

# **Environmental Sustainability in Asia:** **Analysis of Carbon Reduction Plans in** **Southeast Asian NDCs**



Environmental Sustainability in Asia:  
Analysis of Carbon Reduction Plans in Southeast Asian  
NDCs

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# ACRONYMS AND ABBREVIATIONS

AOSIS	Alliance of Small Island States
ADB	Asian Development Bank
AFoCO	Asian Forest Cooperation Organization
ASEAN	Association of Southeast Asian Nations
BBB	Build Back Better
BERDE	Building for Ecologically Responsive Design Excellence
CSIS	Center for Strategic and International Studies
DER	Distributed Energy Resources
EV	electric vehicles
FiT	Feed-in-tariffs
GGGI	Global Green Growth Organization
GVC	Global Value Chain
GHG	Greenhouse Gas
HDB	Housing Development Board
IPEF	Indo-Pacific Economic Framework
IPCC	Intergovernmental Panel on Climate Change
IMCCC	Inter-Ministerial Committee on Climate Change
IKI	International Climate Initiative/ Internationale Klimaschutzinitiative
IRENA	International Renewable Energy Agency
LULUCF	Land Use, Land-Use Change & Forestry
LEAP	Low Emissions Analysis Platform
MRV	Measurement, Reporting and Verification
MEPS	Minimum Energy Performance Standards
NDC	Nationally Determined Contributions
NMT	Non-Motorized Transport
PUB	Public Utilities Board
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RETC	Regional Education and Training Center
THAAD	Terminal High Altitude Area Defense
NCCC	National Committee on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization

## Green Technology Competition in the Era of Economic Security: Implications of Global Supply Chain Restructuring for Korea



## Green Technology Competition in the Era of Economic Security: Implications of Global Supply Chain Restructuring for Korea

Eunjung Lim<sup>1)</sup>

### I. Introduction

The global energy market has gone through several critical junctures in the last five years. First, the technology competition between the United States and China has intensified; the so-called “Huawei Incident”<sup>2)</sup> revealed a fierce competition being waged between the two great powers for technological hegemony in the era of the Fourth Industrial Revolution (hereafter, 4IR). Second, the COVID-19 pandemic, which began in early 2020, lasted for more than two years, and altered the landscape of the globalization era. Energy consumption decreased, as flows of both human and logistics resources were blocked. But at the same time, digitalization — a fundamental 4IR factor inevitably accompanying electrification — accelerated, and distributed energy resources (DER) such as renewable electricity rapidly expanded. Third, on February 24, 2022, when a stagnant global economy was just emerging from the pandemic, Russia invaded Ukraine. Even as the conflict between Russia and Western powers intensified, the war disrupted the global energy supply, which led to a surge in energy prices. In addition, the composition of geoeconomics changed. Now, in the energy sector, power is being restructured, centered on major global actors such as the US, Russia, and China.

These and other dramatic changes are creating a non-economic logic which is different from the market-first principles of the globalization era. There is no longer such a thing as a purely economic issue, and there are more and more cases in which economic issues are considered to be linked to national security. The purpose of this work is to outline what the competition over green technology looks like in the energy sector in an era in which economic issues are intertwined with national security issues, and to diagnose the impacts of supply chain restructuring on the Korean economy.

1) Kongju National University I ej-lim@kongju.ac.kr

2) In February 2018, US intelligence agencies, including the Central Intelligence Agency, Federal Bureau of Investigation, and National Security Agency, warned that Huawei products should not be used. In August, the US Defense Authorization Act banned government procurement officers from purchasing Huawei products. In December, the eldest daughter of Huawei's founder, Meng Wanzhou, who served as vice president and the Chief Financial Officer of Huawei, was arrested. In early 2019, the US diplomats began pressuring allies not to purchase or use Huawei products. In May, an executive order by President Donald J. Trump declared a national emergency, going as far as to demand that the private sector cease business relationships with Huawei. Kim describes this series of events as the “Huawei Incident,” and highlights how the US government dealt with the Huawei issue as a security issue rather than an industrial issue. Sangbae Kim, “The Huawei Incident and US-China Technological Hegemony Competition: The Complex Geopolitics of Leading Sectors and Cyber Security [In Korean],” *Journal of International Area Studies* Vol. 28, No. 3 (2019): 126.

This article is structured as follows. Chapter 2 describes economic security and green technology, the two main concepts explored in this study. Chapter 3 examines China's dominance in solar power, wind power, and energy storage, three major green technologies. Chapter 4 analyzes the potential impacts of the US Inflation Reduction Act (IRA) on the current situation and describes the implications the law carries for Korea. Finally, the conclusion of the paper summarizes the key findings of the study and proposes a set of policy recommendations for Korea.

## II. Conceptual Background

### 1. Economic Security

For the purposes of this article, the concept of economic security needs to be defined. Although the term economic security is widely used, there remains no firm consensus on the exact definition of the term. The International Committee of the Red Cross (ICRC) for example defines economic security as “the ability of individuals, households or communities to cover their essential needs sustainably and with dignity.” Thus, economic security will according to this definition vary depending on an individual's physical needs and environment, as well as prevailing cultural standards.<sup>3)</sup> According to International Labour Organization (ILO), economic security is “composed of basic social security, defined by access to basic needs and infrastructure pertaining to health, education, dwelling, information, and social protection, as well as work-related security.” Work-related security, according to the ILO definition, has seven dimensions: (1) income security, (2) representation security, (3) labor market security, (4) employment security, (5) job security, (6) work security, (7) skill reproduction security.<sup>4)</sup>

However, recent changes to the geopolitical order have given rise to an alternate definition of economic security, and it is new understanding of the term that this study explores. The ongoing competition for technological hegemony between the US and China is an interconnected phenomenon. With the end of the Cold War, liberalism grew ascendant in the global political economy. Globalization accelerated, and market value became a fundamental axiom. Voices urging that restrictions on the movement and exchange of goods, capital, and people be minimized grew louder. All this has resulted in the formation of a liberal international economic order.

Since the 2000s, through the rapid spread of globalization and the expansion of the global supply chain, countries have become increasingly interdependent and hyper-connected, and economic-security linkages have evolved to take on an entirely new form. Companies prioritized cutting production and investment costs through the appropriate use of the

3) ICRC, “What Is Economic Security? (June 18, 2015),” <https://www.icrc.org/en/document/introduction-economic-security> (Accessed on September 10, 2022).

4) ILO, “Definitions: What We Mean When We Say “Economic Security”,” <https://www.ilo.org/public/english/protection/ses/download/docs/definition.pdf> (Accessed on September 10, 2022).

Global Value Chain (GVC), and began pursuing increased economic efficiency. Yet at the same time, asymmetries and imbalances in GVCs resulted in a new phenomenon: the weaponization of interdependence. Countries occupying critical links on GVCs became able to leverage their position to pressure competitors. This reflects a strategy that prioritizes national security interests, rather than the economic efficiency, and reflects an entirely different understanding of the concept of economic security. This definition of economic security inverts the traditional understanding of the term, in which security empowers and enables the economy, to a definition in which economic power is seen as a prerequisite to national security. The steps the Trump administration has taken to confront China evoke this new understanding.<sup>5)</sup>

Korea has proven no exception to this trend. Up to the Moon Jae-in administration, Korea employed a pragmatic two-track strategy: *Kyung-Joong Ahn-Mi*, or, “China for the economy, and the US for security.” However, during the term of the Moon administration, several major global events produced a new public awareness among the Korean people of the interconnectedness between the economy and security. The first: the Shinzo Abe government of Japan levied export control measures against Korea, removing Korea from the Japanese government’s “whitelist” of export partners to which strategic materials could be legally sold, citing security concerns. Then, in 2021, China restricted the export of raw materials necessary in fertilizer production, which resulted in a shortage of urea in Korea. This was not the first Sino-Korean trade conflict, however; prior to the urea episode, in 2016, Korea deployed an American-made anti-ballistic missile defense system, the Terminal High Altitude Area Defense (THAAD) system. China, seeing this as a security threat, retaliated by restricting tourism to Korea, and the tourism sector in Korea suffered accordingly. Through these and other events, the Korean public has come to understand economic and security issues as being two sides of the same coin.

Following the conclusion of Moon’s term in 2022, the conservative Yoon Seok-yeol administration took power and Korea changed its strategic approach significantly. President Yoon has continued to emphasize economic security as key national responsibility; the Korea Institute for International Economic Policy (KIEP), a national policy research institute, established an entirely division, the Economic and Security Strategy Department, to support the new government’s approach.<sup>6)</sup> As conflict and competition between the US and China has intensified, the Yoon government seems to have chosen to cooperate with the US for both economy and security. For example, it decided to join the Indo-Pacific Economic Framework (IPEF) led by the US, abandoning the Moon government’s strategic ambiguity vis a vis the US and China.<sup>7)</sup>

We see from the above that in the current era, countries have increasingly come to view threats to the national economy as indistinguishable from threats to national security. This phenomenon is what has given rise to the new definition of economic security.

5) This material is grounded in the arguments of Hyo-young Lee, “The Concept of Economic Security and Evaluation of Recent Trends [In Korean],” *IFANS Analysis of Major International Issues* 2022-08 (April 2022): 1, 4-6.

6) Jinkyu Kang, “The Yoon Government’s National Task, ‘Economic Security,’ KIEP to Strengthen Its Research on Supply Chain [In Korean],” *Hankook Gyeongjae* (May 15, 2022). <https://www.hankyung.com/economy/article/202205156271i> (Accessed on September 10, 2022).

7) In-cheol Jang, “Economic Security Is the Logic of the US-China War for Hegemony... Efforts Should Be Made to Maximize Practical Interests [In Korean],” *Hankook Ilbo* (July 7, 2022). <https://www.hankookilbo.com/News/Read/A2022070716030000189> (Accessed on September 10, 2022).

## 2. Green Technology

In the field of energy and environmental policy, the terms green technology, clean technology, and climate technology are often used in a similar context. According to the United Nations’ Economic and Social Commission for Asia and the Pacific (ESCAP), there is no commonly accepted or internationally agreed-upon definition of green technology, but the term can be broadly defined as “technology that has the potential to significantly improve environmental performance relative to other technology.” It is related to the term “environmentally sound technology,” which was adopted by the United Nations Conference on Environment and Development under Agenda 21.<sup>8)</sup> Therefore, green technology can be understood as “an umbrella term that covers a broad array of technologies associated with improving environmental sustainability and energy and other resource efficiency across the economy.”<sup>9)</sup> The term is used interchangeably with clean technology.

Meanwhile, climate technology is defined as “the subset of those technologies that are intended to reduce greenhouse gas (GHG) emissions or mitigate the impacts of climate change,”<sup>10)</sup> or alternatively, as “technologies that are explicitly focused on reducing GHG emissions or addressing the impacts of climate change.”<sup>11)</sup> The International Energy Agency (IEA) occasionally uses the term low carbon energy<sup>12)</sup> synonymously with climate technology.

This paper uses the term green technology instead of the related phrase climate technology, as it carries a broader meaning. Green technology-associated sectors include the energy, transportation/mobility, agriculture and food, manufacturing, and construction industries.<sup>13)</sup> The purpose of this study is to examine the competitive situation of green technology in the energy sector, the main analysis of the work focuses on renewable electricity, namely solar power, wind power, and energy storage.

This work analyzes the above three sectors for three main reasons. First, the importance of renewable energy is greater than ever. A transition to clean energy is essential to mitigate the threat to the survival of mankind posed by climate change, and at the same time, the Russia-Ukraine war has brought the concept of energy security once again back to the foreground. Renewable energy can solve both energy transition and energy security. Second, batteries are a vital strategic component in the decarbonization of transportation and the expansion of renewable energy. Third, in expanding the use of renewable energy and batteries, there exists a fundamental problem: not all of the necessary goods can be procured entirely within one country. Both renewable energy devices and battery manufacturing are spread across various stages of GVCs. Being excessively dependent on imports from a specific country can give rise to economic security risks for the importing country, especially if the relationship between the trade partners is a contentious one.

8) ESCAP, “Green Technology,” <https://www.unescap.org/sites/default/files/34.%20FS-Green-Technology.pdf> (Accessed on September 10, 2022).

9) Bruce Dick and Heather Karell, *2022 Emerging Technology Trends: Market and Legal Insights for Innovators* (Seattle: Perkins Coie, 2022), 38.

10) Ibid., 38.

11) PwC, *State of Climate Tech 2021: Scaling Breakthroughs for Net Zero* (London: PwC, 2021).

12) IEA, *Patents and the Energy Transition: Global Trends in Clean Energy Technology Innovation* (Paris: IEA, April 2021).

13) Dick and Karell (2022), 38.

However, this kind of economic security risk should be distinguished from energy security risk. Energy security is “the uninterrupted availability of energy sources at an affordable price.”<sup>14)</sup> Imagine a country that produces 100% of its electricity requirements using solar photovoltaic arrays, but imports 100% of its solar panels from a country with which it does not have a good relationship. This country’s energy security may remain secure, assuming climactic conditions continue to allow to produce electricity from solar panels within its borders. However, if this hypothetical country’s relationship with its primary solar panel supplier were to deteriorate, the country would suddenly experience a major economic security crisis.

Many Western think tanks and policy institutions have expressed such concerns. Nikos Tsafos, the Chair for Energy and Geopolitics at the Center for Strategic and International Studies (CSIS), in describing China’s rise to become the world’s dominant green energy power, writes: “China sees the energy transition as an opportunity to lead in technologies and products not currently dominated by the West. In pursuing this ambition, China will rewire the energy system: it is already drawing commodities like oil, natural gas and coal; and it totally dominates the markets for the critical minerals that will enable the energy transition.” He sees China’s position in the green energy technology market as both an industrial and commodity challenge, and is calling on the US to reshore, reroute, or otherwise rebalance its supply chain.<sup>15)</sup> Nis Grünberg, lead analyst at the Mercator Institute for China Studies (MERICS), looks at China’s systemic competition and normative rivalry with the US and the European Union (EU) in the field green technology, describing green tech products as “crucial for the transition from fossil to renewable energy systems – electrolyzers for green hydrogen production, new energy vehicles, carbon-capture technology and more.”<sup>16)</sup>

# III. China’s Dominance in Green Technology

The competition for technological hegemony between the US and China is not a recent phenomenon. A report published by Duke University’s Nicholas Institute for Environmental Policy Solutions in 2011 warned against China’s rapid advance in “clean technology.” It highlighted that China had in its 11th Five-Year Plan (which covered the years from 2006 to 2010) set ambitious environmental targets, including a 20% reduction in energy intensity (energy per unit of GDP) and a 10% reduction in major pollutants. These goals constituted China’s first quantitative, legally binding targets on energy intensity in any Five-Year Plan.<sup>17)</sup> The Duke report went on to encourage the US to increase its competitiveness

14) IEA, “Energy Security (Last updated December 2, 2019b),” <https://www.iea.org/areas-of-work/ensuring-energy-security> (Accessed on September 30, 2022).  
15) Nikos Tsafos, “China’s Climate Change Strategy and U.S.-China Competition,” Statement before the U.S.-China Economic and Security Review Commission (Washington D.C.: CSIS, March 17, 2022).  
16) Nis Grünberg, “Green-tech Rivalry Will Complicate US-China Climate Cooperation (January 19, 2022),” <https://merics.org/en/short-analysis/green-tech-rivalry-will-complicate-us-china-climate-cooperation> (Accessed on September 10, 2022).  
17) Brian Murray, Jonas Monast, Chi-Jen Yang, and Justine Chow, “The United States, China, and the Competition for Clean Energy,” *Nicholas Institute Policy Brief* 11-05 (July 2011): 5.

in green technology by providing supply and demand incentives to prepare for the threat posed by the rise of China.<sup>18)</sup>

Ten years have passed since the publication of the Duke report; the US intervening period has been unkind to the US. China has already outpaced the US in green energy, according to a report published by Harvard University’s Belfer Center for Science and International Affairs in December 2021.<sup>19)</sup> The report argues that “China will be a senior partner as the biggest producer, user, and exporter of green energy technologies which the US, EU, and others will depend on for their own green energy transitions.” This is because China dominates key links of the green energy supply chain.<sup>20)</sup>

Not a year after the publication of the Belfer report, the IRA entered into legal force. The bill has made political waves in Korea, dividing the winners and losers. Before discussing the IRA and the implications the law carries for Korea, this chapter analyzes the three fields — solar power, wind power, and energy storage — in which China has become the world’s dominant player.

## 1. Solar Power

Solar power has developed rapidly in the last ten years. According to IEA, solar power has significantly contributed the expansion of renewable energy capacity, and at a rate faster than was previously forecasted.<sup>21)</sup> In 2010, global installed solar capacity totaled 40.34 GW, but by 2021, capacity had exploded, reaching 843.09 GW. China has been driving this growth. China’s installed solar capacity amounted to just 1.02 GW in 2010, but surged to 306.40GW by 2021. In that same year, the installed solar capacity was just 93.71 GW in the US in the same year.<sup>22)</sup> Chinese solar power consumption accounts for nearly 32% of the global total; the US’ corresponding share was 16% in 2021.<sup>23)</sup> The number of solar power generation facilities increased significantly in 2021, equivalent to 179 TWh, of which nearly 40% was installed in China.<sup>24)</sup> In 2022, it is predicted that solar power will account for 60% of growth in renewable energy.<sup>25)</sup>

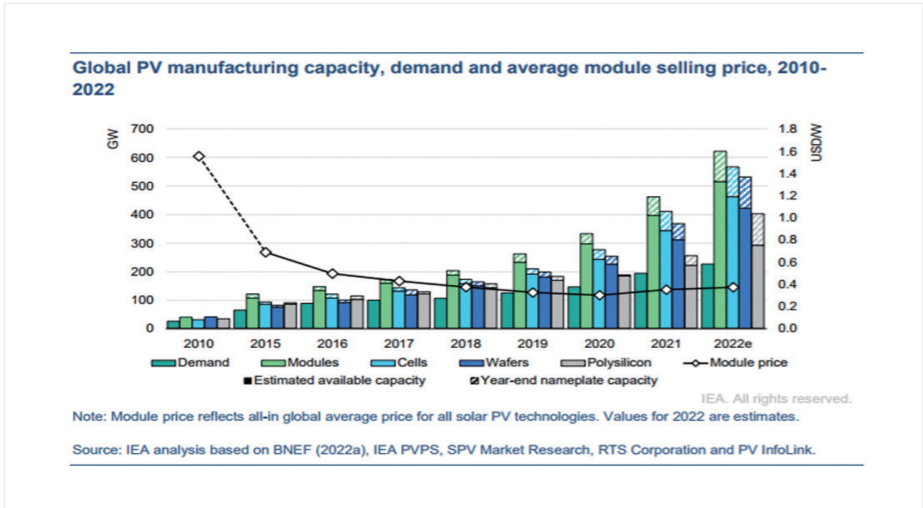
It is also important that China has an overwhelming advantage in the production of solar photovoltaic (PV) panels. The IEA draws attention to the fact that solar PV manufacturing capacity is now dominated by China. The solar PV production value chain comprises the following five stages: (1) polysilicon production, (2) ingot production, (3) wafer production, (4) cell production, and (5) panel/module assembly. China’s share in every stage of the chain exceeds 80%, according to the IEA.<sup>26)</sup>

18) Ibid. 7-11.  
19) Graham Allison, Kevin Klyman, Karina Barbesino, and Hugo Yen, “The Great Tech Rivalry: China vs the U.S.,” Harvard Kennedy School’s Belfer Center Avoiding Great Power Wars Project (December 2021).  
20) Ibid., 34.  
21) IEA, “Solar PV (September 2022g),” <https://www.iea.org/reports/solar-pv> (Accessed on September 30, 2022).  
22) Our World in Data, “Installed Solar Energy Capacity,” <https://ourworldindata.org/grapher/installed-solar-pv-capacity> (Accessed on September 30, 2022).  
23) Madhumitha Jaganmohan, “Leading Countries by Solar Energy Consumption Worldwide in 2021 (July 26, 2022),” Statista, <https://www.statista.com/statistics/815187/countries-with-the-highest-share-of-solar-consumption/> (Accessed on September 30, 2022).  
24) IEA 2022g.  
25) IEA, *Renewable Energy Market Update: Outlook for 2022 and 2023* (Brussel: IEA, May 2022c): 5, 7.  
26) IEA, *Special Report on Solar PV Global Supply Chains* (Brussel: IEA, August 2022f): 7.

Regarding solar PV manufacturing, the IEA analysis makes four key points. First, while PV production has overall exceeded demand, polysilicon manufacturing stage of the chain has not kept up with demand, and prices have risen. Figure 1 illustrates this, showing that the price of solar PV went up for the first time in 2021, owing to bottlenecks in polysilicon production. Second, the geographical shift of the value chain to China away from Europe, the US, and Japan has greatly accelerated over the past decade. Figure 2 depicts the geographical distribution of the solar PV manufacturing value chain; China's market share in all stages is overwhelming. Third, in the module assembly stage of the chain, even though other Asian countries have meaningfully improved production capacity, production levels in those countries are not high enough to meet demand and offset reliance on China. Fourth, solar PV manufacturing requires a wide variety of minerals and raw materials and the supply chains for these inputs are very complex.<sup>27)</sup> In sum, considering China's overwhelming dominance in solar PV manufacturing and the sheer variety and volume of raw materials required for the process, reducing dependence on China is not likely to be achieved in a short period of time.

Then, what of trends in patents related to relevant technologies? The number of renewable energy-related patents has been steadily increasing over the last decade, and solar has led this growth. The number of new solar power patents was about 18,000 in 2011 alone; this figure jumped to nearly 30,000 in 2021. According to intellectual property law firm Reddie & Grose, China filed more solar-related patents than any other country, for solar PV, solar thermal and solar thermal-PV hybrid technologies. The number of solar-related patents filed in China between 2011 and 2020 numbered more than 18,000, three times higher than the 6,000 patents filed in the US during the same period.<sup>28)</sup>

Figure 1. Global PV Manufacturing Capacity<sup>29)</sup>

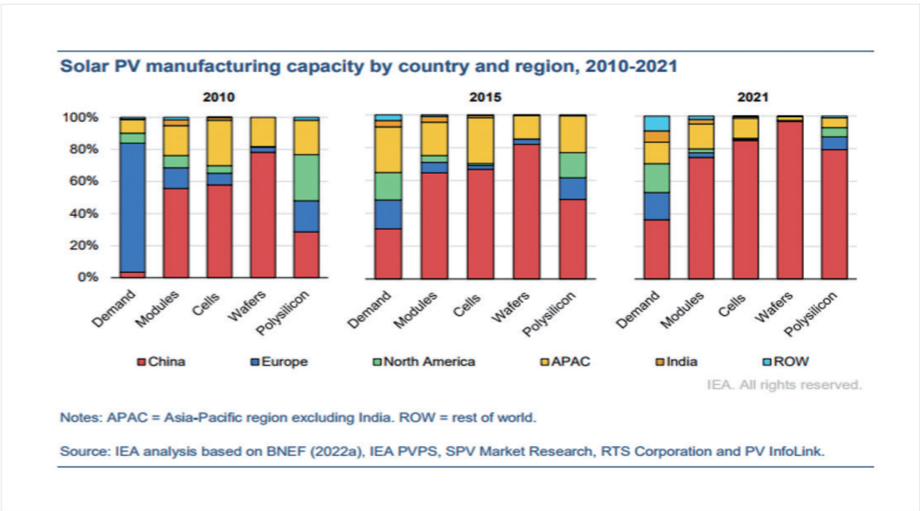


27) Ibid., 16-22.

28) Georgina Ainscow and Olivia Buckingham, "The Future of Renewable Energy – Tracking the Patent Trends," Reddie & Grose IP News (June 15, 2021), <https://www.reddie.co.uk/2021/06/15/the-future-of-renewable-energy-tracking-the-patent-trends-2/> (Accessed on October 2, 2022).

29) Ibid., 17.

