APEC Workshop on Promoting Decarbonization of Power Sector by Using Carbon-Free Energy (CFE)

APEC Energy Working Group

October 2025

Asia-Pacific
Economic Cooperation

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Executive summary

Introduction

As the urgency of addressing climate change grows, APEC economies are stepping up their efforts to reduce greenhouse gas emissions. According to the IEA's Net Zero by 2050 roadmap, renewable energy is expected to account for up to 70% of global electricity generation by 2050, but this progress alone will not be enough to achieve net-zero emissions. This will require the adoption of a range of carbon-free energy (CFE) technologies, including nuclear, hydrogen/ammonia, carbon capture and storage (CCUS), and energy storage systems (ESS).

The first Global Stocktaking(GST) at COP28 in 2023 emphasized the goal of tripling renewable energy capacity and doubling energy efficiency by 2030, and identified the need to utilize a range of low- and zero-carbon technologies. Building on this international consensus, Korea has recognised the need to actively utilise a variety of clean technologies in addition to renewable energy. To spread this consensus internationally, in September 2024, Korea hosted the APEC CFE Workshop in Busan, Korea, where APEC economies collaborated to explore technical and policy strategies for decarbonizing the power sector.

Key Themes and Insights

- Global trends and technology innovations

The rapid proliferation of clean energy technologies such as solar, wind, carbon capture and storage (CCS) and energy storage systems(ESS) is encouraging. In 2023 alone, nearly USD 2 trillion was invested in clean energy globally. However, the fact that greenhouse gas emissions are at an all-time high suggests that scaling up renewables alone will not be enough, and that a range of CFE technologies will play an important role.

- Developing policies and infrastructure

Strong policy support and improvements to grid infrastructure are essential for grid integration and reliable operation of carbon-free energy. Korea's grid transformation policy and ESS industry development strategy are recognized as best practices for supporting renewable energy targets by building a flexible grid and expanding energy storage capacity. However, local opposition and lack of financing for grid investments remain challenges to overcome.

- International cooperation and standardization

International cooperation and technology standardization are essential for technology expansion and cost reduction. APEC economies are promoting the adoption of a range of carbon-free technologies, including renewable energy, hydrogen and CCS, through strategies tailored to their local conditions, and there is consensus on the need to strengthen regional cooperation through certification schemes and standardization.

- The role of the private sector

The private sector is a key pillar of decarbonization and the expansion of carbon-free energy. Industries are embracing carbon-free energy technologies as a necessity to strengthen their ESG management and remain competitive in global supply chains. However, high costs, supply reliability issues, and lack of institutional support are major barriers to private sector adoption. To address this, institutional improvements such as tax incentives, financial support, and increased investment in technology are needed.

- The challenges and opportunities of disruptive technologies

Innovative technologies such as small modular reactors (SMRs), hydrogen and ESS are being recognized as critical to the future of the energy transition. However, many challenges remain, including achieving affordability, meeting safety standards, and building infrastructure. Continued research and development, international cooperation and policy support are essential to address these challenges, as is building public consensus and increasing technology acceptance.

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1. Introduction

As the global climate change challenge continues to accelerate, there is a growing call for stronger and more diverse commitments to contribute to global greenhouse gas reductions. The International Energy Agency's (IEA) 'Net Zero by 2050: A roadmap for the Global Energy Sector [1] report (2021)', which forecasts global greenhouse gas emissions, projects that renewable energy will account for 55% of global electricity generation in 2050 under the 'Stated Policies Scenario' (STEPS), a scenario that assumes the continuation of current policies in each economy. In the Announced Pledges Case (APC), which assumes all pledges are realized, the share of renewable energy generation increases from 29% in 2020 to about 70% in 2050. Nuclear power generation would remain at around 10%, while coal power generation would decline from 30% to less than 10%, suggesting that even if only current pledges are realized, renewable energy generation could increase significantly by 2050. While this is significant progress, the IEA notes that it falls far short of what is needed to achieve the global 2050 net-zero goal.

