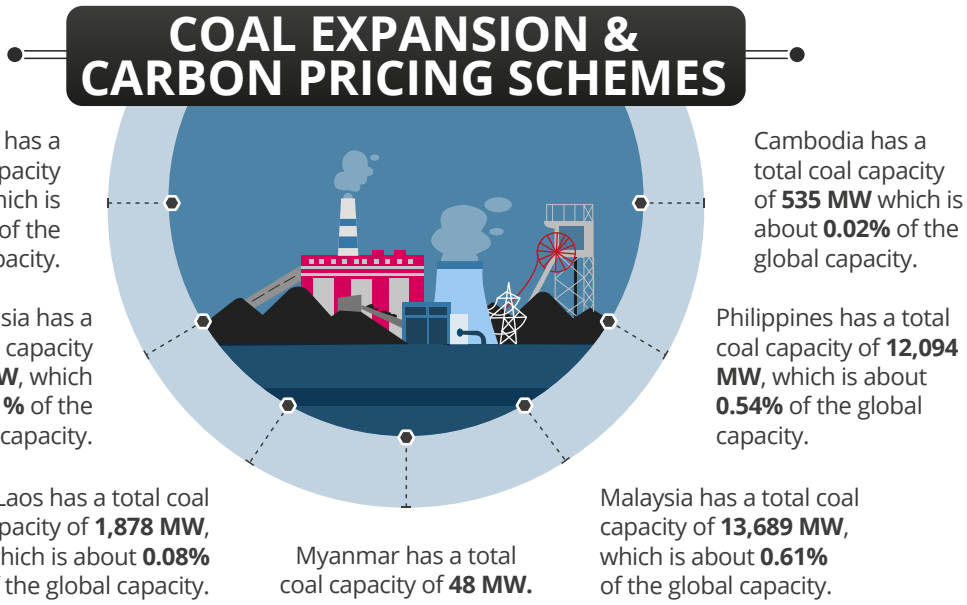
Once Crucial issue for ASEAN states is the energy efficiency investment delivery mechanisr that can be adapted to the national and local economic environment.

Energy efficiency pricing schemes in ASEAN states are:

- Dedicated energy efficiency grants
- Dedicated EE loans
- Dedicated Equity
- Dedicated debt guarantee
- EPC

Barriers in energy efficiency pricing include:

- Insufficient financial capacities
- Insufficient technical capacities
- The need for favorable policy frameworks that encourages investments



Coal Expansion And Carbon Pricing Schemes

As discussed before, energy demand and emissions are growing rapidly in ASEAN, driven by economic growth and demographic changes. The choice to use coal to meet the demand was largely driven by and abundance of national resources in Indonesia and Vietnam, and the relative price advantage. The current and planned coal power generation is presented in Table 22.

Without carbon pricing schemes for learning, the coal industry in ASEAN would not generate enough positive spill overs and technology adoption to achieve clean coal. AMSs do need to spend the carbon pricing revenue on facilitating technology transfer, building better innovation systems for clean coal and tailoring innovation systems to their specific endowments and needs.

Table 23 shows the marginal abatement curve of the power, industry, and transport sectors in ASEAN. Carbon intensity and energy efficiency improvement requires substantial introduction of carbon pricing mechanisms either through direct tax or establishing ETSs.

Table 22: Current Planning for Coal-Fired Power Generation in ASEAN

Country	Total coal capacity operating and under construction (MW)	Operating and under-construction capacity as a share of global capacity	Total planned coal capacity (MW)	Planned growth of coal capacity	Planned capacity as a share of the global planned expansion
Cambodia	535	0.02%	2,520	472%	0.69%
Indonesia	42,664	1.91%	26,611	62%	7.29%
Laos	1,878	0.08%	600	32%	0.16%
Malaysia	13,689	0.61%	1,200	9%	0.33%
Myanmar	48	0.00%	1,530	3,188%	0.42%
Philippines	12,094	0.54%	9,437	78%	2.59%
Thailand	6,331	0.28%	3,600	57%	0.99%

Table 23: Overall Marginal Abatement Cost Curve of the Power, Industry and Transport Sectors

Sector	Scenario	Mitigation Potential (MtCo)	Marginal Abatement Cost ($/tCo)
Cement	Combustion system improvements	73	0
	Other improvements	22	25
Fertilizer	Installation of variable speed drives for cooling tower fans of ammonia and power plants	18	0
	Other improvements	8	1
Household	Air conditioning	49	18
	Lighting	68	11
	Low E windows or shades + HE ceiling fans	186	10
	Refrigerators	31	23
	Water heaters	24	13
	Other household appliances	45	18
Integrated steel plant	BOF gas sensible heat recovery	33	2
	Hot charging in rolling mills	24	2
	Installation of the top pressure recovery turbine	22	2
	Natural gas injection in blast furnaces	33	1
	Pulverized coal injection (PCI) in blast furnaces	32	1
	Sinter plant heat recovery	25	0
	Thin Slab Casting and Strip Casting	198	2
Power	Biomass	1,0648	2
	Hydro	37	5
	Solar	978	0
	Wind	299	2
Pulp and Paper	Increased use of recycled pulp	25	2
	Waste heat recovery from paper drying	15	0
	Other improvements	13	2
Refinery	Other improvements	4	4
Steel ISP	Blast furnace and coke oven cogeneration	49	1
	Other improvements	4	1
Steel SSP	Other improvements	26	1
Transport	Freight modal shift from road to coastal	16	14
	Fuel switching to Compressed Natural Gas (CNG) for buses	20	71
	Increased freight modal shift from road to rail	41	0
	Increased sales of electric two-wheelers	180	0
	Increased use of biofuel	96	0
	Inland waterways improvement	16	0
	Passenger modal shift from 2W and cars to buses	68	26
	Technology improvement in private vehicles to meet EU efficiency standards	200	0
	Other improvements	8	36
Total		**4,368**	**0.68**

Progress in The Implementation of Carbon Pricing Mechanisms in ASEAN

Based on the above discussions, the motivation for implementing carbon pricing in AMSs could be concluded as (i) providing an incentive to reduce carbon emissions, (ii) to support the implementation of NDC goals and (iii) to raise funds and finance for climate-aligned projects.

Several studies have pinpointed the introduction of carbon pricing as the most effective way of cutting down national and global emissions by making low-carbon energy sources more competitive. To keep global warming below two degrees Celsius, it has been found that a global carbon tax at the rate of 75 U.S. dollars per tonne of CO_2 emissions by 2030 would be effective. Such carbon pricing would automatically drive up the price of fossil fuels, the major energy source in ASEAN. It is essential that this effect on the poor people be assessed and for the tax revenue to be recycled. Table 24 shows the current status of carbon pricing in ASEAN.

At present, within ASEAN, only Singapore has a direct carbon tax set at 3.5 U.S. dollars (SGD5) per tonne of CO_2 equivalent which is paid by major industrial emitters and which could rise to SGD15 by 2020. Indonesia and Vietnam are considering introducing an ETS, whilst Thailand is thinking about adopting either emission allowances or a carbon tax. Almost all AMSs have project development experience with carbon crediting mechanisms such as Clean Development Mechanisms, Joint Credit Mechanism, etc.

While these developments are encouraging, faster and more ambitious carbon pricing is needed to achieve the goals of the Paris Agreement as well as develop new revenue streams. Globally, average pricing remains at only two U.S. dollars per tonne of carbon, and existing schemes cover about 20 per cent of total emissions. In East Asia, the price ranges from about one U.S. dollar per tonne in subnational ETSs in China and Japan to 29 U.S. dollars per tonne in South Korea (Figure 6).

These are substantially lower than the required range estimated in most studies to meet the Paris Agreement and Climate stabilisation goals. Within East Asian carbon pricing schemes, there is considerable variation in the sectoral coverage, with the industry and power sectors the most widely covered and to a lesser extent the transport and building sectors.

Figure 6: Carbon Pricing Mechanisms in East Asia

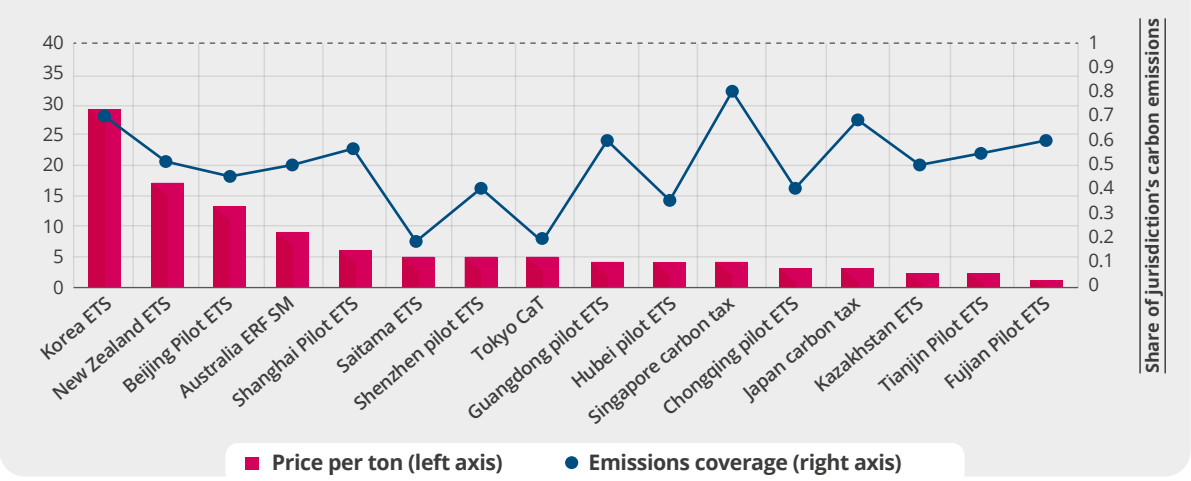


Table 24: Current Status of Carbon Pricing in ASEAN

Country	Status	Development
Singapore	Under implementation	An economy-wide carbon tax was introduced on 1 January 2019. It covers 80% of national emissions.
Indonesia	Under consideration	Emission trading is the carbon pricing instrument of choice. But it has been decided to implement a limited scale of carbon tax in 2022. Government regulations mandate the establishment of an ETS by 2024.
Malaysia	Under consideration	Carbon tax and an ETS are being considered in the national context.
Thailand	Under consideration	A voluntary ETS is undergoing piloting, and a Climate Change Act is expected to be submitted for cabinet approval.
Vietnam	Under consideration	An ETS is under consideration, with recent focus on readiness and capacity building. Power generation, steel and the waste sectors are the most likely candidates for piloting approaches.

Carbon Pricing, Competitiveness and Leakage

Institutional Arrangements for Tackling Competitiveness Issues

The European Union has in place the world's largest carbon pricing mechanism through its emission trading EU-ETS, as well as an energy taxation directive which sets minimum rates of excise duties on fossil fuels. More than a decade of experience with the EU-ETS has yielded valuable lessons on the importance of emission data availability and quality, the possibility of windfall profits from generous free allocation rules where allowance costs are nonetheless passed through to consumers, and the need for a robust governance structure for market oversight.

The EU-ETS involves issuing, normally by governments, of emission permits, or allowances to cover the desired quantity of information, and their transfer, by sale or otherwise to emitters. Emitters may trade these permits among themselves, subject only to the requirement that they surrender to the authorities at the end of the relevant period, normally each year, a quantity of permits that is equal to their carbon emissions over a period. Normally, the number of permits is lower than there would have been in the absence of the scheme, so that some emitters will need to undertake abatement.

It is expected that the limiting of carbon emissions through the imposition of a cap and the creation of a carbon price to reflect the scarcity of associated emissions will have an effect on the competitiveness of the firms included in the EU-ETS. Currently it operates in 31 countries — all 28 EU member states as well as Iceland, Liechtenstein and Norway — and covers emissions from emitters in the power sector, aviation, combustion plants, oil refineries, iron and steel works, as well as installations producing a range of products including aluminium, lime, cement, glass, ceramics, bricks, pulp, paper, board and certain petrochemicals. More than 11,000 covered entities account for around a billion metric tons or 45 per cent of EU carbon emissions, making the EU-ETS the centrepiece of the European climate policy.

There is a concern within AMSs that carbon pricing could disadvantage domestic industries if unilaterally introduced. However, the EU-ETS experience and a wide range of empirical studies, both ex ante and ex post, have concluded that carbon pricing does not have significant adverse

effects on economic competitiveness or carbon leakages, moving of high carbon industries to other judications. This could be because the positive effects of carbon pricing on industries that manufacture in a low-carbon way and offer new carbon-efficient technologies and services offset the negative effects on the competitiveness of polluting industries.

Further, the EU-ETS was introduced in a phased approach. The general framework is contained in a directive setting out its central features such as scope and coverage, issuance of units, and compliance with enforcement. Governance of the EU ETS evolved significantly over the three initial trading periods of 2005–2007, 2008–2012 and 2013–2020, with competencies in a number of areas — such as allocation of units and registry operation — becoming successively more centralised with implementation at member state level proving inadequate.

Challenges in Implementing Carbon Pricing Mechanisms in ASEAN

Over the last decade, the number of national and sub-national jurisdictions with an explicit carbon tax or ETS has roughly tripled. But the current levels fall short of achieving national and international targets of alleviating climate change. Carbon pricing schemes often encounter political challenges and resistance from the private sector. Lack of policy coordination, higher cost of emission reductions and absence of measurement and monitoring systems remain obstacles to upscaling carbon pricing policies in ASEAN (Anbumozhi, 2021).

Alignment of policies and objectives for successful carbon pricing is part of a suite of measures that facilitate competition and openness, ensure equal opportunities for low-carbon alternatives, and interact with a broader set of climate and non-climate policies. Successful carbon pricing policies are supplemented by measures that support deeper emissions reductions over time. These include innovation policies, the removal of institutional barriers, behavioural incentives, public spending reallocations and policies that encourage investment in low-carbon infrastructure and seek to avoid lock-in of polluting investments. Providing consistent signals to consumers, producers and investors requires reforms to address counterproductive policies (e.g. fossil fuel subsidies). A carbon tax or ETS policies coexist with a range of non-climate policies that can either support or undermine the efforts to meet NDC targets. Policy coherence across a range of policy areas is therefore important.

Successful carbon prices, either in the form of taxation or ETSs have to be part of a stable policy framework that gives a consistent, credible, and strong investment signal to the private sector, the intensity of which should increase over time, opening up new business opportunities and innovative business models. A lower carbon price creates less incentives, and produces greater short-term emissions than an initially higher carbon price would. While predictability is essential to support long-term investment decisions, incorporating flexibility — by adjusting the carbon tax or rules-based interventions in an ETS — can help economies adapt to unpredictable economic and technological developments. Judicious use of revenues from carbon taxes or emission allowance auctions will be challenging to have additional economic benefits, including fiscal dividends for the affected industries in the short term.

Though successful carbon pricing schemes in some jurisdictions have also resulted in a measurable reduction in environmentally harmful behaviour, comprehensive coverage of fuels, sectors and gases remain a challenge in many jurisdictions. Evolving carbon pricing policies need to be consistent with other environmental objectives such as local air pollution and identifying substitutes for carbon emission-intensive activities that could easily be available at low cost. Carbon pricing policies can deliver multiple benefits.

Implication of EU Carbon Border Adjustment Mechanisms and Carbon Pricing Initiatives in Asia-Pacific

The Carbon Border Adjustment Mechanism (CBAM) was conceived for implementation since 2021 to avoid carbon leakages, in carbon-intensive industries like fossil fuels, steel, cement, mineral

resources, etc. and generates revenue. Though the design of such cross-border tax architecture is not yet clearly defined, the political momentum for such a unilateral initiative appears to be growing, which will have sectoral implications on regional free trade, development assistance and carbon governance.

