ASIA SOCIETY POLICY INSTITUTE

SUMMARY REPORT

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CARBON BORDER ADJUSTMENT MECHANISMS, CARBON PRICING POLICY, AND THE INFLATION REDUCTION ACT:

The EU and U.S. Study Tour by Korea's Young Leaders in Climate and Energy Policy

EXECUTIVE SUMMARY

As Korea seeks to achieve a 40% reduction in GHG emissions from 2018 levels by 2030 to meet its Nationally Determined Contribution (NDC) under the Paris Agreement, including strengthening the Korean Emissions Trading System (K-ETS), Korea can learn from significant climate policy developments taking place in the European Union (EU) and United States. The EU Emissions Trading System (EU ETS) continues to advance and is aiming to achieve a 62% reduction in GHG emissions from 2005 levels by 2030, in combination with implementation of the EU Carbon Border Adjustment Mechanism (CBAM). The United States is actively considering its own CBAM policy and has triggered massive investment in clean energy technology through the Inflation Reduction Act (IRA).

The Asia Society Policy Institute, with the generous support of the Korea Foundation, organized a study tour to the EU and the United States in which seven young Korean leaders in climate and energy policy participated in meetings and networking events. The project was aimed at equipping the participants with knowledge, insights, and networks to understand the implications of EU and U.S. policies related to ETS, CBAM, and broader climate and energy policies, and how Korea could revise the K-ETS in line with the more ambitious 2030 GHG emissions reduction target, respond to and comply with the EU's CBAM, and support and implement GHG emissions reduction technologies that enable achievement of Korea's 2030 NDC and 2050 net zero targets in an economically viable way.

The key learning points from the study tour that can support Korea in achieving its ambitious 2030 GHG emissions reduction target and 2050 net zero target can be summarized as follows:

Korean Emissions Trading System (K-ETS)

- **Cap setting.** The EU has successfully applied the same method as in Phase 3 to determine the ambitious revised Phase 4 EU ETS cap, based on cost-effective sharing of the overall EU emission reduction burden between ETS and non-ETS sectors. Under the K-ETS a clear and practical method for setting the cap has been applied so far, based on Korea's national emission targets multiplied by the historic share of emissions from ETS entities compared to total national emissions. However, given the differences in reductions between ETS and non-ETS entity emissions over time, there may be a need to re-assess the method of sharing the emission reduction burden, whilst still maintaining the direct link between the cap and the national target, in which case the approaches in other jurisdictions including the EU can be reviewed in developing the approach for Phase 4 of the K-ETS (2026-2030).

- **Free allocation.** The EU's push to reduce the level of free allocation should be followed in Korea, especially due to the current low K-ETS carbon price indicating an excess supply of allowances. Furthermore, some industrial sectors such as steel may be able to pass through some carbon costs as customers are demanding low-carbon products, risking "windfall" profits if there is too much free allocation. Korea can consider the experience of the EU and the United States in setting more ambitious benchmark levels in developing its own approach for Phase 4 of the K-ETS and should consider making 100% free allocation conditional on adequate energy efficiency measures and, for worst performers, carbon neutrality plans, as in the EU.

- **Auctioning.** The substantial amount of auction revenue available under the EU ETS is due to full auctioning for the power sector and a high carbon price (due to an ambitious cap). Korea should also consider full auctioning for the power sector, combined with full pass-through of carbon costs to retail electricity prices. Furthermore, Korea should also consider full auctioning for the domestic aviation sector and any other sectors where carbon costs can be passed through to product prices.
- **Auction revenue recycling.** The increase in the share of auctioning described above, as well as the higher carbon price when the cap is aligned to the 2030 NDC, will significantly increase the size of Korea's Climate Response Fund supplied by K-ETS auction revenue. The targeting of this fund should be reviewed considering the latest EU and U.S. experience with similar funds, as well as Korea's priorities. Opportunities exist to improve targeting of finance toward ETS entities in comparison to the EU experience, while also considering support to mitigate impacts of higher energy prices for vulnerable stakeholders and other beneficial purposes. Korea can learn from successful design features of EU and U.S. funds, including upfront payments, support for both capital and operating costs, and use of carbon contracts for difference to minimize financial uncertainty.
- **Carbon market.** Price-based mechanisms to counter risks of excessive prices are now being proposed for the EU's ETS2,[1] in addition to the experience in the United States with cost containment reserves. This experience should be considered in developing rule-based market stability measures for the K-ETS. Furthermore, in relation to plans to include third-party participants in the carbon market, useful learning points could be gained from the recent in-depth assessment by the European Securities and Markets Agency into the functioning of the EU carbon markets, including the assessment methods and corrective actions identified.
- **Scope expansion.** While the K-ETS covers a significantly greater share of total emissions than the EU ETS, this will be addressed in the EU by expanding the scope of the EU ETS to include maritime emissions and introducing ETS2 for buildings and road transport to achieve more reductions from these sectors, targeting fuel suppliers. The coverage of K-ETS would be reduced if there is a phaseout of indirect emissions allocation[2] and hence options to expand the scope should be considered. These can include upstream fuel suppliers (for transport and building sectors) and international maritime emissions.

Compliance with EU CBAM

- **Minimizing the CBAM charge.** The above actions to reduce free allocation and tighten the cap of the K-ETS will help reduce the CBAM charge for Korean exporters of relevant goods.
- **Supporting smooth implementation.** Korea should continue engagement with the European Commission on implementation of CBAM especially during the transitional phase to help ensure its design is fit for its purpose and addresses the needs and concerns of Korean companies exporting CBAM-covered goods. This could include a bilateral agreement with the EU, for example, on how the K-ETS carbon price is recognized and applied, cooperating on potential CBAM training workshops, and continuous engagement to address key questions.

Renewable and clean energy

- **Targets of renewable energy deployment.** A key constraint for industry in the transition to net zero is having access to sufficient quantities of renewable and clean energy. Huge increases in electricity consumption will be required to implement decarbonization technologies. This will require sufficiently ambitious targets for deployment of

[1] ETS2 will be a separate new ETS in the EU to include emissions from buildings, road transport and additional sectors not covered in the current EU ETS.

[2] Indirect emissions allocation would no longer be necessary once carbon costs are fully passed through to electricity prices.

renewables and clean energy. Korea should review its targets, also in light of recent research, for example by Lawrence Berkeley National Laboratory,[3] on how Korea can dramatically expand renewable energy capacity.

- **Permitting reform.** A common problem in the EU and the United States is the slow process of permitting some clean energy projects, with permitting reform being a priority in these jurisdictions. By considering the latest experience in the EU and the United States in addressing this issue, Korea can learn valuable lessons. Reforms should also consider technology-specific issues, such as ways to address this for offshore wind.
- **Infrastructure support.** A key role of government is to bring together the right partners to develop cost-effective infrastructure, for example, pipelines for hydrogen and CO_2 and grids to get power from windfarms. Significant learning opportunities for Korea are available from tracking the latest experiences and solutions in the EU and the United States in these areas.
- **Technology cooperation.** Korea and the United States have multiple memorandums of understanding (MoUs) in place to boost bilateral cooperation covering batteries, hydrogen, nuclear power generation, and carbon neutrality. These provide the scope for more in-depth relationships that should be pursued, including with the Loan Programs Office of U.S. Department of Energy (DOE), especially given the significantly increased funding available from the IRA for investment in new projects in the United States over the next few years. Cooperation on low-carbon technology developments will be valuable, for example, with the relevant technology offices in the U.S. DOE, and in the EU, with organizations such as the European Turbine Network (ETN).