Figure 2. Solar PV Manufacturing Capacity by Country and Region<sup>30)</sup>



## 2. Wind Power

Wind power is divided into onshore and offshore generation. According to the IEA, onshore wind power is a mature technology, with additional installed capacity nearly doubling in 2020 alone. The IEA analysis argues that offshore wind power has great potential, especially in the EU, where climactic conditions are particularly favorable.<sup>31)</sup> Offshore wind turbine technology has advanced dramatically. Wind power installations are farther apart than ever, and the diameter of a one wind turbine currently under development is 80% of the height of the Eiffel Tower.<sup>32)</sup>

The Global Wind Energy Council (GWEC) argues that the COVID-19 pandemic has played a major role in the spread of wind power. Newly-installed wind power capacity in 2021 was 93.6 GW, which was the second-highest figure on record.<sup>33)</sup> The GWEC analysis shows that 72.5 GW of new onshore wind capacity came online in 2021, 42% of which was installed in China. Whereas 21.1GW of new offshore wind power capacity began feeding the grid in the same year; 80% of this new capacity is in China.<sup>34)</sup> The world's largest onshore wind farm is located in the Gansu province of China.<sup>35)</sup>

Total combined wind power capacity in China is more than double of total combined capacity in the US. In 2021, total global wind power capacity came to 824.87 GW, with 328.97 GW of this capacity in China and 132.74 GW in the US.

30) Ibid., 18.

31) IEA, "Wind (Last updated January 10, 2022b)," <https://www.iea.org/fuels-and-technologies/wind> (Accessed on October 2, 2022).

32) IEA, *Offshore Wind Outlook 2019* (Paris: IEA, November 2019a), 19, 22.

33) GWEC, *Global Wind Report 2022* (Brussel: GWEC, April 2022), 8.

34) Ibid., 8, 109.

35) World Economic Forum, "These Are the Countries Bidding to Become Wind Power Superpowers (March 29, 2022)," <https://www.weforum.org/agenda/2022/03/offshore-onshore-wind-power-auction-capacity/> (Accessed on October 2, 2022).

This represents a major shift from the past. In 2010, installed capacity of the US stood at 39.13 GW, exceeding the 29.63 GW of wind power capacity in China. Capacity in the US since grown, tripling over the past ten years. But new wind capacity in China has exploded, increasing more than tenfold.<sup>36)</sup>

The most important stage in the wind power value chain is turbine manufacturing. According to the International Renewable Energy Agency (IRENA), “the amount of power that can be harvested from wind depends on the size of the turbine and the length of its blades. The output is proportional to the dimensions of the rotor and to the cube of the wind speed.”<sup>37)</sup> Table 1 contains a list ranking the top wind turbine manufacturers. Danish firm Vestas is in first place, followed by Spanish-German joint outfit Siemens Gamesa in second. However, these are the only European firms on the list, and six Chinese companies are among the top 10.

China’s dominance in wind power-related patents is also clearly evident. Between 2011 and 2020, there were over 50,000 Chinese patents filed related to wind power. During the same period, fewer than 20,000 patents were issued in the US.<sup>38)</sup> In 2020, at the height of the COVID-19 pandemic, a Wood Mackenzie analysis found that despite rising demand for wind power, the pandemic hampered logistics flows and disrupted wind turbine production. The Mackenzie report also found that India was the biggest beneficiary of the intensifying US-China trade conflict.<sup>39)</sup>

Table 1. Top 10 Global Wind Turbine Manufacturers,2022<sup>40)</sup>

Rank	Company	Headquarters	Total Capacity (Gigawatts)
1	Vestas	Aarhus, Denmark	9.60
2	Siemens Gamesa	Biscay, Spain	8.79
3	Goldwind	Beijing, China	8.25
4	GE	Boston, US	7.37
5	Envision	Shanghai, China	5.78
6	MingYang	Zhongshan, China	4.50
7	Windey	Zhejiang, China	2.06
8	Nordex	Hamburg, Germany	1.96
9	Shanghai Electric	Shanghai, China	1.71
10	CSIC	Chongqin, China	1.46

36) OurWorldinData, “Installed Wind Energy Capacity,” [https://ourworldindata.org/grapher/cumulative-installed-wind-energy-capacity-gigawatts?country=USA~CHN~OWID\\_WRL](https://ourworldindata.org/grapher/cumulative-installed-wind-energy-capacity-gigawatts?country=USA~CHN~OWID_WRL) (Accessed on October 2, 2022)

37) IRENA, “Wind Energy,” <https://irena.org/wind> (Accessed on October 2, 2022).

38) Ainscow and Buckingham 2022.

39) Wood Mackenzie, “Global Wind Turbine Supply Chain Trends 2020,” <https://www.woodmac.com/our-expertise/focus/Power-Renewables/global-wind-turbine-supply-chain-trends-2020/> (Accessed on October 2, 2022).

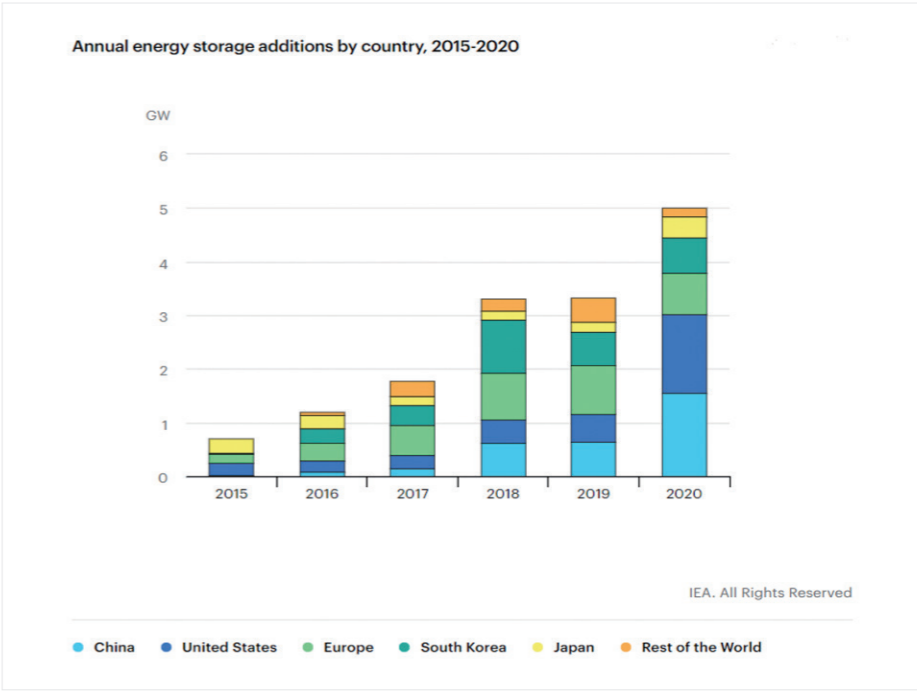
40) BizVibe, “Global Wind Turbine Industry Factsheet 2022: Top 10 Largest Wind Turbine Manufacturers (May 26, 2022),” <https://blog.bizvibe.com/blog/energy-and-fuels/top-10-wind-turbine-manufacturers-world> (Accessed on October 2, 2022).

### 3. Energy Storage

An IEA report details the reasons why energy storage devices are critical considerations in discussions of green technology: “Today, areas like electricity storage and smart grids are creating market value by supporting higher levels of variable renewable power without compromising electricity network resilience. In future, innovations that help companies offer consumers contracts for the quality of their heating, cooling and vehicle charging – ‘energy-as-a-service’ – while also getting paid by energy suppliers for the demand-side flexibility they can guarantee will further expand these overlaps.”<sup>41)</sup> In short, the diffusion of distributed energy resources (DER), such as electricity generated from renewable energy sources, and the distribution of energy storage devices must go hand in hand with the comprehensive provision of energy services.

In this context, battery storage capacity has also surged recently, with an additional 5 GW installed in 2020, a record-high. China and the US performed similarly, with China installing 1.6 GW of storage capacity and the US 1.5 GW in 2020. As Figure 3 shows, while China overtook the US in 2018-2019, the US seems to have caught up with China in 2020.<sup>42)</sup>

Figure 3. Annual Energy Storage Additions by Country<sup>43)</sup>



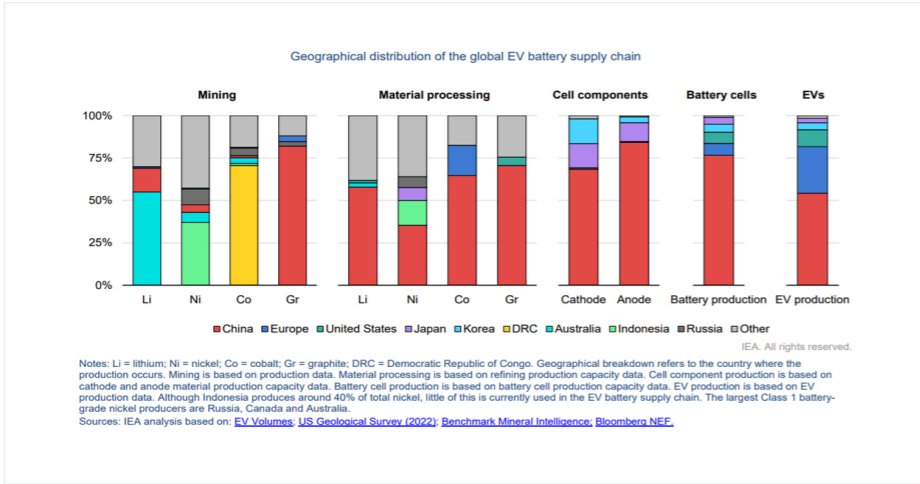
41) IEA 2021, 12.

42) IEA, “Energy Storage (Last updated January 7, 2022a),” <https://www.iea.org/fuels-and-technologies/energy-storage> (Accessed on October 3, 2022).

43) Ibid.

The most important market for energy storage devices is the electric vehicles (EV) segment of the automotive industry, in which large batteries are a fundamental component. EV sales continue to grow and broke records in 2021, when approximately 16.5 million EVs were in use. This is a threefold increase compared to just three prior. The rapid growth of the market for EVs in China is especially remarkable: in 2021 alone, Chinese consumers bought 3.3 million EVs. Outside China, sales came to just 3 million vehicles in 2020. Sales in Europe are also increasing rapidly. American consumers, meanwhile, bought 1 million EVs in 2021.<sup>44)</sup> As EV sales surge, battery demand is bound to skyrocket. In 2021, battery demand nearly doubled compared to the previous year.<sup>45)</sup> Changes in China are truly dramatic. Just over two decades ago, China lagged far behind Japan in terms of both technology and performance, but with the support of the government has achieved tremendous growth. The technological gap with Japan is expected to narrow over the next five years.<sup>46)</sup>

Figure 4. Geographical Distribution of the Global EV Battery Supply Chain<sup>47)</sup>



The battery manufacturing value chain comprises the following stages: (1) the mining of raw ores/materials, (2) the processing of raw materials, (3) battery cell components production, (4) battery cell/pack production, (5) EV assembly (the integration of batteries and hardware), and (6) the recycling of used batteries.<sup>48)</sup> China's presence in the battery manufacturing chain is superlative. Figure 4 illustrates the dominance of Chinese battery players. Lithium and nickel are two key inputs in battery manufacturing. Australia is the dominant exporter of the former and Indonesia of the latter, but when it comes to raw materials processing, China is the leading player for all materials save for nickel. China has no peer in any stage of the value chain, including cell component manufacturing (both cathodes and anodes), battery cell manufacturing, and final EV assembly.

44) IEA, *Global EV Outlook 2022: Securing Supplies for an Electric Future* (Brussels: IEA, May 2022d), 14-16.

45) IEA, *Global Supply Chains of EV Batteries* (Brussels: IEA, July 2022e), 9.

46) John D. Graham, Keith B. Belton, and Suri Xia, "How China Beat the US in Electric Vehicle Manufacturing," *Issues in Science and Technology* Vol. 37, No. 2 (Winter 2021), 73.

47) IEA 2022e, 5.

48) Ibid., 19.

Of the top three firms in each stage of the battery value chain tend to dominate production. The top three lithium producers represented 40 percent of total lithium supply and the biggest nickel miners accounted for 30% of nickel production in 2021. In that same year, the top three cathode makers manufactured 30% of all cathodes; for anode makers, this figure rises to 45%. Battery cell production is even more lopsided, with approximately 70% of all battery cells produced by the top three companies. The top three EV OEMs assemble more than 30% of all electric vehicles.<sup>49)</sup> Table 2 below lists the top three companies in important stages of the battery value chain and their nationalities. China's dominance is readily apparent.

Table 2. Top Three Companies in Each Stage of the EV Battery Supply Chain (2021)<sup>50)</sup>

EV Battery Supply Chain	Top-Three Companies in Each Stage (2021)	Country
Lithium	- Sociedad Química y Minera de Chile - Pilbara Minerals - Allkem	Chile Australia Australia
Nickel	- Jinchuan Group - BHP Group - Vale SA	China Australia Brazil
Cathode	- Sumitomo - Tianjin B&M Science and Technology - Shenzhen Dynanonic	Japan China China
Anode	- Ningbo Shanshan - BTR New Energy Materials - Shanghai Putailai New Energy Technology	China China China
Battery Production	- CATL - LG Energy Solutions - Panasonic	China Korea Japan
EV production	- Tesla - VW Group - BYD	US Germany China

Third Way, a public policy think tank based in Washington, D.C., analyzed the challenges facing the US today in the battery sector in a 2022 report. First, the US lags its competitors in terms of intellectual property rights and battery raw materials. Second, American companies are exposed to numerous threats in battery production. CATL (China), LG (Korea), and Panasonic (Japan) together account for more than 70% of global market share. Third, a shortage of skilled technicians and a lack of investment in the US has made catching up with China a daunting prospect.<sup>51)</sup>

49) Ibid., 20.

50) Compiled by the author based on information from a figure on page 20 of the above material.

51) Karan Mistry, Tina Zuzek-Arden, Thomas Baker, and Emma Delrose, *Potential for US Competitiveness in Emerging Clean Technologies* (Washington D.C.: Third Way, September 2022): 17-20.

# IV. The IRA and its Impacts on Korea

As described in the previous sections of this work, China has made remarkable strides in green technology, solar power, wind power, and energy storage over the past ten years. And as mentioned in the introduction of this paper, the US-China conflict characterized by a battle for technology supremacy and trade and embodied by the Huawei incident, has only intensified since Trump first took office. Yet in contrast to the Trump administrations ambivalent attitude to climate change and energy policy centered on traditional energy sources, the US policy stance has become much more proactive with regards to climate under the administration of current president Joe Biden. Since Biden took office, US policy language has emphasized responding to climate change as a channel for reviving US industry and manufacturing.

The IRA is a product of the Biden administration. On August 7, the bill that would become the law made it out of the Senate when Vice President Kamala Harris cast a tie-breaking vote. On August 12, the House of Representatives, the lower chamber of the US Congress which the ruling Democratic party controls, passed the bill, sending it to the desk of President Biden, who signed it, making the IRA the law of the land on August 16. The law is a modification of the so-called Build Back Better (BBB)<sup>52)</sup> bill that the White House had previously promoted. The previous BBB bill had required about USD 3.5 trillion in financial resources; these budget requirements meant that the bill found opposition. The successor IRA requires a far lower budget commitment of USD 740 billion.<sup>53)</sup>

The ostensible goal of the IRA is to contain soaring energy medical costs by focusing financial resources on energy security, the climate crisis, and health care for the common people, using funds raised by an increase in the corporate tax rate.<sup>54)</sup> The bill is expected to improve fiscal soundness in the long term, but experts do not anticipate significant macroeconomic impacts on inflation and growth given the scale of the bill.<sup>55)</sup> The main provision of the bill seems to raise USD 737 billion over ten years by introducing a minimum corporate tax. These monies are to be used to fund USD 437 billion in clean energy and health care investments, reduce the federal budget deficit, and contain inflation (see Table 3).<sup>56)</sup> Of the USD 437 billion earmarked for investment, USD 369 billion is to be invested in energy security and climate change initiatives.

52) IRA did not include the followings that BBB originally included: (1) Investment tax credit for transmission lines, (2) permitting reforms, (3) Clean Electricity Performance Program (4) Childcare (universal pre-K, paid family leave, enhanced child tax credit, etc.), and (5) Affordable housing. Julia Berg, "U.S. Inflation Reduction Act of 2022," (Irvine: Edison Energy, September 2022), 6.

53) Nan-yi Huh, Soo-ryung Park, and Hee-eun Mun, "Main Contents of the US Inflation Reduction Act (IRA) and its Implications for Korean Companies [In Korean]," *Law Times* (August 26, 2022) <https://m.lawtimes.co.kr/Content/Article?serial=181459> (Accessed on October 2, 2022).

54) PwC Korea, "Check the Impact of the Implementation of the US Inflation Reduction Act (IRA) [In Korean]," *Insight Flash* (August 2022), 3.

55) Ye-ji Chung and Seo-hee Hong, "Main contents and evaluation of the US Inflation Reduction Act [In Korean]," *Korea Center for International Finance Issue Brief* (August 11, 2022), 2; PwC Korea 2022, 8.

56) Senate Democrats Leadership, "Summary: The Inflation Reduction Act of 2022 (Updated August 11, 2022)," [https://www.democrats.senate.gov/imo/media/doc/inflation\\_reduction\\_act\\_one\\_page\\_summary.pdf](https://www.democrats.senate.gov/imo/media/doc/inflation_reduction_act_one_page_summary.pdf) (Accessed on October 2, 2022).

Table 3. IRA Topline Estimates<sup>57)</sup>

TOTAL REVENUE RAISED	\$ 737 billion
15% Corporate Minimum Tax	222 billion*
Prescription Drug Pricing Reform	265 billion***
IRS Tax Enforcement	124 billion**
1% Stock Buybacks Fee	74 billion*
Loss Limitation extension	52 billion*
TOTAL INVESTMENTS	\$ 437 billion
Energy Security and Climate Change	369 billion*
Affordable Care Act Extension	64 billion**
Western Drought Resiliency	4 billion***
TOTAL DEFICIT REDUCTION	\$ 300 + billion

\* = Joint Committee on Taxation estimate

\*\* = Congressional Budget Office estimate

\*\*\* = Senate estimate, awaiting final CBO score

Table 4 summarizes the investment goals of the IRA. A total of USD 177 billion is earmarked for investments in the clean energy sector; combining these investments with energy-related incentives targeting individuals and climate-related investments produces a much greater total, however. It can be said that one of the main goals of IRA is to contain inflation caused by rising energy prices by expanding the use of clean energy in the mid- to long-term.

As the IRA is the most significant law to address climate change in US history and provides new tax credits to enhance manufacturing capabilities related to eco-friendly industries in the US in the mid- to long-term, it will doubtlessly have a positive impact on industries and products that benefit from the credits. In addition, the IRA will ultimately enhance the competitiveness of the US industry by promoting investments that can contribute to tackling climate change. For example, new and renewable energy fields such as solar power, wind power, hydrogen, EV assembly, and subsegments in the secondary battery industry (especially the parts and materials sectors) are likely to be among the key beneficiaries of the law's provisions.<sup>58)</sup>

57) Ibid.

58) PwC Korea 2022, 8.

Table 4. Key Investment Provisions of the IRA<sup>59)</sup>

**Spending and Tax Cuts**  
Figures in billions over 10 years from 2022-2031

Investments	Amount
<b>Health Care</b>	
Affordable Care Act subsidies	\$ 64
Medicare Prescription drug benefit	\$ 34
<b>Clean Energy</b>	
New tax credit for emissions-free electricity	\$ 63
Extending existing tax credits for wind and solar power	\$ 51
Tax credit for existing nuclear reactors	\$ 30
Extending energy credit	\$ 14
Clean energy rebates and grants for residential buildings	\$ 9
Financing energy infrastructure	\$ 7
Tax credit for carbon capture and storage	\$ 3
<b>Individual Clean Energy Incentives</b>	
Tax credit for individuals	\$ 37
<b>Clean Fuel and Vehicles</b>	
Clean fuel tax credits	\$ 22
Tax credits for clean energy vehicles	\$ 17
<b>Manufacturing</b>	
Clean manufacturing incentives	\$ 37
Reduction of emissions from energy-intensive industries	\$ 5
<b>Air Pollution</b>	
Air pollution investments	\$ 35
<b>Conservation, rural development and forestry</b>	
Agricultural and forestry conservation	\$ 22
Rural development	\$ 13
<b>Transportation and Infrastructure</b>	
Improvements to federal buildings and highways	\$ 5
Loans and grants for electricity transmission	\$ 2
<b>Climate</b>	
Drought resilience	\$ 5
Weather and climate resilience	\$ 5
Other climate spending	\$ 11

However, it remains to be seen how the IRA will impact GVC restructuring. As described in the previous chapter, China's dominance in solar, wind, and batteries is considerable. Of course, the IRA may have the effect of deterring Chinese firms' entry into the American market, but despite its wide-ranging effects, the IRA is the law of the land in just one country, and it is difficult to argue that the law will have the effect of dramatically lowering the dependence of the rest of the world on

59) The Council of State Governments, "Understanding the Inflation Reduction Act (August 16, 2022)" <https://www.csg.org/2022/08/16/understanding-the-inflation-reduction-act/> (Accessed on October 3, 2022).

China. Nevertheless, US efforts to restructure GVCs will continue, and reshoring and the related concept of friendshoring<sup>60)</sup> are likely to play an important role in domestic American politics. When US Treasury Secretary Janet Yellen visited Korea in April 2022, she urged the West to "reduce its reliance" on Russia and China by shifting supply chains "away from strategic rivals" while at the same time deepening relations with friends (such as Korea) in her speech.<sup>61)</sup>

If this does come to pass, what will be the impact of these changes on Korean companies? It is difficult to make broad generalizations, and there will be winners and losers among Korean companies. One key variable is whether they can make products in the US. For example, Hanwha Solutions has manufacturing facilities in the US. Top-line growth at Hanhwa is likely to accelerate given the benefits (tax credits and preferential treatment) provided by the IRA.<sup>62)</sup>

On the other hand, for EV automakers, qualifying for tax credits is more difficult due to the current production structure. The IRA has strict requirements not only for final assembly but also for mineral and component ratios of batteries, meaning Korean OEMs are likely to face an uphill battle in qualifying for incentives. Even for battery producers able to source a substantial proportion of inputs in the US, firms that import any minerals or parts procured by a foreign entity of concern (FEC) are automatically excluded from any breaks. The list of FEC companies includes both Chinese and Russian government-controlled companies. Korean battery manufacturers are heavily reliant on Chinese parts and materials; for these firms, restructuring the supply chain to meet the demands of the IRA may prove a an undertaking.<sup>63)</sup>

In addition, the two major Korean automakers — Hyundai Motors and Kia Corporation — face an uphill battle in the short term, as they will need to rapidly expand their US production bases and reorganize their battery supply chains in order to take advantage of the provisions of the IRA. Kim et al(2022) identifies the many issues constraining attempts to move up the construction timeline for a Georgia EV plant, for which ribbon-cutting is currently planned for 2025. The plant is to have an annual capacity of 300,000 units. The study suggests that expanding and remodeling the production line at Hyundai-Kia's existing US facility is the fastest and most realistic way to increase local EV production capacity.<sup>64)</sup>

Although challenges are great, the impact on business competitiveness of Korean companies will be limited to the short term. American automakers procure most of their batteries from Korean and Japanese companies, and foreign competitors are also dependent on China for the supply of minerals and battery materials. The changes to subsidy allocations wrought by the IRA is likely to affect Korean battery and materials companies in a very limited way.<sup>65)</sup> And considering possibilities that Chinese investments in North America may shrink, and Korean companies are rapidly expanding their production base in

60) Wooldridge defines 'friendshoring' as follows; friendshoring is "shifting your supply chains from hostile countries to friendly ones." Adrian Wooldridge, "The West Needs Friendshoring, Not Reshoring," *Bloomberg* (August 29, 2022), <https://www.bloomberg.com/opinion/articles/2022-08-29/the-west-needs-to-friendshore-not-reshore-supply-chains> (Accessed on October 6, 2022).

61) Ibid.

62) Ibid., 10.

63) Huh, Park, and Mun 2022, 5-6.

64) Kim et al. 2022, 10.