Cross-Border Carbon Tax and Perceived Conflicts with Trade Regimes

From the perspective of developing and emerging economies in Asia and the Pacific, cross-border tax and trade restrictive measures are not necessarily the most appropriate or preferrable means to address global climate change concerns. Rather there is great concern, as reflected during the Paris Climate Agreement and WTO negotiations, that the use of trade measures by developed countries ostensibly to address carbon emissions in fact have the effect of restricting the market access of developing country products in the EU and enhancing the competitive edge that developed countries have in global free trade, thereby locking in the current inequitable developmental gap which could be termed as "carbon imperialism".

Trade measures, including unliteral Cross border carbon taxes that may be imposed to combat global carbon emissions, must not among other things discriminate against international trade by developing countries inconsistently both WTO rules and Art 3.5 of the UNFCC — which assures a common but differentiated response.

All WTO member countries including major trade partners in Asia-Pacific have created a legal framework for avoiding (i) import tariffs, (ii) FDI regulatory restrictions, (iii) non-transparent procurement processes, and (iv) trade-related investment measures. Applied import tariffs are relatively low in the EU for high-carbon products such as fossil fuels, steel, and cement. Evidence shows that higher import tariffs are sometimes used as part of the design of green industrial policies. However, both developed and developing member countries of the WTO tend to remove tariff barriers once their domestic industries reach maturity. For example, China removed its tariff on imported wind turbines in 2010.

The use of some trade restrictive measures has resulted in a total of 75 WTO disputes since 2010 related to the above four categories. The relevant articles that would invite CBAM scrutinisation under free trade rules include the 1994 General Agreement on Tariffs and Trade (GATT: article III4, 5 and 8 a), the agreement on Trade Related Investment Measures (TRIMS, Article II and Annex); and The agreement on Trade remedies (SCM; Article III 3.1b) including anti-dumping and countervailing duty measures, which are used to remedy injury caused by the introduction of CBA to domestic industries in the Global South by allegedly unfair trade practices that negatively affect employment, productivity, profit or market shares.

There is precedence wherein the investor-state dispute settlement (ISDS) system addresses arbitration claims brought by countries against governments that impose trade and investment restrictions through direct tax or indirect subsidies. Though the WTO has enacted some rules governing remedies or nullification, there are important gaps. For instance, Local Content Requirements in public tenders are difficult to challenge in the WTO. Most of the WTO rules, GATT, SCM and TRIMs apply to goods and not services, which are covered by the General Agreement on Trade in Services (GATS).

Hence, the EU should seriously design appropriate institutional frameworks within the WTO architecture or outside it (like EU-centred bilateral and multilateral FTAs) to avoid such disputes, by negotiating with developing and emerging economies on the premise of how to avoid potential disputes and offering some sort of compensation for the thorough revenue recycling programmes, which could be an incentive for low carbon investments within the ambit of non-discriminatory free trade. The options for the EU to address such trade disputes also include (i) In regard to level, for example by using a lower CBA level, i.e. by imposing taxes at a level that is acceptable to major exporting countries in the Global South, (ii) In regard to scope, by reducing the scope of the CBAM on import values and volumes and then specific products within the spectrum of goods, and (iii) In regard to time, by introducing time limitations for the CBA to be in place in a differentiated way.

Impact of the CBAM and Emissions from Resource — Exporting Asia-Pacific Economies

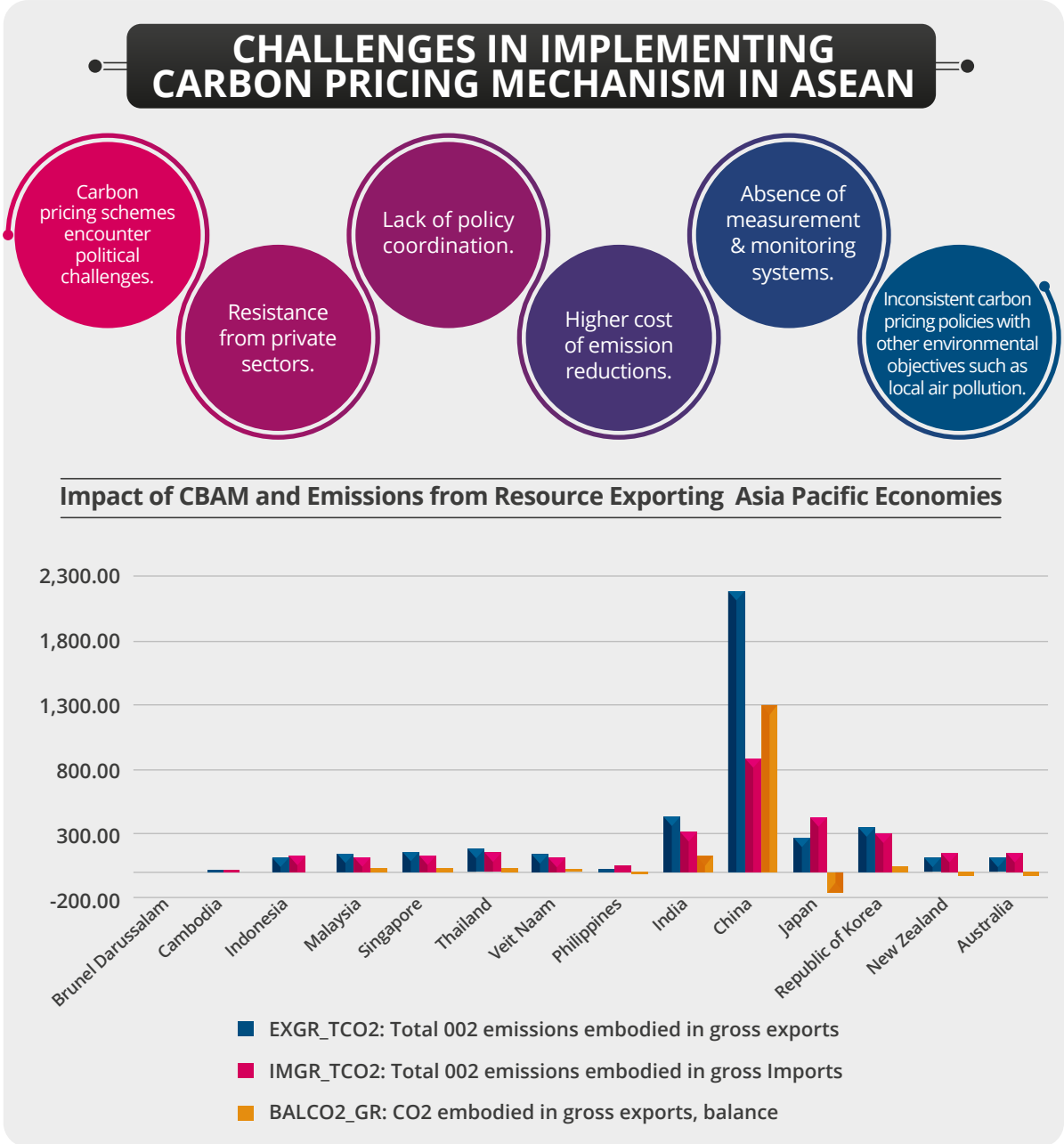
Figure 7 shows the degree to which carbon emissions are embedded in the exports and imports of ASEAN and East Asian countries and India. Except for Australia, Japan, the Philippines, and New Zealand, the rest of the countries' exports are carbon-intensive. China is at the top of the list of countries exporting high-carbon manufactured products, while Japan has the least embedded carbon in its exports.

Countries in the region like Australia, Indonesia and Malaysia possess the world's largest reserves of minerals and coal. Australia's exports of the above two products still generated 12.6 billion U.S. dollars worth of income from 2019–20. Hence, Muller et al. (2021) cautioned that there will be a real concern about the impact of the CBAM on Australia's exports, if other G7 countries follow the EU's decision. The analysis is only based on the value of Australia's emissions-intensive exports to major destinations including the EU, but overlooks the economy-wide impact of the CBAM, such as the industrial structural change that might happen due to a unilateral carbon tax.

A simulation by Adams (2021) captured the impact of the CBAM by taking into account not only emission intensities and the destination for individual Australian emissions-intensive exports. It also studied the extent to which producers can transform their industrial energy structure into clean energy without introducing their own carbon pricing regimes. It concluded that the long-term projected loss in gross domestic product due to the EU's CBAM would only be 0.05 per cent, which is equivalent to a fall in weekly income of less than one U.S. dollars per person. At industry level, the fall in EU demand would be more than compensated for by the weaker exchange rate influencing increases in the exports of other non-emissions-intensive exports due to their cheaper prices (Figure 8). Thus, at the economy-wide level, in the short run there would be an increase in unemployment and job losses in declining industries, but in the medium to long run these negative impacts would be offset by expansion in other industries.

Therefore, a CBAM whether it is by the EU or other countries is certainly expected to reduce the demand for some goods in resource-exporting countries in Asia-Pacific like Australia. Nevertheless, a CBAM has the potential to create strong opportunities for those industries which decarbonise production methods by utilising a strategic approach like a "technology, not taxes" approach to contain carbon emissions. Therefore, the answer to the question of whether the emissions reduction policy, such as the CBAM contradicts fair trade policy is NO. Technological innovation, the dissemination of technologies and facilitating the adoption of "best practice techniques" of the technologies are the solutions. Overall, if the objective of the EU CBAM is to create positive price signals for clean exports, it could be done by promoting new and transformed industries that are cleaner and more resilient through international cooperation.

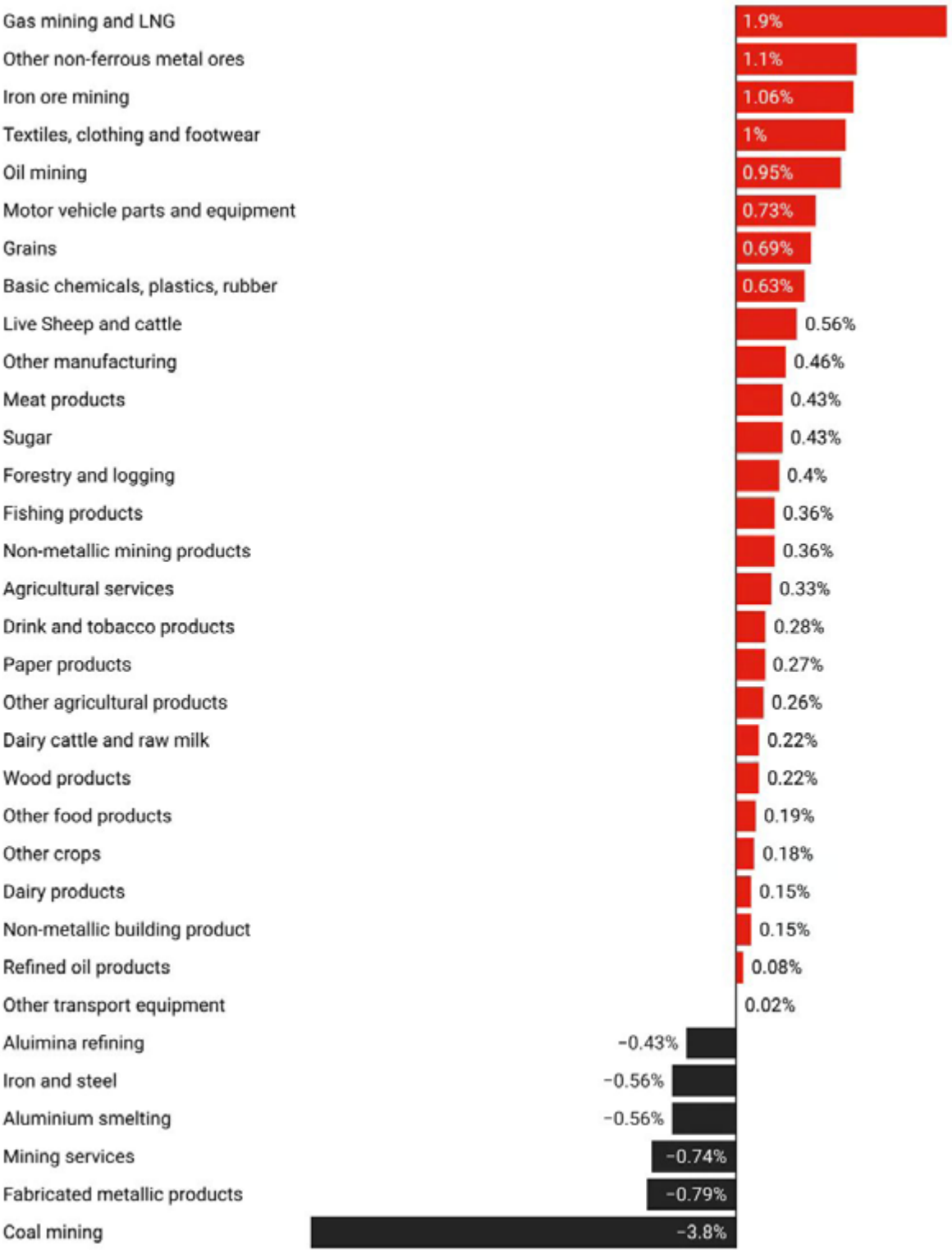
Figure 7: CO_2 Emissions Embedded in the International Trade of Asia-Pacific Countries and India, 2015



Source: OECD (n.d.).

Note: CO_2 = carbon dioxide, RCEP = Regional Comprehensive Economic Partnership.

Figure 8: Change in Industry Output Under the EU's Carbon Border Adjustment Mechanism



Source: Adams (2021).

Geopolitics of the CBAM, Paris Climate Agreement and International Developmental Assistance

The CBAM is one of the several mechanisms that the EU will be implementing as part of the European Green Deal — a bold initiative to cut carbon emissions by European industries and protect their competitiveness. The current trade intensity and carbon intensity patterns — the degree to which trade in goods and services within a sector is closely related and complex along the global supply chains. The EU-27 accounts for around 15 per cent of the world's trade in goods. The EU imports goods mainly from the US, China, UK, Russia, Turkey, Norway, South Korea, India and Singapore. The value of the EU's trade in goods significantly exceeds that of services, by about three times, reflecting the nature of some services which makes them harder to trade across borders, when CBA is introduced.

On the basis of trade intensity and carbon intensity, among the sectors that are most directly hit by the CBAM could be refined petroleum products, as well as mining. Countries that export carbon-intensive industries would risk losing market share to EU-based competitors. On the other hand, EU-based companies that import carbon-intensive energy and other minerals that provide raw ingredients for industrial processes such as chemical products, will be affected. It is likely that European member states and export-oriented industries will be unevenly affected when CBA comes into implementation. Small and medium enterprises (SME) along the global value chain may lose their competitiveness in the long run, due to the increased cost of inputs. Impacts of the CBAM on Global Supply chains and on the profits of small European businesses, which export to developing and emerging economies need to be studied if short- and medium-term effects and appropriate safety nets are to be created. If not they could be forced to pay additional costs and pass them through the rest of the value chain to consumers.

Given the global controversies surrounding the CBAM, ensuring WTO- and FTA-compatibility of the initiative is one of the core fix-points for the EU. Without a functioning WTO-appellate body, this seems to be particularly important. However, as the CBA is still at an early stage of design/ implementation, technical details on WTO- and FTA-compliance remain vague. In this context, the EU has to make a decision whether the mechanism will be pursued as an economic tax/tariff-measure or a purely environmental measure (referring to GATT Art. 20). Anyhow, understanding the conflicting points from the perspective of free trade is important for making operational decisions.