Furthermore, following the outcome of the first global stocktake at COP28 in 2023, we all recognized that additional global efforts are needed to achieve the Paris Agreement's 1.5-degree goal. In response, all signatory economies of the Paris Agreement agreed to commit to tripling renewable energy capacity and doubling energy efficiency by 2030, as well as to utilize a wider range of technologies. In Decision 1/CMA.5, they agreed to accelerate zero- and low-emission technologies, including renewables, nuclear, CCUS for hard-to-abate sectors and low-carbon hydrogen.[2] This reaffirms the consensus that in addition to scaling up renewables, zero- and low-carbon energy technologies must be utilized to meet the Paris Agreement temperature goal.

Recognizing that global climate change mitigation requires the adoption of a variety of carbon-free energy technologies, Korea proposed the workshop through the APEC Fund to promote the expansion of the use of renewable energy and other carbon-free energy technologies, taking into account the diverse environments of APEC economies. The workshop provided an important opportunity for APEC economies to explore concrete ways to effectively introduce and expand the use of carbon-free energy technologies. This briefing paper summarizes the key presentations and discussions from the workshop, which we aim to share across the APEC region to build consensus and accelerate efforts in promoting the deployment of carbon-free energy technologies.

[1] IEA (2021). Net-Zero 2050 Report published in May, 2021.
[2] unfccc (2023). COP28 Decision. Global Stocktaking. 1/CMA5

2. Background

According to the APEC Energy Demand and Supply Outlook 8th edition[3], published by the Asia-Pacific Energy Research Center (APERC), clean energy generation in the APEC region accounted for about 35% in 2020. As the APEC region still relies heavily on fossil fuel generation, the expansion of clean energy sources is critical to achieving carbon neutrality in the region. In addition, expanding electricity generation is essential to meet the energy demands of APEC's growing economies, which requires a diverse mix of energy sources.

As noted in the IEA's Net-Zero report, this generation mix is not solely reliant on renewable sources but also incorporates technologies such as nuclear, hydrogen/ammonia, carbon capture and storage (CCS) and energy storage systems (ESS). This combination aims to effectively reduce GHG emissions while considering the domestic circumstances of different economies.

Against this background, the APEC Workshop on "Promoting Decarbonization of Power Sector by Using Carbon-Free Energy (CFE)" (hereinafter referred to as the APEC CFE Workshop), held in Busan on 5-6 September 2024, discussed technical and policy strategies for the adoption and utilization of CFE technologies in the power sector. CFE was defined as a concept that goes beyond renewable energy and encompasses a range of energy technologies that can contribute to GHG reductions, including nuclear, hydrogen and ammonia, CCS and ESS.

The APEC CFE Workshop convened international organizations and major economies, including Korea, to share experiences and best practices from their respective economies and explore ways to effectively implement CFE in the power sector. Policymakers and private sector stakeholders were able to further strengthen consensus among economies, reaffirming the importance of securing CFE technologies tailored to each economy's circumstances.

The workshop was organized by the Korean Ministry of Trade, Industry and Energy (MOTIE) and hosted by the Korea Institute of Energy Economics (KEEI). As part of the event, participants also visited the ammonia terminal of Lotte Fine Chemicals in Ulsan, Korea. With the active participation of APEC economies and public-private partnerships in Korea, the workshop was successfully concluded with a broad consensus on the importance of scaling up CFE to achieve carbon neutrality in the region.

[3] APERC (2022). Published in September, 2022.