1. INTRODUCTION

With the 2030 climate targets fast approaching, the EU and the United States have made significant strides in climate policy. The EU officially adopted a comprehensive set of legislation under the "Fit for 55" package in April 2023 to help achieve the EU's ambitious target of a 55% reduction in GHG emissions from 1990 levels by 2030. This included a major revision of the EU ETS and the introduction of the EU CBAM. Meanwhile, across the Atlantic, President Joe Biden signed the Inflation Reduction Act in August 2022, clearing the path for the investment of approximately $400 billion in climate and clean energy, the single-largest U.S. investment of its kind, and building on the Bipartisan Infrastructure Law of 2021.

The study tour facilitated meetings between Korea's young leaders in climate and energy policy and 40 leading policymakers and experts in the EU and the United States to learn about these developments and share them with a wider group of stakeholders to help Korea develop its own effective policies and plans to achieve its ambitious 2030 GHG emissions reduction target and 2050 net zero target in a cost-effective way.

The study tour took place over five days in July 2023 in Brussels and Washington, D.C.; the tour participants met with leading EU and U.S. climate and energy policy, technology, sectoral, and other experts, including staff from the following organizations:

- **POLICYMAKERS:** European Commission DG Climate Action (CLIMA), DG Taxation and Customs Union (TAXUD), DG Regional and Urban Policy (REGIO), White House Council on Environmental Quality, U.S. Senate (Senator Bill Cassidy's Office and Senator Sheldon Whitehouse's Office), U.S. Department of State (Office of the U.S. Special Presidential Envoy for Climate), and U.S. Environmental Protection Agency.
- **SECTORAL ORGANIZATIONS AND CORPORATIONS:** Belgian Offshore Platform (BOP), a petrochemicals company, European Steel Association (EUROFER), American Iron & Steel Institute, Business Council for Sustainable Energy, and Clean Energy Business Network.

[3] https://eta-publications.lbl.gov/sites/default/files/a_clean_energy_korea_by_2035.pdf

- **TECHNOLOGY:** ETN Global, and U.S. Department of Energy (Loan Programs Office, Hydrogen and Fuel Cell Technologies Office, and Office of Nuclear Energy).
- **ADVISORS ON POLICY:** European Roundtable on Climate Change and Sustainable Transition (ERCST), SQ Consult B.V., Center for American Progress, Center for Climate and Energy Solutions (C2ES), Resources for the Future, World Resources Institute (WRI), Niskanen Center, Climate Leadership Council, and E3G.

The learnings were shared to a broader group of Korean stakeholders in an online workshop in August 2023.

Participants represented leading climate and energy policy organizations in Korea, including the Ministry of Environment (MoE), Presidential Commission on Carbon Neutrality and Green Growth, Korea Energy Economics Institute (KEEI), Korea Chamber of Commerce and Industry (KCCI), Global Green Growth Institute (GGGI), and Ecoeye Co., Ltd.

This following is a summary of the learning points from the study tour.

2. EU VISIT

Policies

EU ETS

The EU ETS is the EU's core instrument to reduce GHG emissions in the industry, power, and intra-EU aviation sectors. So far, this policy has achieved a 35% reduction in GHG emissions from 2005 levels and covers 40% of EU-wide emissions. A major revision of the EU ETS entered into force in 2023, as part of a package of measures to achieve the EU's legally binding target of at least a 55% reduction in economy-wide GHG emissions by 2030 compared to 1990 levels ("Fit for 55" Package). Key details follow.

Cap setting. The cap has been updated in line with the EU's overall 55% reduction target, based on equivalent cost-effectiveness of emissions abatement options between ETS and non-ETS sectors, resulting in a 62% reduction in ETS sector emissions (compared to 2005) and 40% reduction in non-ETS sector emissions (also compared to 2005). Modeling plays a pivotal role in determining the ETS cap. The greater reduction for ETS sectors occurs because abatement is less expensive in these sectors. The economic and environmental impact assessment of 2030 GHG emissions reduction targets[4] is undertaken with a suite of interlinked economic, energy, and land-use models.[5] The revised reduction target represents a substantial tightening in the EU ETS cap, which previously required a 43% reduction by 2030, and represents an approximate halving in the cap from 2021 to 2030. This will be achieved by increasing the linear reduction factor (LRF) from 2.2% per year to 4.3% (2024–2027) and 4.4% (2028–2030), in conjunction with "rebasing," involving cuts of 90 million allowances in 2024 and 27 million in 2026, which helps avoid an excessive LRF.

Allocation. There is a consistent push to reduce the level of free allocation to industry. While the share of free allocation remains at 43% of total allocation, with 57% being auctioned, this is a percentage of a smaller overall cap; therefore, the absolute amount is smaller. A buffer of 3% (within the auctioning amount) is also available for use as free allocation if the initial allocation calculated using the benchmarks exceeds the amount available under the cap, to help avoid the need for the cross-sectoral correction factor (CSCF).[6] Benchmarks have been updated to reflect technological progress based on data from 2016–2017[7] (previously 2007–2008 data) with the next update to be based on 2021–2022 data; the maximum annual reduction rate of benchmarks has increased to 2.5% (previously 1.6%), with the minimum rate increasing to 0.3% (previously 0.2%). One hundred percent free allocation for sectors at risk of carbon leakage is now conditional on implementation of energy efficiency measures and, for the worst

[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0176 (Documents 1 and 2)

[5] Including GEM-E3 (economic structure), PRIMES (energy system), TREMOVE (transport system), GLOBIOM (forestry and land-use), CAPRI (agriculture), and GAINSs (non-CO2 emissions). Further details available at https://climate.ec.europa.eu/eu-action/climate-strategies-targets/economic-analysis/modelling-tools-eu-analysis_en

[6] The CSCF has been unpopular with industry.

[7] Under an absolute cap (as for the EU ETS and the K-ETS), the role of the benchmark is to apportion the allowances within the overall cap and does not ultimately control the level of emissions. As such, it is not essential for the benchmark to be updated very frequently.

20% performers, carbon neutrality plans; otherwise, free allocation is reduced by 20%. For CBAM sectors (iron and steel, cement, fertilizers, aluminum, and hydrogen), free allocation will be phased out gradually from 2026 to 2034 as CBAM (and auctioning) is phased in – with the auctioning of free allowances that would have been allocated and with the revenue going to the Innovation Fund (see EU ETS related funds below). Free allocation will also be phased out for the aviation sector beginning in 2026.

Indirect cost compensation. The risk of carbon leakage for electricity-intensive sectors can continue to be mitigated through financial compensation by Member States, subject to approval by the European Commission.

Scope expansion. The coverage of the EU ETS will expand beginning in 2024 to include maritime transport (all intra-EU emissions and half of extra-EU emissions), with no free allocation (100% auctioning). Including the maritime sector eases the impact of the tightening cap due to relatively cost-effective abatement measures in this sector.