As the level of uncertainty of the exact design/ implementation of the CBAM remains high, an additional tax on carbon emissions tied to imports would cut profits for the EU's trade partners with carbon intensity and could be the next disruptive force in global trade. Countries with their own carbon pricing schemes such as Japan, Korea, Singapore and Indonesia would negotiate for concessions within their FTA or fight within WTO framework conditions. Despite the uncertainties surrounding the CBA implementation plan, the timing of the introduction of the policy and rationality of unilateral actions, the EU should look for integrated climate, trade and economic diplomacy wherein its trade partners will be compelled to manage their carbon emissions with greater urgency in an inclusive manner.

There are several precedents where such cross-border levies that flout WTO rules, which require equal treatment for similar products and no discrimination between domestic and foreign producers, have resulted in trade disputes. Hence, the EU should seriously design appropriate institutional frameworks within the WTO architecture or outside it (like EU-centred bilateral and multilateral FTAs) to avoid potential disputes, by negotiating with its trade partners on the premise of avoiding potential conflicts.

Further, the concept and practice of Common but Differentiated Responsibilities (CBDR) is well-recognised in the Paris Agreement. Although climate actions are a global public good in nature, and emissions from developing countries are increasing, each country has the right to develop its economy and alleviate poverty. Given this

fact, there is every possibility that the CBAM will be deemed as a sign of carbon imperialism by the EU in relation to developing and emerging economies in Asia, Africa and Latin America. One approach to avoid such accusation is to earmark or designate a fund at the EU level to redistribute all or a substantial part of the proceeds of the CBAM to vulnerable countries and communities in the Global South to absorb the climate shocks and avoid refugees. Also, individual members of the EU could consider the revenue distribution of the CBAM proceeds to meet the aspired international cooperation targets embedded in the Nationally Determined Contribution (NDC) goals of developing countries by 2030.

EU member states are generous Official Development Assistance (ODA) providers to developing countries in the Global South — either through grant-in aid programmes or soft loans from the private sector and multi-lateral financial institutions. As each EU member generates different revenue streams from the CBAM, it is recommended to formulate technical and economic cooperation strategies through budgetary support, wherein carbon targets are mainstreamed in their ODA commitments to assist most vulnerable countries through integrated climate, industrial and environmental policies.

In reality, major economies such as China, India, Brazil, and South Africa are already the EU's top FDI destinations and the CBAM indicates an imminent risk that there will be double taxation for several MNCs if recipient countries also introduce a carbon tax in one form or another. New tax policies will not work effectively without good implementation capacity, the lack of which could constrain policy choices. Hence, the EU should engage foreign missions in Brussels to obtain their feedback on the avoidance of double taxation, and allocation of revenues among the developing and emerging economies. Global cooperation amongst tax authorities within the G20 process could bring more transparency, trust, and accountability of cross-border carbon taxation.

Cooperation with big emerging economies and the G20 alone cannot solve the climate change problem. Cooperation from small and medium-sized economies and regional groupings such as the African Union, Association of South East Asian Nations (ASEAN), South Asia Association for Regional Cooperation (SARRC), Central Asia Regional Economic Cooperation (CAREC) and the G77 is essential. In order for the CBAM to have a broader political buy-in at the global level, its adverse impact on small developing economies needs to be studied. For the unilateral EU initiative on the CBAM to succeed, the EU parliament and Commission must decolonise the elite norms of engaging large economies and should include regional economic blocks — agglomerations of small and medium-sized economies in consultations. They must give due consideration to prioritising basic human needs as they will disproportionately bear the impacts of the CBAM directly or directly in the globalised world. Without such an inclusive approach, this initiative will push the EU to the corridors of isolation, nationalist populism and social injustice.

A Regional Cooperation Framework for Carbon Pricing

The Legitimacy Theory Behind Regional Cooperation

Carbon pricing cannot be handled by a single country effectively, but considerable cooperation across countries in the region and beyond. It would be neither desirable nor feasible for each country separately to pursue carbon pricing actions towards reducing national abatement costs. It would not be desirable because lower-cost abatement options would be foregone, and higher-cost options would be accepted. It would not be feasible, as there would be no financial incentive for AMS to participate in higher carbon pricing that needs actions at the global level (Bosetti et al., 2013; Vuuren et al., 2009). GHG mitigation and carbon pricing in developing countries within ASEAN could be lowered by regionally coordinated flow of technology and finance as quickly and as widely as possible.

Regional cooperation can be conceived as a networked system for accelerating the interdiction of universal carbon pricing or taxation. Addressing the operating challenges and investment issues

related to low-carbon development will require a wise combination and adaptation of both market and non-market options. In that sense, regional cooperation in regard to carbon pricing partnerships could be defined as a cooperative arrangement among AMS that has common understanding and objectively addresses the challenging issues of technology transfer as well as capacity building needs. This can epitomise an institutionalised cooperative relationship among the public actors (governments and international organisations) and private actors (corporate and civil society) across ASEAN to capitalise on the market forces. Open regionalism is already progressing in ASEAN with the proliferation of free trade agreements and evolving monetary policy coordination mechanisms. These market-driven regional cooperation efforts have the potential to complement and strengthen the present and future carbon pricing mechanism — either ETS or a unified carbon tax — and pool together to diversify resources due to its flexibility. Further argument with respect to the legitimacy of regional cooperation can be seen as an institutionalised arena where different levels of efforts collectively amount to an emerging domain for state and non-state actors to provide for a global public good such as climate change mitigation. Given the current trend in GHG emissions and the latest round of stalled global climate talks, the traditional ways of problem solving are no longer sufficient. Innovative actions that must accelerate paradigm shifting could be driven by a regional cooperation architecture to avoid the tragedy of commons, where in international cooperation efforts often takes time .

Mapping the Landscape for Regional Cooperation

Even though countries face different challenges and needs in managing carbon pricing thereby jeopardising the benefits of climate change mitigation, competitiveness is never an option. How can ASEAN and East Asian countries cooperate together to maximise the efficient and equitable use of resources, while meeting the challenges of ensuring economic stability and growth? Carbon pricing mechanisms should be conceived of as an inclusive development model that improves resource efficiency and mitigates climate change while generating a number of co-benefits, including accelerated job creation, healthier population, expanded access to secure energy supplies and sustained economic growth. The policies needed to achieve the goals are known. But implementing carbon pricing requires a data inventory, institutional mechanism and effective monitoring system.

The emerging economies of ASEAN need to deploy existing energy efficiency and low-carbon technologies using carbon pricing as a powerful instrument and develop new goods and services as well as infrastructure on a hitherto unprecedented scale. The most effective way to address this challenge is to develop a market framework which stimulates and scales up the Singapore model. Nevertheless, the region is vastly underinvesting in innovative systems that can catalyse domestic capacity to develop, adapt and diffuse beneficial technology and business models. Experiences in China, India, Japan and Korea indicate that effective carbon pricing and ETSs need to encompass not only the hardware of technology but also the software of knowledge management. Both the knowledge based as well as learning economic rationale argue that in the globalising economy knowledge is the most strategic resource and learning the most fundamental activity to foster economic competitiveness.

ASEAN + Carbon Pricing Coalition

The experience of almost three decades of climate negotiations suggests that it is very unlikely that all countries will agree to open negotiations about a global carbon price. The COP includes large and small states, importers and exporters of high-carbon goods, developed and developing countries, and fossil fuel rich and poor nations — representing a range of interests. Past climate negotiations have clearly shown the barrier role played by hesitant and even unwilling countries. One promising route towards a carbon-pricing agreement, which could overcome many political

barriers, is to establish a "carbon-pricing coalition" among ASEAN and East Asian countries with an ambition to implement effective climate pricing policies.

The carbon coalition would coordinate pricing mechanisms or markets to achieve a uniform carbon price across member states. It would progressively cover all energy-related emissions and possibly even other sources, to ensure that few emissions escape regulation and that economy-wide emissions reduction is cost-effective. The coalition could also opt for a minimum rather than a uniform carbon price, to allow participating countries which already have a relatively high unilateral carbon price to maintain it.

The ASEAN-carbon pricing coalition would apply a uniform cross-border carbon adjustment under the Regional Comprehensive Economic Partnership (RCEP) signed in November 2020 with a rate no higher than the carbon price, on imports of goods and raw materials from non-members. Non-members would then feel economic pressure to join the club, and possibly even moral pressure if many AMSs already participate, as then non-members would be perceived as free-riders. A trade adjustment of this kind would align the national interests of non-members with carbon pricing since their exports would be taxed/priced in accordance with carbon content, which could encourage them to join the coalition in order to access the carbon tax or ETS.

This carbon coalition would also allow countries to learn from each other about their institutional design or to link national regulatory systems, creating larger and thus more effective carbon pricing mechanisms. Perhaps the best starting point for a coalition would be countries that already have some form of carbon tax or emission trading with considerable coverage such as China, Singapore, Korea, Japan and India. Other AMSs such as Indonesia, Malaysia and Thailand might be motivated to participate because of the co-benefits.

Conclusion

Developments in Asia-Pacific and the EU over the past years have given a major boost to carbon pricing mechanisms and an acknowledgement of the growing roles that markets could play in national and international efforts to reduce GHG emissions. Many emission trading mechanisms that are evolving in ASEAN and East Asian initiatives are in response to meeting national climate targets. Some are driven voluntarily by business. Japan, China, India, Singapore and Korea are now at the forefront in proposing innovative systems, whereas they lagged behind in their usage of tradable permits in the past. The Tokyo Cap and Trade Program and China's ETS are the world's first carbon pricing and market programmes targeting urban facilities. The Japan programme started in April 2010, and so far it has been successful. In 2015, emissions had been reduced to 23 per cent compared to the base year. This is a further 10 per cent from the first year in 2010, which showed to a 13 per cent reduction in 2011. The PRC has approved a pilot pricing scheme in seven provincial regions in an effort to encourage carbon emission reductions. In 2012, as a market-based emissions reduction policy measure, India launched a scheme called Perform, Achieve and Trade (PAT) to improve energy efficiency in which industry operators are assigned tradable quotas and the energy efficiency is increased. These led to the creation of domestic markets for domestic players. While carbon pricing mechanisms vary across judications, their design depends on local needs, economic structure and carbon market capacity. Key considerations in this regard include the largest emitting sectors in a given jurisdiction and the available abatement options. Some sectors, like the power or industry sector, are included in the scope of all emission trading systems.

At the international level, the Clean Development Mechanism (CDM) was designed to help developed countries meet a part of their emission reduction targets on carbon-offset principles. The projects of the CDM provide certified emission reduction (CER) credits, which can be traded or sold, by participants in the projects. To date, market creation through CDM is highly concentrated in a few countries of ASEAN.

Within each type of carbon market, either ETS or CDM, different emission management approaches are being implemented thereby creating a different cost of carbon within its targeted sector or country, explicitly through the incremental cost of policy requirements. This fragmented market and diversified carbon pricing approach also does not favour investors, as the transaction costs are more. The creation of regional carbon markets by linking different carbon pricing approaches together will establish a single carbon cost and create equitable access to the prevailing lowest-cost abatement opportunities.

The EU's Border Carbon Adjustment Mechanism (CBAM), a plan to decarbonise the EU, can have different implications for ASEAN and East Asian economies regarding international trade, carbon dioxide (CO_2) emissions, income and employment. New studies confirm that the introduction of carbon pricing coupled with a CBAM will help reduce carbon emissions but international trade patterns are changing in favour of countries where production is relatively carbon efficient. However, the reduction represents only a small percentage of global CO_2 emissions. The implementation of a CBAM could cause declines in exports of developing countries in favour of developed countries, which tend to have less carbon-intensive production processes or technologies to recoup the initial losses caused by such CBAM. Potentially, the EU could consider CBAM flanking policies, including the use of revenue generated by the CBAM, to accelerate the diffusion and uptake of cleaner production technologies by developing country producers. This could be beneficial both in terms of decarbonising the world economy and fostering a more inclusive trading system.

Coordinated carbon pricing mechanisms, an inclusive CBAM and integrated markets will deliver a number of benefits. They will expand the scope and diversity of low-cost carbon abatement opportunities, thereby enhancing cost-effective emission reduction in participating countries. Deeper and more liquid carbon markets will also operate more efficiently and effectively — provided there is strong confidence in the governance and credibility underpinning the markets. As regional carbon markets evolve and carbon pricing is coordinated, price volatility should decrease, because supply and demand for permits will be less dependent on a single country or region's short-term economic outlook. Linked markets decrease the transaction costs for businesses with liability under various schemes, and reduce the risk of competitiveness impacts on businesses and of potential consequential carbon leakage.

Linkages among carbon pricing mechanisms occur when one country recognises the carbon pricing instruments (e.g. allowance) operating within another system and allows its use to meet the compliance objective of the first system. An ASEAN and East Asian agreement to integrate markets could take a stepwise approach that allows linkages between various national approaches, covering both direct emission management and the need to offset emissions. A signatory country may choose multilateral participation in the regional carbon market by accepting, at the national or sector level, a fixed carbon emission budget for a given future period. Alternatively, a signatory country may choose to begin the task of managing its emissions without participating multilaterally, but instead engage in regional trade through unilateral recognition of project mechanisms.

Dr. Venkatachalam Anbumozhi is Director of Research Strategy and Innovation at Economic Research Institute for ASEAN and East Asia.