3. APEC CFE Workshop Sessions

The APEC CFE Workshop in Korea was organized into four sessions. Each session featured presentations by key speakers, followed by panel discussions with panelists on each of the key topics

- Session 1: Global Trends in Recognizing the Need for Diverse Carbon-Free Energy (CFE) in Power Sector
- Session 2: Policy Trends for Expanding Power Generation from Diverse Carbon-Free Energy(CFE) Technologies
- Session 3: Efforts to Expand and Strengthen the Role of Carbon-Free Energy (CFE) in Private Sector
- Session 4: Trends in Innovative Carbon-Free Energy (CFE) Technologies in Power Sector

Table1 . APEC CFE Workshop Agenda

5 September	**Opening Session & Sessions 1-3**
10:00-10:30	**Opening Session** **- Opening Remarks**: Mr. LEE Kyoungsoo, Director of Energy Policy Division, Ministry of Trade, Industry and Energy (MOTIE) **- Welcome Remarks**: Dr. KIM Hyun-Jae, President of Korea Energy Economics Institute (KEEI) **- Photo Session** **- Keynote Speech**: Dr. Kazutomo IRIE, President of the Asia Pacific Energy Research Centre (APERC) - Facilitating decarbonization in the power sector of APEC region: Overview of the current state of the power sector in the APEC region; Importance of transitioning to Carbon-Free Energy (CFE) in the power sector to mitigate climate change
10:30-12:00	**[Session 1] Global Trends in Recognizing the Need for Diverse Carbon-Free Energy (CFE) in Power Sector** **- Main Topic**: Global decarbonization trends and best practices, applicability of various Carbon-Free Energy (CFE) Technologies in the power vector, along with their benefits and limitations, enhancing social recognition and acceptance **- Presentation**: Mr. KIM Tae-Yoon, Head of Energy Minerals Analysis of International Energy Agency (IEA) **- Panel Discussions**: - Session Moderator: Dr. CHUNG Woongtae, Senior Research Fellow of Korea Energy Economics Institute (KEEI) - Dr. Kazutomo IRIE, President of the Asia Pacific Energy Research Centre (APERC) - Dr. Priyantha WIJAYATUNGA, Senior Director of Energy of Asian Development Bank (ADB) - Ms. Analeigh SUH, Research Associate of BloombergNEF
12:00-13:20	**Luncheon**

13:20-14:40	**[Session 2] Policy Trends for Expanding Power Generation from Diverse Carbon-Free Energy(CFE) Technologies** **- Main Topic**: Sharing policy efforts among APEC economies to expand the supply of electricity generated by Carbon-Free Energy (CFE), discussing their integration into the power grid, identifying challenges, and exploring various solutions **- Presentation**: Mr. LEE Daeyoun, Head of Department of Electricity Policy Research of Korea Energy Economics Institute **- Panel Discussions:** - Dr. Bingqi JIAO, Deputy Director of NEA, China - Ms. Kavitha KOLANDAI, Assistant Secretary of Ministry of Energy Transition and Water Transformation (PETRA), Malaysia - Ms. Jenifer WOLIN, DOE Office Director & Energy Attaché of US Embassy Seoul, US - Ms. Thi Thuy NGUYEN, Official of Ministry of Industry and Trade, Viet Nam
14:40-15:00	Coffee Break
15:00-16:10	**[Session 3] Efforts to Expand and Strengthen the Role of Carbon-Free Energy (CFE) in Private Sector** **- Main Topic**: Exploring efforts to expand private sector use of and investment in CFE technologies and discussing cooperation for rapid, stable, and just decarbonization of supply chains **- Presentation**: Ms. LIM Eun-Jung, Manager of Korea Chamber of Commerce and Industry (KCCI) **- Panel Discussions**: - Mr. CHUNG Ki-Suk, Vice President/Team Leader of SAMSUNG C&T - Mr. JO Yun-Taek, Senior Researcher of POSCO Research Institute (POSRI) - Mr. Seon-Wook Kim, Director of Carbon Free Alliance (CFA)
16:10	The End of 1st Day Session
6 September	**Session 4 & Closing Session**
10:00-11:30	**[Session 4] Trends in Innovative Carbon-Free Energy (CFE) Technologies in Power Sector** **- Main Topic**: Discussing innovative Carbon-Free Energy technologies for the power sector such as SMR, CCS, hydrogen/ammonia co-firing and sharing best practices for their application **- Presentation**: Mr. Hun-Jik Chung, Principal researcher, Korea Institute of Energy Technology Evaluation and Planning (KETEP) **- Panel Discussions**: - Dr. LEE Ho-Seob, Director General of Korea CCUS Association - Dr. KANG Young-Taec, Director of Korea Hydrogen Alliance - Mr. NA Jang-Hwan, Senior Researcher of i-SMR Development Agency - Ms. YEON Sun-Hwa, Principal Researcher of Korea Institute of Energy Research (KIER)
11:30-12:00	**Closing Session**