Market stability reserve (MSR). The increased annual intake rate of allowances has been prolonged to more rapidly reduce the surplus of allowances.

Market oversight and volatility. Recent high carbon prices have led to accusations of major deficiencies in the functioning of the EU carbon market. An in-depth assessment was undertaken by the European Securities and Markets Agency (ESMA), and no evidence of major deficiencies was found. No limitation remains on participation in the market, and no position limits remain, although some changes have been made to improve transparency.

ETS2. A separate new ETS will be introduced beginning in 2027 for buildings, road transport, and combustion fuels used by non-ETS industries, as emissions reductions from these sectors in the EU have not been significant. Furthermore, while electricity consumers pay a carbon price, fuel consumers do not currently do so in the same way. This will increase the coverage of ETSs to about 75% of EU emissions. ETS2 will be an "upstream" system targeting fuel suppliers. The emissions cap is set in line with a cost-effective contribution of 42% reduction by 2030 compared to 2005 levels. Free allocation will be eliminated, with auctioning revenues used to finance the Social Climate Fund (see next section). An MSR will provide volume-based controls, similar to the EU ETS, as well as a price-based mechanism to counter risks of excessive prices and fluctuations.

EU ETS related funds

- **Auction revenue recycling.** A substantial amount of EU ETS auction revenue (EUR 140 billion up to 2022) is raised and distributed to Member States in line with their level of auction purchases. The EU ETS revision now requires that Member States use 100% of their revenues on climate, energy, and related social purposes, compared to previously when this target was only aspirational and actual levels were approximately 80%. EU ETS sectors have not historically been the main focus for the use of revenue.
- **Innovation Fund.** This fund supports investment in innovative low-carbon technologies in ETS sectors (with special attention to CBAM sectors), through the sale of 530 million EU ETS allowances, worth approximately EUR 40 billion[8] from 2021 to 2030. Competitive bidding has been introduced, as well as carbon contracts for difference. As much as 40% of the payment can be made up front before construction, without depending on verified emissions avoidance, with the balance depending on verified emissions avoidance.[9] Funds can be used to support operating as well as capital costs.
- **Modernization Fund.** This fund supports lower-income Member States in modernizing their energy systems, through the sale of EU ETS allowances equivalent to 2.5% of total allowances from 2021 to

[8] With a EUR 75 carbon price.

[9] Examples of projects funded include 1.2Mt/y direct reduction steel plant based on renewable hydrogen (HYBRIT project); 500MW electrolyzer (HYBRIT) and 50MW electrolyzer (SHARC); CO_2 capture in cement (K6); steam methane reforming, ammonia and ethylene oxide production (Kairos@C); preparation for carbon capture and utilization (CCU) for refineries (SHARC); first-of-a-kind ship for CO_2 transport (Kairos@C); and four projects supplying CO_2 for geological storage in various locations in the North Sea (Kairos@C, BECCS@STHLM, SHARC, K6).

2030.

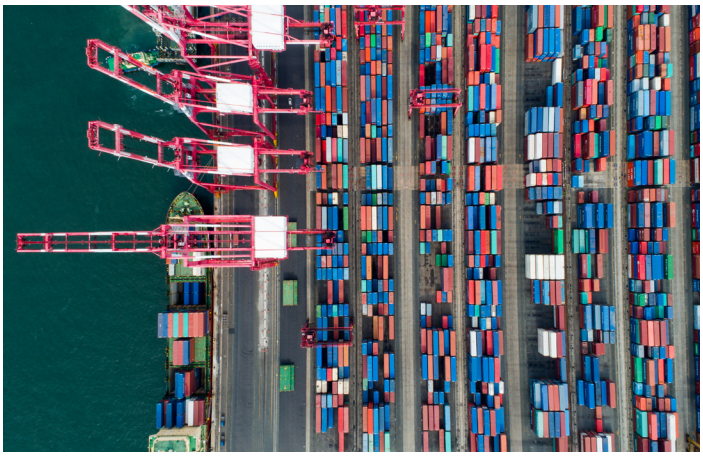
- **Social Climate Fund.** This fund is part of ETS2 and will mobilize EUR 65 billion over 2026–2032 from auctioning of EU ETS and ETS2 allowances, plus 25% national contributions from Member States. The fund will support vulnerable households, transport users, and micro-enterprises concerning the impact of ETS2; investments in energy efficiency and renovation of buildings; and zero- and low-emission mobility and transport; it will also provide temporary direct income support. Paying more attention to vulnerable stakeholders is seen as critical to maintaining public acceptance of climate policy.
- **Other.** The sale of 20 million EU ETS allowances will go to incentivize the use of sustainable aviation fuels. EUR 20 billion from EU ETS will be used to support investment in renewable energy under the REPowerEU policy.[10]

Future developments. A new EU economy-wide 2040 GHG emissions reduction target[11] and the contribution of the EU ETS to meeting this target will be central elements for consideration in the next revision of the EU ETS. Public consultation on the target has been undertaken, with an impact assessment and communication to be published in first half of 2024.

Cooperation with Korea. The potential for EU-Korea cooperation on an ETS is included in the EU-Korea Green Partnership Action project that is expected to start in late 2023 involving European Commission DG CLIMA and operating for four years.

EU CBAM

The EU Carbon Border Adjustment Mechanism (CBAM) has been introduced as an environmental measure to address the increased risk of carbon leakage as the EU raises its climate ambition and differences in levels of ambition worldwide persist. It is an integral part of the EU's Fit for 55 Package, along with the Revised EU ETS (see above) and several other policies, to achieve at least a 55% reduction in GHG emissions by 2030 from 1990 levels. It is the import arm of the EU ETS, mirroring EU carbon pricing for imports into the EU and focusing on the most carbon-intensive sectors. It is designed to comply with the World Trade Organization's policies and be fully in line with international trade rules.



Shipping containers sit stacked among gantry cranes in a port in South Korea (SeongJoon Cho/Getty Images)

Key resources related to the EU CBAM are available on the European Commission CBAM website,[12] which will be regularly updated. These include:

- Legislative documents, including the CBAM Regulation and CBAM Implementing Regulation for the transitional phase (including Annexes).
- Guidance documents and template.
- Details of webinars.

CBAM charge. EU businesses pay a carbon price on their production in the EU; under the EU CBAM, importers will need to pay a carbon adjustment, corresponding to the price they would have paid if the goods had been produced under the EU ETS. The CBAM charge will be adjusted to reflect the level of free allocation under the EU ETS; if a non-EU producer can show that they have already paid a carbon price to

[10] REPowerEU is the EU's plan, launched in May 2022, to help the EU save energy, produce clean energy and diversify its energy supplies in response to the hardships and disruptions caused by Russia's invasion of Ukraine.

[11] Potential targets ranging from 70% to 95% have been suggested.

[12] https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

produce the imported goods in a third country, that amount can be deducted. To reduce the amount of the CBAM charge, the K-ETS carbon price should be increased (through tighter cap setting), and the amount of free allocation should be decreased.