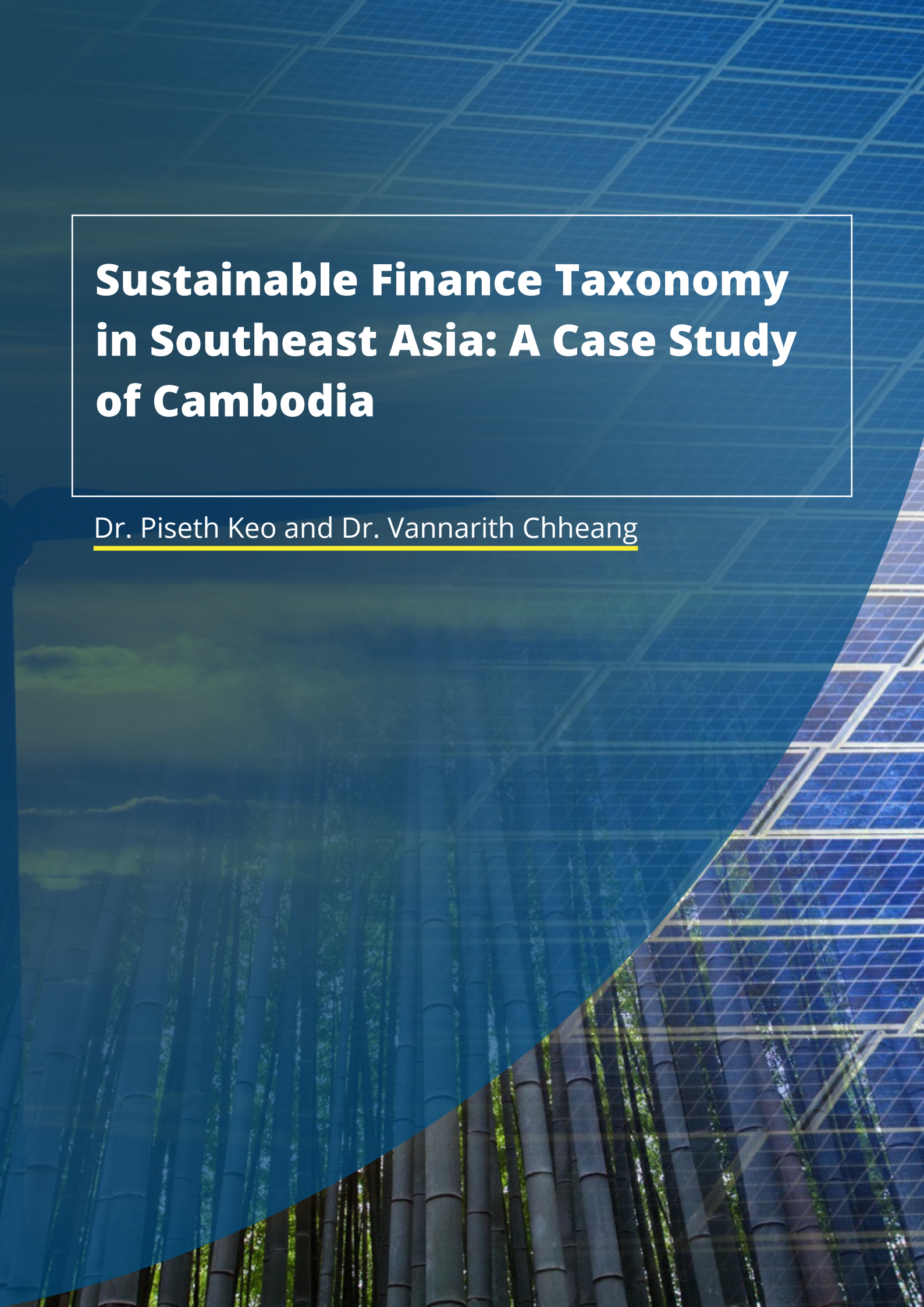
1. ACE 2018: Energy Efficiency Financing in ASEAN, ASEAN centre for Energy, Jakarta.
2. ACE 2018: ASEAN Feed in Tariff Mechanism Report, ASEAN centre for Energy, Jakarta.
3. Adams, P. 2021: Australia's Economy can Withstand the Proposed European Union Carbon Tariff, Centre of Policy Studies, Victoria University, Melbourne, in: https://www.vu.edu.au/about-vu/news-events/news/australia-s-economy-can-withstand-the-proposed-european-union-carbon-tariff [03 Nov 2021].
4. ADB 2015: South East Asia and The Economics of Global Climate Stabilization, Asian Development Bank Manila.
5. ADB 2016: Asian Development Outlook 2016, Update: Meeting the Low Carbon Growth Challenge, Asian Development Bank, Manila.
6. ADB 2017: Meeting Asia's Infrastructure Needs, Asian Development Bank, Manila, p. 105.
7. Aldy, E. Joseph 2016: Frameworks for Evaluating Policy Approaches to Address the Competitiveness Concerns of Mitigating Greenhouse Gas Emissions, Harvard Project on Climate Agreements Discussion Paper, 2016, 83, Google Scholar.
8. Anbumozhi, V. 2021: Carbon Pricing in ASEAN, Keynote Speech, The 4th Indonesia Energy Transition Dialogue, 21 Sept 2021, Jakarta.
9. Anbumozhi, V. / Kimura, F. / Kalirajan, K. 2020: Unlocking the Potentials of Private Financing for Accelerated Low-Carbon Energy Transition: An overview, Springer, p. 1-13, in: https://www.researchgate.net/publication/325955008_Unlocking_the_Potentials_of_Private_Financing_for_Accelerated_Low-Carbon_Energy_Transition_An_Overview [10 Oct 2021].
10. Anbumozhi, V. / Kalirajan, K. 2017: Paris Agreement and Globalization of Low-Carbon Technologies: What is Next for Asia, in: Anbumozhi V / Kalirajan, K. (Eds.): Globalization of Low-Carbon Technologies: The Impact of Paris Agreement, Springer, p. 1-17.
11. Anbumozhi V. / Kawai M. 2015: Towards a Low-carbon Asia: Challenges of Economic Development, in Anbumozhi V. / Kawai M. / Lohani B. N. (Eds.): Managing the Transition to a Low-carbon Economy, Asian development Bank Institute, Tokyo, p. 11-44.
12. Anbumozhi V. / Rakhmah T. F. 2018: Prospects of catalysing Regional Solutions and the Role of Low-Carbon Transition Fund, in: Anbumozhi V. / Kalirajan, K. / and Kimura F. (Eds.): Financing for Low-carbon Energy Transition: Unlocking the Potential of Private Capital, Springer, p. 397-421.
13. Anbumozhi V. / Yao X. 2015: Serendipity of Low Carbon Energy System and the Scope of Regional Cooperation, in: Anbumozhi V. / Kalirajan K. / Kimura F. /Yao X. (Eds.): Investing in Low-Carbon Energy Systems, Springer, p. 1-27.
14. Anbumozhi V. / LoCastro M. / David, D. / Lutfiana, D. / Rakhmah, T. F. 2020: Unlocking the Potential of Private Financing for Low-carbon Energy Transition: Ideas and Solutions from ASEAN Markets, ERIA Discussion paper, # 313, Economic Research Institute for ASEAN and East Asia, Jakarta.
15. Anbumozhi V. / Wolff, P. / Yao X. 2020: Policies and Financing Strategies for Low-Carbon Energy Transition: Overcoming Barriers to Private Financial Institutions, ERIA Discussion Paper #324, Economic Research Institute for ASEAN and East Asia, Jakarta.
16. Anbumozhi V. / Valautham, S. / Fauzhia, T. / Suryadi, B. 2017: Clean Energy Transition for fuelling economic integration ASEAN, in: Bhattacharya S. (Ed.): Rutledge Hand Book of Energy in Asia, p. 331-347.
17. Anderson S. M. / Ekins, P. 2008: Carbon Energy Taxation: lessons from Europe, Oxford University Press, London.
18. Ang G. / Burli, P. / Rottgers, D. 2017: The empirics of enabling investment and innovation in Renewable energy, OECD working papers, No 123, Organization for Economic Cooperation and Development, Paris.
19. ASrIA 2016: Asia Sustainable Investment Review, Association for Sustainable & Responsible Investment in Asia, Hong Kong.
20. Barbier E. B. 2020: How is the Global Green New Deal Going on?, Nature, Apr 2010.
21. Beijing Development and Reform Commission (DRC) 2014: Guidance on Accounting and Reporting of Carbon Emissions in Beijing, Google Scholar, in: http://www.iso50001.com.cn/uploadfile/2014/1120/20141120032649307.pdf [10 Oct 2021].
22. Berensmann K. / Dafe F. / Lindenberg N. 2017: Demystifying Green Bonds, in: Boubaker, S. / Cummings, D. / Nguyen, D. (Eds.): Sustainable Investing and Financial Markets, Edward Elgar, Cheltenham.
23. Bowen A. 2015: Carbon Pricing: How best to use the revenue, Grantham Research Institute on Climate Change and Environment, Policy Brief, London.
24. Calvin, Katherine / Fawcett, Allen / Jiang, Kejun 2012: Comparing Model Results to National Climate Policy Goals: Results from the Asia Modeling Exercise, in: Energy Economics, 34 (2), pp. 306-15, Crossref, Google Scholar.
25. Calvin, Katherine et al. 2012: The Role of Asia in Mitigating Climate Change: Results from the Asia Modeling Exercise, in: Energy Economics, 34 (2), pp. 251-60, Crossref, Google Scholar.
26. China-Beijing Environmental Exchange 2014: Annual Report on Carbon Market in Beijing 2014, in: http://www.cbeex.com.cn/images2016/bjtsc_2014.pdf [11 Oct 2021].
27. Climate Analytics 2019: Decorbonising South and South East Asia.
28. Cramton, P. / MacKay, D. J. / Ockenfels, A. /Stoft S. 2017: Global Carbon Pricing, MIT Press, Jun 2017.
29. Durrani A. / Volz, U. / Rosmin, M. 2020: The role of central bank in Scaling up Sustainable finance, What do monetary authorities in Asia and the Pacific Think, ADBI working Paper, #1099, Asian Development bank Institute, Tokyo.
30. Environmental Defence Fund, Institute for Global Environmental Strategies, and Climate Challenges Market Solutions 2016a: Japan: Market-Based Climate Policy Case Study, Google Scholar, https://www.edf.org/sites/default/files/japan_case_study.pdf [11 Oct 2021].
31. Environmental Defence Fund, Institute for Global Environmental Strategies, and Climate Challenges Market Solutions 2016b: Republic of Korea: An Emissions

Trading Case Study, Google Scholar, http://www.ieta.org/resources/2016%20Case%20Studies/Korean_Case_Study_2016.pdf [11 Oct 2021].
32. ERIA 2012: Mid-term Review of the Implementation of AEC Blueprint, Economic Research Institute for ASEAN and East Asia, Jakarta,
33. ERIA 2016: The Development of Regulatory Management Systems in East Asia, Economic Research Institute for ASEAN and East Asia, Jakarta.
34. ERIA 2017: Energy Outlook and Energy Saving Potential, Economic Research Institute for ASEAN and East Asia, Jakarta.
35. ERIA 2020: Policy brief Implications of the COVID-19 Crisis for the Energy Sector and Climate Change in ASEAN, Economic Research Institute for ASEAN and East Asia.
36. EU 2020: EU plan for the Recovery, European Parliament, Brussels.
37. Flachsland, Christian / Marschinski, Robert / Edenhofer, Ottmar 2009: Global Trading versus Linking: Architectures for International Emissions Trading, in: Energy Policy, 37 (5), pp. 1637-47, Crossref, Google Scholar.
38. General Office of the Beijing People's Government 2013: Decisions on Carrying Out Carbon Emissions Trading Schemes in Beijing under the Control of Total Emissions, Google Scholar, in: http://www.bjrd.gov.cn/zdgz/zyfb/jyjd/201312/t20131230_124249.html [11 Oct 2021].
39. General Office of the Beijing People's Government 2014: Management Methods on Carbon Emissions Trading in Beijing, Google Scholar, in: http://zhengwu.beijing.gov.cn/gzdt/gggs/t1359070.htm [11 Oct 2021].
40. Hongo, T. / Anbumozhi, V. 2015: Reforms for Private Finance toward Green Growth in Asia in Anbumozhi V. / Kawai M. / Lohani B. N. (Eds.): Managing the Transition to a Low Carbon Economy, Asian Development Bank, Manila — Asian Development Bank Institute, Tokyo.
41. Hübler, Michael / Löschel, Andreas / Voigt, Sebastian 2014: Designing an Emissions Trading Scheme for China — An Up-to-Date Climate Policy Assessment, in: Energy Policy 75, pp. 57-72, Crossref, Google Scholar.
42. IEA 2016: Energy and Climate Change, International Energy Agency, Paris.
43. IEA 2020: World Energy I Outlook, International Energy Agency, Paris.
44. International Carbon Action Partnership 2017a: Emissions Trading Worldwide: Status Report 2017, Korea Emissions Trading Scheme, Google Scholar, in: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=47 [11 Oct 2021].
45. International Carbon Action Partnership 2017b: Emissions Trading Worldwide: Status Report 2017, Japan-Tokyo Cap-and-Trade Program, Google Scholar, in: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=51 [11 Oct 2021].
46. International Carbon Action Partnership 2017c: Emissions Trading Worldwide: Status Report 2017, Japan-Saitama Target Setting Emissions Trading System, Google Scholar, in: https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=84 [11 Oct 2021].
47. Jaffe, Judson / Ranson, Matthew / Stavinsm, Robert N. 2009: Linking Tradable Permit Systems: A Key Element of Emerging International Climate Policy Architecture, in: Ecology Law Quarterly, 36 (4), pp. 789-808, Google Scholar.
48. Limaye D. / Limaye E. S. 2011: Scaling up Energy Efficiency: The case for a Super ESCO, Journal of Energy Efficiency, 22(1), pp: 17-28.
49. Massetti, Emanuele / Tavoni, Massiomo 2012: A Developing Asia Emission Trading Scheme (Asia ETS), in: Energy Economics, 34, pp. 436-43, Crossref, Google Scholar.
50. Mo L. / Zhai, Y. / Lu X. 2017: Establishing Low-carbon Technology Finance Mechanisms Asian Development Bank Experiences on Climate Technology Finance Centre, in: Anbumozhi V and K. Kalirajan, Globalization of Low-Carbon Technologies, ERIA, Springer, pp. 537-566.
51. Montagnoli, Alberto / de Vries, Frans 2010: Carbon Trading Thickness and Market Efficiency, in: Energy Economics, 32 (6), pp. 6040-54, Crossref, Google Scholar.
52. Muller, F. / Saddler, H. / Melville-Rea, H. 2021: Carbon Border Adjustments What are they and how will they impact Australia, The Australia Institute, Canberra.
53. OECD 2015a: Mapping Channels to Mobilize Institutional Investment in Sustainable Energy, Green Finance and Investment, Organization for Economic Cooperation and Development, Paris.
54. OECD 2015b: Overcoming Barriers to International Investment in Clean Energy, Green Finance and Investment, Organization for Economic Cooperation and Development, Paris.
55. OECD 2016: Green Investment Banks, Scale up Private Investment in Low-Carbon, Climate Resilient Infrastructure, Green Finance and Investment, Organization for Economic Cooperation and Development, Paris, pp. 117.
56. OECD (n.d.): Carbon Dioxide Emissions Embodied in International Trade, Embodied CO2 Emissions in Trade: Principal Indicators, in: https://stats.oecd.org/index.aspx?queryid=92932# [27 May 2021].
57. OECD-ASEAN 2020: Enterprise policy response to COVID-19 in ASEAN, Association of South East Asian Nations, Jakarta.
58. Olivier, J. G. J. / Greet Janssens-Maenhout / Peters, Jeroen A. H. W. 2016: Trends in Global CO_2 Emissions, Emission Database for Global Atmospheric Research (EDGAR), Google Scholar.
59. Paltsev, Sergey et al. 2012: The Role of China in Mitigating Climate Change, in: Energy Economics, 34, pp. 444-60, Crossref, Google Scholar.
60. Palttsev, S. et al. 2017: Pathways to Paris: Association of South East Asian Nations- technology and Policy Options to Reduce GHG emissions, Massachusetts Institute of technology, Boston.
61. Payerols C. 2020: Energy Transition issues within ASEAN, Trssor Economics, No 263.
62. Perdan, Slobodan / Azapagic, Adisa 2011: Carbon Trading: Current Schemes and Future Developments, Energy Policy, 39 (10), pp. 1331-36, Crossref, Google Scholar.