Opening remarks were made by the Ministry of Trade, Industry and Energy (MOTIE) and the host organization, the Korea Energy Economics Institute (KEEI), to highlight the need for carbon-free energy(hereinafter CFE) sources in the APEC region, followed by a presentation by APERC, a research center under APEC, on regional trends and the potential for utilizing CFE technologies in the future.

The Ministry of Trade, Industry and Energy has emphasized that the utilization of various carbon-free and low-carbon emission technologies, including nuclear power, CCUS and low-carbon hydrogen, as well as renewable energy, is essential to achieve the 2050 carbon neutrality goal. In particular, Korea launched the Carbon Free Alliance (CFA) in 2023 to promote global CFE and proposed the CFE initiative to the international community under the leadership of the CFA. Through this initiative, Korea is committed to bridging the climate gap by supporting the expansion of CFE in economies vulnerable to climate change. Additionally, Korea announced plans to strengthen global cooperation by revitalizing international collaborative research and promoting technological innovation and private sector investment.

In addition, the Ministry of Industry and Energy emphasized that decarbonizing the power sector is an urgent task and that there is a consensus in the region on the use of carbon-free and carbon-neutral sources. The US Chair's Statement of the 13th APEC Energy Ministerial Meeting in 2023 and the Lima Statement of the 14th APEC Energy Ministerial Meeting in Peru in 2024 also set new common goals for the APEC region's power sector and agreed to utilize carbon-free and carbon-neutral sources. Accordingly, Korea, as the host of the 2025 APEC Energy Working Group and Energy Ministers' Meeting, has set the theme of the 2025 Energy Ministerial Meeting Policy Dialogue as "Utilizing CFE Technologies to Expand Clean Electricity in APEC" and will explore ways to expand CFE technologies in the power sector. Korean "*carbon-free energy technologies"* is a more flexible and broader concept that encompasses both carbon-free and carbon-neutral sources, as referred to by the US Chair's Statement and Peru's Lima Statement.

Following the opening remarks by MOTIE, Mr. Hyun Jae Kim, President of the Korea Energy Economics Institute (KEEI), presented that decarbonization of the power sector is a key element in combating climate change and achieving sustainable economic growth. In addition, as electricity consumption in the APEC region has a significant impact on achieving global climate goals, this workshop is an important opportunity to strengthen cooperation in the APEC region and explore new opportunities for collaboration among APEC member economies. He emphasized the importance of the workshop to discuss policy and technical measures for a carbon-free future in the APEC region, share global trends in the utilization of carbon-free power sources, the role of the private sector, trends in technological innovation, and identify practical ways to cooperate. He expressed his hope that the workshop will be valuable in identifying practical and concrete measures to decarbonize the power sector in APEC economies.

Dr. Kazutomo IRIE, President of the Asia-Pacific Energy Research Centre (APERC), stated that there is no globally uniform definition of CFE sources, but in a narrow sense, it refers to fuels with no carbon emissions, and in a broad sense, it includes low-carbon fuels, renewable hydrogen, by-products such as ammonia, and CCUS. He also emphasized the need to discuss the development of new technologies that take into account the different geopolitical environments, infrastructure, and capabilities of different economies. However, he noted that the current challenges of economics and financing need to be addressed in order to expand CFE technologies, while overcoming challenges such as the variability of renewable energy, grid reliability and flexibility issues, and market entry barriers.