Scope. The CBAM will initially cover basic materials including cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen. In a second stage, the scope can expand to additional sectors, potentially chemicals and polymers. The CBAM does not currently address exports from the EU, which is a significant concern to some EU stakeholders – a review of carbon leakage risk related to exports will be undertaken to assess this.

Calculation of carbon content of covered goods. The methodology replicates as much as possible the EU ETS methodology, although the EU ETS applies to installations while the CBAM applies to goods – which was the biggest challenge in developing the methodology. One difference with the EU ETS is the lack of a tier system for required accuracy levels; instead, there are two definitions: "minimum requirements" and "recommended improvements" (best practice, equivalent to the highest tier in EU ETS). When actual emissions cannot be adequately determined, embedded emissions can be determined by reference to default values that will be developed by the European Commission. Emissions can be verified by verifiers based in Korea, although they would need to be accredited by an EU Member State accreditation body. Key support materials will be published to facilitate calculations, including guidance documents and a template spreadsheet, which are recommended to be used.

Transitional phase (October 2023 to December 2025). The phase-in will be gradual to allow businesses to adjust. In this phase, only monitoring and reporting obligations will apply for direct and indirect emissions for all CBAM goods. A CBAM report will need to be submitted each quarter that includes the quantity of goods imported, total embedded emissions, and the carbon price due for these emissions. Verification is not required in this phase. A review will be undertaken in 2025 to consider potential revisions (e.g., inclusion of goods further down the value chain, coverage of indirect emissions, treatment of exports, and methodology to calculate embedded emissions).

Post-transitional phase (January 2026 onward). This phase is the start of full implementation of the CBAM, with a gradual phaseout of free allocation for covered sectors, reducing free allocation to zero by 2034. A CBAM declaration will need to be submitted each year that includes the quantity of goods imported, total embedded emissions, emissions to be verified, number of CBAM certificates to be surrendered, and the carbon price effectively paid for these emissions. Emissions reporting will exclude indirect emissions for CBAM goods that may receive indirect cost compensation under the EU ETS.[13]

Cooperation with Korea. The European Commission (EC) has a positive view on engagement with Korea and finding common ground regarding the EU CBAM. A bilateral agreement between Korea and the EU is possible to facilitate smooth implementation, for example, of how the K-ETS carbon price is recognized and applied. Training on the EU CBAM by the EC is being planned for late 2023 in different countries, potentially including Korea. The EC desires to better understand the K-ETS in the context of CBAM and requests to remain in collaboration with Korea in addressing key questions.

Beyond the direct impacts of the EU CBAM for Korea, its introduction has greater significance in that it is poised to trigger similar measures by other countries, including the United States, as detailed below.

EU Just Transition Fund

In the context of the European Green Deal, which aims to transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of GHGs by 2050, economic growth is decoupled from resource use, and no person and no place left behind. A key principle is ensuring a just transition for all. The Just Transition Fund (JTF) has been established to address this, in particular the negative socio-economic impacts of the transition to a decarbonized EU, with approximately EUR 20 billion from 2021 to 2027. It does not support the transition itself, which is supported

[13] Indirect emissions would currently only be included for the cement and fertilizer sectors, and not for iron and steel, aluminum, and hydrogen.

by many other funds including Horizon Europe, Important Projects of Common European Interest (IPCEI), and so on. The JTF focuses on regions that are hardest hit by the transition, because they are heavily dependent on the extraction and production of fossil fuels which are expected to face an irreversible decline, or on carbon-intensive industries which will need to undergo transformation, and will face negative socio-economic impacts. The fund supports retraining workers, investment in new factories, and so on. It can also support EU ETS entities' low-carbon investments when they go beyond the requirements of the EU ETS.

Technologies

Offshore wind

Belgium has one of the largest capacities of offshore wind in Europe, ranking third in terms of capacity per million inhabitants,[14] with more than 20 years of development history.[15] Current capacity is 2.3 GW, contributing to 10% of Belgium's total electricity demand. Investment in offshore wind is essential to meet Belgium's renewables targets. By 2030, capacity is expected to increase to 6 GW. By combining wind and solar, a stable level of generation can be provided throughout the year. Belgium benefits from having relatively shallow water[16] and generation sites close to demand.

Thorntonbank Wind Farm, Belgium (Getty Images)

In April 2023, nine European countries including Belgium agreed to boost their combined North Sea offshore wind capacity to 120 GW by 2030 and 300 GW by 2050.

Prerequisites for development. First, areas are allocated for offshore wind under Belgium's Maritime Spatial Plan, which provides legal certainty on where a development can be built. Second, a process for determining who can develop is established, with a competitive procedure involving auctioning and using instruments such as contracts for difference to mitigate financial risks. Third, grid connection infrastructure is needed given that many coastal areas lack sufficient grids – this can significantly influence the timeline of new developments due to lengthy permitting procedures.

Supply chain. A significant challenge is lack of sufficient manufacturing capacity for turbines, foundations, vessels, and so on.

Stakeholder support. Extensive stakeholder engagement has been a key feature of the Belgian government's approach. Windfarm developers are required to pay for surveys to monitor the impacts on the marine environment, with slightly positive impacts observed. Furthermore, windfarms are located outside areas where the fishing industry is active.

Energy storage and flexibility. There is a rising number of hours when a good match between demand and supply does not occur. To make full use of the electricity generated, solutions include generation of green hydrogen,[17] utility-scale battery projects, and grid interconnections, as well as making production process demand more flexible.

Macroeconomic benefits. The estimated impact of achieving 6 GW of offshore wind by 2030 in Belgium is an increase in GDP of EUR 1.5 billion, with approximately 24,000 jobs

[14] Denmark, the United Kingdom, Belgium, Netherlands, and Germany are the top five.

[15] A legal framework to de-risk investments in terms of planning permission and financial returns was established in 2001–2002, providing legal certainty and enabling banks to lend money.

[16] Enabling fixed rather than floating turbines to be used, which are cheaper.

[17] This can be supported by the new European Hydrogen Bank.

created and 8 to 22 million tonnes CO_2e per year avoided.

Hydrogen-fueled gas turbines

A technology that can play a key role in decarbonization of Korea's power sector includes gas turbines operating on alternative low-carbon/carbon-free fuels. The European Turbine Network (ETN) is an organization that facilitates the development of this technology, with a vision of safe, secure, affordable, and dispatchable carbon-neutral energy solutions by 2030, implemented globally by 2050.

ETN is a nonprofit association that focuses on the transition of gas turbine technology to carbon-neutral energy solutions; global cooperation among the stakeholders of the turbomachinery industry and its associated equipment providers and users; acceleration of research, development, and demonstration of solutions; and influencing relevant policy and regulatory frameworks. A total of 125 organizations are members, from 22 countries across Europe, Asia, and North America.

Technology pathways include increased fuel flexibility in gas turbines to allow a fast shift to low-carbon/carbon-free fuels and mixes (hydrogen, biogas, ammonia), supercritical CO_2 cycles, combined cycle gas turbine (CCGT) and carbon capture and storage (CCS), energy efficiency, and decentralized energy systems. Solutions are created through several working groups that bring together a broad range of expertise.