65) Ho-seop Kim, Min-jun Song, Byoung-jun Kang, and Jong-hyun Won, "Impact of the Inflation Reduction Act," Korea Investors Service Special Report (August 18, 2022), 1.

the US through joint ventures or direct investments with American automakers, it is expected that the Korean battery and materials industry will ultimately be beneficiaries of the IRA in the long term.<sup>66)</sup>

Korea's three main battery companies are LG Energy Solutions, Samsung SDI, and SK On. Each has production capacity up and running in the US. Among their competitors, only Japan's Panasonic has production facilities stateside, but annual battery production capacity at that plant amounts to just 40 GWh. Currently, the three Korean firms' combined US production capacity targets is 380 GWh annually, which is equivalent to about 4.2 million EVs.<sup>67)</sup>

Moreover, LG and SK are diversifying their imports by investing in mines in Australia and Indonesia and signing long-term purchase contracts. However, the mining and smelting process (that is, the refining process) is environmentally harmful, producing sulfur oxides and other pollutants. Thus it is likely expanding minerals refining outside of China is likely to take a considerable amount of time, and the cost burden may rise in the process.<sup>68)</sup> Korean firm POSCO Chemical currently procures lithium, a core material in cathodes, from a variety of countries, including Chile. POSCO also has plans to import lithium from Argentina in the future; the steelmaking giant broke ground on the construction of a salt lake lithium plant in Argentina in March 2022, and the plant is expected to be completed in the first half of 2024 with an annual capacity of 25,000 tons of lithium hydroxide. POSCO Chemical is also working on localizing production of anode materials, which is the most difficult single material to procure outside of China.<sup>69)</sup>

## V. Summary and Policy Recommendations for Korea

The key findings of this study can be summarized as follows. First, China's presence in the field of green technology, and particularly in the solar power, wind power, and energy storage subsegments, is prominent. China is leagues ahead of the US in terms of solar and wind power generation, and its market share in the manufacturing of related devices is staggering. Although the US has caught up with China in terms of battery supply, it is not feasible to exclude China completely from the manufacturing sector. And in terms of patents as well, China has made remarkable achievements.

Second, in an era of competition for technological hegemony between the US and China when economic security has become a main feature of national strategy, China's dominance in green technology has come to be seen as a threat to American national security. Although the main purpose of the IRA is to reduce the deficit and curb inflation, it also aims

66) Kim et al. 2022, 1; PwC Korea 2022, 9.

67) PwC Korea 2022, 9.

68) Kim et al. 2022, 7.

69) POSCO-related information in this paragraph is drawn from Sung-eun Kim, "Korean Battery and Materials Companies Were Stronger... Reasons for Confidence in the US IRA [In Korean]," *Money Today* (September 7, 2022), <https://news.mt.co.kr/mtview.php?no=2022090615310692481> (Accessed on October 3, 2022).

to contain China's dominance in the green technology sector and balance its influence. While Europe has responded to a similar challenge in a more indirect and regulatory way — namely through the Carbon Border Adjustment Mechanism (CBAM)<sup>70)</sup> — the US has sought to put checks on China and on-shore related industries and manufacturing in a much more explicit and direct way.

Third, it remains to be seen to what extent such attempts by the US can influence the restructuring of GVCs. Considering the purchasing power of the US market and the political influence of the US as a superpower, the global impact of the IRA will be considerable. However, it is likely to take a significant amount of time until the prominent Chinese position is dramatically brought down, or until a US-centered supply chain achieves parity with or surpasses the China-centered one. Therefore, it is expected that multipolar competition in the field of green technology will continue for the time being.

Given the situation described in the preceding paragraphs, what should Korea do? The effects on Korean companies were discussed in the previous chapter. Winners and losers emerge, and sound risk management is the main determinant separating the two. In field the green technology, three are two critical risk management factors. The first: it is necessary to diversify import sources and/or localize production of key materials to secure a stable supply of raw materials. Second, it is crucial to maintain technological competitiveness. Korean companies must keep working on these tasks.

At the same time, the Korean government should make corresponding policy efforts to back up Korean companies. As the Kyung-Joong Ahn-Mi era of strategic ambiguity has passed, the Korean government needs to use its diplomatic skills in a more subtle and delicate way to manage risks for the country's economic security. First and foremost, the Korean government should solidify diplomatic relations with resource-rich countries and diversify its import sources for a stable supply of raw materials. In particular, it will be a necessary to carefully review relationships between Korean import partners and the US. Second, to support market-leading technology competitiveness of Korean firms capable of withstanding any shocks to GVCs following a restructuring of key supply chains, the Korean government should work to cultivate R&D professionals and other highly-skilled workers in critical fields. Last but not least, it will be necessary to provide appropriate incentives to domestic companies. In the era of reshoring and GVC restructuring, Korea is vulnerable to deindustrialization, which will ultimately be detrimental to its economic security. Therefore, the Korean government needs to design and implement policies that can encourage domestic companies to stay in the country and policies to attract more foreign investment.

70) For more on CBAM, see World Economic Forum, "What is a Carbon Border Tax and What Does it Mean for Trade? (October 26, 2021)," <https://www.weforum.org/agenda/2021/10/what-is-a-carbon-border-tax-what-does-it-mean-for-trade/> (Accessed on October 2, 2022).

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# Greenhouse Gas Mitigation Policies in ASEAN Countries



## Greenhouse Gas Mitigation Policies in ASEAN Countries

Jeong Won Kim<sup>1)</sup>

### I. Introduction

The frequency and intensity of climate-related hazards and natural disasters, such as typhoons, storms, and floods, have surged over the last decade. While every country on earth is exposed to some degree to the risks of climate change, Southeast Asia is one of the most vulnerable to its adverse impacts, due to the region's unique geographic, economic and sociodemographic circumstances. The region's lands have extensive coastlines, with economic activities highly concentrated in coastal areas, and many of the region's people are dependent on agriculture to make a living. Moreover, deforestation and poverty levels remain high across the region (ASEAN, 2021, p.35; Overland et al., 2021). As shown below in Table 1, from 2000 to 2019, five member states of the Association of Southeast Asian Nations (ASEAN) — Myanmar, the Philippines, Thailand, Viet Nam and Cambodia — were among the top 20 countries most exposed to climate risks (Eckstein, Künzel, and Schäfer, 2021, pp.44-49). In addition, several major cities in ASEAN countries, including Jakarta, Manila, Kuala Lumpur, and Singapore, have been found to face extreme or high climate change risks (Verisk Maplecroft, 2021, p.11). Indeed, in recent years, the region has experienced more severe and frequent extreme weather events. In Viet Nam, more than 90,000 people were displaced by floods caused by two heavy tropical storms in 2020, Linfa and Nangka. Typhoon Saudel wreaked havoc across the Philippines, Viet Nam, and parts of Cambodia, Thailand, and Malaysia, causing landslides and flooding (Frye, 2020). Furthermore, seven of the ten ASEAN member states saw record-high temperatures at some point over the last ten years (Living ASEAN, 2017).

1) Energy Studies Institute, National University of Singapore | esikjw@nus.edu.sg

Table 1. Climate Risk Index: ASEAN Countries, 2000-2019

CRI rank	ASEAN County	Average CRI Score
2	Myanmar	10.00
4	Philippines	18.17
9	Thailand	29.83
13	Viet Nam	35.67
14	Cambodia	36.17
52	Lao PDR	60.50
72	Indonesia	74.00
116	Malaysia	105.67
176	Brunei Darussalam	167.50
179	Singapore	172.00

Source: Eckstein, Künzel, and Schäfer, 2021, pp.44-49.

Increased exposure to climate change risks poses serious socioeconomic threats to the region, with significant potential to disrupt economic growth and impair quality of life. The Asian Development Bank (ADB) estimated that the collective economic losses and social costs to be borne by ASEAN countries from climate-related catastrophic risks, damage to agriculture and tourism, health and ecosystem losses, and decreasing labor productivity, would lead to 3% lower gross domestic product (GDP) by 2050 and an 11% reduction by 2100 under the business-as-usual (BAU) emissions scenario (Raitzer et al. 2015, pp.49-51). Other estimates are direr. According to Swiss Re’s modelling, the results suggest that ASEAN countries stand to lose 37% of their current GDP by 2048 if they take no climate action; the world economy over the same period projects to lose a far small smaller fraction of global economic production, estimated to be approximately 18% (Gray and Haller, 2021). Climate risks can also incur unexpected additional costs. Indonesia announced in 2019 that it would relocate its capital from Jakarta to Nusantara, partly because the northern part of Jakarta is sinking (Lyons, 2019). This relocation will incur costs of USD 34 billion for construction and infrastructure upgrades (Yuniar, 2022).

Given the ASEAN countries’ rapid economic growth and reliance on fossil fuels, the negative impacts of climate change described above may in fact be even more severe in the future. If energy demand in ASEAN countries follows historical trends, total final energy consumption (TFEC) would rise from 385 million tons of oil equivalent (Mtoe) in 2020 to 473 Mtoe in 2025, and then to more than 1,200 Mtoe by 2050 (ACE, 2022, pp.64-65). This would represent a concomitant increase in energy-related greenhouse gas (GHG) emissions in the region, from 1,991 million tons of carbon dioxide equivalent (MtCO2e) in 2020 to 2,471 MtCO2e in 2025 and up to 7,178 MtCO2e by 2050 under the BAU scenario. However, the implementation of relevant national GHG mitigation policies, including energy efficiency improvements and the deployment of renewable energy, could help the region mitigate almost 40% of GHG emissions compared to BAU (ACE, 2022, pp.94-95). Therefore, it is essential for ASEAN countries to cut GHG emissions based on sound policies. ASEAN countries are joining global efforts to tackle climate change by setting various climate targets, and by pursuing

policies to achieve these targets. This paper summarizes ASEAN countries’ GHG emissions mitigation targets and policies and explores select areas where these countries have common priorities.

## II. Summary of Key GHG Mitigation Targets and Policies in ASEAN Countries

ASEAN countries have communicated their climate targets through a series of nationally determined contributions (NDCs), submitted to the United Nations Framework Convention on Climate Change (UNFCCC). While most countries pledged relative emissions reductions based on BAU scenarios, Malaysia set reduction targets in terms of carbon intensity, and Singapore’s target shows absolute emissions reductions. Also, as of June 2022, eight ASEAN countries committed to more long-term ambitious targets, achieving net zero emissions. In addition, ASEAN countries have established various policies to help reduce GHG emissions and meet climate targets. Table 2 presents the key GHG mitigation targets and a handful policy measures for individual ASEAN countries.

Table 2. Key GHG Mitigation Targets and Policies of ASEAN Countries

Key Targets and policies
Brunei Darussalam

Overall mitigation targets:

- NDC (2020): Reduce GHG emissions by 20% by 2030, relative to BAU (Baseline: 2015 emissions, BAU emissions in 2030: 29.5 MtCO2e).
- Net zero by 2050.

Electricity generation:

- Energy White Paper (2014): Expand generation from renewable sources from around 1.7 GWh in 2014 to 124 GWh by 2017 and 954 GWh by 2035.
- Brunei Darussalam National Climate Change Policy (BNCCP) (2020): Increase renewable energy generation share to 30% of the electricity generation mix by 2035; reduce GHG emissions by 10% based on better power supply and demand management.
- The Ministry of Energy pledged to construct large-scale solar PV plants to increase the installed capacity to 100 MW capacity by 2025 and identified three sites for developing solar farms in 2021.

Transport:

- BNCCP (2020): Reduce GHG emissions from land transportation by increasing the share of electric vehicle (EV) sales to 60% of total vehicle sales by 2035.
- Formed an Electric Vehicles Joint Task Force in 2019.

- Launched a two-year pilot project in 2021, testing the effectiveness of exemptions for annual vehicle license fees for EV owners and rapid charging stations.

**Industry:**

- BNCCP (2020): Lower GHG emissions from the industrial sector through zero routine flaring and As Low As Reasonably Practicable (ALARP) standards.
- Introduced a mandatory carbon reporting requirement in 2021.
- Introduce carbon pricing by 2025 on all industrial facilities and new power utilities.

**Buildings and residential:**

- Energy Efficiency Order 2021: Energy labeling scheme using a star rating system and MEPS for air conditioners.
- MEPS will be expanded to other appliances, such as lighting and refrigerators.

**Agriculture, Forestry and Other land use (AFOLU):**

- BNCCP (2020): Plant 500,000 trees by 2035.

Cambodia

**Overall mitigation targets:**

- NDC (2020): Reduce GHG emissions by 41.7% by 2030, relative to BAU (Baseline: 2016 emissions, BAU emissions in 2030: 155 MtCO<sub>2</sub>e).
- Net zero by 2050.

**Electricity generation:**

- NDC (2020): Achieve 25% renewable energy (solar, wind, hydro, biomass) in the energy mix by 2030.
- National Strategy Development Plan 2019-2023 (2019): Achieve a village electrification rate of 100% by 2020, including solar and battery illumination, and achieve a household electrification rate of 90% by 2023.
- Provide remaining and remote off-grid villages and households with low-carbon energy.
- Two large-scale solar farm projects have been piloted; other solar park programs are in progress.

**Transport:**

- Convert 40% of cars and buses and 70% of motorcycles to EVs by 2050.
- Implement 50% reduction of EV import duties.
- Operate 30 vehicle inspection centers by 2030 to facilitate vehicle maintenance.
- Promote integrated public transport systems in major cities.

**Industry:**

- NDC (2020): Cut GHG emissions by 42% relative to BAU by 2030.
- Introduce energy-efficient electric motors and boilers.
- Establish energy management systems for large buildings and factories (voluntary for SMEs).

**Buildings and residential:**

- Developed the National Cooling Action Plan, including enhanced MEPS and F-gas transition for air conditioners and refrigerators.
- Promote climate-friendly cooling of public sector buildings.
- Develop building code and certification for new buildings and retrofits.
- Develop MEPS and energy labeling for lighting and cooling equipment.

**AFOLU:**

- NDC (2020): Cut GHG emissions by 23% and 50% by 2030, relative to BAU, in the agriculture and FOLU sectors, respectively.
- Increase the effectiveness and sustainability of agricultural land management techniques and promote manure management.
- Implemented several REDD+ projects and developed National REDD+ Strategy (2017–2026).

Indonesia

**Overall mitigation targets:**

- NDC (2022): Reduce GHG emissions by 31.89% (unconditional) or 43.2% (conditional) relative to BAU by 2030 (Baseline: 2010 emissions, BAU emissions in 2030: 2,869 MtCO<sub>2</sub>e).
- Net zero by 2060.

**Electricity generation:**

- National Energy Policy (2014) sets targets for energy mix in the primary energy supply: 23% in 2025 and 31% in 2050 for renewables; 25% in 2025 and 20% in 2050 for oil; 30% in 2025 and 25% in 2050 for coal; and 22% in 2025 and 24% in 2050 for gas.
- National Medium-Term Development Plan (2019): Reach 37.3 GW of renewable power generation capacity in 2024.
- Electricity Supply Business Plan (2021-2030): Install 41 GW of generation capacity additionally, of which 48% will be renewable sources.
- Support for renewable energy
  - Tax incentives for foreign investment in renewable energy projects; exemptions from value-added tax and import duties for renewables-related machinery and capital goods.
  - PLN prioritizes electricity generated by renewable IPPs when purchasing electricity.
  - Feed-in-tariffs (FiT) for renewables: Capped at 85% of the region's electricity supply costs (BPP) for general renewables, and 100% of BPP for geothermal and municipal waste-to-energy plants.
  - Promote rooftop solar power generation.
  - Institute a single tariff ceiling for all geothermal projects.

**Transport:**

- Acceleration of the Battery Electric Vehicle (BEV) Program for Road Transportation: See the introduction of 750,000 four-wheeled BEVs and 2,450,000 total BEVs by 2030.

- Support for EVs: Grant luxury tax exemptions for BEVs purchases and lower the luxury tax to 5% for purchases of plug-in hybrids; grant a 10-year tax holiday for EV manufacturers who invest more than IDR 5 trillion in the country.
- Mandatory biofuel blending:
  - Biodiesel: 20% blending in 2016 and 30% blending in 2020; 40% blending targeted for 2022.
  - Bioethanol: 5% blending in gasoline in 2016 and 10% blending in 2020.
- Support for biofuels: Offer low-interest loans for farmers planting oil palms for biofuels; subsidize for domestic biodiesel consumption.

**Industry:**

- NDC (2022): Cut GHG emissions by 10% by 2030, relative to BAU.
- Established base qualifications for energy auditors and managers.
- Set emissions standards for industrial boilers and oil and gas industry activities.
- Set mandatory minimum energy intensity standards for heavy industries.
- The government proposed levying a carbon tax in 2022, but the plan was postponed.

**Buildings and residential:**

- Set building codes for energy conservation.
- Launched GreenShip scheme (a rubric for rating green buildings)
- MEPS and energy labeling are required for air conditioners, rice cookers, refrigerators, fans and fluorescent lightbulbs.
- Replace halogen streetlights with LED bulbs.
- Conduct energy efficiency awareness-raising campaigns.

**AFOLU:**

- NDC (2022): Reduce agriculture GHG emissions by 8.3% and FOLU emissions by 70% by 2030, relative to BAU.
- FOLU net sink target: -140 MtCO<sub>2</sub>e by 2030.
- Rehabilitate degraded land (12 million ha) and restore peatlands (2 million ha) by 2030.
- Developed REDD+ National Strategy and monitoring and evaluation guidelines for REDD+ projects.
- Introduced a sustainable palm oil production certification scheme.

Lao PDR

**Overall mitigation targets:**

- NDC (2021): Reduce GHG emissions by 60% relative to BAU, or around 62 MtCO<sub>2</sub>e by 2030 (Baseline: 2000 emissions).
- Net zero by 2050.

**Electricity generation:**

- Renewable energy development strategy (2011): Increase renewable energy share to 30% of TFEC by 2025.
- Installed capacity targets for renewables by 2030: 13 GW in hydropower ,1 GW in solar and wind, and 300 MW in biomass.

**Transport:**

- Renewable energy development strategy (2011): Increase biofuels share to 10% of the total transport energy consumption by 2025.
- See EVs account for 1% of total vehicles in the country by 2025 and over 30% by 2030.
- Support for EVs: Impose no restrictions on EV imports with appropriate standards; offer tax reductions or exemptions on the import of equipment related to EV production and charging stations; institute 30% reduction of annual road tax for EVs.
- Establish a new bus rapid transit system in Vientiane.

**Buildings and residential:**

- The Lao PDR Clean Cookstove Initiative aims to distribute 50,000 energy-efficient cookstoves.

**AFOLU:**

- NDC (2021): Reduce GHG emissions by 1.1 MtCO<sub>2</sub>e per year relative to BAU between 2020 and 2030.
- Developed National REDD+ Strategy.
- Forest management projects funded by international organizations, including the World Bank and GCF.

Malaysia

**Overall mitigation targets:**

- NDC (2021): Reduce carbon intensity by 45% compared to 2005 levels.
- Net zero by 2050.

**Electricity generation:**

- Renewable Energy Policy and Action Plan (2009): Set renewables targets in total capacity and generation mix: 975 MW (6%) and 5.3 TWh/year (5%) by 2015; 2,065 MW (11%) and 11.2 TWh/year (9%) by 2020; 3,484 MW (14%) and 16.5 TWh/year (11%) by 2030.
- Renewable Energy Act (2011) established FiT for solar PV, mini-hydro, biomass and biogas with annual installed capacity caps; FiT for geothermal energy was added in 2015.

**Transport:**

- Increase market share of EVs to 38% by 2040.
- Support for EVs: Subsidies, import duty exemptions, consumption and sales tax breaks.
- Mandated 20% biodiesel blending.
- Expand public transportation.

**Industry:**

- Call for energy audit and management at large and medium-sized enterprises.
- Award Energy Audit Conditional Grant to commercial and industrial buildings and facilities with pursuing energy efficiency improvement projects.
- Promote cogeneration in industries and commercial buildings.

- Reduce GHG emissions from the manufacturing sector by promoting efficient energy use, encouraging green processes, and utilizing green products and services.

**Buildings and residential:**

- Green Building Index: Issue green certificates to promote energy efficiency and renewable energy in Malaysian buildings.
- Call for energy audit and management in buildings.
- Mandate MEPS and energy labeling for 11 appliances, including lighting, motors, washing machines, refrigerators, and air conditioners (MEPS requirement is 2 stars).

**AFOLU:**

- Developed National REDD+ Strategy.
- Planted 46 million trees until October 2022 under Greening Malaysia, a campaign to plant 100 million trees by 2025.

Myanmar

**Overall mitigation targets:**

- NDC (2021): Reduce GHG emissions by 244.52 MtCO<sub>2</sub>e (unconditional), or 414.75 MtCO<sub>2</sub>e (conditional) by 2030, relative to BAU (various baselines by sector).

**Electricity generation:**

- NDC (2021): Increase the capacity of renewable energy generation to 2,000 MW by 2030, mitigating 105.24 MtCO<sub>2</sub>e, relative to BAU by 2030.
- Foreign Investment Law (2012): Provides incentives for foreign investors in renewable energy projects, including a 5-year income tax holiday and other forms of income tax relief, and exemptions or reductions of customs duties on imports of machinery, equipment and materials.
- 12 renewable energy projects (1,376 MW of hydropower and 1,268 MW of solar and wind) are in the works.
- Encourage installation of rooftop solar PV and solar water heating systems in commercial buildings.

**Transport:**

- Government now allows imports of reconditioned vehicles up to three years old now, but will eventually allow only new vehicles that meet Euro 4 standards.
- Require emissions testing for new vehicles: three years after registration for private vehicles; annual tests for commercial vehicles.
- Promote EVs by eliminating tariffs on EV imports.

**Industry:**

- NDC (2021): Improve energy efficiency by cutting energy use by 6.63% in the industrial sector relative to BAU by 2030.
- Launched industrial energy efficiency programs funded by international development finance.
- Develop Energy Conservation Guidelines.
- Recruit and train energy managers and energy auditors and introduce certification programs for them.

**Buildings and residential:**

- Developed the Myanmar National Building Code, which includes green building guidelines.
- Proposed climate-region-specific implementation guidelines focusing on energy efficiency, natural cooling and climate-resilient construction.
- Develop MEPS and energy labeling for home appliances.

**AFOLU:**

- NDC (2021): Reduce 123.6 MtCO<sub>2</sub>e, relative to BAU by 2030 in FOLU.
- National REDD+ Strategy: Reduce the annual rate of deforestation by 50% by 2030 and achieve net zero deforestation by 2045.
- Myanmar Reforestation and Rehabilitation Program (2017–2027): Includes forest management targets, such as conservation of Reserved Forests (0.59 million ha), plantation management (0.25 million ha), community forestry management and agroforestry (0.3 million ha), establishment of Reserved Forests and Protected Public Forests (4.1 million ha).
- Eight agricultural and more than 30 forestry projects that contribute to achieving NDC targets are currently active.

Philippines

**Overall mitigation targets:**

- NDC (2021): Reduce GHG emissions by 2.71% (unconditional) or 72.29% (conditional) relative to BAU for the period from 2020 to 2030 (BAU emissions for the same period: 3,340 MtCO<sub>2</sub>e).

**Electricity generation:**

- National Renewable Energy Program (2020-2040): Increase renewable energy share to 35% by 2030 and 50% by 2040 in power generation mix.
- FIT and priorities for grid connections and purchases of renewable electricity (biomass, ocean, hydropower, solar and wind).
- Net metering.
- Tax increase on coal: USD 0.19 cents/ton in 2017, up to USD 2.85/ton in 2020.

**Transport:**

- Mandatory biofuels blending:
  - Biodiesel: 2% blending.
  - Bioethanol: 10% blending in gasoline.
- Eliminated import duties on EVs and EV parts/components for 5 years.
- Mandated energy labeling for passenger cars and commercial vehicles.

**Industry:**

- National Climate Change Action Plan (2011–2028): Create green jobs and prioritize sustainable consumption and production.
- Encourage energy audit.

**Buildings and residential:**

- Set Green Building Code, which includes minimum standards for energy-efficient buildings.

- Introduced several green building certifications.
- Mandated MEPS and energy labeling for air conditioners, refrigerators, televisions, washing machines, and fluorescent lights.