63. Polycarp, C. / Venugopal, S. / Nagle T. / Catania, A. 2013: Raising the Stakes: A survey of Public and Public-Private Fund Models and Initiatives to Mobilized Private Investment, Working Paper, World Resources Institute, Washington, p. 40.
64. Popp, D. / Vonna, F. / Noailly J. 2020: The employment impact of Green Fiscal Push: Evidences from the American recovery act.
65. Ranson, Matthew / Stavins, Robert N. 2015: Linkage of Greenhouse Gas Emissions Trading Systems: Learning from Experience, Working Papers, 16 (3), pp. 284-300, Google Scholar.
66. Research Institute of Innovative Technology for the Earth 2008: International Comparisons of Energy Efficiency (Sectors of Electricity Generation, Iron and Steel, Cement), Google Scholar, in: http://www.rite.or.jp/system/en/global-warming-ouyou/download-data/E-Comparison_EnergyEfficiency.pdf [11 Oct 2021].
67. Robins, N. / Choudhury, R. 2015: Building a Sustainable Financial Systems to Serve India's Developmental Needs, UNEP inquiry into the Design of Sustainable Financial Systems, Geneva and Federation of Indian Chambers of Commerce and Industry, New Delhi.
68. Schmidt-Traub, G. / Sachs, J. 2015: The Role of Public and Private Development Finance. SDSN Issue Brief, Sustainable Development Solutions Network, Paris and New York.
69. Simon, Z. / Zhang, Chenghui 2015: Greening China's Financial System: Synthesis Report, Institute for Sustainable Development, Winnipeg and Research Centre of the State Council, Beijing.
70. Sovacool, Benjamin K. 2016: The history and politics of energy transition, WIDER Working Paper No 2106/81, United Nations University, Helsinki.
71. Stadelmann, M. / Castro, P. / Michaelowa, A. 2011: Is there a leverage paradox in climate finance?, Cambridge.
72. Matthew, R. / Stavins, R. N. 2016: Carbon Markets: U.S. Experience and International Linkage, Track II Dialogue to Strengthen China–U.S. Collaboration on Energy, Climate Change, and Sustainable Development, Google Scholar.
73. Trotignon, Raphael / Delbosc, Anais 2008: Allowance Trading Patterns During the EU ETS Trial Period: What Does the CITL Reveal, Climate Report, 13 Jun 2008, pp. 1-36, Google Scholar.
74. UNFCCC 2015: Conference of the Parties. United Nations Framework Convention on Climate Change, Berlin.
75. Wang, X. / Barroso, L. / Elizonodo, G. 2014: Promoting Renewable Energy through Auctions: The Case of China, Live Wire 2014/14, World Bank Group.
76. WIR 2017: World Investment Report, United Nations Commission on Trade and Investment, Geneva.
77. Wolf, P. / Kohl, C. / Rinke, T. / Stuff, L. / Theisling, M. / Weigelmeir, C. 2016: Financing Renewable Energy Investments in Indonesia, German Development Institute, Bonn.
78. World Bank 2016: Readiness for Investment in Sustainable Energy (RISE), World Bank Group, in: http:/rise.worldbank.org [11 Oct 2021].
79. Yang, Yuan / Zhang, Junjie / Wang, Can 2018: Forecasting China's Carbon Intensity: Is China on Track to Comply with Its Copenhagen Commitment, Google Scholar, in: Energy Journal, 29 (2), pp. 63-86.
80. Zhang, Junjie / Wang, Zhenxuan / Du, Xinming 2017: Lessons Learned from China's Regional Carbon Market Pilots, Crossref, Google Scholar, in: Economics of Energy and Environmental Policy, 6 (2), pp. 1-20.

Sustainable Finance Taxonomy in Southeast Asia: A Case Study of Cambodia

Dr. Piseth Keo and Dr. Vannarith Chheang



"[The Taxonomy Regulation] aims to define environmentally sustainable activities. [It] is an important piece of legislation for enabling and scaling up sustainable investment and thus implementing the European Green Deal, including an economy that works for people and ensures a just transition that creates employment and leaves nobody behind. Notably, by providing companies, investors and policymakers with the definitions of which economic activities can be considered as environmentally sustainable, it is expected to help shift investments where they are most needed." [1]

Abstract

Having been at the forefront of efforts to combat climate change and environmental degradation, in 2018, European Union (EU), introduced sustainable finance taxonomy, which is "a tool to help investors, companies, issuers and project promoters navigate the transition to a low-carbon, resilient and resource-efficient economy". Taxonomy covers climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems. Implementation and regulation of the taxonomy in Europe will have broad implications on international trade, and politics. This paper seeks to discuss the progress and challenges in introducing sustainable taxonomy in Southeast Asia in general and in Cambodia in particular. The paper is divided into four main sections including (1) conceptual framework on sustainable taxonomy, (2) EU's experiences, (3) ASEAN's experiences, and (4) case study of Cambodia. The assumption is that ASEAN does not have systemic, integrated sustainable taxonomy yet. Each ASEAN Member State pursues its own SDGs financing strategy. Therefore, ASEAN, and Cambodia in particular needs to develop its own regional standard on sustainable taxonomy.

Introduction

To tackle climate and environment-related challenges, the European Commission (EC) introduced the European Green Deal, which aims to "transform the [European Union (EU)] into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use" .[2] The above quote of the legislation of the European Commission focuses mainly on the European Taxonomy Regulation, which aims to push forward sustainable investment as one of the key mechanisms for achieving the European Green Deal. The Taxonomy provides a clear definition of environmentally sustainable economic activities and how multi-stakeholders from policymakers, government regulators, independent evaluators, private companies, and investors play their roles in the process.

Having spearheaded international leadership for climate change over the decades, the EU Taxonomy, using global financial power as a tool, will create geopolitical friction and have transformative impacts on European societies and the international landscape. As evident, the European Union (EU)'s Forest Law Enforcement, Governance, and Trade (FLEGT) Programme adopted 2003 for forest protection and sustainable development based on legality licensing system, changed practices of forestry trade around the globe, even though positive outcome of the intervention remains contentious.[3] An EU resolution adopted on 4 April 2017 on palm oil and deforestation of rainforests over the concerns caused by global carbon emissions and biodiversity loss receives protests from Indonesia and Malaysia.[4] [5] The recent adoption of the European Carbon Border Adjustment Mechanism (CBAM), which put a carbon tax on imports of a targeted selection of products of non-EU countries, has received resistance from Russia, India, China, and other Asian nations and considered it as protectionism.[6] [7] The Third Generation Environmentalism Ltd (E3G) argues that CBAM is contrary to "the principle of common but differential responsibilities in UNFCCC negotiation, and would not fall under the legally acceptable objectives for such a measure on the General Agreement".[8]

The purpose of this chapter is to investigate the implications of the EU Taxonomy Legislation adopted on 12 July 2020 on the EU-ASEAN geopolitics. This paper is divided into six sections, including

1. an introduction,
2. a summary of the EU Taxonomy,
3. ASEAN Responses to Climate Change and Sustainable Finance Taxonomy,
4. Cambodia's Climate Change Responses and Sustainable Financing Taxonomy,
5. geopolitics of EU Taxonomy, and
6. conclusion

First, the introduction section provides a brief background of the EU Taxonomy, its implication for the ASEAN, and outlines of the chapter. Next, section 2 provides a summary of EU Taxonomy. Then Section 3 investigates the ASEAN Climate Change Responses and Regional Sustainable Financing Taxonomy. Next, section 4 examines the Cambodia case, covering the initiatives, challenges, and ways forward for sustainable financing taxonomy. Next, section 5 investigates the implication of the EU Taxonomy on EU-ASEAN Geopolitics. The final section concludes the discussion and proposes ways forward for the ASEAN region.

EU Taxonomy

The EU Taxonomy Legislation entered into force on 12 July 2020. It aims to scale up sustainable investment, which will contribute to the achievement of the European Green Deal. Furthermore, it is an important tool for promoting and enabling changes and transition towards sustainability.[9]

It is a classification system establishing a list of environmentally sustainable economic activities, and it provides companies, investors and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable. The Taxonomy Regulation sets out six overarching environmental objectives:

1. climate change mitigation,
2. climate change adaption,
3. the sustainable use and protection of water and marine resources,
4. the transition to a circular economy,
5. pollution prevention and control, and
6. the protection and restoration of biodiversity and ecosystems.[10]

In addition, the Taxonomy emphasises that in order to meet taxonomy criteria, each economic activity has to meet four conditions, including

1. one of the making a substantial contribution to at least one environmental objective,
2. doing no significant harm to any other environmental objective,
3. complying with minimum social safeguards, and
4. complying with the technical screening criteria.

Based on the Taxonomy, European companies can assess potential regulatory and financial risks and take measures to mitigate risks to align with the Taxonomy. However, it does not mean the company that does not meet the taxonomy criteria has unsustainable practices.

The scope of the EU Taxonomy applies to "financial market participants that offer financial products, financial and non-financial undertakings"[11] as highlighted in the Directive 2014/95/EU on the disclosure of non-financial information, including environmental matters and corporate social responsibilities, sustainability, potential risks, and other key information.[12] Reporting of the Taxonomy-aligned activities are mandatory for large EU companies and voluntary for small and medium enterprises. The disclosure of the information is key for informing investors and the public about the company's performance towards sustainable practices. In addition, this would help avoid greenwashing by certain companies. On the other hand, having sustainable practices would also help the companies apply for green financial products, including the future EU Green Bond Standard and EU Ecolabel.

Even though the regulation makes it mandatory for the EU companies to report their Taxonomy-aligned, it does not mean that they would lose their financial access. The purpose of the Taxonomy is to disclose information and leave it to investors and the public to decide what to invest and purchase.[13] With growing public consciousness on the environment and climate change, pressures from EU customers would be intense, and trend for green investment and green products are mostly likely to be growing.

ASEAN's Responses to Climate Change and Sustainable Finance Taxonomy

ASEAN's Responses to Climate Change

Climate change has significant impacts on the economy and society in Southeast Asia. The frequency and intensity of climate change-related natural disasters are rising. The risks and vulnerability caused by climate change are acute.[14] Nevertheless, there is a certain degree of political will and commitment at the national level of the ASEAN Member States (AMS) to address climate change issue. Remarkable action has been taken at domestic and regional levels. AMS have developed frameworks to coordinate, monitor, and evaluate the progress of agreed National Determined Contributions (NDC). According NDC target, Brunei plans to reduce 63 per cent of total energy consumption by 2025, Cambodia to reduce 27 per cent of GHG emissions by 2030, Indonesia to reduce 29 per cent of GHG emissions by 2030, Laos to reduce CO_2 from transportation with the amount of 191 ktCO_2e/year, Malaysia to reduce GHG emissions per GDP by 35 per cent by 2030, Myanmar to realise electricity saving potential of 20 per cent by 2030, the Philippines to reduce 75 per cent of GHG emissions by 2030, Singapore to reduce 36 per cent of GHG emissions per GDP by 2030, Thailand to reduce 20 per cent of GHG emissions by 2030, and Vietnam to reduce nine per cent of GHG emissions by 2030.

ASEAN's regional climate response and cooperation have been steadily strengthened. Under ASEAN's socio-cultural pillar, strategic priority areas relating to climate change include nature conservation and biodiversity, coastal marine environment, water resources management, environmentally sustainable cities, climate change, and environmental education and sustainable consumption and production. ASEAN Joint Statement on Climate Change to the 25th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change in 2019 stressed the need to strengthen support for AMS and other developing country Parties to analyse climate risks, formulate and implement adaptation measures, recognising the important role of agriculture in ensuring food security and providing co-benefits.[15]

Moreover, institutional structure has been designed to address climate change including the ASEAN Ministerial Meeting on Environment, the ASEAN Senior Officials Meeting on Environment, ASEAN Working Group on Climate Change, and the establishment of the ASEAN Centre for Biodiversity. The ASEAN Working Group on Climate Change Action Plan focuses on adaptation, mitigation, long term planning and assessment of National Determined Contributions, climate modelling and assessment, Measurement, Reporting, and Verification (MRV), Green House stocktaking, climate financing, technology transfer, and cross-sectoral collaboration. The ASEAN Centre for Biodiversity was established in 2005 in response to environmental degradation and biodiversity loss. It facilitates cooperation and coordination among the then ASEAN Member States and with regional and international organisations on the conservation a sustainable use of biological diversity, and the fair and equitable sharing of benefits arising from the use of natural assets.

Some flagship initiatives include ASEAN Climate Finance Strategy, ASEAN Climate Change Partnership Conference, the ASEAN Heritage Parks Programme, ASEAN SDG Frontrunner Cities Programme, and ASEAN Eco-Schools and Youth Eco-champion Award Programmes. ASEAN also produces ASEAN State of Environment Reports and ASEAN State of Climate Change Report to support evidence-based policy decision making process in ASEAN. The ASEAN State of Climate Change Report (ASCCR) provides an overall outlook of the state of play of climate change issues in the ASEAN region. ASCCR is also a forward-looking report, which includes recommendations on making the transition toward 2030 and on to 2050 for both adaptation and mitigation, considering ASEAN's development context and the long-term goals of the Paris Agreement.[16]

ASEAN'S RESPONSES TO CLIMATE CHANGE AND SUSTAINABLE FINANCE TAXONOMY

Climate change has significant impacts on the economy and society in Southeast Asia

Malaysia to reduce GHG emissions per GDP by 35% by 2030

The frequency and intensity of climate change-related natural disasters are rising

Myanmar to realize electricity saving potential of 20% by 2030

The risks and vulnerability caused by climate change are acute

The Philippines to reduce 75% of GHG emissions by 2030

Remarkable action has been taken at domestic and regional levels

Singapore to reduce 36% of GHG emissions per GDP by 2030

Brunei plans to reduce 63% of total energy consumption by 2025

Thailand to reduce 20% of GHG emissions by 2030

Cambodia to reduce 27% of GHG emissions by 2030

Vietnam to reduce 9% of GHG emissions by 2030

Laos to reduce CO_2 from transportation with the amount of 191 $ktCO_2e$/year

Indonesia to reduce 29% of GHG emissions by 2030

ASEAN Member States (AMS) have developed frameworks to coordinate, monitor, and evaluate the progress of agreed National Determined Contributions (NDC)

Some Flagship initiatives include:

- ASEAN Climate Finance Strategy,
- ASEAN Climate Change Partnership Conference,
- the ASEAN Heritage Parks Programme,
- ASEAN SDG Frontrunner Cities Programme,
- ASEAN Eco-Schools and Youth Eco-champion Award Programmes

Adaptation Measures

In terms of adaption, ASEAN has adopted some measures and development mechanism to assist the member states especially concerning disaster management including ASEAN Agreement on Disaster Management and Emergency Response (ADMER) adopted in 2005 and the ASEAN Vision on Disaster Management 2025. ADMER sets the foundation for regional cooperation, coordination, technical assistance, and resource mobilisation in all aspects of disaster management and emergency response. The signatories are obliged to cooperate in developing and implementing measures to reduce disaster losses, including identification of disaster risk, development of monitoring, assessment and early warning systems, standby arrangements for disaster relief and emergency response, exchange of information and technology, and the provision of mutual assistance.[17] In 2016, ASEAN adopted the declaration on "One ASEAN One Response: ASEAN Responding to Disasters as One in the Region and Outside the Region" to further enhance regional coordination and collaboration on disaster response.

The ASEAN Disaster Resilience Outlook suggests ASEAN to employ strategic foresight, develop a regional data platform, increase gender inclusivity in disaster management, strengthen investment in risk assessment and monitoring, disaster education and communication, enhance cross-sectoral synergies and inter-regional cooperation, diversify finance mechanisms, and support the development of sub-national disaster management actors including the provincial, city and community levels. More importantly ASEAN needs to implement a whole-of-society anticipatory approach to build disaster resilience and regional prosperity by 2025 and towards 2035.[18] Three mutually reinforced strategic elements — institutionalisation and communications, finance and resource mobilisation, and partnerships and innovations — play a critical tole in implementing the policy.[19]

Brunei as the Chair of ASEAN in 2021 proposed the idea of "SHIELD" (ASEAN Strategic and Holistic Initiative to Link ASEAN Response to Emergencies and Disasters) to promote a strategic, holistic, coordinated, and cross-sectoral approach in responding to emergencies and disasters. The key elements of the proposed approach are as follows:

i. "SHIELD" is aimed at gradually building a more effective network of ASEAN mechanisms and sectoral bodies across the three ASEAN Community Pillars in the area of response to regional emergencies and disasters;

ii. "SHIELD" places emphasis on a "whole-of-ASEAN" approach and more effective cross-pillar and cross-sectoral. As of 30 September 2021, coordination to ensure that ASEAN is better prepared for the next crisis and may better protect its people from adverse impact;

iii. "SHIELD" promotes expeditious activation of ASEAN mechanisms and processes in times of regional emergencies and disasters to minimise the impact on peoples' live.