Cooperation with Korea. Opportunities for Korean stakeholders to cooperate with ETN in the development and application of gas turbines operating on low-carbon/carbon-free fuels include participation in the annual High-Level User Meeting and the International Gas Turbine Conference, both to be held in October 2023.

Company strategies

Iron and Steel Sector

The iron and steel sector is the largest GHG-emitting industrial sector in Korea, with substantial investments required to meet climate targets. The EU's iron and steel sector has 500 installations covered by the EU ETS that are exposed to high carbon prices, reduced levels of free allocation, and a transition to auctioning under the EU's CBAM. Insights into this sector's responses to more ambitious climate policy can be especially informative for Korea.

Transition pathways. The trend toward decarbonization in the EU iron and steel sector accelerated from 2018 in line with increasing carbon prices, with the two pathways being carbon capture, utilization and storage (CCUS) with the existing fossil base and hydrogen steelmaking replacing fossil fuels with alternative energy. The first part of the investment wave involved testing and identifying technical solutions. Now the focus is on scaling up to an industrial level—the most complex part, requiring capital and an exponential increase in electricity consumption. Companies are determined to advance their projects by launching most at a commercial/industrial scale by 2026–2028, and others by 2030. Of the announced projects, capital requirements are EUR 30 billion, with operating costs of EUR 50 billion. The success of projects depends on the cost of energy with a transition from global commodity prices of fossil energy to more variable local/regional prices of renewable energy.

Challenges. Energy supply is the biggest issue, and lengthy procedures for permitting renewable energy projects are a key challenge. An acceleration in these procedures is needed. Availability of hydrogen is another key challenge. The steel industry suggests that use of hydrogen should be prioritized where the abatement potential is greatest and should focus on 25 primary steel sites in the EU.

Impact of high carbon prices. Carbon prices of EUR 90/tonne are significant for companies, although the high prices have coincided with abnormal market conditions including the COVID crisis, the COVID recovery, and the energy war. The impact of high carbon prices on the resilience of the manufacturing sector under normal economic conditions has not yet been tested. Some ability to pass through carbon costs to product prices can be assumed given the interest of some customers in low-carbon steel to help meet environmental, social and governance (ESG) targets, for example, in the car sector.

Funding support. The EU Innovation Fund has supported investments at one steel company in Sweden, while other companies have sought other funding sources, for example, Important Projects of Common European Interest (IPCEI),

which supports the EU's Industrial Strategy. The huge competition under the Innovation Fund, as the funding is spread widely across countries and sectors, means that it plays only a limited role in meeting the needs of the sector.

Petrochemical plant in Korea – the petrochemical sector is Korea's second-largest industrial GHG-emitting sector (Alamy Stock Photo)

Petrochemical company

The petrochemical sector is the second-largest GHG-emitting industrial sector in Korea and is an especially complex and challenging sector for achieving emissions reductions. The tour made a visit to a major petrochemical site to learn about its ambitious plans for approaching net zero, the associated technologies to achieve this, and supporting policies. Motivated by social responsibility, high EU carbon prices, and the anticipation of a future market for low-carbon chemical products, the company is determined to be a pioneer in achieving net zero, with a clear roadmap and notable progress.

Transition pathway. Key phases in the petrochemical site's transition toward net zero emissions include the following:

- **Historical reductions.** Major steps were taken in the past to reduce GHG emissions including energy integration, which almost balances energy producing and consuming processes and hence minimizes the need for additional energy inputs, the introduction of N_2O catalysts on four nitric acid plants, and an on-site CCU application.
- **A 50% reduction in GHG emissions below current levels by 2030.** The site's electricity will come from 100% renewable sources through investment in a major offshore windfarm and various long-term power purchase agreements with onshore windfarms. Also, a CCS project will capture concentrated CO_2 from an ethylene oxide plant and ammonia plants; dry, purify, and compress it; transport it by gathering pipeline; and then ship/pipe to empty oil and gas fields for storage.
- **A 95% reduction below current emissions by 2035.** E-furnace technology is being considered for the steam cracker, switching from natural gas to electrical heating using renewable energy, with a pilot plant planned by the company for this year. CCS, either post- or pre-combustion, is also being investigated as an option.
- **A 100% reduction.** Removing the remaining "hard to abate" emissions will require innovation and new ideas, for example, involving producing steam with electrical power; reducing steam consumption; and using e-boilers, heat pumps, and e-drives.

Challenges. A key challenge is having enough renewable energy. The company's transition to green power and electrification will increase electricity consumption by a factor of 3 to 4. Sufficient grids and deployment of renewables will be crucial.

Funding support. Given the current lack of customer willingness to pay for low-carbon chemical products, it is important for extra funds to be provided for first-of-a-kind projects. There was a negative business case for the CCS project, although money from the Innovation Fund helped compensate by supporting 60% of capital and operating costs and providing some upfront payments.

Other supporting policies. It is also important for governments to give companies freedom to operate and avoid overregulation, make targets science based – ambitious but SMART[18] – with renewables targets especially important given the critical need for renewable energy, and bring

[18] Specific, measurable, achievable, relevant and time-bound

together the right parties to develop cost-effective infrastructure (e.g., pipelines for hydrogen and CO_2 and grids to get power from windfarms).

3. U.S. VISIT

Policies

Inflation Reduction Act

Solar panels in Dangjin-si (Shutterstock)

The Inflation Reduction Act (IRA) is the centerpiece of the Biden administration's climate action plan and became law in 2022. It is the single-largest U.S. investment on climate, with approximately $400 billion for climate and clean energy investment. Investments are split into approximately two-thirds for tax credits and one-third for direct expenditure, including grants and loans. Predominant allocations are to clean electricity, transmission, and clean transportation, including incentives for electric vehicles (EVs). The White House Guidebook provides detailed information on IRA investments.[19]

With the IRA, clean energy transition is now considered to be hard wired into the U.S. economy, with investments able to withstand political changes. The IRA is bringing manufacturing into states, which is a loud signal to politicians.

Tax credits. Two-thirds of IRA investments are for tax credits, amounting to approximately $271 billion. Tax credits include $161 billion for clean energy, $37 billion for individual clean energy incentives, $37 billion for clean manufacturing, and $36 billion for clean fuel and vehicles. These credits are structured to stimulate private investments in clean energy, transportation, and manufacturing.

Demonstration projects. The Department of Energy Office of Clean Energy Demonstrations (OCED), established by the IRA, manages more than $25 billion in funding to deliver clean energy demonstration projects at scale in partnership with the private sector to accelerate deployment, market adoption, and the equitable transition to a decarbonized energy system. This includes regional clean hydrogen hubs, CCUS, industrial demonstrations, advanced reactor demonstrations, and long-duration energy storage demonstrations.

First commercial deployment and commercial scale-up. The Department of Energy Loan Programs Office (LPO) works with the private sector to finance the deployment and scale-up of innovative clean energy technologies that have not been financed in the market. The IRA has increased the loan authority of the LPO from $40 billion to $225 billion, although with a short time window up to 2028 to deploy the IRA funds. Loans are typically between $100 and $500 million, although they can be much higher. Financing programs include the following:

- Clean energy including innovative energy (e.g., $12 billion for the first AP1000 advanced nuclear reactor in the United States and support for offshore wind, as this technology is not yet widely applied in the United States), innovative supply chains, and energy infrastructure reinvestment (supports retirement of fossil fuel power plants and reuse of sites for clean energy e.g., small solar modular nuclear reactors).
- Advanced transportation including manufacturing of advanced technology vehicles, components (e.g., $9.2 billion for a Ford-SK battery plant), and EV charging infrastructure.
- CO_2 transportation infrastructure, including large-capacity, common carrier CO_2 transportation projects.