**AFOLU:**

- Enhanced National Greening Program (2019): Rehabilitate 1.2 million ha of denuded forest lands and preserve existing forests.
- Master Plan for Climate Resilient Forestry Development (2016): Specified various policies to strengthen the forestry sector, including:
  - Ecosystem-based vulnerability assessments.
  - Protected area and forests management.
  - Protection of existing forests and rehabilitation and conservation of mangroves.
  - Implementation of REDD+ programs for climate change adaptation and mitigation.

Singapore

**Overall mitigation targets:**

- NDC (2020): Reduce GHG emissions to around 60 MtCO<sub>2</sub>e in 2030 after peaking its emissions earlier.
- Net zero by 2050.

**Electricity generation:**

- Achieve a minimum 2 GWp of installed solar capacity by 2030, accounting for around 3% of total electricity demand.
- Built large-scale floating solar PV systems.
- Support for Solar PV:
  - Support for various RD&D projects, including floating and building-integrated solar PV and energy storage systems.
  - SolarNova program has promoted and supported rooftop solar PV systems for residential buildings (HDBs) since 2014.

**Transport:**

- EV roadmap under the Singapore Green Plan 2030 (2021):
  - Replace 400 diesel buses with electric buses by 2025
  - Build 60,000 EV charging points and increase the share of electric or hybrid buses and taxis to 50% by 2030
  - Phase out internal combustion engine (ICE) vehicles by 2040
- Imposed a vehicle quota system to limit excessive growth in number of vehicles.
- Financial support for EVs includes rebates, lower Additional Registration Fee floor, and lower road taxes.
- Implement an EV carsharing program.

**Industry:**

- Since 2019, a carbon tax of SGD 5/tCO<sub>2</sub>e has been imposed on facilities with annual GHG emissions of at least 25,000 tCO<sub>2</sub>e without exemption. The tax rate will be raised to SGD 50-80/tCO<sub>2</sub>e by 2030.
- Mandated energy management practices for new and existing industrial facilities, including minimum energy efficiency standards.
- Instituted grants for corporate GHG emissions reductions and energy efficiency improvements (more than SGD 1 billion earmarked for 2019-2023).

**Buildings and residential:**

- Building Control Act (2013): Mandated MEPS for new and existing buildings under retrofitting; required energy audit.
- Green Mark Certification Scheme (2005): A green building rating system.
- Founded Green Buildings Innovation Cluster and funded RD&D on energy-efficient technologies in the building sector.
- Instituted MEPS and energy labeling for air conditioners, refrigerators, clothes dryers, lamps, and electronic ballasts.
- Climate Friendly Households Program: Provides e-vouchers to HDB households that purchase energy-efficient appliances.

**AFOLU:**

- Launched an initiative that aims to plant one million trees across the country between 2020 and 2030; planted more than 450,000 trees as of November 2022.

Thailand

**Overall mitigation targets:**

- NDC (2022): Reduce GHG emissions by 30% (unconditional) or 40% (conditional) by 2030, relative to BAU (Baseline: 2005 emissions, BAU emissions in 2030: 555 MtCO<sub>2</sub>e).
- Carbon neutrality by 2050 and net zero GHG emissions by 2065.

**Electricity generation:**

- Alternative Energy Development Plan (2018-2037): Increase renewables share to 30% of TFEC.
- Plan also specifies capacity targets for renewable energy: A total of 29.4 GW of renewable capacity by 2037, among which 15.6 GW are solar, 5.8 GW are biomass, 3 GW are wind, 3 GW are hydropower, and 0.9 GW are from waste.
- Support for renewable energy: Corporate income tax holiday of 6-8 years; exemptions of customs duties for the equipment imports; FIT for solar, wind, biomass, biogas and waste-to-energy power plants.

**Transport:**

- National EV Roadmap (2020):
  - Phase 1 (2020-2022): Promote electric motorcycles and develop infrastructure.
  - Phase 2 (2023-2025): Develop the EV industry with production targets (225,000 cars and pick-up trucks, 360,000 motorcycles, and 18,000 buses and trucks).
  - Phase 3 (2026-2030): Adopt a “30/30 policy,” in which EVs are to account for 30% of all auto production by 2030.
- Support for EVs: Tax incentives and investment subsidies in the EV industry; financial support for EV charger installation.
- Introduced a vehicle tax based on CO<sub>2</sub> emissions in 2016.
- Instituted 10% biodiesel blending mandate.

**Industry:**

- Energy Efficiency Development Plan (2015-2036): Reduce energy intensity by 30% compared to 2010 levels by 2036.
- Economic incentives, such as tax relief and financial support, to abate industrial GHG emissions.
- Encourage investment in low-emission industries and the use of high-efficiency cooling equipment.
- Impose additional fees on electricity consumption that exceed standards set for factories.
- Emissions Trading Scheme (ETS) is under review.

**Buildings and residential:**

- Set the Building Energy Code for commercial buildings.
- Set various standards and energy usage reporting requirements for new buildings.
- Levy additional fees on electricity consumption exceeding a standard for buildings.
- Instituted MEPS for refrigerators and air conditioners.

**AFOLU:**

- Target forest coverage of 55% of national territory by 2037.
- Various forest management regulations are in effect and REDD+ projects are currently operational.

Viet Nam

**Overall mitigation targets:**

- NDC (2022): Reduce GHG emissions by 15.8% (unconditional) or 43.5% (conditional) relative to BAU by 2030 (Baseline: 2014 emissions, BAU emissions in 2030: 927.9 MtCO<sub>2</sub>e).
- Net zero by 2050.

**Electricity generation:**

- National Energy Development Strategy (2020): Increase renewables share to 15-20% of energy mix by 2030 and 25-30% by 2045.
- Support for renewable energy: FiT for wind, biomass, and waste-to-energy power plants (solar FiT now use auction model); import duty exemptions.

**Transport:**

- Convert all road vehicles and trains to electric propulsion by 2050
- CNG buses trialed on pilot basis in Ho Chi Minh.
- Restrictions on the manufacture and import of ICE vehicles will be imposed from 2040.

**Industry:**

- Regulation on Industrial Energy Efficiency (2014) requires and specifies:
  - Energy audit.
  - Economical and efficient energy use in industrial processes, including combustion processes, heat supply and cooling systems, and electrical engines.
  - Energy efficiency improvement measures for the chemical industry.
- Vietnam Scaling Up Energy Efficiency Project: Provides risk-sharing facilities and technical assistance to companies that want to develop and execute energy-efficiency projects.
- Instituted MEPS for boilers, electric motors, and distribution transformers.
- ETS and carbon tax are under review.

**Buildings and residential:**

- National Technical Building Energy Efficiency Code provides mandatory technical energy efficiency standards for the design, construction and retrofit of residential and public buildings.
- MEPS and energy labeling for fluorescent lamps, televisions, refrigerators, printers, photocopiers, washing machines, electronic ballasts, rice cookers, fans, and computer screens.

**AFOLU:**

- REDD Action program (2021-2030):
  - Stabilize the natural forest areas by 2030, at least at the same level as 2020.
  - Aim for 45% forest coverage by 2030.
  - Replicate effective REDD+ and sustainable forest management models.
- Carbon Payment for Forest Ecosystems Services Program, under which the 100 largest emitters pay for forest protection and expansion, is under discussion.

Source: Compiled by the author based on NDCs of each country (Kingdom of Cambodia, 2020; Lao PDR, 2021; Republic of Indonesia, 2022; Republic of the Philippines, 2021; Republic of the Union of Myanmar, 2021; Socialist Republic of Viet Nam, 2022; The Government of Brunei Darussalam, 2020; The Government of Malaysia, 2021; The Government of Singapore, 2022; The government of Thailand, 2022), NewClimate Climate Policy Database (NewClimate Institute, 2022), and International Energy Agency (IEA) Policies Database (IEA, 2022b).

III. Focus Areas for GHG Emissions Reductions

Table 3 summarizes some of the key policies being implemented by ASEAN countries to decrease GHG emissions. The table shows several focus areas in which the ASEAN countries share common interests. First, deploying renewable energy is a critical mitigation strategy being pursued by virtually every ASEAN country. Second, ASEAN countries recognize that EVs will become an essential mode of future transportation for the low-carbon society. Third, the governments of ASEAN countries consider increasing energy efficiency a primary policy objective for the industry, building, and residential sectors. Finally, forest protection also plays a significant role in ASEAN countries’ GHG mitigation policies.

3.1. Deployment of Renewable Energy

Many ASEAN countries historically have relied heavily on fossil fuels. In 2019 and 2020, fossil fuels still made up about 80% of the total energy supply in the region. Notably, in Brunei Darussalam, Malaysia, and Singapore, fossil fuels accounted for more than 90% of primary energy supply. The share of coal in the total energy supply has increased since 2000, going from 8% to 26% in 2020 (IEA, 2022a, pp.24-26). Therefore, reducing the dependence on fossil fuels is the most critical and urgent

measure ASEAN countries can take to significantly abate GHG emissions. In this context, ASEAN countries have pledged to expand power generation from renewable sources and have developed specific plans and strategies to do so.

All ten ASEAN countries have set targets for installed capacity or share of renewable energy of the total electricity generation mix (or TFEC). Moreover, they have employed various policy instruments to achieve these targets. Many ASEAN countries have chosen to utilize feed-in tariffs (FiT) to promote renewable electricity generation. Five countries in particular (Indonesia, Malaysia, the Philippines, Thailand and Viet Nam), use FiT to compensate for the costs of power generation based on solar, wind, mini-hydro, biomass, geothermal, and waste-to-energy technologies. Tax incentives are also commonly used to support renewable energy developers and generators. Indonesia, Thailand and Viet Nam have exempted renewable energy-related machinery and capital goods from import duties, and Thailand grants renewable power producers a corporate tax holiday of up to eight years. Indonesia and the Philippines instruct the state electricity authority to prioritize purchases of electricity from renewable sources for grid connections.

Table 3. Summary of Key GHG Mitigation Policies of ASEAN countries

Policies		Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
Electricity generation	Deployment of renewable energy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Rural electrification		✓								
Transport	Increase in share of EVs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Biofuel blending mandates			✓	✓	✓		✓		✓	✓
	Enhancement of vehicle inspection		✓				✓				
	Vehicle emissions tax									✓	
Industry	Energy audit	✓	✓	✓		✓	△	✓	✓	✓	✓
	Financial support/technical assistance for energy efficiency improvement		✓	✓		✓	✓	✓	✓	✓	✓
	Carbon pricing	△		△					✓	△	△
	Emissions/energy efficiency standards			✓		✓			✓	✓	✓
Building	Green building code		△	✓		✓	✓	✓	✓	✓	✓
	Green building certification		△	✓		✓		✓	✓	✓	✓
Residential	MEPS and MELS for appliances	✓	△	✓		✓	△	✓	✓	✓	✓
	Financial support for household energy efficiency improvement				✓				✓		
AFOLU	REDD+ program		✓	✓	✓	✓	✓	✓		✓	✓
	Tree planting campaign	✓				✓			✓		
	Sustainability certification			✓							

△: Not implemented yet: postponed or under review.  
Source: Compiled by the author.

In addition to fiscal incentives, the governments of ASEAN countries are sometimes directly engaged in renewable energy projects. For instance, Brunei Darussalam pledged to construct large-scale solar PV plants with 100 MW of capacity by 2025, and identified three potential sites for solar farms: Bukit Panggal, Belingus, and Kampung Sungai Akar (Baker and Han, 2021). In Singapore, the Public Utilities Board (PUB) broke ground on one of the world’s largest floating solar farms in the Tengeh Reservoir in 2021 in collaboration with Sembcorp, and is developing two more floating solar PV projects (PUB, 2021). Also, Singapore’s SolarNova program, managed by the Housing Development Board (HDB), installed solar panels on the rooftops of 2,700 HDB blocks as of 2021 (HDB, 2022). In Myanmar, there are 12 renewable energy projects (1,376 MW of hydropower and 1,268 MW of solar and wind) now underway (Republic of the Union of Myanmar, 2021, p.61).

3.2. Increase in the Share of Electric Vehicles

The transport sector is another crucial sector in which GHG emissions must be mitigated in ASEAN countries. Owing to rapid population and economic growth, the number of vehicles, including passenger cars, trucks, and buses, has continuously increased. In 2000, there were just 27 vehicles for every 1,000 habitants across ASEAN; this figure had more than doubled to 59 by 2020 (IEA, 2022a, p.26). This has led to a surge in oil demand in the transport sector, an 80% increase between 2000 and 2020, and ultimately resulted in a considerable rise in GHG emissions from this sector (IEA, 2022a, p.29). Although some countries, such as Indonesia, Lao PDR, Malaysia, the Philippines, and Thailand, have mandated the blending of biodiesel and bioethanol with diesel and gasoline, the penetration rate of renewable energy in the transport sector is still low. Thus, the shift towards low-carbon vehicles is set to significantly contribute to reductions in both GHG emissions and air pollution in ASEAN countries.

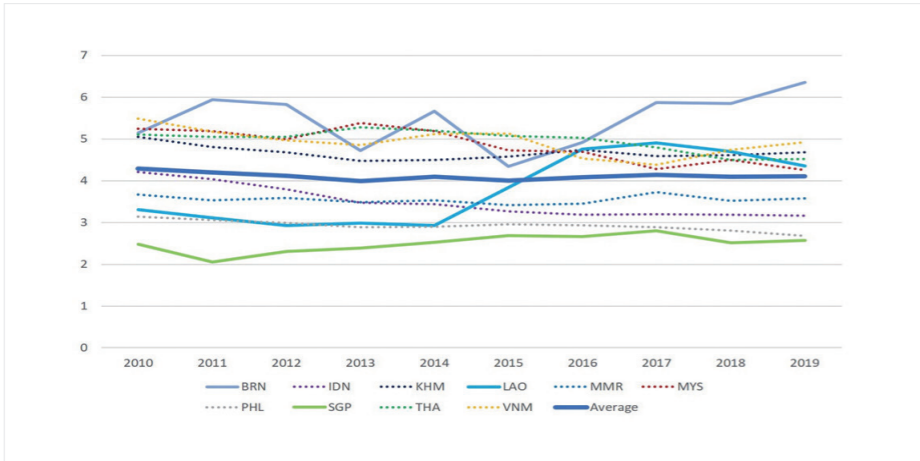
To make the transport sector greener, all ASEAN countries have plans in place to promote electric vehicles (EVs). Singapore and Thailand have established roadmaps for EV adoption, with stepwise targets and specific tasks. Similar to the support for renewable energy, financial incentives are the main policy tools to expand the market share of EVs. Given that most ASEAN countries import EVs, reductions of or exemptions from import duties are frequently used instruments. Cambodia cut import duties on EVs by 50%, and Lao PDR, Malaysia, Myanmar and the Philippines all exempt EVs from import duties. ASEAN countries have also cut or eliminated other kinds of taxes and fees normally applied to internal combustion engine (ICE) vehicles, such as luxury taxes (Indonesia), consumption and sales taxes (Malaysia), road taxes (Lao PDR, Singapore), and annual vehicle license fees (Brunei Darussalam). Furthermore, in Singapore, EV owners are eligible for rebates and enjoy a lower floor for the Additional Registration Fee. Viet Nam currently does not have an EV support policy in place, but is set to impose restrictions on the manufacture and import of ICE vehicles beginning in 2040 (Chan, 2022).

Some countries provide financial incentives not only to increase EV ownership, but also to support the domestic EV industry. Indonesia grants a maximum 10-year tax holiday to EV manufacturers that invest more than IDR 5 trillion in the country (Ponti, 2021). Lao PDR and Thailand also offer tax incentives and subsidies to attract investment across the EV value chain, including parts production and charging stations (Asia News Network, 2021; NewClimate Institute, 2022). Additionally, Singapore has plans to replace all buses and taxis with EVs and hybrid vehicles by 2040. To this end, electric taxi pilot projects were undertaken in 2017, and 60 electric buses were deployed between 2020 and 2021 (IEA, 2022b; LTA, 2021).

3.3. Energy Efficiency Improvement

Figure 1 presents ASEAN countries’ primary energy intensity levels between 2010 and 2019. Average energy intensity across the ASEAN bloc dipped very slightly, from 4.28 MJ/USD in 2010 to 4.11 MJ/USD in 2019, representing a reduction of 4%. However, energy intensity at the national level is more heterogenous. While Indonesia (25% reduction) and Malaysia (19% reduction) have achieved large reductions in energy intensity over the last decade, energy intensity in Lao PDR and Brunei Darussalam increased by 31% and 23%, respectively, over the same period. This suggests that ASEAN countries still have room to lower energy intensity. Indeed, the governments of ASEAN countries have identified energy efficiency and conservation as a cost-effective priority strategy for mitigating GHG emissions (ACE, 2019, p.13). In this regard, every ASEAN country has various policies to improve energy efficiency in effect.

Figure 1. Energy Intensity of ASEAN Countries (MJ/USD 2017 PPP GDP)



Source: Illustrated by the author, based on World Bank Open Data.

Energy efficiency policies can play a role in the industrial, building, and residential/household sectors. For the industry sector, ASEAN countries use both mandates and financial incentives. On the one hand, many governments require companies to conduct energy audits and establish energy management systems (Cambodia, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam). They provide training and certification for energy auditors and managers to ensure the credibility of energy audits. Mandatory standards for energy efficiency or emissions have also been established. For instance, Indonesia set mandatory minimum energy intensity standards for heavy industries and emissions standards for oil and gas industry activities and industrial boilers. Viet Nam also specified economical and efficient energy use in industrial processes. Moreover, Thailand set electricity consumption standards for factories and imposes additional fees on electricity consumption that exceeds said standards. On the other hand, companies that want to develop and conduct energy efficiency projects can receive financial support from the government. Indonesia, Malaysia, Singapore and Thailand run grant schemes and/or loan programs supporting energy efficiency improvement and GHG emissions abatement in the commercial and industrial sectors. Myanmar and Viet Nam also have industrial energy efficiency programs funded by international development finance. For example, Viet Nam Scaling Up Energy Efficiency Project provides a risk-sharing facility and technical assistance to companies

looking to implement energy efficiency projects, using funds from the World Bank (Pham, 2022).

Building codes and green building certifications are other tools widely used to increasing energy efficiency in the building sector. Building codes stipulate energy consumption and performance standards for new and retrofitted buildings. Green building certifications across the ASEAN countries include Indonesia’s Greenship, Malaysia’s Green Building Index, the Philippines’s Building for Ecologically Responsive Design Excellence (BERDE), Singapore’s Green Mark, and Viet Nam’s LOTUS. These programs assess the environmental impacts and energy performance of buildings and assign a rating.

For energy efficiency improvement in the residential sector, seven ASEAN countries have already adopted minimum energy performance standards (MEPS) and energy labeling based on a star rating; Cambodia and Myanmar have plans in place to do in the future and mention the use of these policies in their NDCs. Typical appliances covered by MEPS and labeling schemes include air conditioners, refrigerators, washing machines, televisions and fluorescent lightbulbs. Many countries have plans to expand the regulation to cover more appliances. Some countries are implementing more direct household support programs. The Lao PDR Cookstove Initiative will distribute 50,000 energy-efficient cookstoves, and Singapore’s Climate Friendly Households Program provides e-vouchers (SGD 25-150) to HDB households that purchase energy-efficient appliances.

3.4. Forest Protection and Afforestation

Southeast Asia is home to nearly 15% of the world’s tropical forests, but at the same time, the region has been suffering from severe deforestation because of logging and conversion into farmland (Estoque et al., 2019, p.2; Russell, 2020, p.2). Reaching net zero emissions has become a favored long-term goal, and so forests are now drawing international attention for their value as natural carbon sinks. Hence, ASEAN countries are increasingly paying attention to protecting and expanding forests in their territories.

Forest protection and afforestation in ASEAN countries are undertaken through participation in international initiatives and domestic projects. All ASEAN countries except for Brunei Darussalam and Singapore are participants in the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program, the forest conservation program created launched by UNFCCC COP. As parties to the program, these countries have developed national strategies and action plans and submitted relevant information to the UNFCCC. Under the REDD+ scheme, developing countries can receive financial support and rewards for efforts to curb deforestation (Russell, 2020, pp.5-6). Moreover, Myanmar, Lao PDR and Viet Nam are conducting various forest management projects funded by international organizations, such as the World Bank and Green Climate Fund. At the domestic level, several governments have launched tree-planting campaigns. Brunei Darussalam announced its plan to plant 500,000 trees by 2035, and Malaysia is running a 100 million tree planting campaign (2021-2025). Singapore also launched the One Million Trees Movement, aiming to plant a million trees across the country from 2020 to 2030. As of November 2022, Malaysia has planted more than 46 million trees, and Singapore planted more than 450,000 (ST Admin, 2022; TreesSG, 2022). Meanwhile, in Viet Nam, a carbon payment for forest ecosystem services program was proposed in 2020. If this bill is passed, the 100 largest emitters in Viet Nam, primarily coal-fired power plants and the cement industry, would pay for forest protection and expansion (Clouse, 2020).

# IV. Conclusion

So far, the roles of ASEAN countries in climate change mitigation have been rarely discussed due to their comparatively small contributions to global GHG emissions. However, given the pace of economic and population growth in the region, their GHG emissions would increase tremendously if no mitigation action is taken. The governments of ASEAN countries have recognized that considerable efforts are necessary in order to meet global climate targets and avoid the most serious impacts of climate change on their economies and societies. Consequently, they have established GHG emissions reduction targets and various policies to achieve the targets, and have repeatedly updated those targets and policies to make them more ambitious. Nevertheless, these efforts for climate change mitigation are often evaluated as highly insufficient. Another concern is whether ASEAN countries even have the capability to successfully implement planned policies and meet their pledged targets. A lack of financial and/or administrative capacity often hinders smooth policy implementation in this region. For instance, the Viet Nam Scaling Up Energy Efficiency Project was not launched until March 2021, although the government approved it in June 2019, because the government had not secured external funding (Pham, 2022). Therefore, international support, including financial and technical assistance and knowledge sharing, is necessary to enable ASEAN developing countries to build capacity. This kind of assistance will help these countries meet not only their unconditional targets but also their conditional targets.

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## Climate Mitigation Measures in Southeast Asian NDCs and Opportunities for Korea–ASEAN Cooperation for Carbon Neutrality

Heejin Han<sup>1)</sup>

## Climate Mitigation Measures in Southeast Asian NDCs and Opportunities for Korea-ASEAN Cooperation for Carbon Neutrality



## I. Introduction

The Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change(IPCC) asserted that countries party to the Paris Agreement need to pursue more ambitious greenhouse gas (GHG) emissions reduction targets and proactively develop and implement more proactive and effective reduction and adaptation measures to meet these targets. The IPCC argues that such measures are necessary to effectively respond to a worsening climate crisis.

The international community needs to achieve carbon neutrality by around 2050 to meet the agreed-upon target of limiting the increase in the global average temperature to well below 2°C over pre-industrial levels. This report aims to explore potential areas of climate cooperation between Korea and ASEAN, and to formulate and recommend implementation measures based on an analysis of the ten ASEAN member states' Nationally Determined Contributions (NDCs). ASEAN states include notable emerging economies, namely Indonesia and Viet Nam. While the NDCs also encompass adaptation measures, this report exclusively focuses on mitigation efforts.

<sup>1)</sup> Division of Global & Interdisciplinary Studies, Pukyong National University | polhan@pknu.ac.kr

# II. NDC Analysis of 10 ASEAN member countries

This section analyzes the most recent NDCs submitted by ten ASEAN members to the UNFCCC NDC registry. The countries are analyzed in an alphabetical order.

## 1. Brunei Darussalam<sup>2)</sup>

As of 2018, Brunei Darussalam (hereinafter Brunei) was responsible for just 0.0025% to total global GHG emissions. That said, the government has remained on constant alert for national security threats posed by climate change, especially sea level rise. The Brunei government has developed national climate change response measures as part of its overarching Wawasan Brunei 2035 (Vision Brunei 2035) strategic national initiative, which aims to establish an eco-friendly welfare state and to pursue sustainable green growth. The government states that it has adopted a whole-of-nation approach in preparing its NDC by institutionalizing diverse, stakeholder-based national climate governance. The structure of climate change governance in Brueni consists of: the Brunei Darussalam National Council on Climate Change, the Executive Committee on Climate Change, the Mitigation Working Group, the Adaptation and Resilience Working Group, and the Support Framework Working Group. The Mitigation Working Group, Adaptation and Resilience Working Group, and Support Framework Working Group comprise government officials, representatives from the private and public sectors, and other experts. They serve as fora for the exchange of opinions and ideas on how to respond to climate change in their respective fields of expertise.