To strengthen a climate resilient community, ASEAN requires capacity building at the regional, national, and local levels to reduce exposures and vulnerabilities. For instance, ASEAN has carried out a comprehensive study on drought. The joint study between ASEAN and ESCAP proposes that to build drought resilience, ASEAN needs to strengthen drought risk assessment and early warning services, foster drought risk financing markets, and reduce conflict by enhancing the adaptive capacity to drought. ASEAN should give more attention to the region's poorest people, who are already likely to live on the degraded land that is most vulnerable to the effects of drought.[20]

ASEAN State of Climate Change Report 2021 suggested that to promote transparency of adaptation, ASEAN and AMS should promote risk and vulnerability assessment as a basis for adaptation planning, develop best practice guidelines and roadmap for diffusion of adaptation technologies, and strengthen the scientific information base. To promote transformation of adaptation to achieve increased ambition, ASEAN and AMS should mainstream adaptation into sectoral and development planning, promote adaptation and mitigation co-benefits, develop regional, national and local adaptation plans, sustain actions through

public-private-people partnerships, promote multi-stakeholder processes, promote regional cooperation on adaptation, set adaptation goals, develop climate risk transfer system, and enhance technology diffusion on adaptation.[21]

Mitigation Measures

Notably, the greenhouse gas (GHG) emissions in the region have been increasing in tandem with the speed of industrialisation based on fossil-fuel energy and associated land-use change resulting in the loss of tropical forest and peatland rich in biodiversity. It is predicted that the region's energy-related GHG emissions will increase by 34–147 per cent between 2017 and 2040. Climate change impacts will intensify unavoidably due to accumulated global emissions in the atmosphere over time. The costs incurred from damage wrought by climate change will be many times larger than investments needed to mitigate such damage.[22]

Concerning mitigation, ASEAN has conducted study on ways to support region's transition to circular economy and developed the Framework for Circular Economy for the ASEAN Economic Community in 2021, which is supported by the Economic Research Institute for ASEAN and East Asia (ERIA). ASEAN recognises that Circular Economy is crucial in attaining the ASEAN Community Vision 2025 of a "vibrant, sustainable, and highly integrated economies". The circular "reuse-reduce-recycle" approach promotes a more efficient use of resources, thereby contributing to ASEAN Member States' commitment to the Paris Agreement on climate change and the achievement of the UN 2030 Agenda for Sustainable Development.[23] The Circular Economy focuses on minimising the use of resources, reusing the products and services, designing the products and services from a sustainability lens, improving the system efficiency, and minimising the system externalities.

AMS have proactively taken measures in the areas of GHG inventory and monitoring, reporting and verification (MRV) for GHG emissions and reductions and sector policy planning while developing their nationally determined contributions (NDC). A key challenge is how to raise the level of ambition of the NDCs and related long-term national strategies and policies.[24]

ASEAN adopted the Guidelines on Green Meetings in 2020 to support ASEAN Member States or ASEAN organs or other entities in organising ASEAN-related meetings that are more resource-efficient and environmentally responsible. Green meeting is defined as the meeting that is designed, organised, and implemented in a way that minimises negative environmental impacts and leaves a positive impact for the host community. The green meetings concept can also inspire broader organisational behaviour change such as creating demand for environmentally friendly services and raising awareness of individuals and service providers involved in the meetings.[25]

Renewable Energy Development

Growing populations, rising incomes and rapid rate of urbanisation have combined to boost consumption levels for energy and other resources across the region. By 2050, the region's population is expected to grow by another 25 per cent, putting pressure on national and local governments to keep pace with rising needs for housing, transportation, water and sanitation, and other infrastructure. Governments also need to ensure the creation of jobs and provision of social services.[26] The ASEAN Plan of Action for Energy Cooperation (APAEC)'s Renewable Energy target of 23 per cent in total primary energy supply by 2025 is critical for the transition through 2030 and on to 2050.

It is paradoxical that ASEAN's climate change mitigation efforts to date are not commensurate with the multifaceted threats that climate change poses to the region. The continued emphasis on and subsidisation of fossil fuels is paradoxical because it is not only detrimental for the climate but also poses a public health hazard, is costly in the short term, and carries a longer-term stranded asset risk.

Adnan Z. Amin argues: "Affordable, secure, and environmentally sustainable energy will be crucial to underpin Southeast Asia's development

over the coming decades. Energy consumption is expected to more than double by 2040. The diversification of Southeast Asia's energy supply through investments in renewables offers a viable option to support expansion and achieve wider socio-economic and environmental benefits."[27]

The ASEAN State of Climate Change Report 2021 suggested that to promote transparency of mitigation, ASEAN needs to strengthen the scientific information base, enhance collaboration on co-benefits research and actions, and establish a knowledge centre hub on MRV for ASEAN and AMS. To promote transformation of mitigation to achieve increased ambition, ASEAN and AMS should adopt an interdisciplinary approach for combatting air pollution, accelerate regional power interconnectivity to promote renewable energy in the region, promote green recovery from the COVID-19 pandemic, establish networks, groups of scientists, and communities of practice for mitigation, promote regional cooperation on mitigation through specific regional activities, and promote education and awareness raising for clean technology diffusion at all levels. To facilitate the implementation, ASEAN and AMS should set long-term mitigation goals and roadmaps at regional, national, and local levels, facilitate mitigation planning including addressing sectoral challenges, and enhance access to international mitigation finance.[28]

Despite the concerted region-wide push to reduce emissions, domestic level analyses suggest that there remain some key challenges such as continued reliance on coal, and the persistence of a supportive policy landscape, financing gaps faced by ASEAN member states in pursuit of achieving emissions reductions, institutional gaps which lead to fragmented development, implementation, and measurement of initiatives.

It is suggested that ASEAN should pay more attention on key areas to address climate change including

1. developing regional approaches on resource mobilisation on sustainable financing;
2. promoting knowledge sharing and institutional capacity building on climate change mitigation and adaptation;
3. promoting low carbon value chains and renewable energy trade;
4. seizing green economy opportunity;
5. developing a regional body overseeing and coordinating regional response on climate change.

ASEAN's External Relations

Dialogue partners of ASEAN have supported several projects such as the project on Climate Change Projections and Assessment of Impacts, Modelling and Capacity Building Programme was supported by India Institute of Science Bangalore in coordination with climate change institutes in AMS (the project completed in 2017). The ASEAN-German development partnerships on developing urban resilience, which was completed in 2018. The project, "Advancing the Clean Air, Health and Climate Change Integration Agenda in the Association of Southeast Asian Nations (ASEAN) Region" supported by the Coalition's Action Programme to address the 1.5 degrees Celcius Challenge.[29] The project on Enhancing Climate Change Adaptation in Southeast Asia is a regional project implemented by Southeast Asia Disaster Prevention Research Initiative Universiti Kebangsaan Malaysia in cooperation with other partner institutions from the region. Phase I of the project completed in 2016. The EU and ASEAN have established dialogue mechanism and jointly developed actions to adapt to climate change such as effective handling of wildfires on the ground for reduction of carbon emissions, scaling up international finance to build climate resilience, and promotion of environmentally sustainable economic activities.

ASEAN and Japan have developed their common agenda on climate change. Japan supports the development and use of critical tools including guidelines and methodologies for the national governments and the private sector to carry out monitoring reporting and verification systems and enhance cooperative climate actions across the

ASEAN Member States. Concerning adaptation, Japan supports the AMS to build capacity to plan and implement adaptation activities to develop bankable adaptation projects and encourage the private sector to invest in adaptation projects. Japan also supports the development and implementation of disaster risk assessment and climate risk mapping, so that the AMS can adapt to increasing climate and water related disasters. Concerning mitigation, Japan supports AMS to facilitate transfer of advanced low/zero carbon technologies. Japan accelerates commercialisation of innovative technologies and support their application toward building carbon neutral future compatible with the goal of the Paris Agreement. In May 2021, Japan pledged to provide ten U.S. dollars billion to support ASEAN's decarbonisation.

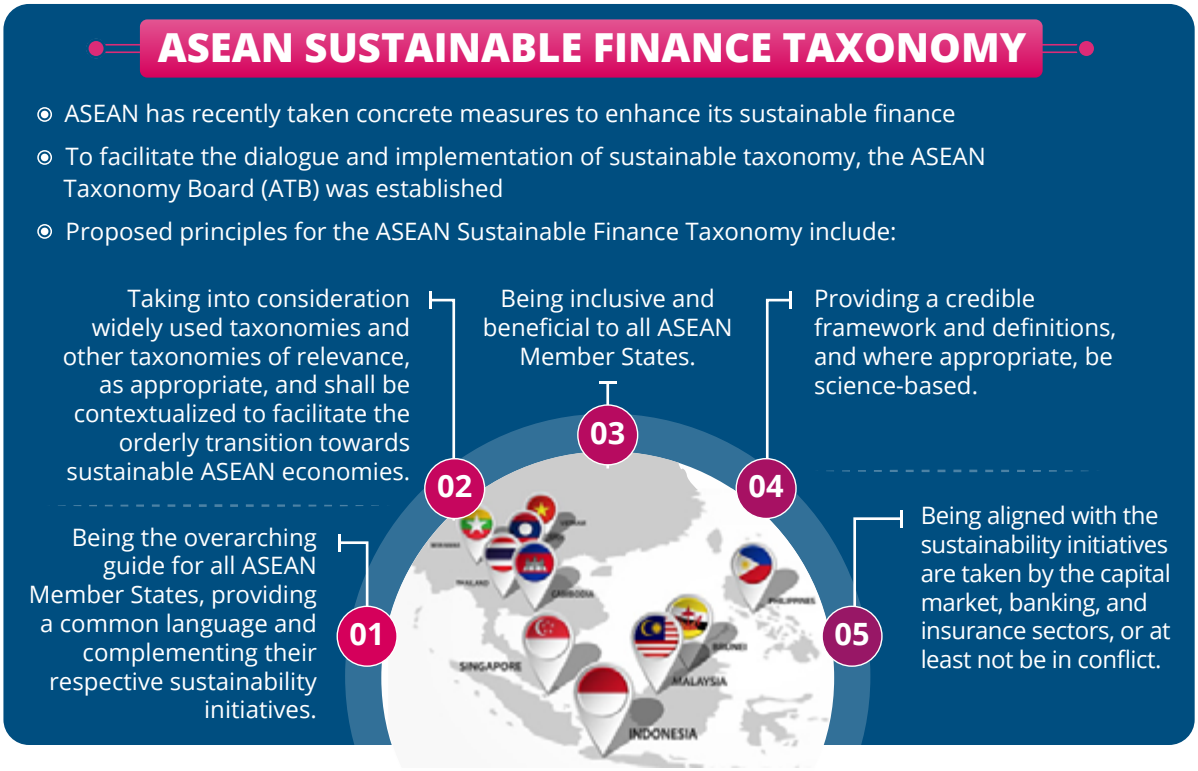
ASEAN has also closely cooperated with international development agencies on climate-related issues. For instance, JICA has developed climate related support portfolio and regional capacity building and empowerment through climate change international technical training centre. GIZ has developed climate-smart land use in ASEAN. Republic of Korea has promoted dialogue on carbon pricing.[30] The Norwegian government supported ASEAN Climate Change and Energy Project under the Norwegian-ASEAN Regional Integration Programme with the aim to improve the coherence between the ASEAN energy and climate policies, contribute to more climate-friendly development of the energy sector. The UN Environment Programme (UNEP), through its Southeast Asia Network of Climate Change Offices (SEAN-CC), has contributed to knowledge sharing and capacity building on climate change. The SEAN-CC aims to strengthen the capacities of National Climate Change offices on areas requested by network members both at the national and regional level and provide a platform for members to network and share knowledge, best practices and first-hand experiences in climate policy formulation and implementation in their respective countries.

ASEAN Sustainable Finance Taxonomy

ASEAN has recently taken concrete measures to enhance its sustainable finance. The joint statement of the 7th ASEAN Finance Minsters' and Central Bank Governors' Meeting adopted in March 2021 includes five paragraphs under "sustainable finance". In addition, the ASEAN Taxonomy on Sustainable Development was endorsed to serve as the overarching guide for all AMS, complementing their respective national sustainability initiatives and serving as ASEAN's common language for sustainable finance.

The development of an ASEAN Sustainable Finance Taxonomy across capital markets, banking, and insurance sectors, which will be the overarching guide for all ASEAN Member States, complementing their respective national sustainability initiatives and serving as ASEAN's common language, is also ongoing and expected to be completed within the year. The ASEAN Taxonomy will be multi-tiered and inclusive and beneficial to all ASEAN Member States and facilitate an orderly and effective transition towards a sustainable ASEAN. The ASEAN Taxonomy was promoted during the 26th United Nations Convention Framework on Climate Change Conference (UN COP 26) in November 2021. ASEAN is also working to encourage the promotion, development, and operationalisation of Sustainable Urban Mobility Plans (SUMP) and the Metropolitan Transport Executive (MTE) model in ASEAN Member States, through the issuance of Phnom Penh Declaration on Sustainable Urban Mobility by the ASEAN Transport Ministers in November 2021.

To facilitate the dialogue and implementation on sustainable taxonomy, ASEAN Taxonomy Board (ATB) was established to develop, maintain, and promote a multi-tiered taxonomy that considers the needs, international aspirations and goals of AMS. ATB aims to develop and promote a multi-tiered ASEAN Taxonomy for Sustainable Finance that identifies economic activities that are sustainable and help direct investment and funding towards a sustainable ASEAN. The ASEAN Taxonomy is an overarching guide for all ASEAN Member States, complementing their respective national sustainability initiatives and serving as ASEAN's common language for sustainable finance. The transition is a key element of ASEAN's sustainability agenda, and the ASEAN Taxonomy will incorporate an effective pathway to enable an orderly transition.[31]



Proposed principles for the ASEAN Sustainable Finance Taxonomy include:

1. being the overarching guide for all ASEAN Member States, providing a common language and complementing their respective sustainability initiatives;
2. taking into consideration widely used taxonomies and other taxonomies of relevance, as appropriate, and shall be contextualised to facilitate the orderly transition towards sustainable ASEAN economies;
3. being inclusive and beneficial to all ASEAN Member States;
4. providing a credible framework and definitions, and where appropriate, be science-based;
5. being aligned with the sustainability initiatives taken by the capital market, banking and insurance sectors, or at least not be in conflict.[32]

The implementation plan of the ASEAN Comprehensive Recovery Framework issued in 2020 lays out a strategic goal among others on promoting sustainable financing. There are six initiatives and programmes under the goal. First, the promotion of sustainable finance. The deliverable is the publication of report on promoting sustainable finance by the Working Committee on Capital Market Development (WC-CMD). Second, the roadmap on ASEAN sustainable capital markets. The deliverable is the development of actionable recommendations included in the roadmap to be produced by ASEAN Capital Markets Forum. Third, the promotion of ASEAN Green, Social and Sustainability Bond Standards. The outcome of this programme is to develop engagement programmes or roadshows to promote investment and issuance of ASEAN Green, Social and Sustainability Bond to be carried out by WC-CDM and ACMF. Fourth, the promotion of sustainable banking principles to guide future related policies and commitments to promote sustainable banking by ASEAN central banks. The outcome under this initiative is to formulate and adopt the ASEAN Sustainable Banking Principles (SLC is the leading agency). Fifth, following through on the non-binding recommendations of the SLC Task Force Report on the Roles of ASEAN Central Banks in Managing Climate and Environment-related Risks based on AMS's readiness and national

- The implementation plan of the ASEAN Comprehensive Recovery Framework issued in 2020 lays out a strategic goal among others on promoting sustainable financing.
- There are six initiatives and programs under the goal:

01 The promotion of sustainable finance.

02 The roadmap on ASEAN sustainable capital markets.

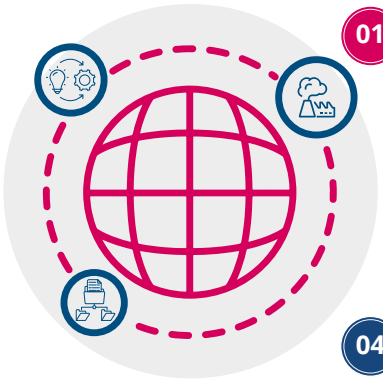
03 The promotion of ASEAN Green, Social and Sustainability Bond Standards.