Session 1. Global Trends in Recognizing the Need for Diverse Carbon-Free Energy in Power Sector

Session 1, themed decarbonising the power sector and the role of CFE technologies, explored the trends in the utilization of CFE technologies around the world. Mr. KIM Tae-Yoon, Head of Energy Minerals Analysis of International Energy Agency (IEA), presented the energy market trends, electricity supply and demand status, and cases of CFE utilization by economic regions, as well as measures to spread CFE technologies, focusing on various carbon-free power sources.

According to the IEA, share of clean energy penetration is growing rapidly around the world, especially solar and wind. In 2023, USD 2 trillion of the total global investment in the energy sector (USD 3 trillion) went to clean energy, and electric vehicle sales are also on the rise, with global electric vehicle sales expected to grow by about 25% in 2024. In addition, power grid development is essential to meet new electricity demands, such as the rise of AI data centers. Reflecting this, investment in the grid is also increasing, with a goal of tripling the capacity of renewable energy facilities.

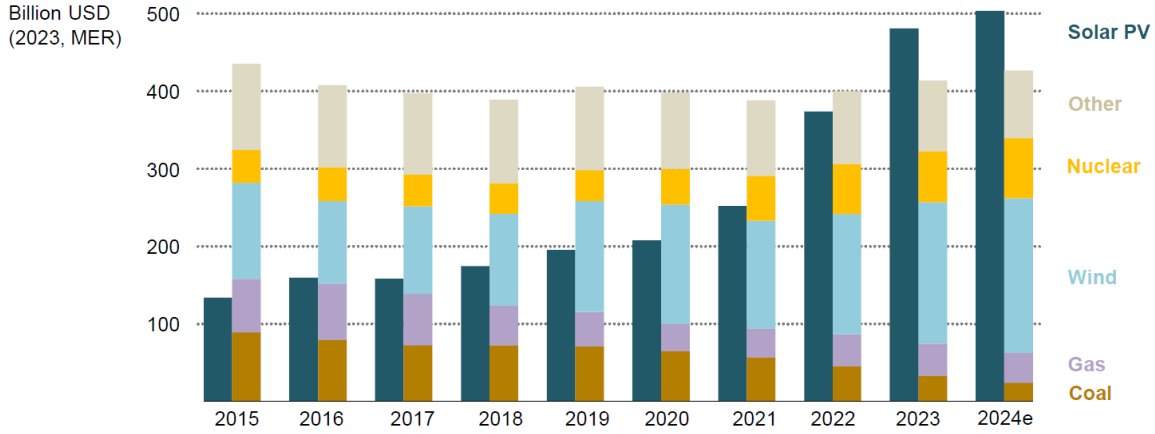

Figure1 . Global annual investment in solar and other generation technologies
Source: IEA Presentation (Sep 5, 2024)

However, he emphasized that despite this, the world has not yet crossed the tipping point for emissions reductions. Despite encouraging progress in the deployment of clean energy, greenhouse gas emissions reached a record high in 2023, and much more needs to be done to avoid a serious climate catastrophe.

The presentation also noted that decarbonization will require the expansion of transmission and grid-connected infrastructure to connect generation and consumption areas, with an estimated 80 million kilometers of additional grid capacity needed. In addition, tripling renewable energy installations will require a significant expansion of battery and other energy storage capacity. To meet the "tripling renewables by 2030" target set out at COP28, storage capacity will need to increase sixfold (to more than 1,500 GW), with batteries expected to account for 90% of this, and pumped storage, compressed air energy storage (CAES), and thermal storage for the remainder.