Prepared by the above-mentioned working groups in 2018, the NDC targets for 2030 will be adopted across the economy. The NDC was developed based on the Brunei Darussalam National Climate Change Policy (BNCCP), which was promulgated on July 25, 2020. A total of 39 agencies, including relevant government bodies, private sector groups, research and academic institutions, and NGOs participated in drafting the policy. In addition, a group of 51 youth representatives aged 25 to 40 were invited to participate in the drafting process. Ten key strategic areas are identified: industrial emissions, forest cover, electric vehicles, renewable energy, power management, carbon pricing, waste management, carbon inventory, climate resilience/adaptation, and climate awareness/education. **Beginning in January 2021, the NDC targets a reduction of GHG emissions by 20% compared to business-as-usual (BAU) levels by 2030. The 2030 BAU emissions are set at approximately 29.5 mtCO<sub>2</sub>e based on 2015 emissions of 11.6 mtCO<sub>2</sub>e.** Carbon dioxide, methane and nitrous oxide are specifically targeted for cuts. Sectors expected to cut emissions encompass energy, industrial processes/product use, agriculture, forestry/other land use, and waste. The NDC does not specify detailed strategies for achieving stated reduction targets 2030. However, it does present details on key strategic areas covered by the BNCCP.

2) This section is an analysis of the NDC Brunei Darussalam submitted to the UNFCCC in 2020.

- 1) Industrial emissions:** Brunei aims to lower its industries’ carbon by 2035 through zero-routine flaring, as defined by the World Bank standard. The emissions reduction will be achieved by improvements to both onshore and offshore oil and gas facilities.
- 2) Forest cover:** Brunei boasts one of the most diverse and complex ecosystems in the world. In an effort to generate a positive impact on habitats, biodiversity and ecosystems, the country targets to enhance its existing carbon sinks through afforestation and reforestation initiatives, and specifically by planting 500,000 new trees. Increased forest cover would enhance the country’s carbon sequestration potential. Forest cover in the country currently accounts for approximately 72.1% of land area or 380,000 hectares (ha) of land, or the equivalent of 11.4 mtCO<sub>2</sub>e sequestered. Brunei also plans to expand its forest reserves, from 41% to 55%. Under current reforestation plans, 104,920 trees are scheduled to be planted. The document also proposes an additional 400,000 be planted by 2035.
- 3) Electric vehicles (EV):** Land transportation is responsible for about 13.6% of total energy-related GHG emissions. As of 2020, there are over 253,000 active private vehicles in Brunei. The government plans to make EVs account for 60% of annual vehicle sales by 2035 through various policy instruments, including electricity price cuts, tax benefits, and infrastructure improvements (e.g., charging stations). The government also created an Electric Vehicle Joint Task Force (EVJTF) in 2019 to establish a national EV promotion policy. The policy measures are considered highly feasible, as traveling distances in the country are short and electricity is relatively inexpensive.
- 4) Renewable energy:** Brunei plans to expand the total share of renewable energy (mainly solar PV) in electricity generation. Renewables currently produce just 0.14% (1.2 MW) of the country’s electricity needs; the government hopes to increase this to at least 30% of total capacity by 2035.
- 5) Power management:** The government set a target of reducing GHG emissions by at least 10% by 2035 through improved management of electricity supply and demand. Efforts to enhance energy efficiency include programs to improve transmission and distribution and the enforcement of a 48% minimum efficiency rule for all power plants.
- 6) Carbon pricing:** To control excessive GHG emissions, carbon pricing will be applied to all industrial facilities that generate carbon emissions past a given threshold by 2025. To implement the carbon pricing scheme, a measurement, reporting and verification (MRV) system will be established to ensure accuracy and credibility in baseline emissions data.
- 7) Waste management:** The government will take measures to reduce the amount of municipal waste disposed in landfills by one kilogram per person per day by 2035. To minimize waste volumes, best practices and innovative technologies will be adopted.
- 8) Carbon inventory:** The government will mandate monthly and annual carbon inventory reporting. To ensure transparency and robustness in national GHG emissions and sink data, all entities generating GHGs are to improve their data collection and management systems.

Brunei plans to achieve its NDC goals primarily through domestic policy efforts and financing. The government will also consider bilateral, regional, and international GHG reduction cooperation. However, the NDC offers no detailed plans for cooperation.

2. Cambodia<sup>3)</sup>

Cambodia set a target of reducing poverty, achieving sustainable economic growth, and becoming a middle-income country by 2030. However, the Global Climate Risk Index ranked Cambodia as the 12th most climate risk-prone country in light of its high-level of vulnerability to extreme weather events resulting from its exposure to rising sea levels and coastal erosion. GHG emissions have also been on the rise, in line with the country's economic development. The Cambodian government promulgated its overarching strategic climate framework, the Cambodia Climate Change Strategic Plan 2014-2023, in 2013. Relevant ministries have formulated associated action plans. Following the publication of the first Biennial Update Report in August 2020, the country has established the National Monitoring & Evaluation Framework to mitigate climate change risks.

In the process of developing the country's NDC, a number of concerned stakeholders, including relevant ministries/agencies, NGOs, academia, and the private sector (for example, the finance industry) participated over a nine-month period. The Department of Climate Change (DCC), supported by the Cambodia Climate Change Alliance, is responsible for coordinating climate change policies with input from stakeholders. The DCC also provides technical support to major government bodies in charge of sustainable development and climate change initiatives, namely the National Council for Sustainable Development.

While the updated NDC discusses GHG mitigation efforts in the areas of energy, agriculture, and waste, it proposes a robust and diversified suite of adaptation measures, attesting to Cambodia's high level of interest in adaptation efforts as a developing and weather-vulnerable country. The government also takes into consideration gender, vulnerable groups, and SMEs in developing mitigation and adaptation policies to ensure that these efforts also contribute to a more inclusive society.

**Cambodia has set a target of reducing GHG emissions by 41.7% (64.6 mtCO2e) below BAU (155 mtCO2e) by 2030.** Of note, the government aims to reduce emissions from the Forestry and Land Use (FOLU) sector, the greatest contributor to GHG emissions, by 50%. This cut would represent of 59.1% of total emissions reductions. The energy (21.3%), agriculture (9.6%), industry (9.1%), and waste (0.9%) sectors are also expected to contribute to reduction efforts.

Another noteworthy FOLU target: the government plans to halve the deforestation rate by 2030 under the REDD+ mechanism. The government has also been making efforts to develop an effective framework for MRV to track progress in its emissions reduction efforts. In the electricity sector, the government will introduce measures to promote renewable energy, improve grid availability and absorption capacity, and enhance energy efficiency. The government is also poised to explore low-carbon measures in the transport sector.

The Cambodian government's emissions mitigation projects/ activities and relevant ministries/industries are as in Table 1 below.

3) This section is based on Cambodia's Updated Nationally Determined Contribution submitted to the UNFCCC by the Kingdom of Cambodia in 2020.

Table 1. Cambodia's Mitigation Projects and Activities

No	Mitigation Projects/Activities	Lead Ministry	Sector
1	Promote sustainable energy consumption practices in manufacturing Garments: 55% by 2030 (2.291 mtCO2e) Bricks: 44% by 2030 (1.799 mtCO2e) Food and beverages: 25% by 2030 (1.043 mtCO2e)	MISTI	Various industries
2	Urban planning tools for climate change mitigation and urban planning solutions in three sub-cities	MLMUPC	Residential/ commercial buildings
3	Application of electrical equipment labelling & MEPS (Lighting, Cooling & Equipment) Reduce electricity use by 1.2 TWh (29.7%) by 2030	MME	Residential/ commercial buildings
4	Improved energy efficiency through better energy management in buildings/ industries 10% reduction by 2030 through voluntary corporate participation, especially SMEs	MME	Various industries Residential/ commercial buildings
5	Public awareness campaigns Reduce energy consumption by 2% by 2030	MME	Residential/comm- ercial buildings
6	Building codes and certification for new buildings and those undergoing major renovations Reduce electricity consumption by 10% by 2030	MME	Commercial buildings
7	Introduction of efficient electrical motors and boilers Reduce electricity consumption by 2.3% by 2030	MME	Commercial buildings Other industries
8	Improve sustainability of charcoal production through improved regulatory enforcement	MME	Residential buildings
9	Conduct roadmap study on integration of renewable energy resources Increase the share of renewable energy (solar, wind, hydro, biomass) in the energy mix to 25% by 2030	MME	Energy generation
10	New sanitary landfills with LFG extraction Implement LFG extraction at the Dangkor Landfill Increase the share of waste disposed at sanitary landfills with LFG extraction from 0% in 2020 to 50% by 2030	MoE	Waste-MSW
11	Separation of organic waste and composting of biodegradable organic fraction of MSW If 10% of all MSW generated is composted by 2030, up to 0.5 mtCO2e/year of GHG emissions can be reduced by 2030	MoE	Waste-MSW
12	Production of Refuse-Derived Fuel (RDF) from either a) fresh MSW or b) old MSW mined from the Dangkor landfill GHG anaerobic digestion from RDF + anaerobic digestion up to 0.2 mtCO2e/year	MoE	Cement Waste-MSW
13	Implementation of National 3R strategy	MoE	Waste-MSW
14	Enhance maintenance and inspection of vehicles Operate 30 vehicle inspection centers by 2030	MPWT	Passenger vehicles

No	Mitigation Projects/Activities	Lead Ministry	Sector
15	Promote integrated public transport systems in major cities	MPWT	Passenger vehicles
16	Reduce GHG emissions in rural municipalities though off-grid street lighting	NCDD	Commercial/residential buildings
17	Build bio-digesters in small/medium/large sizes	MAFF	Residential buildings, energy generation, agricultural land, waste-MSW
18			
19			
20	Build a centralized recycling facility for industrial waste from the garment sector Reduce emissions by 0.11 mtCO2e from 2021-2030	MISTI	Waste-MSW
21	Install climate-friendly cooling systems in public sector buildings Reduce emissions by 0.04 mtCO2e/year	NCSD	Residential buildings
22	Transform Battambang into a green city	NCDD	Residential/ commercial buildings
23	Promote use of long-distance freight trains instead of trucks	MPWT	Freight transport
24	Improve factory emissions management Monitor air quality at 105 factories annually and issue emissions permits to 90 factories	MoE	Other industries
25	Increase the effectiveness and sustainability of agricultural land management techniques	MAFF	Agriculture
26	Introduce organic input agriculture /bio-slurry and deep placement fertilizer technologies to 10 provinces by 2030	MAFF	Agriculture
27	Introduce manure management techniques in 25 provinces and cities by 2030	MAFF	Agriculture
28	Better management of industrial waste water in the food & beverage sector	MISTI	Waste water
29	Implement the National Cooling Action Plan	MLMUCP	Commercial buildings
30	Include passive cooling systems in the building energy code 20% of the newly constructed buildings must comply with revised building energy code	MLMUCP	Commercial buildings
31	Implement passive cooling system requirements in cities, public buildings and commercial buildings	MLMUCP	Commercial buildings

The government forecasts that achieving emissions mitigation targets will incur costs of approximately USD 5.8 billion, with the FOLU, waste, and energy sectors requiring the most funding. Despite stating that it will utilize national and international funds in addition to market mechanisms in line with Article 6 of the Paris Agreement, the government has not disclosed specific mechanisms the country plans to use. As a developing country, the government also emphasizes the necessity of international support for personal/institutional capacity building and technology needs.

### 3. Indonesia<sup>4)</sup>

Indonesia boasts the fourth-greatest population and the 14th largest economy in the world. As an archipelago with extended coastlines, marine areas account for 74% of its total area, which makes the country vulnerable to sea level rise resulting from global warming and climate change. Indonesia is recognized as a key player in global efforts to combat climate change due to its extensive tropical rainforests, which feature both high levels of biodiversity and an abundance of mineral resources.

As of 2014, approximately 11% of Indonesia's population was living below the poverty line. In order to bring the poverty under 4% by 2025, the country has established national development plans closely intertwined with climate change policy. Indonesia's long-term development plan, Visi Indonesia 2045, is designed to balance economic development goals with environmental conservation, poverty reduction, human resource development, and economic and social transformation. Major strategic objectives integrated into the country's long-term development plan include achieving low-carbon economic growth and strengthening resilience to climate change..

In the first term of President Joko Widodo, a suite of national objectives called the Nine Priority Agendas was announced. This initiative was designed move the country toward protecting its citizens, pursuing national development, and improving quality of life. The core missions outlined in the strategy are consistent with the country's commitment to low-carbon, climate-resilient development. In the second term, the Widodo administration began to implement the National Medium Term Development Plan 2020-2024. The package of policies aims elevate Indonesia into a high middle-income country through fair and sustainable development. One major strategic goal under the plan aims to restore the environment and strengthen resilience to natural disasters and climate change impacts.

Recognizing the significance of climate change response in the country's pursuit of sustainable development goals and economic development, Indonesia has promulgated various policy measures. With regard to land use, for example, the country has implemented a moratorium on new permits for the clearing of primary forests, banned deforestation, worked to restore key ecosystem functions, and practiced sustainable forest management. Of particular note are the country's efforts to carry social forestry programs in which local communities, including the indigenous Adat people, and various other stakeholders participate.

The government's stated NDC goals are grounded in a framework that takes the following perspectives into account. First, Indonesia takes an integrated landscape-scale approach incorporating its varied geography in its climate change mitigation and adaptation efforts. Second, the country has strongly emphasized best practices, embracing both traditional wisdom as well as innovative, modern measures. Third, the government aims to mainstream its climate agenda into development planning. Fourth, the government has sought to promote climate resilience in the food, water and energy sectors.

4) This section is based on Indonesia's Updated Nationally Determined Contribution submitted to the UNFCCC in 2021.

**The Government of Indonesia has pledged to reduce emissions by 29% below the unconditional scenario and up to 41% under the conditional targets against BAU by 2030.** Under the 2030 BAU scenario, Indonesia expects to emit 2.87 gtCO<sub>2</sub>e. However, with the support of the international community, the country expects that ambitious targets could be achievable. In the most recent update to its NDC , the government recognizes carbon dioxide (CO<sub>2</sub>), methane and nitrous oxide as major GHGs. For implementing the provisions of its NDC, Indonesia has outlined a nine-pronged strategy. Its key stipulations are described below.

- 1) Strengthen ownership and commitment of ministries, local governments, the private sector, civil societies, and financial institutions
- 2) Work to build capacity at all levels, covering all aspects of climate change action (mitigation and adaptation, in particular), implement a transparency framework, and develop climate finance
- 3) Create an enabling environment to engage a wide range of stakeholders in resource mobilization through appropriate regulatory framework and policy measures
- 4) Develop a framework and network for coordinating and generating synergies between sectors, regions and actors/ stakeholders
- 5) Implement a One GHG-data policy to support the implementation of a national transparency framework
- 6) Design policies and planning/intervention programs for implementing the NDC, integrating mitigation (forestry, energy, IPPU, waste, agriculture sectors) and adaptation (sectoral and regional) into development planning initiatives to secure financial support and mobilize resources
- 7) Devise NDC implementation guidance for ministries and other stakeholders
- 8) Ensure that NDC implementation encompasses policies, planning and intervention programs based on the NDC implementation guidance
- 9) Monitor, review, and revise the NDC as necessary

Section II of NDC report outlines more detailed mitigation plans. In the country, emissions are generated mostly from land use and energy, with land use change, peat<sup>5)</sup>, and forest fires producing the biggest contributions to emissions, followed by the combustion of fossil fuels. The combined contributions of forest fires, land use, and the energy sector amount to 97.2% of total emissions amounts to 97.2%.

Indonesia is committed to better forest management. By 2030, the country plans to restore 2 million ha of peatland (90% under both conditional and unconditional scenarios) through rewetting<sup>6)</sup> and revegetation. The country also set a target to rehabilitate 12 million ha of degraded land. For land use, REDD+ should serve as an important component of the NDC target. Under the guidance of the UNFCCC, Indonesia submitted its first and second Forest Reference Emission Level (FREL) reports. The country aims to improve productivity by controlling illegal logging and expanding regulated timber

5) Peat is an accumulation of partially decayed vegetation or organic matter. Peatlands are significant carbon stores. Over a third of all tropical peatlands globally are located in Indonesia.

6) The process of expanding land to absorb GHGs by restoring natural water flow and saturating peatland <https://carbonremoval.economist.com/peatland-rewetting/>

plantations (mostly in unproductive soil). The government intends to promote carbon sequestration through afforestation and reforestation projects.

In the energy sector, the government has resolved to achieve NDC targets based on a mixed energy-use policy. The country has already identified clean energy development as a national policy directive. Based on the country's 2014 National Energy Policy, the government set the following energy mix targets for 2025 and 2050:

- a) new and renewable energy over 23% of mix in 2025 and 31 % in 2050;
- b) oil below 25% of mix in 2025 and 20% by 2050;
- c) coal over 30% in 2025 but down to 25% by 2050;
- d) gas over 22% by 2025 and 24% by 2050.

For coal, clean coal technologies such as supercritical and ultra-supercritical coal-fired power plants and other technologies are to be widely adopted. One major accomplishment in this area: Indonesia has successfully phased out fossil fuel subsidies. For biofuels, the country established a national mandatory biodiesel policy of B20 and revised up its target to B30 in 2020, 10 years earlier than proposed in the first NDC. As part of efforts to achieve the Visi Indonesia 2045 strategic national vision, President Joko Widodo pledged to reduce oil imports and to enhance domestic oil production by constructing additional oil refineries. Furthermore, Indonesia is developing green refineries to produce various drop-in green fuels from bio-resources in order to increase biofuel content (primarily palm oil).

For waste management, the government is committed to developing a comprehensive strategy to improve policy and institutional capacity at the local level, enhance urban waste water management capacity, and reduce landfill waste volumes. To achieve these objectives, the government will adopt the 3R (Reduce, Reuse, Recycle) approach. In addition, the government is to actively promote better utilization of waste and garbage in energy production. With regard to the agriculture sector, the government will foster the cultivation of low emission crops, enhance the efficiency of water resources management, implement manure management techniques (including the utilization of biogas), and promote the production and use of low-carbon cattle feed.

In Indonesia, the FOLU and energy sectors are the biggest GHG emitters, followed by the agriculture, waste, and IPPU sectors. Accordingly, the government expects to see the largest reductions in emissions in the FOLU and energy sectors. For energy, Indonesia has set an unconditional reduction target of 29% (11% of its total reduction target) and a conditional target of up to 41% (15.5% of total) compared to BAU by 2030. For FOLU, an unconditional cut of 29% accounts for 17.2% of its total reduction target. Under the conditional scenario, the sector's 41% reduction target corresponds to 24.1% of the total.

Following a presidential decree issued in 2015, the government established the Directorate General of Climate Change under the Ministry of Environment and Forestry to coordinate progress toward meeting NDC goals and implement climate change policy. Through the agency, various stakeholders from the Ministry of Environment and Forestry, the National Development Planning Agency, and the Ministry of Finance exchange opinions and consensus among these parties is to

be reflected NDC targets. The agency should also serve as the national mediator with the UNFCCC, effectively facilitating the execution of climate change mitigation and adaption programs.

To enhance transparency in the process of achieving its NDC goals, the government will enforce the Integrated National Transparency Framework. Under the framework, the National Registry System (SRN) for mitigation, adaptation and means of implementation will be established using national and international resources. The framework also embraces the development of a national GHG inventory system and the reinforcement of MRV for mitigation activities (e.g., REDD+). The SRN was first launched in 2016. The system is expected to be able to provide data and information for National Communication and the biennial transparency report by 2024, and be fully operational by 2030. The government expects financial and capacity building support from the international community to facilitate its commitment to mobilizing national resources to build a data system.

For financing mitigation and adaption, the government will implement related activities as part of the National Development Plan. In addition, it will continue to utilize various forms of international support, including aids and grants via multilateral channels (e.g., GEF, FCPF, FIP, UNREDD+, Bio-CF, GCF, and other financial institutions). Indonesia is committed to meeting its NDC commitments through diverse policy initiatives namely Article 6 of the Paris Agreement. Recognizing technical limitations in accurately forecasting financing needs, the country plans to request international support to enhance personal, institutional, and technological capabilities in the innovative field of green financing. In order to bolster climate financing, Indonesia established Badan Pendelola Dana Lingkungan (BPD LH) in October 2018 to manage and mobilize finance for climate change policies.

4. Laos<sup>7)</sup>

The Lao People’s Democratic Republic (hereinafter Laos) submitted its first NDC in 2015 and ratified the Paris Agreement in 2016. An updated 25-page NDC report was submitted in March 2021, reflecting new NDC objectives updated in 2020 based on multiple rounds of consultations and feedback from various stakeholders. The new NDC goals are in line with the targets for limiting temperature increases under the Paris Agreement, the country’s sustainable development goals, and the country’s ninth five-year National Socio-Economic Development Plan (2021-2025). In September 2019, then-Prime Minister Thongloun Sisoulith issued the Decree on Climate Change, which defines national principles, regulations, and measures for climate change management and monitoring. The Decree mandates that climate change be mainstreamed into national socio-economic development plans, sectoral policies, and local development strategies.

**In the NDC report, Laos set 2000 as the base year and created an unconditional mitigation scenario for the period until 2030.** According to the baseline scenario, emissions in Laos will increase from 82 mtCO<sub>2</sub>e in 2020 to 104 mtCO<sub>2</sub>e in 2030. However, the government estimates emissions in 2020 at 53 mtCO<sub>2</sub>e, as the country had reduced emissions by 34% compared to the baseline scenario (average annual growth of 0.3%) on the back of progress in the

7) This section is based on Nationally Determined Contribution that Laos submitted to the UNFCCC in 2021.

Land Use, Land-Use Change & Forestry (LULUCF) (e.g., increased forest cover) and power (e.g., expansion of hydropower, rural electrification program) sectors. Given Laos’ average per capita GDP growth of 5.3% between 2000 and 2019, emissions growth largely decoupled from the country’s economic growth.

**In the NDC, the government of Laos set an unconditional reduction target of 60% (62 mtCO<sub>2</sub>e) compared to BAU by 2030.** To achieve this goal, the government established reduction targets in the LULUCF and transportation sectors and proposed energy efficiency goals; relevant action plans accompany these objectives. The LULUCF sector will reduce emissions by an average of 1,100 ktCO<sub>2</sub>e annually between 2020 and 2030 by curbing emissions from deforestation and forest degradation, creating buffer zones of protected areas and other preserves, and enhancing forest carbon stocks. In the energy sector, total hydropower capacity for domestic consumption and exports will be expanded to 13 GW, which is expected to reduce emissions by an annual average of 2,500 ktCO<sub>2</sub>e (based on the 2016-2030 Power Development Plan). In addition, the installation of 50,000 energy efficient cook stoves is anticipated to mitigate emissions by 50 ktCO<sub>2</sub>e on average annually, while the introduction of a new Bus Rapid Transit System in the capital of Vientiane and an associated Non-Motorized Transport (NMT) component is forecast to reduce emissions by 25 ktCO<sub>2</sub>e. The government also aims to cut annual emissions by 300 kt CO<sub>2</sub>e by constructing and operating a Laos-China railway.

The Laos NDC also describes a conditional mitigation scenario contingent on increased levels of financial support from developed countries. In the LULUCF sector, the government pledges to curtail emissions by 45,000 ktCO<sub>2</sub>e annually via an increase in forest cover to 70%. Also included are projects related to forest restoration/conservation, the sustainable management of forests, the expansion of buffer zones in national parks and other preserves, and the enhancement of forest carbon stocks. These goals will be achieved through on-going projects the country is executing with international organizations such as the World Bank and the GCF. In the energy sector, the country will increase solar/wind and biomass energy capacities by 1GW and 300MW, respectively (vs. 32MW for solar in 2018; no wind capacity was online in 2020), lowering emissions by 100 ktCO<sub>2</sub>e and 84 ktCO<sub>2</sub>e, respectively, every year. In the transport sector, the proportion EV motorcycles and passenger cars will be raised to 30%, enables emissions reductions of 30 ktCO<sub>2</sub>e per year. In addition, the government will work to increase the percentage of biofuels uses in transport to 10%,mitigating annual emissions by 29 ktCO<sub>2</sub>e. In the sphere of energy efficiency, the country aims to meet an annual emissions mitigation target of 280 ktCO<sub>2</sub>e through a 10% reduction in final energy consumption. The agriculture sector is to cut emissions by 128 ktCO<sub>2</sub>e per year by improving water management practices in lowland rice cultivation. With regard to waste, the country aims to lower emissions by 40 ktCO<sub>2</sub>e annually via sustainable management of municipal solid waste (500 tons/day) in Vientiane.