04 The promotion of sustainable banking principles to guide future related policies and commitments to promote sustainable banking by ASEAN central banks.

05 Following through on the non-binding recommendations of the SLC Task Force Report.

06 Enhancing awareness on inclusive business model including promotion of enabling environment for impact investment in ASEAN.

- The Global Taxonomy Initiative Regional Action Plan for Southeast Asia 2017-2025 sets out four main goals:



01 Address taxonomic needs and strengthen capacities at the national and regional levels based on the priority needs assessment.

02 Support the establishment and maintenance of systems and infrastructures needed to obtain, collate, and curate the biological specimens that are the basis of taxonomic knowledge.

03 Facilitate an improved and effective infrastructure or system for accessing taxonomic information through the existing platforms such as the regional and national clearing-house mechanisms among others.

04 Assist the ASEAN Member States in generating information needed for decision-making in the conservation and sustainable use of biological diversity and its components.

interest, and in compliance with domestic rules and regulations. Sixth, enhancing awareness on inclusive business model including promotion of enabling environment for impact investment in ASEAN.[33]

AMS have different policies and standards regarding sustainable taxonomy. For instance, Malaysia's taxonomy aims to set a common language to categorise economic activities based on their impact on climate change and facilitate financial flows to activities that support the transition to a lower carbon economy.[34] Indonesia's taxonomy serves as a classification system that categorises economic activities and sectors that play key roles in climate change mitigation and adaptation, enabling financial institutions and investors to identify environmentally sustainable investments.[35]

The Global Taxonomy Initiative Regional Action Plan for Southeast Asia 2017–2025 sets out four main goals:

1. address taxonomic needs and strengthen capacities at the national and regional levels based on the priority needs assessment;
2. support the establishment and maintenance of systems and infrastructures needed to obtain, collate, and curate the biological specimens that are the basis of taxonomic knowledge;
3. facilitate an improved and effective infrastructure or system for accessing taxonomic information through the existing platforms such as the regional and national clearing-house mechanisms among others; and
4. assist the ASEAN Member States in generating information needed for decision-making in the conservation and sustainable use of biological diversity and its components.[36]

Cambodia's Climate Changes Responses and Sustainable Financing Taxonomy

Cambodia's Climate Changes Responses

Cambodia is a mainland Southeast Asian nation, sharing borders with Vietnam to the east, Lao PDR to the northeast, Thailand in the west and northwest, and Gulf of Thailand in the southwest. With a total land area of 181,035 kilometers squares, Cambodia is populated with 15.3 million people.[37] National Gross Domestic Products (GDP) per capita has annually grown at an average eight per cent from 244 U.S. dollars in 1993, when Cambodia transformed into a market economy, to 1,679 U.S. dollars in 2019.[38] [39] The COVID-19 pandemic, however, has severely affected the Cambodian economy. In 2020, the economy is contracted by two per cent.[40] Cambodia depends on three main sectors namely agriculture, industrial, and services, which share 20.8 per cent, 33.8 per cent, and 39.5 per cent of the GDP in 2019, accordingly.[41] The employment composition differs slightly, with agriculture constituting 37.0 per cent of the total, while the shares of manufacturing and service sectors are 26.2 per cent and 36.8 per cent, respectively.[42] Service sector in Phnom Penh is high at 75.7 per cent, compared to 65 per cent in other rural areas.[43] In addition, the percentage of Cambodians living under national poverty line has fallen from 48 per cent to 13.5 per cent, 2007 to 2014. About 90 percent of the poor live in the countryside. Around 4.5 million people remain near-poor and vulnerable to falling back into poverty when exposed to economic and other external shocks.[44]

Cambodia ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 18 December 1995 and acceded to the Kyoto Protocol on 4 July 2002. The country also ratified the Climate Paris Agreement in 2016. Since the ratification of the convention, Cambodia has actively played its roles as a member, based on the principle of "Common But Differentiated responsibilities". Even though, Cambodia was, in 1994, a net sink country, emitting 59,708 megatonnes of CO_2-eqivalent, and removing 64,850 megatonnes of CO_2-eqivalent, and became a low-emitting country in early 2000s, the country has actively involved and voluntarily implementing projects for GHGs Mitigation.[45] In addition, Cambodia has built institution for climate change responses, and mainstreamed it into national policy, public investment, sectoral and sub-national development plans.

In 2013, Cambodia adopted Climate Change Strategic Plan (CCCSP) (2014–2023), aiming to develop the country towards a green, low-carbon, climate resilient, equitable, sustainable, and knowledge-based society.[46] The CCCSP covers eight main strategic objectives that aim to promote climate resilience through improving food, water, and energy security; reducing sectoral, regional, gender vulnerability, and health risks to climate change impacts; ensuring climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, and highlands, etc.), biodiversity, protected areas, and cultural heritage sites; promoting low-carbon planning and technologies to support sustainable development; and others. Climate change responses were also integrated into sectoral plans including environmental management, agriculture development, water management, energy development plan, transportation, sub-national development plans, and others.

Additionally, climate change was highlighted in the "Rectangular Strategy for Growth, Employment, Equity, and Efficiency (2019–2023), a guiding policy for inclusive and sustainable national development, stressing the needs for intensifying the efforts to reduce the impacts of climate change by strengthening adaptation capacity and resiliency to climate change, and to contribute to global GHGs reduction.[47] Similarly, National Strategic Development Plan (2019–2023) emphasises the needs for decarbonisation of the economy to combat climate change, and sustainably manage natural resources, in order to achieve sustainability and stability of Cambodia's economic growth and development. Environmental issues, including climate change, are cross-cutting and require close collaboration among government agencies from both the national and sub-national levels, private sectors, and all stakeholders.[48]

There are also a number of policies and programmes, which aim to help Cambodia transit towards a low-carbon, clean, green, resilient, and sustainable society. These include National Strategic Plan on Green Growth (2013–2030), National Green Growth Roadmap, Cambodian Sustainable Development Goals (2016–2030), National REDD+ Strategy 2017–2026, National Forest Programme (2010–2029), Cambodia's National Environment Strategy and Action Plan (2016–2023), National Protected Area Strategic Management Plan (NPASMP) (2017–2031), Waste Management Strategy and Action Plan (2018–2030), National Energy Efficiency Policy (2018–2035), Industrial Development Policy (2015–2035), Policy on the Promotion of Paddy Rice Production and Export of Milled Rice, and National Strategic Planning Framework for Livestock (2016–2025).

Cambodia submitted the updated Nationally Determined Contribution (NDC) in 2020. According to NDC, in 2016, the FOLU shares 61 per cent of the total GHG emission, followed by agriculture (17%), energy (12%), industry (8%), and waste (2%). The NDC projects that under the Business-As-Usual practice, by 2030, FOLU remains the largest sector for GHG emissions, sharing more than 49 per cent of total amount. With constant economic growth, it is expected that emission from energy sector is expected to take a larger share than agriculture with 22 per cent and 17 per cent, subsequently. With the interventions proposed under NDC, it is expected that emission can be reduced almost 42 per cent. There are potentials for reducing GHG emission in FOLU sector by almost 50 per cent, followed by energy (40%), agriculture (22%), Industry (42%) and Waste (18%).

One of the major actions being proposed is to reduce 50 per cent of the historical emission from forest cover loss by 2030. With FOLU sharing the largest proportion of GHG emission, this will significantly reduce GHG emission in Cambodia. Besides the interventions in FOLU, there are number actions for energy, agriculture, industry, and waste sectors including

1. promoting sustainable renewable energy practices in manufacturing,
2. introducing urban planning tool for climate change mitigation,
3. utilising electrical equipment and minimum energy performance standard,
4. improving process performance of energy efficiency in commercial building/industries,
5. promoting integrated public transport system,
6. introducing climate-friendly technology for transportation, building, food chain and health,
7. increasing renewable energy into the energy mix 25 per cent by 2030,
8. properly managing industrial wastewater in the food & beverage sector,
9. centralising recycling facility for waste from garment sector, and
10. improving effectiveness and sustainability of agricultural practices, among others.

With forest and other land use sharing a large proportion of the National Greenhouse Gas Emission of 60.94 per cent and 49.23 per cent between 2016 and 2030, Cambodia has been promoting sustainable forest management as one of the key measures for reducing GHG and responding to climate change. To achieve the goals, the government has established more than 70 protected areas covering 7,3 million hectares, which is approximately 41 per cent of the country's total land area, one of the highest proportions in the world. At the same time, Cambodia has developed the Strategy for Reducing Emissions from Deforestation and Forest Degradation (REDD+) (2017–2026) and has implemented several actual REDD+ projects.

Cambodia's Sustainable Financing Taxonomy

The discussion about Sustainable Financing Taxonomy has started in Cambodia in the last decade. The progress has been, however, slow. It largely remains project-based and has not yet been included in national policies. In 2016, with the support from the United States Agency for International Development (USAID), Pact, Wildlife Conservation Society (WCS), and Mekong Strategic Partners, the Association of Banks of Cambodia (ABC), the official institution recognised by the Royal Government of Cambodia to represent banks and microfinance in Cambodia, launched the Cambodian Sustainable Finance Initiative was launched with cooperation from the National Bank

of Cambodia and the Ministry of Environment.[49] In 2019, the ABC signed a Memorandum of Understanding on "Cooperation for Sustainable Finance" with the National Bank of Cambodia, Ministry of Environment, and United States Agency for International Development to promote and strengthen cooperation on sustainable finance.[50]

In the same year, the ABC produced a Cambodian Sustainable Finance Principles Implementation Guidelines for its members, in which 47 out of its 66 members, has adopted the document, and integrated into their business operation.[51] [52] The purpose of the Guideline is to provide a list of principles that members can adopt and integrate in their own sustainable finance rules. These principles include management of environmental risks related to climate change, pollution, waste management, and protection of critical natural resources, and the negative impacts on human well-being and cultural heritages.[53] The principles also contains the commitment to "finance innovations that create efficiencies and improvements of existing, traditional sectors and business activities, as well as for developing new green economy activities… build capacity across the banks to deliver on our commitments [including] rais[ing] awareness of our customers and communities about sustainable, inclusive finance manage our own environmental and social (E&S) footprints and request similar standards from our suppliers… annually report our individual and sector progress against these commitments".[54]

In April 2021, there was an event virtually organised by a Cambodia-based NGOs named NGO Forum on the "Launching of Study Reports on Cross Border Investment in Agriculture and Environmental Impact Assessment (EIA) Compliance with Banking Sectors in Cambodia".[55] The author of the report mentioned that even though there are financial and banking institutions adopting the sustainable financing guideline, they had not introduced the requirement of environmental and social impact assessment in their loan approval.[56] Low motivation, high market competition, and limited awareness of the benefits of the environmental and social protection among banking and financial operators and the public were some of the key factors for ongoing practices, the author added. In addition, there have not introduced any mandatory legal requirements from the Cambodian National Bank and Ministry of Environment for such practices.[57]

Besides the initiative of the Association of Cambodia, Oxfam is implementing a project called Fair Finance Asia, which aims to establish "a more sustainable banking sector in Asia, where banks are more transparent, accountable, and adhere to standards on human rights standards and environmental, social and governance criteria".[58] As part of a regional Fair Finance Asia Initiative being implemented in seven countries, Fair Finance Cambodia aims to serve as a platform for NGOs in Cambodia to promote sustainable finance. The local network is established with six members at the moment. More specific objectives of the project include

1. strengthening Civil Society Organisations' capacity in contributing to the promotion of responsible finance,
2. facilitating awareness-raising among the public on responsible finance,
3. increasing awareness and political will among government agencies, regulators, banks, and banking associations to be more adherence to responsible and sustainable finance standards, and
4. supporting key stakeholders to assume leadership in developing appropriate policies and regulatory initiatives that will improve social and environmental performances of banks.[59]

In addition to the above initiatives, with the support of development partners, namely Sweden and the United Nations for Development Program, the Cambodian Ministry of Environment is piloting a project for Payment of Ecosystem Services at two protect sites that play essential ecological functions for water supply and habitats for aquatic and terrestrial resources.[60] It aims to generate incomes from water users, mainly from private businesses, including large factories, hotels, restaurants, and drinking water companies. The Kulara Water Co., LTD, a Cambodian-based company founded by French investors in 2009, is one of the potential proponents of the Payment of Ecosystem

Services, as it has provided support for social and environmental corporate responsibilities.[61] The Kulara can serve as one of the models in which an SME voluntarily contributes to sustainable practices. Good lessons learnt can be drawn for the promotion and implementation of sustainable practices throughout Cambodia.

To summarise the findings from Cambodia, Sustainable Financing Taxonomy has been introduced and slowly integrated into Cambodia's financial and banking systems with recognition and collaboration for the government institutions in charge. However, the Sustainable Financing Taxonomy has not been integrated into national policy, making it compulsory for large companies to disclose their information on sustainable practices. Presently, there are ongoing initiatives by the government and individual corporations, mainly on small scales. Sustainable financing is expected to grow with the network of government agencies, financial and banking sectors, development partners, international and national non-government organisations working together to promote this practice.

Impacts of EU Taxonomy on EU-ASEAN Relations

ASEAN is the third-largest trading partner of the EU after the United States and China, while vice versa for the EU trade to ASEAN. However, the EU is the largest investor in ASEAN.[62] In 2019, Foreign Direct Investment from the EU into ASEAN was approximately 358 U.S. dollars billion (313.6 billion Euro). In the same year, ASEAN investment in the EU was about 164 U.S. dollars (144 billion Euro).[63]

As the financial market is global, the EU Taxonomy will significantly impact ASEAN and global trade and business, which will lead to friction between the EU and ASEAN. With stringent regulation introduced, EU investors would most likely question partners in Southeast Asia about Taxonomy-aligned activities, and certain pressures would be applied. Taking the example of the European Union (EU)'s Forest Law Enforcement, Governance, and Trade (FLEGT) Action Plan, which "aims to prevent the trade of illegal timber among the EU and its trading partners especially in the "Global South", the plan has dramatically altered political, policy, institutional, and business landscape in Southeast Asia and Africa.[64] While there are positive impacts of FLEGT for improving the rules of law, checks and balance, and deliberative democracy, it has also been criticised for the mismatch between the conceptual design and the actual process. The focus is heavily on process and technical aspects while ignoring the socio-economic and political angles, where the drivers of forest loss and deforestation were not addressed. The plan is also criticised for creating barriers for small-scale businesses, as the process for receiving forest licenses takes tremendous financial resources and efforts, which makes it almost impossible for small businesses to fulfil.[65]

Drawing experiences of the FLEGT, the complex and costly technical processes brought by the EU Taxonomy, along with differences of social values and systems between the EU and ASEAN, the friction between the two continents are most likely to occur. For example, introducing the EU Taxonomy may intensify Indonesia's and Malaysia's ongoing protests over the EU's decision to list palm oil as an unsustainable product, as the EU considered it the driving cause of deforestation and biodiversity loss.[66] [67] Similarly, the decision of the EU to withdraw some of Cambodia's typical products from duty-free quota-free access to the EU market via the Everything But Arms, the EU's trade arrangement for Least Developed Countries due to the allegation over human rights issue remains a dissidence between Cambodia and the EU.[68] [69] Furthermore, more intense friction is expected with the introduction of the EU Carbon Border Adjustment Mechanism (CBAM), which puts a price on the import products, particularly on the carbon-intensive products, that aims to help the EU attain its climate mitigation target, as there are already protests from several Asian countries that consider CBAM as protectionist, and in violation of the principle of "Common but Differentiated Responsibilities and Respective Capabilities" of UNFCCC to respond to climate change.