[19] https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf

Greenhouse Gas Reduction Fund (GGRF). This fund of $27 billion, implemented by the U.S. Environmental Protection Agency, aims to reduce emissions of GHGs and other air pollutants, deliver benefits to low-income and disadvantaged communities, and mobilize finance and private capital to stimulate additional deployment. Three grant competitions will be held for the National Clean Investment Fund (for tens of thousands of clean technology projects), Clean Communities Investment Accelerator (so every community has access to capital to deploy clean technology), and Solar for All. Unlike the LPO, this fund focuses on commercially viable technologies.

Implementation. The White House has established a dedicated team to oversee coordination among programs from the IRA and the Bipartisan Infrastructure Law. This cross-agency collaboration engages relevant departments, ensuring program alignment and addressing key questions. The intention is for the various programs to work together, with layering of funds encouraged to facilitate multiple sources of finance and achieve optimal impact. Implementation is generally constrained by a tight timeline; for example, the LPO hopes to close IRA-related loans by 2026–2028, and the GGRF funds are expected to be committed by September 2024.

Challenges. A fundamental challenge is whether the investments can be made at the pace that is necessary – permitting reform (e.g., time limits on decisions, one federal agency covering permitting[20]) is needed because the permitting process in the United States can be very slow, especially for transmission lines. This can be a huge bottleneck for the IRA. The success of the IRA will also depend on implementation of the tax credit system, with some concerns about the capacity of the Internal Revenue Service to effectively undertake this role.

Impacts on GHG emissions. Compared with the U.S. target to reduce GHG emissions by 50%–52% below 2005 levels by 2030, estimates are that with the IRA emissions reductions of 32%–42% will be achieved (24%–35% without the IRA). As such, a large gap to meet the target still remains. Most emissions reductions will take place in the power sector (70%–80% below 2005 levels by 2030). Emissions reductions are expected to be smaller in the industrial sector (3%–16% below 2005 levels) and transport sector (18%–26% below 2005 levels), with an increase expected in the buildings sector (6%–11% above 2005 levels).

Cooperation with Korea. Korea and the United States have multiple MOUs in place to boost bilateral cooperation covering batteries, hydrogen, nuclear power generation, and carbon neutrality. The MOUs provide scope for more in-depth relationships. The LPO, for example, has had meetings with the Korea Trade Insurance Corporation (K-Sure) and is in contact with large companies in Korea.

Beyond the IRA

Rapid and effective implementation of the IRA including timely tax credit guidance is seen as critical. However, the IRA is not considered sufficient to help the United States meet its 2030 climate goals, and it does not have emissions reductions targets, although it provides the foundation to work from. To narrow the gap, policy priorities include the following:[21]

- EPA-proposed new vehicle emissions standards for model years 2027 through 2032 (requiring 67% of new vehicles sold in 2027 to be zero emissions).
- EPA-proposed new emissions standards for existing coal-fired power plants and existing/new natural gas-fired power plants (requiring CCS, co-firing coal with natural gas, and co-firing natural gas with clean hydrogen).
- New legislation addressing permitting reform to get energy projects approved more quickly.

Carbon pricing

Carbon pricing in the United States remains restricted to state-level programs. Despite the continuing absence of a nationwide carbon pricing policy, the systems in the United States have had an outsized influence. For example, the Regional Greenhouse Gas Initiative (RGGI, covering 11 states) introduced 100% auctioning in 2009, including a price floor, and prompted the introduction of auctioning in the EU ETS;

[20] There is a proposal to give Federal Energy Regulatory Commission (FERC) more power.

[21] https://www.c2es.org/document/reaching-for-2030-climate-and-energy-policy-priorities/

the California Cap-and-Trade program introduced consignment auctioning for retail electricity companies as an alternative to free allocation; and both systems have cost (or allowance price) containment reserves that control high prices by releasing allowances from a reserve when certain trigger prices occur (California also includes a fixed price ceiling), with an emissions containment reserve in RGGI to control low prices.

Washington State Cap-and-Invest Program. This program was launched in 2023, setting a cap on approximately 70% of the state's GHG emissions. The program design closely resembles those of California and Quebec, which are also members of the Western Climate Initiative (WCI). A key feature of this program is investment of 70% of auction revenues to support disadvantaged communities, compared with 25% in California. This program is expected to link to California's after one year of trading.

New York State Cap-and-Invest Program. New York State is already covered by RGGI (power sector only) but is now developing an economy-wide system, with the design prioritizing the following principles: affordability (revenues to citizens), climate leadership to drive a nationwide approach to carbon pricing, job creation through new investment opportunities, prioritizing disadvantaged communities in use of revenues, and funding a sustainable future.

U.S. CBAM

A key challenge the U.S. CBAM proposals are trying to address is how more cleanly produced goods can gain benefits in global trade. Current proposals include the following objectives: economic (domestic manufacturing and jobs), geopolitical (e.g., competition with China), and national security goals.

U.S. CBAM proposals. A common feature of CBAM proposals is consideration of the emissions intensity of producing a product. However, detailed aspects vary; for example, one approach seeks to apply fees depending on how much more carbon intensive the imported product is compared to a U.S. produced product, with no fee for products less than 50% more carbon intensive (decreasing to 25% and 0% after specific time periods), or products from countries with a free trade agreement (FTA)[22] (including Korea). Another approach (the Clean Competition Act) would involve setting annually declining benchmark emissions intensity levels applicable to domestic and imported goods and a CO_2 fee in $/t payable for products when emissions are above the benchmark. Finished goods would also be covered when the amount of a covered primary good within a finished good exceeds a set amount. Methods for calculating embedded carbon have been considered although not yet at the same level of detail as in the EU CBAM.

Key issues. The need for a domestic carbon price for implementing a CBAM is considered essential by some experts, as well as inclusion of both primary and finished goods and compliance with WTO rules. Furthermore, while methodologies for calculating embedded carbon are considered feasible, it may be difficult to achieve a harmonized approach between the United States and the EU due to the EU methodology mirroring the EU ETS, which may not be an optimal approach for other jurisdictions. However, approaches would be expected to converge over time, supported by pressure from industry for consistent guidelines.

Political outlook. There is consensus that a carbon border adjustment is needed, as well as bipartisan support. Only a narrow window of opportunity exists in 2023 to pass such a law within broader policy packages, although it is expected that the United States will consider doing so after the next national election in 2024.

Technologies

CCUS

Carbon capture, utilization, and storage (CCUS) and CO_2 removal (CDR) can contribute 10% to 20% of the required reductions for the United States to achieve net zero. The United States has 50 years of experience with the technology through enhanced oil recovery projects.