The government estimates that achieving its conditional goals will cost USD 4.73 billion. The LULUCF and solar/wind energy sectors will require the lion’s share of the funds, pegged at USD 1.7 billion and USD 1.5 billion, respectively, followed by biomass, EV, and biofuels. The government also states that it is crucial for the country to strengthen administrative, legal, technical, and institutional capacities in addition to receiving ODA and financial support from private sector partners in order to accomplish its objectives.

For effective governance, a mechanism for monitoring and supervising NDC implementation and coordination between

ministries will be adopted. The Decree on Climate Change issued by the Prime Minister directs the Ministry of Natural Resources and Environment to coordinate between relevant ministries and stakeholders. The Department of Climate Change under the Ministry of Natural Resources and Environment supervises the collection, compilation, provision, and monitoring of climate change data and information.

5. Malaysia<sup>8)</sup>

Malaysia submitted its first NDC in 2015 and ratified the Paris Agreement in November 2016. In July 2021, the country submitted an updated 14-page NDC to the UNFCCC. Developed by relevant ministries, experts in academia, NGOs, and the private sector, the report was endorsed by the National Steering Committee on Climate Change and approved by the Cabinet.

According to the NDC report, Malaysia is committed to reducing its carbon intensity of GDP by 45% by 2030 compared to 2005 levels. This is an unconditional scenario target, and reflects a target 10% higher than the goal presented in its first NDC. Malaysia identifies seven GHGs, including carbon dioxide and methane, for reduction. In implementing mitigation activities, the country pledges to adhere to the principles of transparency, accuracy, consistency, comparability, and completeness.

The major targets for emissions reduction include the energy, industrial processes and product use, waste, agriculture, and LULUCF sectors. However, the report lacks detailed measures, programs, and strategies for reduction. Although the 14-page report dedicates nine pages to outlining mitigation plans, the document contains no detailed action plans for executing these plans. The country pledges to reduce carbon emissions in consideration of its economic situation and contingent circumstances, in which oil and gas make a significant contribution to GDP. According to the report, Malaysia has no intention of pursuing voluntary cooperation provided for in Article 6 of the Paris Agreement to achieve its NDC goals.

6. Myanmar<sup>9)</sup>

Myanmar submitted a 99-page NDC report to the UNFCCC. Recognizing the impacts of climate change, which included more frequent natural disasters (e.g., cyclones, landslides, flooding, droughts), sea-level rise, and saline intrusion, the country has expressed a determination to participate in international efforts to combat climate change. The government of Myanmar promulgated the Myanmar Climate Change Policy, Strategy and Master Plan in June 2019, and shortly thereafter submitted its National Forest Reference Level to the UNFCCC and REDD+. In addition, the country has been mainstreaming climate change into all relevant economic development plans and policies. As illustrated by the announcement of the Myanmar Climate Change Policy (2019), the Myanmar Climate Change Strategy (2018-2030), and the Myanmar Climate Change Master Plan (2018-2030), the country is developing climate change action plans

8) This section is based on Malaysia's Nationally Determined Contribution submitted to the UNFCCC in 2021.

9) This section is based on Nationally Determined Contribution Myanmar submitted to the UNFCCC in 2021.

across a diverse swath of government and society, encompassing policy, institutions, finance, capacity, technology, and partnerships.

In light of its current levels of economic and technological development, Myanmar has been calling for international support to help establish and meet emissions reduction targets throughout its economy, calling for support in determining emissions baselines, building an information system and database, and applying appropriate technologies to required areas.

**Based on a conditional scenario, Myanmar aims to reduce net emissions by 50% by 2030. Total reduction targets are 244.52 mtCO<sub>2</sub>e in the unconditional scenario, and 414.75 mtCO<sub>2</sub>e in the conditional scenario.**

The NDC includes detailed mitigation plans by sector. They are as follows:

1) Energy

In the energy sector, Myanmar seeks to achieve a conditional emissions reduction of 144 mtCO<sub>2</sub>e by 2030 against the BAU level of 297.01 mtCO<sub>2</sub>e. The country plans to increase the total share of renewable energy (solar and wind) by 53.5% (from 2000MW to 3070MW) by 2030, expanding renewable energy's share of the total energy mix to 11% (unconditional) or 17% (conditional). In addition, the country is considering the adoption of other renewable energy sources, including mini-hydro, biomass, and tidal energy. To accelerate the shift toward clean energy, the country launched the National Renewable Energy Management Committee in 2019 via Presidential Decree.

The government aims to reduce the proportion of electricity generated by coal by 73%, from a BAU level of 7940 MW to 2120 MW. One notable feature of Myanmar's energy mitigation plans: the country deigns to cut coal power generation GHG emissions by 102.24 mtCO<sub>2</sub>e from 2030 BAU levels solely through its own efforts. The government is committed to reducing its reliance on coal to produce electricity; coal power generation is estimated to account for 33% of the energy mix under the BAU scenario. The government hopes to cut this figure to to 20% (3620 MW, unconditional) and 11% (2120 MW, conditional) by 2030. Aiming to completely phase out coal by 2050, Myanmar intends to steadily expand the proportion of renewable energy sources in its energy mix, and in particular it intends to use utilize LNG as an alternative energy source in the process of shifting from coal to clean energy.

In the implementation of energy policy, supplying cheap, fast, and clean power is the top priority of the government, given that 44% of households in Myanmar are still without electricity. However, the government faces limitations in terms of policy, technology, and financial resources in its efforts to supply renewable energy using the current national grid. While the government recognizes growing environmental and social concerns over large-scale hydropower generation, the country's hydropower capacity is as high as 19,567 MW. That said, instead of pursuing large-scale hydropower generation, the government plans to meet the growing power demand through renewable energy sources utilizing micro-hydro energy and mini-grids.

Meanwhile, Myanmar has resolved to expand investment in the renewable energy sector as part of its post-COVID Economic Response Plan. The government allocated USD 2.482 billion for hydropower development to support ongoing energy mix diversification projects through 2030. In addition, the country has applied for a soft-loan of USD 310 million from development finance institutions including ADB to upgrade its rural transmission and distribution systems. Meanwhile, many renewable energy-related plans remain in the planning phase. To implement these plans, the country is working to apply for grants from the GCF and other development partners. The government estimates that achieving the conditional targets for the energy sector as outlined in the NDC will incur costs of USD 1.209 billion.

## 2) Agriculture and Agroforestry

The agriculture sector is the second-largest contributor to GHG emissions in Myanmar, representing 32.1% of all emissions in the baseline year of 2013. Myanmar has introduced a new conditional cumulative sequestration target of 10.4 mtCO<sub>2</sub>e by 2030 for the sector. GHG emissions in the agriculture sector are largely attributable to deforestation and land-use changes for farming. Thus, the government plans to create tree canopy cover across 275,000 ha of agricultural land through tree planting and agroforestry projects, and gradually expand this coverage over time. The government hopes to utilize taungya, Myanmar's traditional system of agroforestry, in the pursuit of this initiative. The government will also work to more effectively manage water, reduce soil erosion, and develop new farming technologies simultaneously.

However, the country still lacks data and the technical capacity to properly estimate potential mitigation that factors in GHG emissions and tree cover. Without the baseline data on GHG emissions disaggregated by farming method and type of crop, it could be difficult for the country to predict the impacts of emissions reduction plans.

For the FOLU sector, Myanmar introduced the Forest Law in 2018 and the 30-year National Forestry Master Plan (covering the years from 2001-2002 to 2030-2031), designed to contribute to international agreements on forest conservation. The measures are also anticipated to support the country's climate change response and agricultural development through the conservation of natural forests and the establishment of forest plantations. In the NDC, the government proposes a conditional target of 17% net emissions reductions by 2025 and a 50% reduction by 2030 from the 2005-2015 baseline, representing an aggregate cut of 256.5 mtCO<sub>2</sub>e from 2021 to 2030 through reforestation and rehabilitation programs. Under the unconditional scenario, the government proposes a goal to reduce deforestation by 25% by 2030, which is expected to mitigate cumulative net emissions by 123.6 mtCO<sub>2</sub>e. Myanmar also plans to increase the net area of Reserved Forests (RF) and Protected Public Forests (PPF) to 30% of total national land area by 2030, expanding area covered by Protected Areas Systems (PAS) to 10% of national land area by 2030. Given that the conversion of land to plant rubber and palm tree plantations is the main culprit behind deforestation, the Ministry of Agriculture, Livestock and Irrigation is engaging various stakeholders, including ethnic minorities and local/provincial governments, in its efforts.

Myanmar submitted a FREL estimate to the UNFCCC, pegging net annual emissions from 2005 to 2015 at 50,456,131 tCO<sub>2</sub>e. The country finalized its National REDD+ Strategy in 2019, aiming for net-zero deforestation by 2045. However, challenges remain in estimating accurate emissions volumes in this sector. To acquire precise data on deforestation and reforestation, Myanmar aims to establish a national forest inventory and launch an efficient, satellite-based monitoring

system leveraging financial and technical support from the international community. Indeed, the country is now building satellite-based land monitoring tools and a National Forest Monitoring System.

In addition, traditional, wood and charcoal-burning stoves used by 80% of the population are to be replaced by more efficient LPG stoves. By distributing 5.1 million LPG stoves, the country intends to reduce emissions by 12.99 mtCO<sub>2</sub>e between 2021 and 2030. Notably, the government set an unconditional target for reducing emissions by 14.94 mtCO<sub>2</sub>e by 2030 through subsidies for the distribution of 1 million LPG stoves by the private sector.

Under the national program for rural electrification, renewable energy technologies currently generate 166.4 MW of electricity annually (electricity is supplied to just 50% of total population). Of this total, 44.41 MW is generated through renewable energy mini-grids, providing electricity to 1.8 million people that live off-grid in rural areas. This process generates 0.564 mtCO<sub>2</sub>e fewer emissions compared to diesel-based power generation. In the latest revision to Myanmar's NDC, the government proposed a new conditional target for mini-grid development, committing to provide its off-grid rural population of 3.6 million people with access to renewable energy. Through this plan, the country is expected to generate an additional 88.82 MW of electricity, while reducing emissions by 0.874 mtCO<sub>2</sub>e by 2030. Under the unconditional scenario, the government has designs to provide renewable energy access to 2.7 million people currently living off the grid through mini-grids generating 66.62 MW of electricity, reducing GHG emissions by 0.719 mtCO<sub>2</sub>e by 2030. The government estimates that this project will incur costs of USD 29 million annually, of which USD 20 million is to be financed with support from the international community and USD 9 million per year to be raised domestically. Moreover, Myanmar is currently considering implementing the carbon trading scheme under Article 6 of the Paris Agreement in the distribution of fuel-efficient cookstoves, which is anticipated to reduce emissions by 10,249,200 tCO<sub>2</sub>e.

Myanmar will also initiate efforts to enhance energy efficiency across a wide range of sectors. Amid its industrialization and urbanization, the country aims to improve the energy efficiency of the residential sector by 7.8%, the industrial sector by 6.63%, the commercial sector by 4%, and other sectors by 1.36% by 2030. The energy efficiency target represents a cumulative reduction in energy consumption of 20% by 2030 from 2012 levels, which is expected to reflect an emissions reduction of 0.133 mtCO<sub>2</sub>e under the conditional scenario. The residential sector is expected to produce the largest cuts in energy consumption, followed by the industrial and the commercial sectors. The Ministry of Industry plans to develop energy conservation guidelines, train energy managers/auditors, and introduce Energy Performance Standards and an energy labeling program with the support of the GEF and the FCDO of the UK.

Myanmar has requested international support in several endeavors, from baseline data development to the development of energy and heating/cooling standards. The country also welcomes support for its efforts to develop an integrated resource management and planning (in connection with cities) framework to promote low-carbon urban growth and reinforce urban resilience. Cities are now home to 29% of the country's population; hence the need to create a safe, resilient, eco-friendly, and carbon-efficient environment. Myanmar is also considering the development of carbon reduction strategies in the land, marine, and aviation transport sectors. Priority will be given to the formulation of energy

efficiency management plan and green shipping strategies.

The government expresses in the NDC a commitment to adopting a comprehensive approach to climate change issues by putting an emphasis on improving scientific knowledge and weather forecasting technology and promoting nature-based solutions.

On the institutional front, Myanmar has established its climate change policy and NDC goals based on the opinions of experts and stakeholders in various areas. The National Environmental Conservation and Climate Change Central Committee (NECCCCC) is responsible for determining the direction the country's environmental and climate change policy. The Ministry of Natural Resources and Environmental Conservation (MONREC) functions as a secretariat, coordinating between relevant ministries and local governments. In particular, the Environmental Conservation Department and Climate Change Division of MONREC serves as the national point of contact for the UNFCCC and the GCF. In the document, the government says it recognizes the significant contributions of relevant ministries and international organizations, including the WWF, GGGI, UNDP, and World Agroforestry Center, to the development of its NDC goals.

Myanmar is currently establishing an MRV system to manage and implement its mitigation goals in an efficient and transparent way. The governments expects that, once implemented, the system will enable collection of the kinds of data and information required to build a national GHG inventory, compile data needed to prepare the Biennial Transparency Report (BTR), and identify needs for support in finance, technology, and capacity-building. Myanmar also plans to make a contribution to the Global Stocktake by submitting its biennial update report in 2022, and to submit its BTR in 2024.

7. Philippines<sup>10)</sup>

The Philippines is a low-middle income country with a population of 108.7 million. Located in the Tropical Cyclone belt and the Pacific Ring of Fire, the country is exposed to many climate and geological hazards. Indeed, the Philippines is hit by around 20 tropical cyclones every year and suffers experiences seismic shocks on a near-daily basis, which costs the country an average of 0.5% of its GDP annually.

In the five-page NDC report submitted to the UNFCCC in April 2021, the government describes its determination to shift toward a low-carbon, climate-resilient, green economy. Efforts to effect these plans are to be implemented under the framework of the Philippine Development Plan 2017-2022, which also represents a pan-government initiative to pursue other national goals. These include: sustainable industrial development, the eradication of poverty by 2040, an the creation of an inclusive society in which the rights of all groups, including minorities, youth, and women, are recognized, the attainment of energy security, and social/climate justice.

Starting with the enactment of the Climate Change Act of 2009, also known as Republic Act No. 9729, the Philippines

10) This section is based on the Philippines' Nationally Determined Contribution submitted to the UNFCCC in 2021.

has established a climate change governance system. The pillars of this system are the National Framework Strategy on Climate Change 2010-2022, the National Climate Change Action Plan 2011-2028, the National Climate Risk Management Framework of 2019, and the Sustainable Finance Policy Framework of 2020.

The government of the Philippines aims to reach peak emissions by 2030. It also resolves to accelerate a just transition through the transition to a green economy with green jobs, and to build a climate-resilient, low-carbon nation and society.

The Philippines emitted 1.98 mtCO<sub>2</sub>e per capita in 2020 (versus a global average of 4 mtCO<sub>2</sub>e). Projecting BAU cumulative emissions at 3,340.3 mtCO<sub>2</sub>e in 2030, the country aims to reduce emissions by 75% compared to 2030 BAU levels from 2022 to 2030, of which 2.71% represents an unconditional commitment and 72.29% a conditional one. The country plans to achieve its emissions reduction targets through various mechanisms, including climate finance, technology development and transfer, capacity building, the circular economy, sustainable consumption and production, and Article 6 of the Paris Agreement. However, the country's NDC report lacks detailed strategies and methods to execute these plans. The government is expected to achieve its stated emissions reduction targets via bilateral, regional, and multilateral cooperation.

8. Singapore<sup>11)</sup>

Singapore is a small, resource-poor, densely populated city-state located in Southeast Asia. As a member of the Alliance of Small Island States (AOSIS), the country recognizes the adverse effects of rising sea levels and is determined to engage in international efforts to combat climate change. Singapore has framed its climate change strategies through various initiatives, namely the National Climate Change Strategy 2012 and Singapore's Climate Action Plan: Take Action Today for a Sustainable Future (published in 2016). The government has emphasized that such efforts should be implemented under the two operating principles: minimizing the impact on the national economy and job market and maintaining it's the country's technological and economic competitiveness. In its NDC report, Singapore introduces a number of climate-friendly policies it has adopted ahead of other countries, such as a nationwide switch transition from fuel oil to natural gas for power generation (the share of natural gas-fired power generation soared from 18% in 2000 to 95% by 2019), market pricing of energy costs (abolition of subsidies), and a vehicle quota system to cap growth in the number of vehicles (the country targets a growth rate of zero rate for cars and motorcycles). In addition, the country has imposed a carbon tax on facilities emitting 25 ktCO<sub>2</sub>e or more of GHG; this system taxes emitters responsible for 80% of Singapore's carbon emissions. For the transport sector, the government has promoted increased use of public and shared transport and the adoption of eco-friendly vehicles. For the buildings sector, the country has applied minimum energy performance standards and implemented the Super Low Energy Buildings Program, which supports the adoption of cost-effective, energy-efficient and renewable energy solutions.

The Inter-Ministerial Committee on Climate Change (IMCCC), which is staffed by representatives of relevant ministries,

11) This section is based on Singapore's NDC reported submitted to the UNFCCC in 2020.

plays a leading role in Singapore’s whole-of-government approach to fighting climate change. In addition, the country engages various stakeholders, including private businesses, industry players, academia, and citizens, in communicating ideas and eliciting feedback. The IMCCC coordinates different ministries’ climate change policies.

Singapore presents a target of gradually reducing GHG emissions after reaching a peak peaking at 65 mtCO<sub>2</sub>e in 2023. Based on current projections, the country is expected to be able to reduce its emissions intensity by 36% from 2005 levels by 2030.

The government has set an economy-wide, absolute GHG emissions limitation target covering a broad swath of sectors, including energy, industrial process, product use, agriculture, LULUCF and waste. The county’s updated NDC targets seven GHGs, including nitrogen trifluoride (NF<sub>3</sub>). However, the report does not elaborate any specific reduction strategies.

Singapore acknowledges in its NDC that it faces an uphill battle in the process of achieving its stated reduction targets. Despite constraints on the large-scale expansion of renewable energy facilities due to extremely limited supplies of available land, the country is committed to deploying more solar PV, including off-shore, floating, and building-integrated PV. Singapore has already reached 350 megawatts-peak (MWp) in 2020 and aims to achieve at least 2 gigawatt-peak (GWp) by 2030. The country also describes the limitations it faces in enhancing carbon sinks. Meanwhile, Singapore has established a accurate system for calculating and reporting GHG emissions and removals based on the 2006 IPCC Guidelines and Tier 3 approaches, utilizing high-resolution satellite images and adopting a systematic approach to inventory management through the regular collection of data.

While Singapore’s emissions reductions ambitions are revolve around a strategy that seeks improvements to energy efficiency, the country has in fact already adopted carbon-efficient ways in production; Singapore is among the top 20 countries globally in terms of emissions intensity performance. In an effort to further enhance energy efficiency, the government plans to utilize various policy instruments. Namely, grants to facilitate technological development in the field of energy efficiency.

Singapore intends to accomplish its mitigation goals primarily based on domestic efforts. However, the country will continue to explore cooperation opportunities under Article 6 of the Paris Agreement. The government also made clear in the NDC that, as a member of the international community, it will support developing countries’ efforts to combat climate change. To date, Singapore has provided educational services to more than 130,000 officials from developing countries. The country has also implemented the Climate Action Package under the Singapore Cooperation Programme in 2018 to support capacity building efforts in developing countries in the areas of adaptation and mitigation, flood management, disaster risk reduction, and green climate finance. Of note, the Annex of the NDC report attests to the government’s commitment to making continuous investments in climate change research. Indeed, the country has established the Centre for Climate Research Singapore in 2013, one of the few research centers in Southeast Asia dedicated entirely to climate research, to address the lack of data in the region and to undertake research on sea level rise.

## 9. Thailand<sup>12)</sup>

Thailand ranks 13th in the Global Climate Risk Index 2019, located in the “extreme risk” category consist wing of countries most vulnerable to the anticipated impacts of climate change over the next 30 years. The country’s GHG emissions accounted for 0.77% of global emissions in 2014, which is lower than the global average. The energy sector has been the biggest contributor to the country’s emissions, accounting for 74% of all emissions in 2013. As part of the country’s National Strategy 2018-2037 initiative, the Thai government prioritizes climate change issues and the eradication of poverty.

Thailand has set a target to reduce GHG emissions by 20% relative to a 2030 BAU level of 555 mtCO<sub>2</sub>e. The country is committed to reducing emissions across all economic sectors, including LULUCF. The government suggests that the target could be raised to 25% if the international community provides support for technology development/transfer, financing, and capacity building.

To ensure that its NDC goals are realistic and feasible, the government of Thailand plans to link its efforts to combat climate change with national development priorities, including socioeconomic development and poverty eradication programs. Some of the content in Thailand’s NDC report is based on various national-level development plans, including the 12th National Economic and Social Development Plan (2017-2021), the Climate Change Master Plan (2015-2050), the Power Development Plan (2015-2036), the Thailand Smart Grid Development Master Plan (2015-2046), the Alternative Energy Development Plan (2015-2036), the Environmentally Sustainable Transport System Plan (2013-2020), the National Industrial Development Master Plan (2012-2031), and the Waste Management Roadmap. The report was prepared through a participatory process that included consultations with stakeholders and inter-ministerial cooperation through working groups, led by a steering committee comprising representatives from relevant government agencies, academia, and the private sector.

The action plans to achieve NDC goals will be integrated into Thailand’s national strategies, and be implemented as part of the NDC Roadmap on Mitigation 2021-2030, NDC Sectoral Action Plans, and the NDC Supportive Action Plan. In the process of implementation, stakeholders at the central in the central and local governments will have the opportunity to make their opinions heard, and public participation will be encouraged throughout the process. The NDC Roadmap specifies major policy measures for key areas, including energy, transport, industry, and waste management, as well reduction targets for each sector. It also designates responsibilities for relevant agencies. The NDC Sectoral Action Plans stipulate emissions reduction targets, and the NDC Supportive Action Plan highlights both needs and limitations in creating an environment to support the country’s efforts to achieve its stated NDC goals.

Recognizing the importance of international, market-based cooperation in achieving both its NDC and sustainable development goals, the Thai government plans to explore cooperation opportunities at the bilateral, regional, and

12) This section is based on Thailand’s NDC report submitted to the UNFCCC in 2020.

multilateral levels, including opportunities utilizing the mechanism provided by Article 6 of the Paris Agreement. The government expects this cooperation will facilitate technology development/transfer and capacity building, enabling a sustainable transition to a low-carbon, climate-resilient growth.

The NDC report also takes note of the challenges Thailand faces. In the energy sector, obstacles include limited grid connections, inadequate financial support for energy efficiency and renewable energy investments, a lack of technological capability, and negative public perceptions of waste-to-energy and biomass power plants. Despite its efforts to promote renewable energy, including feed-in tariffs and tax incentives, the country has yet to achieve economies of scale. The government anticipates that international support, such as financial aid and transfers of intellectual property rights, could accelerate the transition of developing countries into low-carbon economies.

Section 4.2 of Thailand’s NDC, titled Technology Development and Transfer, lists the technologies the government says it requires for to mitigate emissions. The list includes the following technologies: energy storage systems, energy efficiency and demand management, renewable energy, offshore wind power generation, smart generation/grid, electrified transportation systems, battery charging, waste-to-energy, and waste management technologies.