Addressing the challenges due to different social values and political system is difficult to resolve. It is, however, important that the EU and ASEAN continue to discuss and dialogues based on the principle of mutual respect, mutual understanding,

mutual trust, and mutual interest in order to narrow down the differences and promote peace and prosperity for both continents, rather than competing for gains for one party at the expense of another and the planet. In addition, the EU and ASEAN may need to establish a coordinating body on the EU Taxonomy and other initiatives under the EU Green Deal to ensure adequate information sharing across ASEAN bodies, convening support from dialogue partners, and engaging with civil society organisations for the effective and successful implementation of the initiatives.

Without proper mechanism and agreement between the EU and ASEAN, the EU Taxonomy is just another environmental "fad", described by Rutt et al.[70] for FLEGT, initially and enthusiastically considered as an effective market-based mechanism for addressing conservation, but eventually failing to deliver its promise as its predecessors.

> **"'[T]hree key stages of a fad:**
>
> **(1) there is initial enthusiasm by a wide range of actors for FLEGT as something "new" or ground-breaking,**
>
> **(2) discrepancies and disagreements emerge about its end goals, i.e. whether it's core purpose is to distinguish legal from illegal wood in the EU marketplace, or to achieve deeper governance reforms; while the means for achieving those goals borrow heavily from previous market-based initiatives**
>
> **(3) actors and champions become fatigued, yet at the same time frame elements of their own involvement as a "success".'"**
>
> **— Rutt, Myers, et al.[71]**

Conclusion and Ways Forward

To conclude, this chapter started with introducing the purposes and mechanism of the EU Taxonomy, followed by the progress being made in Southeast Asia. Southeast Asian nations have made commitments and implemented actions to mitigate greenhouse gases, which are the root causes of global warming and climate change, and address climate change's impacts. Furthermore, there have been initiatives and proposed policy frameworks in place to implement Sustainable Financing Taxonomy in Southeast Asia, even though the actual implementation is at every early stage. Taking the case of Cambodia, the Association of Bank of Cambodia, with the support of government institutions, have introduced Sustainable Financing practices in which a majority of the members adopted and agreed to integrate them into their business operation. However, integration of the Sustainable Financing principles into financing and banking operation has been minimal due to high market competition in the financial and banking sectors, increased costs, limited staff capacity for loan assessment, and absence of national policy.

Overall, even though the progress is slow, there are positive signs that Sustainable Financing practices reach a higher level. For instance, the Cambodian government has also introduced pilot projects, while private corporations have upheld the spirit of social and environmental corporate responsibilities, including watershed protection, forest replantation and rehabilitation, pollution control and solid waste management, and environmental awareness-raising.

There are concerns about the potential frictions that may arise from the introduction of the EU Taxonomy, as it will change business practices in Europe and significantly impact global trade and businesses brought by European investment. Complex and costly technical processes and differences in social values and political systems have been the driving causes of the ongoing dissidence and future conflicts of the EU and Asia, as evident in the case of palm oil products, FLEG programme, and EBA. The friction may be even more intense with the introduction of the EU Carbon Border Adjustment, as countries are protesting against the decision and consider it as protectionist and violation of the UNFCCC principle in addressing climate change.

In order to address the above concerns, it is important for the EU and ASEAN to closely hold discussions and dialogues based on mutual respect, mutual understanding, mutual trust, and mutual interest for peace and prosperity for both continents. Collaboration should be for mutual gains for both parties, rather than gaining for one party at the expense of the other. In addition, a coordinating body on the EU Taxonomy and other initiatives under the EU Green Deal should be established to ensure adequate information sharing across ASEAN bodies, convening support from dialogue partners, and engaging with civil society organisations for effective and successful implementation of the initiatives.

Without a proper and effective mechanism for the implementation, the EU Taxonomy is just another environmental "fad", which receives overwhelming support from the proponents as a key tool for addressing the environmental problems but gradually faded away with its failure to deliver its intended outcomes.

Dr. Keo Piseth is Vice President and Director of Centre for Sustainable Development Studies of Asian Vision Institute.

Dr. Vannarith Chheang is President of Asian Vision Institute.

1 European Commission (EC) 2021a: Commission Delegated Regulation, Brussels: EC.
2 European Union (EU) 2019: Communication from the Commission to the European Parliament, the European Council, the Council, The European Economic and Social Committee, and the Committee of the Region: European Green Deal, Brussels: EU, p. 2.
3 Rutt, Rebecca L / Myers, Rodd / Ramcilovic-Suominen, Sabaheta / McDermott 2018: FLEGT: Another 'forestry fad', Environmental Science and Policy pp. 266–272.
4 European Parliament 2017: Palm oil and deforestation of rainforests, Brussels: European Parliament.
5 Jong, Hans Nicholas 2021: 'We attack,' Indonesia declares in joint bid with Malaysia to shield palm oil 2 Mar 2021, in: https://news.mongabay.com/2021/03/indonesia-malaysia-team-palm-oil-black-campaign-european-union/ [16 Nov 2021].
6 Simon, Frédéric 2021: Asian countries see EU carbon border levy as protectionist: survey, 10 Mar 2021, in: https://www.euractiv.com/section/energy-environment/news/asian-countries-see-eu-carbon-border-levy-as-protectionist-survey/ [16 Nov 2021].
7 Merriman, Jane 2021: Russia says EU carbon border tax may impinge on global trade rules, 18 Jun 2021, in: https://www.reuters.com/business/russia-says-eu-carbon-border-tax-may-impinge-global-trade-rules-2021-06-17/ [16 Nov 2021].
8 Lehne, Johanna / Sartor, Oliver 2020: Navigating the politics of Carbon Border Adjustment, Brussels, Third Generation Environmentalism Ltd (E3G), p.6.
9 European Commission (EC) 2021a: Commission Delegated Regulation, Brussels: EC.
10 Ibid.
11 Ibid, p.1.
12 European Union (EU) 2014: Directive 2014/95/EU of the European Parliament and of the Council, Official Journal of the European Union, Brussels: EU.
13 European Commission (EC), 2021a, n. 9.
14 ASEAN Secretariat 2020: Disaster Management and Human Assistance, in: https://asean.org/our-communities/asean-socio-cultural-community/disaster-management-humanitarian-assistance/ [18 Nov 2021].
15 ASEAN Secretariat 2019: ASEAN Joint Statement on Climate Change to the 25th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP25), 2 Nov 2019 , in: https://asean.org/asean-joint-statement-on-climate-change-to-the-25th-session-of-the-conference-of-the-parties-to-the-united-nations-framework-convention-on-climate-change-unfccc-cop25/ [18 Nov 2021].
16 ASEAN Secretariat 2021a: ASEAN State of Climate Change Report, Jakarta: ASEAN Secretariat.
17 ASEAN Secretariat 2005: ASEAN Agreement on Disaster Management and Emergency Response, Jakarta: ASEAN Secretariat.
18 ASEAN Secretariat 2021b: ASEAN Disaster Resilience Outlook – Preparing for a Future Beyond 2025, Jakarta: ASEAN Secretariat.
19 ASEAN Secretariat 2016: The ASEAN Vision 2025 on Disaster Management, Jakarta: ASEAN Secretariat.
20 United Nations 2020: Ready for the Dry Years: Building resilience to drought in South-East Asia, Bangkok: United Nations.
21 ASEAN Secretariat, 2021a, n. 16.
22 Ibid.
23 ASEAN Secretariat, 2016, n. 19.
24 ASEAN Secretariat, 2021a, n. 16.
25 Ibid.
26 ASEAN Secretariat, 2005, n. 17.
27 International Renewable Energy Agency (IRENA) 2018: Renewable Energy Market Analysis: Southeast Asia, Abu Dhabi: IRENA.
28 ASEAN Secretariat, 2021a, n. 16.
29 Climate and Clean Air Coalition n.d.: Advancing the Clean Air, Health and Climate Integration Agenda in the ASEAN Region, in: https://www.ccacoalition.org/en/activity/advancing-clean-air-health-and-climate-integration-agenda-asean-region [19 Nov 2021].
30 Japan International Cooperation Agency 2019: Engagement in ASEAN Climate Change Working Group /Partnership Conference, 13 Oct 2019, in: https://www.jica.go.jp/project/english/thailand/029/news/general/191013_03.html [19 Nov 2021].
31 ASEAN Taxonomy Board 2021: ASEAN Taxonomy for Sustainable Finance. Jakarta: ASEAN Taxonomy Board [19 Nov 2021].
32 United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) 2021: Green/SDG-Linked Bonds in Southeast Asia: State of Play and Prospects, UNESCAP.
33 ASEAN Secretariat 2020: Implementation Plan: ASEAN Comprehensive Recovery Framework, Jakarta: ASEAN.
34 Bernama 2020: BNM to finalise Climate Change and Principles-based Taxonomy soon – Governor, 6 Oct 2020, in: https://themalaysianreserve.com/2020/10/06/bnm-to-finalise-climate-change-and-principles-based-taxonomy-soon-governor/ [21 Nov 2021].
35 Winosa, Yosi / Jivraj, Hassan 2021: Learning from mistakes, Indonesia moves to next phase of sustainable finance roadmap, 20 Feb 2021, in: https://www.salaamgateway.com/story/learning-from-mistakes-indonesia-moves-to-next-phase-of-sustainable-finance-roadmap [21 Nov 2021].
36 ASEAN Centre for Biodiversity n.d.: Global Taxonomy Initiative: Regional Plan for Southeast Asia (2017-2025), Jakarta: ASEAN Centre for Biodiversity.
37 National Institute of Statistics (NIS) 2019: General Population Census of the Kingdom of Cambodia, Phnom Penh: NIS.
38 Royal Government of Cambodia (RGC) 2019: National Strategic Development Plan 2019-2023, Phnom Penh: Royal Government of Cambodia.
39 United Nations Statistics Division 2019: Per capita GDP at current prices - US dollars, 8 Apr, in: https://data.un.org/Data.aspx?d=SNAAMA&f=grID%3A101%3BcurrID%3AUSD%3BpcFlag%3A1 [20 Jun 2021].
40 World Bank 2020: Cambodia Economic Update, World Bank.

41 Ministry of Agriculture, Forestry, and Fisheries (MAFF) 2019: MAFF's Annual Conference 2019-2020, MAFF Conference, 2020, Phnom Penh: MAFF, p. 137.
42 National Institute of Statistic (NIS) 2020: Report of Cambodia Socio-Economic Survey 2019-20, Phnom Penh: NIS.
43 Ibid.
44 World Bank 2020: Cambodia Economic Update, World Bank.
45 Ministry of Environment (MoE) 2002: Cambodia's Initial National Communication, Phnom Penh: MoE.
46 National Climate Change Committee (NCCC) 2013: Cambodia Climate Change Strategic Plan (2014-2023), Phnom Penh: NCCC.
47 Royal Government of Cambodia (RGC) 2018: Rectangular Strategy for Growth, Employment, Equity, and Efficiency (2019-2023), Phnom Penh: RGC.
48 Royal Government of Cambodia (RGC), 2019, n. 38.
49 Association of Banks of Cambodia (ABC) 2021: Cambodian Sustainable Finance Initiative (CSFI), in: https://www.abc.org.kh/CSFI/about-csfi [21 Nov 2021].
50 Ibid.
51 Rajah and Tann Asia 2021: A guide to sustainable financing in Southeast Asia, Singapore: Rajah and Tann Asia.
52 ABC, 2021, n. 49.
53 Association of Banks of Cambodia (ABC) 2019: Cambodian Sustainable Finance Principles. Phnom Penh: ABC.
54 Ibid.
55 NGO Forum 2021: Launching of Study Reports on Cross Border Investment in Agriculture and Environmental Impact Assessment (EIA) Compliance with Banking Sectors in Cambodia, 28 Apr 2021, in: https://www.ngoforum.org.kh/launching-of-study-reports-on-cross-border-investment-in-agriculture-and-environmental-impact-assessment-eia-compliance-with-banking-sectors-in-cambodia/ [21 Nov 2021].
56 Ibid.
57 Ibid.
58 Oxfam 2021: Fair Finance Cambodia (2018-2022), in: https://cambodia.oxfam.org/what-we-do-inclusive-green-economy/fair-finance-cambodia-2018-2022 [21 Nov 2021].
59 Ibid.
60 Department of Biodiversity (DoB) 2020: Financial mechanism for piloting Payment for Ecosystem Services (PES) in Phnom Kulen National Park and Kbal Chhay Multiple Use Area, Phnom Penh: DoB.
61 Kulara Water 2021: A brief history of Kulara Water and Eau Kulen, in: https://www.eaukulen.com/page/kulara-water [21 Nov 2021].
62 Euroepan Commission 2021b: Countries and Regions: Association of South East Asian Nations (ASEAN), in: https://ec.europa.eu/trade/policy/countries-and-regions/regions/asean/ [21 Nov 2021].
63 Ibid.
64 Rutt et al., 2018, n. 3, p. 268.
65 Rutt et al., 2018, n. 3.
66 European Parliament, 2017, n. 4.
67 Jong, 2021, n. 5.
68 European Commission (EC) 2020: Cambodia loses duty-free access to the EU market over human rights, Brussels: EC.
69 Leang, Uch 2020: 20% of EBA withdrawal effect, 24 Aug 2020, in: https://www.khmertimeskh.com/50756228/20-of-eba-withdrawal-effect/ [21 Nov 2021].
70 Rutt et al., 2018, n. 3.
71 Rutt et al., 2018, n. 3.

List of Figures and Tables

List of Figures

List of Tables

List of Boxes

Images

1. ‘renewable’. seagul. (Pixabay). [download]. Available at: https://pixabay.com/photos/renewable-energy-renewables-solar-2232160/ [Accessed 9 December 2021]
   Appears on p.1, p. 8, p. 28, p. 56, p. 78, p. 94, p. 124 and p. 144 of this study.

2. ‘solar’. Clker-Free-Vector-Images. (Pixabay). [download]. Available at: https://pixabay.com/vectors/solar-panel-sun-energy-power-roof-310031/ [Accessed 9 December 2021]
   Appears on p.164 of this study.

Imprint

Date of Publication: March 2022

Publisher:
Konrad-Adenauer-Stiftung e. V., Berlin, Germany

Cover Illustration: © Pixabay/seagul
Other sources indicated accordingly.

Graphic Design:
https://infobranz.com/ | In accordance with KAS Design Guidelines

KONRAD ADENAUER STIFTUNG

Konrad-Adenauer-Stiftung e.V.
Klingelhöferstraße 23
10785 Berlin,
Germany

Contact:
Max Duckstein
Policy Advisor East Asia / Pacific
Department Asia and the Pacific
European and International Cooperation (EIC)
Konrad-Adenauer-Stiftung e.V.
max.duckstein@kas.de

Konrad-Adenauer-Stiftung e. V.