Role of CCUS. CCUS is considered to have huge potential in decarbonizing sectors, such as steel, chemicals, cement, and power. The initial applications are expected to begin with processes having a high concentration of CO_2 and low impu-

[22] Adding such a fee is not considered compatible with current FTAs, although such mechanisms could be built into FTAs in the future.

rity levels, such as ethanol plants, and cement calcination processes.

Support from IRA. Support includes enhanced CCUS credits and $180/t for CDR.

Other policy support. The White House Council on Environmental Quality (CEQ) prepared a CCUS Permitting Report in 2021 and issued CCUS guidance in 2022 based on the report and has also established two CCUS permitting task forces. A total of $3.5 billion was allocated under the Bipartisan Infrastructure Law to establish four CDR hubs capable of capturing a million metric tons of CO_2.

Challenges. Key challenges include community engagement and the need to be strategic about CO_2 transport hubs.

Hydrogen

Hydrogen is a key element of a portfolio of solutions to decarbonize the economy.

Role of hydrogen. Key tasks of the U.S. hydrogen development strategy are to identify high-impact and high-demand hydrogen applications (e.g., medium- and heavy-duty vehicles, steel, ammonia, energy storage); bring down the cost of green hydrogen to parity with other fuels (the goal is to achieve $1/kg by 2031[23]) by scaling up existing technologies (an increase in production is planned from 10 million t/year by 2030, rising to 50 million t/year by 2050) and reducing some materials challenges; and development of clean hydrogen hubs.

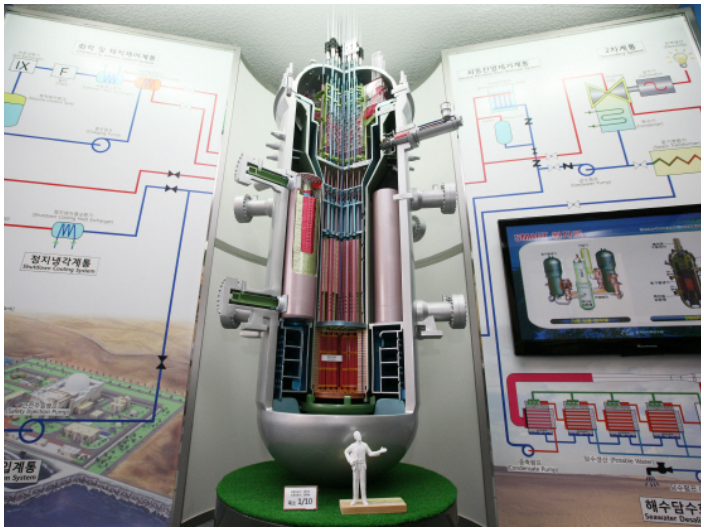
Support from IRA. Support includes clean hydrogen production tax credits (up to $3/kg).

Other policy support. The Bipartisan Infrastructure Law provides $9.5 billion to advance clean hydrogen, encompassing $1 billion for electrolysis, $0.5 billion for manufacturing and recycling, and $8 billion for multiple clean hydrogen hubs across regions.

Challenges. Challenges include timely issuance of tax guidance, permitting, and new pipelines, as well as bringing down electrolyzer costs.

Key information resources. These include the U.S. National Clean Hydrogen Strategy and Roadmap,[24] which explores opportunities for clean hydrogen to contribute to national decarbonization goals across multiple sectors of the economy and presents a strategic framework for achieving large-scale production and use of clean hydrogen. In addition, DOE's Pathways to Commercial Liftoff reports[25] provide details on when various technologies could reach full-scale commercial adoption and critical signposts for investment decisions, covering clean hydrogen, advanced nuclear, and long-duration energy storage.

Nuclear



Small modular nuclear reactor (Korea Atomic Energy Research Institute)

Nuclear energy remains an important source of clean energy in the United States, contributing 18% of total U.S. electricity and nearly half of emissions-free power. The Biden administration maintains the U.S. commitment to advancing nuclear energy as a solution to the climate crisis at home and abroad.

Role of nuclear reactors. The deployment of advanced nuclear reactors, including small modular reactors (e.g., the NuScale Power Demonstration Project), can play a significant role in decarbonization with a broad range of applica-

[23] For trucks, $3–$4/kg can be competitive with alternative fuels (gasoline).

[24] https://www.hydrogen.energy.gov/clean-hydrogen-strategy-roadmap.html

[25] https://liftoff.energy.gov/

tions, including petroleum refineries, chemicals (e.g., Xe-100 high-temperature gas reactor technology at Dow), district heating, and others. Nuclear reactors also provide an important route to generating hydrogen – nuclear can be economically competitive if using older plants where capital has been paid off. Since Fukushima, passive safety has been incorporated into the technology to address concerns.

Support from IRA. The IRA provides production and investment tax credits for nuclear power.

Other policy support. The Bipartisan Infrastructure Law provides $2.5 billion for advanced reactor demonstrations, $6 billion for civil nuclear credits, and $8 billion for regional hydrogen hubs, with at least one hub based on nuclear power.

Cooperation with Korea. The U.S. DOE is ready to work with countries such as Korea on deployment of advanced nuclear technologies with various initiatives, including the International Nuclear Energy Cooperation (INEC) program and Nuclear Innovation Clean Energy Future (NICE Future).

Company strategies

Iron and steel

Integrated steelworks in Korea - the steel sector is Korea's largest industrial GHG-emitting sector (Aflo Co. Ltd. /Alamy Stock Photo)

The United States has experienced a big shift toward the less carbon intensive electric arc furnace route (approximately 70% of total production), compared to the blast furnace/basic oxygen furnace route (approximately 30% of total production), although the latter is necessary for the pure grades of steel required in the car-manufacturing sector.

Transition pathway. The decarbonization pathways are similar to those of the EU, although nuclear energy is additionally noted as having a key role in the U.S. steel industry. A direct reduced iron (DRI) plant using hydrogen has recently been tested in Ohio.

Support from IRA. Provisions of interest to the steel industry include renewable energy production and investment tax credits, credits for using domestic iron/steel content, new nuclear power production credits, new clean hydrogen production credits, enhanced CCUS credits, and expanded advanced manufacturing credits. The previously mentioned funds of the Office of Clean Energy Demonstrations are also of interest.

Other policies driving decarbonization. The Federal Buy Clean Initiative covers steel and requires the federal government to buy low–carbon intensive products. Similar to the experience in the EU, car companies are also demanding low-CO_2 intensity steel to meet their own targets.

Key information resources. These include the DOE's "Industrial Decarbonization Roadmap,"[26] which identifies key pathways to reduce industrial emissions through innovation in U.S. manufacturing and presents an agenda for government, industry, and other stakeholders to work together to accelerate emissions reductions.

Other cooperation opportunities

Korea is an important partner of the United States; it is a leading global economy at the forefront of technology. From the perspective of the United States, the key is to deliver on NDC commitments – hence, meet domestic obligations.

Climate cooperation encompasses many areas, including green shipping, climate financing, battery technology, zero emission vehicles, offshore wind (e.g., floating turbines), and hydrogen.