In addition, the government cites a lack of capacity to cope with climate change, climate change vulnerabilities at the sectoral and regional levels, inadequate data and research, and an absence of implementation tools/mechanisms as obstacles the country faces in fighting climate change. That said, this report does not elaborate on the current status of each challenge.

10. Viet Nam<sup>13)</sup>

Viet Nam is a lower middle-income country, characterized by a high level of vulnerability and exposure to climate change risks. The Central Coastal and Mekong River Delta regions are especially exposed to climate change impact risks. The socioeconomic burden on Vietnam of climate change-related natural disasters is increasing.

Following the submission of the country’s INDC to the UNFCCC in September 2015, Viet Nam signed the Paris Agreement in April 2016 and ratified it in October of that same year. Since the submission of its INDC, the government of Viet Nam has developed and introduced national climate change policies. The include: the Resolution of the Politburo of the Central Committee of the Communist Party of Viet Nam on the Orientation of Viet Nam’s National Energy Development Strategy to 2030 with a Vision to 2045, the Renewable Energy Development Strategy to 2030 with a Vision to 2050, the Revised National Power Development Plan PDP for 2011-2020 with a Vision to 2030, the National Action Plan for Implementation of the 2030 Agenda for Sustainable Development (2017), the Target Programme for Climate Change Response and Green Growth 2016-2020 (2017), the Plan for implementation of the Paris Agreement (PIPA 2016), and the Conclusion of the Politburo on promoting active climate change response and strengthening natural resources

13) This section is based on the NDC report of the Socialist Republic of Viet Nam submitted to the UNFCCC in 2020.

management and environmental protection. Under the PIPA, the government of Viet Nam categorized actions on climate change mitigation and adaptation, resource mobilization, institutional improvements, and enhanced transparency frameworks into 68 groups of specific tasks. These individual undertakings are to be carried out by 2030. Based on these efforts, the country developed and submitted an updated NDC in 2020. Various stakeholder groups, including scientists, ministries, government agencies, NGOs, research institutes, enterprises, international organizations and development partners all contributed to the NDC update.

The National Committee on Climate Change (NCCC), the Advisory Council of the NCCC, and the Department of Climate Change under the Ministry of Natural Resources and Environment serve as the foundation of national climate change governance, tasked with implementing and coordinating the country’s efforts to combat climate change. Going forward, these bodies are to serve inter-ministerial coordination roles and inform the decision-making process for inter-regional/sectoral adaptation projects. Relevant government agencies are to proactively implement climate change action plans. At the regional level, departments dedicated to climate change response have been established and gradually upgraded.

For the mitigation component of the Vietnamese strategy, the NDC report introduces measures for the energy, agriculture, LULUCF, waste, and industrial process (IP) sectors. The government estimates GHG emissions volumes based on BAU to reach 927.9 mtCO<sub>2</sub>e by 2030, using 2014 as the base year (284 mtCO<sub>2</sub>e). Reductions targets propose a 9% cut to emissions by 2030 compared to the BAU scenario; these cuts are to be achieved using domestic resources. The government expects such efforts to require an initial investment of about USD 24.7 billion.

The government projects that, with international support in the form of bilateral and multilateral cooperation, Viet Nam could cut emissions by up to 27%. This figure is a composite of targeted cuts of 16.7% in the energy sector, 3.5% in agriculture, 2.3% in LULUCF, 3,6% in waste, and 0.9% in IP. Under the conditional scenario, emissions reductions would be the largest in the energy sector, followed by the waste, agriculture, LULUCF, and IP sectors. The country expects to mobilize international financial support from the GCF, GEF, Global Climate Partnership Fund, Forest Carbon Partnership Fund, as well as ODA funding, in the pursuit of its mitigation efforts. FDI from businesses is also on the rise, especially in the energy sector, and is anticipated to increase further going forward.

The NDC contains detailed plans for each sector. Mitigation measures were selected based on the results of cost-benefit and feasibility analyses, as well as the potential to generate synergies with existing adaptation and socio-economic development efforts, and also with national/sectoral development plans for 2021-2030. The detailed measures laid out in the NDC are as follows:

1) Energy savings and efficiency improvement, energy consumption reduction, promotion of efficient utilization of renewable energy sources and expansion of their renewables in energy production and consumption

Viet Nam has steadily lowered GHG its emissions through energy efficiency improvements and energy consumption reduction. From 2015 to 2019, electricity losses were curtailed by about 29.7 billion kWh compared to 2010 levels, which helped the country mitigate 26.5 mtCO<sub>2</sub>e of GHG emissions. With regard to renewable energy development, as of the end of 2019, total solar PV capacity 4,696 MW, followed by small-scale hydro-power (3,674 MW), wind power (377 MW), and biomass (325 MW).

The energy sector is to take the following measures in implementing the provisions of the NDC:

- Promote the use of energy-efficient household appliances and industrial/commerce electrical equipment
- Apply energy efficiency measures in industries
- Develop renewable energy in accordance with Viet Nam's potential capacity, merits, and conditions
- Improve energy efficiency in the transport sector
- Transform existing modes of freight transportation models and restructure the transportation market
- Shift from private to public transport
- Transition from conventional fuels to biofuels, natural gas, and electricity
- Improve the energy efficiency of transport vehicles
- Develop and apply new technologies in the production of construction materials
- Reduce proportion of clinker content and carry out GHG emissions reduction measures in cement production
- Develop and utilize energy-saving and eco-friendly materials in the housing and commercial sectors

**2) Structural changes in the use of fuel and in industry and transport; transformation of passenger and freight transport models**

For the transport sector, the government has mainstreamed climate change responses into sub-strategies for seaport groups, the dry port system (by 2030), inland waterway transport master plans, railway network initiatives, and the construction of Long Thanh Airport. The government has also led discussions on increasing the use of renewable energy in public lighting and traffic light systems.

**3) Development of sustainable agriculture and reduction of GHG emissions through improvements in production efficiency and competitiveness**

The agriculture sector has launched a number of efforts to mitigate emissions. These include: the replacement of long-duration rice varieties with short-duration varieties to reduce the amount of time during which emissions are generated, the expansion of alternating wet-dry irrigation and other irrigation techniques, the promotion of integrated crop management, reducing the percentage of rice straw burned in fields from 90% to 30%, improving the diets of dairy cattle, collecting and treatment of livestock organic waste for organic fertilizer production, and applying water-saving irrigation techniques to hundreds of hectares of coffee plantations.

The agriculture sector will implement the following measures:

- Apply new managerial and technological solutions in crop cultivation and animal husbandry, improve the diets of livestock, transform the structure of crop production, and oversee changes to land-use methods- Treat and reuse agriculture and livestock by-products and waste and develop organic agriculture

**4) Management and development of sustainable forests, improvement of carbon sequestration and environmental services, conservation of biodiversity associated with economic development, increase in income for forest-dependent communities and residents**

Viet Nam has actively adopted mitigation measures under the REDD+ mechanism. From 2015 to 2020, the country concentrated on strengthening its institutional frameworks and policies, building capacity, developing technical guidelines, and investing in the implementation of REDD+ provisions. Carbon emissions reductions were estimated for each REDD+ program, and an emissions reduction program for North Central Viet Nam is projected to result in emissions cuts of 25 mtCO<sub>2</sub>e between 2018-2025. In addition, the country has increased forest coverage; forested lands accounted for 41.89% of national territory by the end of 2019. Other forest protection measures to be implemented include:

- Protect and conserve forests and forested lands, increase carbon sequestration through sustainable use of forests and carbon certification
- Reforest and restore forests, focusing on production, timber, and coastal forests, and restore protected and special-use forests
- Designate natural forest restoration areas, plan regeneration and enrichment initiatives for areas allocated for forestry activities, pursue qualitative and quantitative improvements in forest carbon stock
- Develop agroforestry models to enhance carbon stocks and protect land

**5) Waste management**

The waste sector has reduced landfill volumes and mitigated the environmental impact of waste by establishing and operating solid waste treatment facilities and applying new, advanced technologies for compost production.

- The sector has also worked to mitigate GHG emissions through the development of technologies for treating domestic solid waste, general industrial solid waste, and special solid waste

The government has designed and promulgated various waste management measures, including environmental protection taxes and waste treatment fees. The government also encourages all organizations, domestic and foreign, as well as individuals to invest in waste treatment and auxiliary facilities by providing investment support and preferential programs.

**6) GHG emissions mitigation through construction materials replacement, HFC consumption reduction, and improvements to cement and chemical production processes**

The implementation of mitigation targets will be monitored on a biannual basis at both the national and sectoral levels

through an MRV system based on unified regulations issued by competent authorities. Viet Nam still faces a variety of challenges ahead, including: improving the national GHG inventory system, establishing an multi-level MRV system, developing and implementing Nationally Appropriate Mitigation Actions (NAMAs), applying GHG reduction technologies (especially in the agriculture sector), assessing domestic and foreign financial resources for mitigation, and promoting more proactive mitigation efforts in the private sector. Other actions to be taken:

- Enhance measures for grinding blast furnace slag, fly ash, pozzolana, and limestone to replace clinker in cement production
- Reduce HFC consumption

11. NDC Comparison

The states goals in the NDCs of 10 ASEAN member countries are summarized as below.

Table 2. Comparison of NDC goals of 10 ASEAN member countries

Nation	Submission	Reduction target	Major implementation areas	Carbon neutrality target year
Brunei Darussalam	12/31/2020	20% reduction compared to BAU	Energy, industrial processes, product use, agriculture, forest and land use, waste, EV, renewable energy	Not specified
Cambodia	12/31/2020	41.7% (64.6 mtCO2e) reduction compared to BAU (155 mtCO2e)	Forest and land use, energy, agriculture, industry, waste	2050
Indonesia	7/22/2021	29% (unconditional) /41% (conditional) reduction compared to BAU by 2030	Forest and land use, energy, agriculture, waste, industrial processes	2060
Laos	5/11/2021	Unconditional target of 60% (62,000 ktCO2e) reduction compared to BAU; conditional sectoral targets	LULUCF, hydropower, energy efficiency, transport	2050
Malaysia	7/30/2021	45% reduction in carbon intensity relative to GDP by 2030 compared to the 2005 levels	Energy, industrial processes and product use, waste, agriculture, LULUCF (no detailed explanation)	2050
Myanmar	8/3/2021	Conditional 50% reduction in net emissions by 2030	Energy, agriculture, FOLU	2050; Under discussion
Philippines	4/15/2021	75% reduction compared to BAU (2.71% unconditional; 72.29% conditional)	Climate finance, technology development and transfer, capacity building, circular economy, sustainable consumption and production, Article 6 cooperation mechanism of the Paris Agreement (no detailed explanation)	Not specified
Singapore	3/31/2020	Gradual decline in total GHG emissions after peaking at 65 mtCO2e around 2030	Economy-wide measures, encompassing energy, industrial processes, product use, agriculture, LULUCF, and waste	2050
Thailand	10/26/2020	20% reduction compared to BAU (approximately 555 mtCO2e); up to 25% under the conditional scenario	Economy-wide reductions, including LULUCF and energy	2050
Viet Nam	9/11/2020	Unconditional reduction of 9%; conditional reduction up to 27% compared to BAU	Energy, agriculture, transport, LULUCF, waste, industrial processes	2050

III. Suggestions for Korea-ASEAN Carbon Neutrality Cooperation

Since 2017, Korea has pursued its New Southern Policy, a policy suite targeting 10 ASEAN countries, including six key ODA partners (Viet Nam, Indonesia, Cambodia, the Philippines, Laos, and Myanmar). Under this policy, the government promoted 16 national tasks under the three organizing principles: People, Peace, and Prosperity, or the 3Ps. However, these projects have largely neglected environmental issues, including climate change. Task No. 15 mentioned joint research and collection of marine waste and the establishment of a Korea-Mekong Biodiversity Center; task No. 16 briefly referred to the restoration and conservation of damaged wetlands in the region. Environmental issues, including climate change, were not adequately addressed in Korea's ASEAN cooperation projects. In addition, cooperation on environmental issues was mostly limited to biodiversity, wetland conservation, and waste treatment issues. Accordingly, the Korean government revised the policy in November 2020 (called the New Southern Policy Plus), and proposed seven strategic directions. These changes included the addition of a sub-task to Initiative 4 (which concerns building a mutually beneficial and sustainable trade and investment base) that aims to adjust the energy and resource expansion base in Southeast Asia. Initiative 7 (transnational cooperation for safety and peace) now explicitly addressed climate change and environmental issues, and contained provisions for cooperation on climate change response and carbon reduction, improvements to disaster response capabilities and cooperative systems, marine conservation, and environmental cooperation.

However, climate mainstreaming is still in its nascent stage in Korea-ASEAN cooperative endeavors. Although the climate change agenda has been reflected to some extent in the revision to the New Southern Policy, these provisions were limited to climate change adaptation, addressing water management, health and hygiene, and disaster prevention.<sup>14)</sup>

Therefore, it is necessary to conduct basic research on how to integrate and reflect climate issues in current and future Korea-ASEAN cooperation frameworks and plans. Before developing climate change responses and carbon-neutral strategies that take into account the needs of Southeast Asian governments, experts, community members, and cities, it is first necessary to understand the local demand and project feasibility, integrate stakeholders into Korea's ASEAN climate cooperation program, and implement the interests and vision of Korea's participants through cooperation.

The outlook for Korea-ASEAN climate change cooperation is promising, as ASEAN is increasingly determined to work with international partners on global issues such as climate change. ASEAN has announced the ASEAN Comprehensive Recovery Framework as a recovery and response strategy for the COVID-19 pandemic. In June 2019, ASEAN adopted the ASEAN Outlook on the Indo-Pacific (AOIP) to establish an inclusive order in the region based on ASEAN Centrality, and presented development-oriented agendas on maritime cooperation, the strengthening of connectivity, SDGs, and economic/other cooperation<sup>15)</sup> In addition, the ASEAN Blueprint 2025 and the ASEAN Environmental Strategy Plan

14) Kwon, Y. et al. 2021.  
15) Choi In-ah et al., 2022.

suggest that ASEAN will actively cooperate with both neighbors and at the international level to respond to climate change.

Developed countries including the US, the EU, and Japan have begun to meet ASEAN demand for international cooperation and entered the project discovery stage for climate change initiatives. Under the Build Back Better World (B3W), the Joe Biden administration proposed six development directions: value-based infrastructure development, good governance and infrastructure development standards, carbon-neutral development, strategic cooperation, private investment expansion, and multilateral public resources. Under the US-ASEAN Connect Initiative in the energy and climate sectors, renewable energy and climate change issues have been extensively discussed. In addition, the Clean Power Asia Program and the Infrastructure Support Network (ITAN) have also been launched under the Initiative.<sup>16)</sup> This indicates that Korea could explore more opportunities to cooperate with the US in facilitating the carbon neutral future of Southeast Asia.

Korea's cooperation with ASEAN on climate change issues should be pursued in a manner consistent with SDG 7 (on clean energy) and SDG 13 (climate action). In addition, there is a high probability that Korea's cooperation with ASEAN will be promoted as part of development cooperation, so established development cooperation norms, such as recipient ownership, transparency, result-centeredness, mutual responsibility, and sustainability, should be followed. And the Korean government's international development cooperation policies should be carried out in a consistent manner.

In early 2021, through the 3rd Comprehensive Basic Plan for International Development Cooperation (2021-2025), Korea announced four strategic goals for the promotion of inclusive, win-win, innovative, and shared ODA opportunities. Implementation strategies cover health, water, sanitation, education, economic and social infrastructure, climate change, science and technology, digital, and public administration. The policy suite also promotes ODA projects that pursue shared prosperity by creating a foundation for economic and social development, leading the transition to a green economy, and enhancing foreign policy consistency with developing countries. In terms of the green transition, the Plan proposed leading discussions on climate change and strengthening cooperation, promoting strategic Green New Deal ODA, and strengthening support for climate change responses in developing countries. In addition, it emphasized the need for more support for climate change responses, and specified bilateral climate change cooperation with Viet Nam and Myanmar in particular.<sup>17)</sup>

Korea's ODA projects in the renewable energy sector shall be promoted in a way that strengthens linkages with international GHG reduction efforts in recipient countries. In April 2022, the Korean Ministry of Trade, Industry and Energy announced that while previously, ODA projects were run based on recipient country demand, and focused on the provision of policy advice and intensive support for small-scale infrastructure, future energy-related ODA projects should be linked with the overseas GHG reduction efforts of Korean companies. Thus, the Ministry is to discover and

conduct promising reduction projects centering on infrastructure construction. In addition, Korea will focus on supporting developing countries' efforts to monitor NDC implementation and strengthen their DOE capacity, and plans to develop joint projects with international organizations such as the Global Green Growth Organization (GGGI) and the United Nations Industrial Development Organization (UNIDO). As the implementation rules for Article 6 of the Paris Agreement were decided upon at the COP26 climate conference in Glasgow in November 2021, one can expect the international voluntary market for GHGs to expand. Therefore, Korea needs to diversify its climate cooperation strategies so that climate cooperation projects promoted in Southeast Asia can not only contribute to the carbon neutral transition of partner countries, but also be utilized as overseas carbon reduction efforts of the Korean government and firms.

Sitting Korean president Yoon Suk-yeol did not emphasize the New Southern Policy or ASEAN during the presidential election campaign, focusing instead on the denuclearization of North Korea, strengthening the Korea-US alliance, and reinforcing the national security system. Regarding climate change, the Yoon administration has emphasized treating the climate crisis as an opportunity through government-level support, regulation, and global cooperation, and suggested strengthening the omni-directional cooperation system for international environmental issues.<sup>18)</sup> The Yoon administration plans to expand and restructure the New Southern Policy (which was first implemented by the Moon Jae-in) administration to promote a Korean version of the Indo-Pacific strategy framework, but no specific details have yet been released. There are some concerns that the new government is trying to scrap the previous administration's New Southern Policy altogether;<sup>19)</sup> the current administration has renamed the New Northern Trade General Division and the New Southern Trade General Division to the Trade Cooperation General Division and the Aju Trade General Division, respectively.<sup>20)</sup> The current governments plans and policies for cooperation with ASEAN are still in the design stage; concrete details are expected to emerge after the recently-held ASEAN summit of November 2022.

In this section, based on the above analysis of ASEAN member states' NDCs, we identify potential areas of cooperation and propose mechanisms for pursuing collaborative GHG reductions between Korea and ASEAN countries. The Energy and LULUCF sectors, which many Southeast Countries emphasized as key target areas in their NDC reports, represent major areas of potential cooperation. We also propose a set of detailed cooperation tasks. Due to the different environmental, economic, and socio-political situations of the 10 ASEAN countries, there exist significant differences in the baseline conditions necessary to pursue programs at both the national and sub-regional levels. Therefore, rather than proposing specific, detailed implementation measures for each state, we will instead identify several measures for GHG reduction cooperation in the sectors that have the potential to make major contributions to the achievement of NDC and carbon neutrality goals in Southeast Asia.

16) Choi In-ah et al., 2022.

17) Kwon Yul et al., 2021, pp. 99-100.

18) National Election Commission. Election Pledge of the 20th Presidential election winner <https://policy.nec.go.kr/>

19) Naeil, (Oct 7, 2022). In Need of Substantial Leap in Korea-ASEAN Cooperation Relations. [http://www.naeil.com/news\\_view?id\\_art=437877](http://www.naeil.com/news_view?id_art=437877)

20) Naeil, (Oct 7, 2022). In Need of Substantial Leap in Korea-ASEAN Cooperation Relations. [http://www.naeil.com/news\\_view?id\\_art=437877](http://www.naeil.com/news_view?id_art=437877)

1) Energy

Energy demand in Southeast Asia has continued to increase due to rapid economic growth and urbanization. Between 2008 and 2018, demand for electricity increased about 6.3%, increasing the region's dependence on fossil fuels. It is estimated that by 2050 energy demand will increase by about three times compared to 2020<sup>21)</sup> (Handayani et al., 2022). Given that Southeast Asia accounts for about 4% of global emissions, the energy sector must play an important role in achieving each country's GHG reduction goals and the global goal of carbon neutrality by 2050. Indonesia accounts for the highest share of GHG emissions in the region, emitting 32.2% of the region's GHGs. It is followed by Viet Nam (18.8%), Malaysia (16.7%), Thailand (14%), and the Philippines (10.5%)<sup>22)</sup>.

The proportion of GHG emissions in the energy sector remains as high as it is because of the region's over-reliance on coal and other types of fossil fuels for power generation. In 2020, coal-fired power accounted for about 79% of ASEAN's total electricity generation (44% coal, 32% natural gas, and 2% oil). Sixteen percent of electric power was generated by hydroelectric dams, the remaining 6% was generated by other renewable energy sources.<sup>23)</sup>

ASEAN countries are pursuing or planning to improve energy efficiency and expand renewable energy to implement the commitments in their NDCs and cope with climate change. Myanmar, whose population lacks universal access to electricity, is looking to shift to carbon neutrality through electrification.

In order to reduce GHG emissions in the region, active energy conversion policies are required. These will include measures to reduce the share of coal-fired power and replace it with energy sources that generate no or little GHGs, such as renewables and micro-scale hydropower. Considering the environmental harm caused by large-scale hydroelectric power generation, and disputes between countries over the damming of shared rivers like the Mekong, it seems desirable to focus on the expansion of non-hydro renewables, except for micro-hydropower, which has relatively low environmental and social costs. In addition, as climate change intensifies, droughts are becoming more frequent, producing large variations in available water resources for electricity production. This has generated skepticism regarding the viability of new large-scale dams. The region's potential for some forms of renewable power (such as solar) is great, enhancing prospects for the expansion of renewable energy. See Table 2.

21) Handayani et al., 2022.  
22) Handayani et al., 2022.  
23) Handayani et al., 2022.

Table 2. Renewable Energy Generation Potential in Southeast Asia (GW)

ASEAN Member States	Biomass	Hydro	Geothermal	Wind	Solar PV
Brunei	-	0.07	-	0.02	16.00
Cambodia	-	10.00	-	69.00	3,198.00
Indonesia	32.60	75.00	29.50	50.00	1,052.00
Lao PDR	1.20	26.00	0.05	13.00	1,278.00
Malaysia	0.60	29.00	-	2.00	1,965.00
Myanmar	0.99	40.40	-	482.00	7,717.00
Philippines	0.24	10.50	4.00	217.00	1,910.00
Singapore	-	-	-	0.02	2.00
Thailand	2.50	15.00	-	239.00	10,538.00
Vietnam	0.56	35.00	0.34	311.00	2,847.00

Source: Handayani et al (2022, p. 2)

According to an analysis by the ASEAN Center for Energy using the Stockholm Environment Institute's Low Emissions Analysis Platform (LEAP) software, regional power generation capacity will grow from 240 GW to 2,092 GW in 2020, with a variety of renewable energy sources, including energy storage devices with a capacity of 156 GW, accounting for 81% of total energy<sup>24)</sup>. Renewable energy is to account for 99.5% of total electricity production, and solar energy is expected to account for the largest portion of renewable production. The ASEAN Energy Center estimates that it will cost USD 910 billion in total to achieve carbon neutrality in the region's power sector by 2050 through the expansion of renewable energy<sup>25)</sup>.

Based on ASEAN's analysis, Korea can seek diverse project opportunities as follows. Opportunities to expand renewable energy can be sought in consideration of the economic scale, technology, human resources and infrastructure of the country in question. For relatively developed countries, such as Indonesia, Viet Nam, Malaysia, and Thailand, wind and solar projects, which are relatively large in scale and require high initial investment costs, may be feasible. And for countries with relatively less developed economies, such as Laos, Myanmar, and Cambodia, basic infrastructure construction projects such as small-scale solar PV, solar and micro-grid projects and basic grid construction could be considered potential areas of development cooperation.

As shown in Table 2, Thailand, Cambodia, Myanmar, and Viet Nam have the greatest solar potential. Large-scale solar power facilities in particular are most feasible in Thailand and Vietnam, which have superior transmission infrastructure to Cambodia and Myanmar. More sophisticated analysis of local conditions and feasibility will be necessary before deciding capacity and determining other requirements at the sub-region level in each country.

24) Handayani et al, 2022.  
25) Handayani et al, 2022.

Malaysia, which is dependent on thermal power generation from natural gas and other fossil fuels, is also developing solar and biomass projects to improve energy security and respond to climate change<sup>26)</sup>. Despite not being specifically mentioned in its NDC report, the government of Malaysia has decided to end investments in new coal-fired generation, making the 2019 Jimah East project the last new coal-fired plant in the country. The government plans to gradually phase out 7 GW of coal power capacity by 2039, and increase the share of renewables consumption to 31% by 2025 (based on the 12th Malaysian plan, including hydroelectric power).<sup>27)</sup> As of the end of 2021, solar power generation exceeded power generated by biomass and waste processes, accounting for the largest proportion of non-hydro renewable energy. Malaysia's largest electric power company, TNB, is exploring various policy incentives. One such initiative involves addressing consumer concerns by tracking consumption patterns and distributing smart meters, and encouraging the adoption of rooftop solar PV systems. The Energy Minister said that the government aims to make renewable capacity represent 40% of the energy mix by 2035.<sup>28)</sup> Malaysia hopes to become the largest solar PV producer by 2030 by introducing separate, user-based incentives for electricity consumption, offering residences, public agencies, and companies reasons to expand their consumption of solar power.

In addition, the Energy Commission of Malaysia has set up a large-scale solar energy investment program called Large Scale Solar (LSS) to provide various incentives, such as investment attraction.<sup>29)</sup> Korean firm Hanwha Q Cells has acquired a solar cell panel production plant in Malaysia. Considering that Malaysian firms lack energy storage technologies and related capacity, Korean companies have opportunities to cooperate with Malaysia in the energy sector. Malaysia has a relatively high level of economic development, and so cooperation programs in which the private sector can participate in various ways through investment and technology transfer are quite feasible.

The Philippines has also set a goal to reduce energy intensity and transition to low-carbon, eco-friendly energy, stipulated in the Philippines' Energy Efficiency Roadmap 2014-2030. As the world's second-largest geothermal powerhouse, the country has a potential geothermal capacity of 2,500 MW, and the government plans to expand geothermal production by 62% through 26 new geothermal power plants to be build under the auspices of the 2012-2030 Energy Supply and Demand Plan.

Less-developed Southeast Asian countries such as Laos, Myanmar, and Cambodia lack the necessary grid infrastructure to expand renewable energy generation, and their existing networks are of low-quality. In the case of Myanmar, promoting small-scale solar energy projects, micro-grid distribution, grid modernization at the village or community levels is a realistic cooperation scenario. As seen in Viet Nam, which has achieved rapid growth in the solar energy sector thanks to the supply of rooftop solar systems, Myanmar and Laos can also devise solar power projects at the local level focusing on electrification, so that residents can consume electricity produced locally. Laos intends to gradually increase renewable energy generation and minimize energy loss in the transmission process by upgrading the power distribution system and

26) Ahn Hyo-chan, 2022.

27) Ahn Hyo-chan, 2022.

28) Korea Energy Agency, 2022.

29) Ahn Hyo-chan, 2022.

revising electricity supply expansion policy. Korea can support the governments of these countries through the provision of technical assistance and also by building and modernizing power infrastructure.

In addition, Korea and ASEAN can promote technology support and human exchange cooperation in renewable energy as well as energy efficiency improvement. However, as Korea's renewable energy technology and industry capacity cannot compete with the advantage of China, Europe, and the US, particularly in terms of economies of scale, and the Yoon administration has downscaled renewable energy expansion plans, Korean companies need to target different stages in the value chain of the rapidly growing renewable energy industry in Southeast Asia, especially in the materials, parts, and technology subsegments.

As renewable energy generation gradually expands, demand for energy storage systems in the region will also increase steadily. The US government has awarded USD 3 million in grants to energy storage and other solar power plant projects in central Vietnam, and various research projects are being carried out by the Asian Development Bank (ADB), Vietnam Electric Power, and Japan's Ministry of Economy, Trade and Industry.<sup>30)</sup> In Thailand, the ADB also designed, launched, and executed an on-site energy storage battery project at a wind power plant in 2020.<sup>31)</sup>

ASEAN has increasingly emphasized connectivity at the regional level and also recognized the need for expanded linkages between transportation infrastructure and power generation. Sustainable infrastructure is one of five strategic sectors designated in the ASEAN Community 2025 initiative, in which five out of 42 projects revolve around power generation. ASEAN countries have already signed an MOU in 2007 to pursue the development of pan-ASEAN power infrastructure (the ASEAN Power Grid project). Although there has been some progress in transmitting Laos' hydroelectric power to Malaysia via Thailand, inter-regional connections are lacking and levels of integration remain weak.

Although renewable energy has gradually been gaining traction in Southeast Asia, each country has different potential and power generation capacity. Thus, to strengthen the connectivity of power generation at the regional level, it is advised to create platforms for the exchange and trade of renewable energy through the formation of a common power market. Alternatively, it may be possible to expand the interconnected grid that connects Southeast Asian countries and cities. An integrated network would facilitate more flexible and efficient operation and management of energy demand and supply in ASEAN countries. In addition, an integrated transmission infrastructure can promote the expansion of renewable energy in the region by addressing the problem of overcapacity in the event of a sudden spike in renewable energy availability that outstrips demand.<sup>32)</sup> The Korean government and state owned power companies could promote the efficient use of energy and renewable energy in the region by participating in the establishment and operation of a common market, building distribution facilities for integrated grid networks, and improving the quality of connectivity.

30) Nguyen, 2022.

31) Weatherby, 2021, p. 33.

32) Weatherby, 2021.

In addition, it is necessary to actively seek ways to address other regional environmental issues while expanding the use of renewable energy. Waste disposal is a critically important environmental issue in the ASEAN region. Waste-to-energy processes carry the potential to both expand the use of renewable energy and improve local environmental conditions simultaneously. Korea's New Southern Policy included the conversion of waste resources into energy in its provisions, as part of a larger effort to enhance innovative growth through new industries and smart cooperation. The Vietnamese province of Long An is scheduled to launch a waste treatment and renewable energy project in 2023. The project is expected to incur costs of USD 10 to 15 million from 2023 to 2028.

ASEAN has also promoted the development of smart cities to respond to the Fourth Industrial Revolution by utilizing digital and ICT technologies through the ASEAN Sustainable Urbanization Strategy (ASUS). Major cities and countries in the region are implementing international cooperation programs to cope with urbanization issues and to establish sustainable eco-friendly digital cities.<sup>33)</sup> Smart city projects incorporate health, safety, education, transportation, housing, and the environment. Korea may participate in the transition and development of major existing and new cities in Southeast Asia into carbon-neutral cities. The expansion of green buildings in urban commerce and residential areas, the promotion of renewable energy, the improvement of energy efficiency (through the distribution of Advanced Metering Infrastructure or AMI), and the utilization of electric vehicles and hydrogen buses as modes of urban green mobility can be carried out as part of smart eco-city projects.

1. Although absent from NDCs, Carbon Capture Utilization and Storage (CCUS) is also an area which offers opportunities to pursue cooperative projects. The International Energy Agency (IEA) projects that CCUS will be responsible for 18% of emissions reductions required to achieve carbon neutrality by 2050, and the CCUS market is expanding.<sup>34)</sup> Countries that rely heavily on fossil fuels, such as Malaysia, Indonesia, Brunei, and Singapore, are increasing their focus and investment in this sector. Korean companies, namely POSCO and Samsung Heavy Industries, have signed contracts with Malaysian parastatal Petronas to store and utilize carbon.<sup>35)</sup> CCUS have come under fire, however, being accused of greenwashing. However, considering the situation in Southeast Asia, where fossil fuel dependence is still high and power demand is rapidly growing, CCUS represent a realistic way for the region to transition to low-carbon energy and eventually, carbon neutrality. Japan, which launched the Asian CCUS network using its own CCUS technology in 2021, has established a national industrial-academic platform to promote knowledge sharing and the improvement of the business environment in Southeast Asia.<sup>36)</sup> All ASEAN member countries have plans to expand renewable energy. However, only Singapore possesses sufficient human capacity in the renewable energy sector. According to the International Renewable Energy Agency, about 1.7

33) Kwon Yul, 2021, p. 189-90.

34) Chosunbiz, (Aug. 3, 2022). "Samsung, SK, Lotte, Posco... heading to Southeast Asia with carbon technology." <https://biz.chosun.com/industry/company/2022/08/03/IPVOOE4ZW5H6ZEBWBIQFJADARA/>

35) Chosunbiz, (Aug. 3, 2022). Samsung, SK, Lotte, Posco... heading to Southeast Asia with carbon technology. <https://biz.chosun.com/industry/company/2022/08/03/IPVOOE4ZW5H6ZEBWBIQFJADARA/>

36) KOTRA Overseas Market News. (Nov. 1, 2021). Strengthening industrial system using Japanese carbon CCUS technology and building CCUS network with ASEAN. [https://dream.kotra.or.kr/kotranews/cms/news/actionKotraBoardDetail.do?SITE\\_NO=3&MENU\\_ID=410&CONTENTS\\_NO=1&bbsGbn=242&bbsSn=242&pNttSn=191237](https://dream.kotra.or.kr/kotranews/cms/news/actionKotraBoardDetail.do?SITE_NO=3&MENU_ID=410&CONTENTS_NO=1&bbsGbn=242&bbsSn=242&pNttSn=191237)

million jobs will be created in ASEAN's renewable energy sector by 2030, with more job opportunities produced if policies to expand renewable energy are actively pursued (Weatherby, 2021, p. 47). ASEAN member countries expect international support in education and training for renewable energy workforce development. The Korean government could provide assistance and organize cooperative training and capacity building programs, as well as facilitate technology transfers and the construction of infrastructure.

## 2) LULUCF sector

Land and forests serve as major GHG sinks. Rainforests account for only 7% of the world's land, but absorb 68% of global total carbon emissions.<sup>37)</sup> Southeast Asia is home to about 15% of the world's rainforests and four of the 25 most important biodiversity hotspots worldwide. However, forest depredation in the region is worsening due to reclamation for palm oil production: Indonesia, Malaysia, and Thailand are the world's top three palm oil producers. Furthermore, the biodiversity loss in Southeast Asia is particularly severe.<sup>38)</sup> Research suggests that forest loss in Southeast Asia is rapidly accelerating; considering more than 90% of Southeast Asia's forests unprotected in the early 2000s, biodiversity loss in the region is projected to reach more than 40% by 2100.<sup>39)</sup>

The forest sector can achieve excellent reduction performance at a relatively low cost utilizing nature-based solutions. In addition, forest restoration and development could contribute to climate change adaptation efforts by reinforcing natural resistance to droughts and floods. In accordance with the detailed guidelines of the Paris Agreement on the forest sector, emission rights secured through the Red Plus (REDD+) project can be used to achieve the NDC goals.

As discussed earlier, Southeast Asian countries strive to reduce their GHG emissions by expanding carbon sinks in the LULUCF and FOLU sectors, and hope to be rewarded from advanced countries and international organizations (e.g., GCF, FCPF) based on their achievements through international cooperation. They also expect technical and capacity building support from developed countries in this sector. Furthermore, they anticipate additional benefits, such as conserving the rich biodiversity of the region through improvements to land and forest quality, the enhancement of ecological services, and the reduction of poverty by improving incomes and job creation in forestry and agriculture.

Korea can contribute to revitalizing international carbon reduction efforts through cooperation with Southeast Asian countries in the LULUCF sector. The Korean government announced in its revised 2030 GHG Reduction Roadmap (2018) that it will reduce 38.3 mtCO<sub>2</sub>e (4.5 %) of carbon emissions through forest absorption and overseas reductions. The updated Korean NDC, submitted in November 2021, stated that Korea is to would reduce GHG emissions by 40% compared to 2018 (727.6 mtCO<sub>2</sub>e) levels, and achieve a reduction of 33.5 mtCO<sub>2</sub>e out of the total target of 291 mtCO<sub>2</sub>e through international mitigation mechanisms. The 3rd Five-Year Green Growth Plan (2019-2023) promulgated three major promotion strategies and five policy directions under the vision of realizing an inclusive green economy.

37) Estoque et al. 2019.

38) Estoque et al. 2019.

39) Estoque et al. 2019.

The strengthening of global green cooperation is one of the three major strategies. Detailed policy directions include: diversifying GHG reduction measures by expanding carbon sinks or developing international reduction projects, actively leading and participating in new climate system implementation and international cooperation initiatives, increasing the proportion of green ODA, and supporting domestic green industries' overseas outreach efforts. In March 2021, an amendment to the Enforcement Decree of the GHG Emissions Allocation and Transaction Act was ratified by the National Assembly, becoming law. In addition, a regulation on limiting the use of Korea Offset Credits (KOC) below 50% of KCU (Korea Credit Unit) was abolished. As a result, companies are now allowed to use KOC for both domestic and overseas businesses within the submission limit (5% of each entity's compliance obligations). Accordingly, it is becoming more important to take advantage of overseas mitigation project opportunities.

Southeast Asian forests are especially valuable as carbon sinks. Korea can promote various climate development cooperation projects by utilizing REDD+ and the Sustainable Development Mechanism (SDM). Boasting a successful track record of afforestation, technology, and know-how, Korea can contribute to achieving carbon neutral goals of partner countries and generate overseas carbon credits by discovering various project opportunities. These may include projects on: deforestation and loss prevention, forest conservation, sustainable forest management, afforestation, reforestation, and restoration. In Korea, dedicated public agencies such as the Korea Forest Service in addition to private sector actors (e.g., SK Forestry) can participate in ESG management.

Southeast Asian countries are also recognizing the importance of forests to cope with climate change and achieve carbon-neutral goals, and are fighting deforestation and forest loss. However, they lack the ability to establishing forest inventory and MRV systems. In order to efficiently implement REDD+ projects in Southeast Asian countries, it is necessary to support them in the establishment MRV systems for each project in order to accurately estimate change in forest use and carbon accumulation, to set Forest Reference Emission Levels or Forest Reference Levels, and to accept results-based payments (Hong Min-ah et al., 2022). The Korean Forest Service and other relevant entities can promote capacity-building projects in the sector.

Starting with Indonesia's Riau Kampar region in 2012, Korea has worked with international partners to implement initiatives within the REDD+ project framework. In Cambodia, Korea has promoted the REDD+ project with the Cambodian Forest Service since 2015. In 2014, Korea and the Cambodia Forest Service signed an MOU, pledging to jointly respond to climate change, build capacity, and raise local incomes. Since then, the REDD+ pilot project have generated reductions of 650 ktCO<sub>2</sub>e of GHG, equivalent to annual emissions from 340,000 cars. In September 2020, the country succeeded in issuing emission allowances after receiving official certification from the International Carbon Market Standard. Profits from the sale of emission allowances through voluntary carbon market transactions are also anticipated.<sup>40)</sup>

Korea has also striven to curb illegal logging and poaching and promote biodiversity in the region through a variety of initiatives and efforts. It has carried out projects that have provided technical training and soil improvement education to

40) Korea Forest Service, 2020.

local residents and forest watchdogs, worked to prevent the clearing of forested areas for agricultural purposes, generated new sources of local income (e.g., beekeeping), enhanced productivity through the introduction of new agricultural technologies, prevented forest destruction and degradation, and supported monitoring activities. The Korea Forest Service is scheduled to complete projects in Myanmar and Laos in 2022 that began in 2016 and 2018, respectively. Accordingly, Korea can verify the effectiveness of the policy by closely analyzing the performance of the projects that have already been completed or are currently in progress, and devise future cooperation projects in the forest sector with Southeast Asian countries.

In particular, Korea can promote forest cooperation with Southeast Asian countries through the Asian Forest Cooperation Organization (AFoCO), which was established on Korea's suggestion during the 2009 ASEAN-Korea Special Summit to strengthen forest sector cooperation among Asian countries. The summit also addressed organization of a joint response to international forest issues including climate change and forest restoration. Singapore served as Observer; all ASEAN countries save only for Malaysia are participants in the scheme. AFoCO's five-year strategic plan (2019-2023) designates five key areas for forest cooperation as follows: Developing customized forest restoration and recovery models, supporting climate change adaptation R&D, introducing systematic forest disaster management measures, improving the quality of life of local residents and fostering small businesses in rural areas, and strengthening organizational capabilities and promoting regional cooperation. The Regional Education and Training Center (RETC) under AFoCO can lead human capacity building projects, such as technology transfer programs and forest leader training.

As AFoCO was unanimously approved as an eligible for official development aid by members of the OECD Development Assistance Committee (DAC) in April 2021, the possibility of expanding and diversifying resources through cooperation with the GCF, the World Bank, and the International Climate Initiative (IKI) has also increased. The AFoCO is the second environment-focused international organization initiated by the Korean government (the first is the GGGI). The Korean government might reasonably expect diplomatic gains in the form of increased soft power in Southeast Asia through the active use of AFoCO as the platform for forest cooperation. Korean companies can also consider cooperation with AFoCO or participation in government-led pilot projects as part of public-private cooperation projects to strengthen ESG management. For example, Woori Financial Group and AFoCO carried out a private sector REDD+ feasibility study support project in 2022, led by the Korea Forestry Agency.

Along with AFoCO, the Korea-Mekong Forest Cooperation Center, which Korea established in 2016 for forest cooperation with Mekong Delta countries (i.e., Cambodia, Laos, Myanmar, Viet Nam), can also be used as to promote Korea-ASEAN forest cooperation.

Meanwhile, Southeast Asian countries prefer to preserve forests through traditional "social forestry".<sup>41)</sup> There is a social forest working group within ASEAN, and the Center for People and Forests is a civil society group that publicizes the concept of social forestry throughout Southeast Asia. The concept of social forestry, in which local residents participate

41) Wong et al., 2020.

in forest resource management and management governance, positively affects policy implementation and helps reduce poverty by empowering residents with a sense of ownership, and enabling them to participate in sustainable forest development management. Development partners such as KOICA and environmental civic groups may devise and participate in social forestry programs of various scope and scale.

Table 3 lists projects of interest in ASEAN countries in the energy and LULUCF sectors.

Table 3. Energy and LULUCF Projects of Interest in ASEAN Member Countries

Country	Energy	LULUCF	Conditionality of NDC Goals/ Article 6 of the Paris Agreement
Brunei	<ul style="list-style-type: none"><li>- Solar power expansion</li><li>- Energy efficiency improvements through supply and demand management</li><li>- Power transmission and distribution improvement -Power plant energy efficiency improvement</li></ul>	<ul style="list-style-type: none"><li>- Acceleration of carbon sequestration by expanding forest cover through afforestation and reforestation of 500,000 trees</li></ul>	Not specified
Cambodia	<ul style="list-style-type: none"><li>- Expansion of renewable energy (solar, hydro, wind, biomass)</li><li>- Improvement in network supply and absorption capacity</li><li>- Efficiency improvement through building and industrial energy management</li><li>- Energy consumption reduction</li></ul>	<ul style="list-style-type: none"><li>- Emissions reduction contribution of approximately 60% from the forest and land use sectors</li><li>- 50% reduction in forest destruction through REDD+</li></ul>	<ul style="list-style-type: none"><li>- Mobilization of all domestic and foreign financial resources, including Article 6;</li><li>- No specific mechanism mentioned</li></ul>
Indonesia	<ul style="list-style-type: none"><li>- Expansion of renewable energy</li><li>- Expansion of biofuels (e.g., biodiesel)</li></ul>	<ul style="list-style-type: none"><li>- Restoration of peatlands (the largest emissions sink) through rewetting and revegetation</li><li>- REDD+ utilization</li><li>- Eradication of illegal logging</li><li>- Expansion of carbon sequestration</li></ul>	<ul style="list-style-type: none"><li>- Conditional</li><li>- Use of various forms of international support through multilateral channels (GEF, FCPF, FIP, UNREDD+, Bio-CF, GCF, and other financial institutions)</li><li>- Article 6: Intent stated</li></ul>
Laos	<ul style="list-style-type: none"><li>- Expansion of hydropower generation facilities</li><li>- Supply of energy-efficient cooking stoves</li><li>- Expansion of new facilities for solar, wind, and biomass power generation contingent on international support</li></ul>	<ul style="list-style-type: none"><li>- Forest preservation and sustainable management, expansion of national forests and protected forests, and expansion of forest carbon sinks</li></ul>	<ul style="list-style-type: none"><li>- Conditional</li><li>- Forest sector has already carried out projects with WB and GCF</li></ul>
Malaysia	Renewable energy (no specific details)	LULUCF (no specific details)	No stated intent to use Article 6 at of the time of NDC submission
Myanmar	<ul style="list-style-type: none"><li>- Renewable energy (solar, wind), mini-hydropower, biomass</li><li>- Expansion of clean electricity supply through electrification and expansion of transmission and distribution network</li><li>- Mini-grids</li><li>- Supply of household LPG gas stoves</li><li>- Rural electricity distribution</li><li>- Energy efficiency improvement</li></ul>	<ul style="list-style-type: none"><li>- Afforestation and agroforestry</li><li>- Expansion of tree canopy cover</li><li>- Forest recovery, expansion of protected/national forests, reduction of forest conversion to farmland</li><li>- Use of REDD+</li><li>- Establishment of national forest inventory and satellite-based monitoring system</li></ul>	<ul style="list-style-type: none"><li>- Conditional goal</li><li>- Support from GCF and bi/ multilateral development cooperation partners</li><li>- Seeking bilateral, multilateral, and regional cooperation based on Article 6</li></ul>
Philippines	Not specified	Not specified	<ul style="list-style-type: none"><li>- Conditional</li><li>- Seeking bi/multilateral and regional cooperation based on Article 6</li><li>- Bi/multilateral cooperation</li></ul>
Singapore	<ul style="list-style-type: none"><li>- Expansion of solar panel installations</li><li>- Continuous improvement of energy efficiency technology</li></ul>	<ul style="list-style-type: none"><li>- Emission/absorption monitoring and management through the use of high-resolution satellites, etc.</li></ul>	Seeking bi/multilateral and regional cooperation based on Article 6
Thailand	<ul style="list-style-type: none"><li>- Transmission and distribution network improvements</li><li>- Energy efficiency improvements (including energy demand management)</li><li>- Waste-to-energy</li><li>- Energy storage system</li><li>- Renewable energy (including offshore wind power)</li><li>- Smart generation and grids</li></ul>	Not specified	<ul style="list-style-type: none"><li>- Conditional</li><li>- Seeking bi/multilateral and regional cooperation based on Article 6</li></ul>
Viet Nam	<ul style="list-style-type: none"><li>- Energy efficiency improvements</li><li>- Renewable energy generation</li><li>- Biofuels</li></ul>	<ul style="list-style-type: none"><li>- Continuous utilization of REDD+</li><li>- Forest and land protection/sustainable use, forest certification, forest restoration programs</li><li>- Agroforestry</li></ul>	<ul style="list-style-type: none"><li>- Conditional</li><li>- Seeking bi/multilateral, and regional cooperation based on Article 6</li></ul>

# IV. Conclusion

ASEAN has a population of more than 600 million and constitutes the world's seventh-largest economic community. The organization is one of Korea's most important economic cooperation partners due to its high growth potential and abundant resources. The ASEAN community, of which 10 member countries have established diplomatic ties with North Korea, is also of strategic importance to South Korea. Since the upgrade to full dialogue partnership in 1991 from the sectoral dialogue partnership established in 1989, the Korea-ASEAN relationship has gradually been strengthened through the first Korea-ASEAN summit of 1997, the declaration of a strategic partnership in 2004, the signing of the Korea-ASEAN FTA in 2005, and the Korea-ASEAN Special Summit in 2019. As a result, ASEAN today has become Korea's second-largest trading partner, and human and cultural exchanges have continued to grow. Through the New Southern Policy, the previous Moon Jae-In administration sought to further diversify regional cooperation and exchanges beyond economic partnership.

Environmental and climate change cooperation is also beginning to attract more attention as one of the promoting areas of bilateral cooperation due to continually exacerbating global environmental challenges such as climate change and ever-growing GHG emissions in Southeast Asia.

This report proposed possible arenas for for Korea-ASEAN cooperation for facilitating both parties’ carbon neutral transition and climate change responses based on the analysis of the NDC reports submitted to the UNFCCC by 10 ASEAN member countries. Building on this analysis and based on field research and interactions with ASEAN partners, a much more nuanced analysis can be generated.

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