Bringing forward the coal phaseout date in Korea was identified as a key issue, and a recent report by the Lawrence

[26] https://www.energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf

Berkeley National Laboratory on how Korea can dramatically expand renewable energy capacity was highlighted.[27]

4. CONCLUSIONS

The study tour provided a valuable opportunity for participants to gain insights into significant recent developments in climate policy in the EU and the United States that are relevant to Korea from a large number of policymakers and influential experts; it also identified cooperation opportunities for Korea. The meetings provided a unique opportunity to develop connections and networks and build cooperative relationships with counterpart organizations.

Specific learning points that can support the development of Korea's climate policy are summarized below.

Korean Emissions Trading System (K-ETS). The K-ETS is a critical policy for achieving the 2030 NDC, covering more than 70% of Korea's GHG emissions. The K-ETS can be strengthened by applying learnings from the following experiences:

- *Cap setting*. The EU has successfully applied the same method as in Phase 3 to determine the ambitious revised Phase 4 EU ETS cap, based on cost-effective sharing of the overall EU emission reduction burden between ETS and non-ETS sectors. Under the K-ETS a clear and practical method for setting the cap has been applied so far, based on Korea's national emission targets multiplied by the historic share of emissions from ETS entities compared to total national emissions. However, given the differences in reductions between ETS and non-ETS entity emissions over time, there may be a need to re-assess the method of sharing the emission reduction burden, whilst still maintaining the direct link between the cap and the national target, in which case the approaches in other jurisdictions including the EU can be reviewed in developing the approach for Phase 4 of the K-ETS (2026-2030). Detailed information on the EU approach can be found in the Fit-for-55 Impact Assessment and supporting modelling tools.[28, 29] Furthermore, the EU is already considering the potential GHG reduction targets for 2040, including the EU ETS cap, and Korea should also be starting to undertake impact assessments of reduction targets for ETS and non-ETS sectors for this milestone year.
- *Free allocation*. The EU's push to reduce the level of free allocation should be followed in Korea, especially due to current low K-ETS carbon prices, indicating an excess supply of allowances. Furthermore, some industrial sectors such as steel may be able to pass through some carbon costs as customers are demanding low-carbon products, risking "windfall" profits if there is too much free allocation. Korea can consider the experience of the EU and California in setting more ambitious benchmark levels (average of top 10% best-performing installations, and 90% of average performance or best-in-class, respectively) in developing its own approach and should consider making 100% free allocation conditional on adequate energy efficiency measures and, for worst performers, carbon neutrality plans, as in the EU.
- *Auctioning*. The substantial amount of auction revenue available under the EU ETS is due to full auctioning for the power sector and a high carbon price (due to an ambitious cap). Korea should also consider full auctioning for its power sector, combined with full pass-through of carbon costs to retail electricity prices. Furthermore, Korea should consider full auctioning for the domestic aviation sector and any other sectors where carbon costs can be passed through to product prices.
- *Auction revenue recycling*. The above actions to increase the auction share will significantly increase the size of Korea's Climate Response Fund for auction revenue. The targeting and design of this fund should be reviewed considering the latest EU and U.S. experience with similar funds, and Korea's priorities for supporting the transition to net zero, including

[27] https://eta-publications.lbl.gov/sites/default/files/a_clean_energy_korea_by_2035.pdf

[28] Fit-for-55 Impact Assessment: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0176 (Documents 1 and 2)

[29] Details of modelling tools for Fit-for-55 Impact Assessment: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/economic-analysis/modelling-tools-eu-analysis_en

helping K-ETS entities reduce their emissions, in view of much higher expected carbon prices in Phase 4. There are opportunities to improve targeting of finance toward ETS entities in comparison to the EU experience, while also considering support to mitigate impacts of higher energy prices for vulnerable stakeholders and support for just transition. Korea can also learn from successful design features of the EU and U.S. funds, including upfront payments, support for both capital and operating costs, and use of carbon contracts for difference to minimize financial uncertainty.

- *Carbon market.* Price-based mechanisms to counter risks of excessive prices are being proposed for the EU's ETS2, in addition to the experience in the United States with cost (or allowance price) containment reserves. This experience should be considered in developing rule-based market stability measures for the K-ETS. Furthermore, in relation to plans to introduce third-party participants into the K-ETS, useful learning points could be gained from the recent in-depth assessment by the European Securities and Markets Agency into the functioning of EU carbon markets, including the assessment methods and corrective actions identified.
- *Scope expansion.* While the K-ETS covers a significantly greater share of total emissions than the EU ETS, this will be addressed in the EU by expanding the scope of the EU ETS to include maritime emissions and introducing ETS2 for buildings and road transport to achieve more reductions from these sectors, targeting fuel suppliers. The coverage of K-ETS would be reduced if there is a phaseout of indirect emissions allocation[30] and hence options to expand the scope should be considered. These can include upstream fuel suppliers (for transport and building sectors) and international maritime emissions (e.g., half of extra-Korea emissions).

Compliance with EU CBAM. The required response to the EU CBAM is to both minimize the amount of the CBAM charge and ensure smooth implementation:

- *Minimizing the CBAM charge.* The above actions to reduce free allocation and tighten the cap of the K-ETS will help reduce the CBAM charge for Korean exporters of relevant goods.
- *Supporting smooth implementation.* Korea should continue engagement with the European Commission on implementation of the CBAM, especially during the transitional phase to help ensure its design is fit for the purpose and addresses the needs and concerns of Korean companies exporting CBAM-covered goods. This could include a bilateral agreement with the EU, for example, on how the K-ETS carbon price is recognized and applied, cooperating on potential CBAM training workshops in Korea in late 2023, and continuous engagement to address key questions.

Renewable and clean energy

- *Targets of renewable energy deployment.* A key constraint for industry in the transition to net zero is having access to sufficient quantities of renewable and clean energy. Huge increases in electricity consumption will be required to implement decarbonization technologies. This will require sufficiently ambitious targets for deployment of renewables and clean energy. Korea should review its targets, also in light of recent reports, such as that by the Lawrence Berkeley National Laboratory on how Korea can dramatically expand renewable energy capacity.
- *Permitting reform.* A common problem in the EU and the United States is the slow process for permitting some clean energy projects, with permitting reform being a priority in these jurisdictions. This was also one of the focus areas of the EU's REPowerEU policy, which increased the 2030 renewables target from 40% to 45%. By considering the latest experience in the EU and the United States in addressing this issue, Korea can learn valuable lessons.
- *Infrastructure support.* A key role of government is to bring together the right partners to develop

[30] Indirect emissions allocation would no longer be necessary once carbon costs are fully passed through to electricity prices.

cost-effective infrastructure, for example, pipelines for hydrogen and CO_2, and grids to get power from windfarms. Korea can experience significant learning opportunities by tracking the latest experiences and solutions in the EU and the United States in these areas.

- *Technology cooperation.* Korea and the United States have multiple MOUs in place to boost bilateral cooperation covering batteries, hydrogen, nuclear power generation, and carbon neutrality. The MOUs provide scope for more in-depth relationships that should be pursued, including with the Loan Programs Office of the U.S. DOE, especially given the significantly increased funding available from the IRA for investment in new projects in the United States over the next few years. Cooperation on low-carbon technology developments will be valuable, for example, with the relevant technology offices in the U.S. DOE, and in the EU, with organizations such as ETN.