He also highlighted the role that electrification can play in achieving net-zero. As electrification continues to accelerate internationally, CFE technologies are becoming increasingly important in the power generation sector. Renewables such as solar and wind

exceed electricity demand growth in all scenarios[4] , complemented by nuclear and other low-emission energy sources, reducing the use of coal and ultimately natural gas. This demonstrates that a range of CFE technologies must be considered in addition to renewables to realize the goal of carbon neutrality.

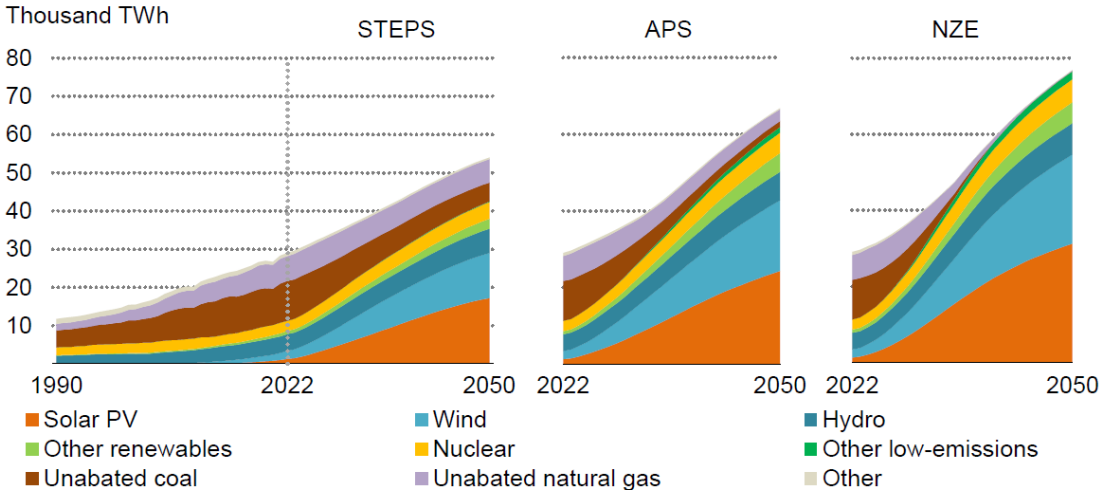

Figure2 . Global electricity generation by source and scenario
Source: IEA Presentation (Sep 5, 2024)

Additionally, he noted that the need for dispatchable sources remains critical for electricity security. CFE technologies are expected to be a key for decarbonization while meeting peak electricity demand. In particular, APS scenarios for Europe; India; and Indonesia show that by 2050, carbon-free sources, including nuclear, hydropower, and bioenergy, along with renewables, will play a significant role in maintaining electricity security, even during peak demand periods.

Panel Discussions on Session 1

The panelists agreed on the multiple benefits and challenges of decarbonizing the power sector, the need for international cooperation and tailored strategies, creating sustainable policy and investment environments, and driving global decarbonization through technological innovation. In particular, the panelists highlighted the potential for power sector decarbonization to spread to other industries, building on the proven capabilities of renewable energy technologies, and proposed specific approaches, such as diversifying energy supply chains, creating innovative financing instruments, and increasing investment in energy development in emerging economies.

Mr. KIM Tae-Yoon, Head of Energy Minerals Analysis at the International Energy Agency and the presenter of this session, highlighted that decarbonizing the power generation sector extends beyond the clean energy sector, playing a key role in driving the low-carbon transformation of entire industries. He emphasized that this shift is being propelled by the growing global investments in the deployment of clean energy technologies. In addition, he underscored the importance of leveraging proven technologies, including renewables, while

[4] All scenarios refer to the IEA's assumptions about energy policy, including the Stated Policies Scenario (STEPS), which projects future energy supply and demand based on currently announced policies and plans. The Announced Pledge Scenario (APS) assumes the achievement of net-zero pledges and targets (e.g. NDCs, net-zero declarations, etc.) by all economies, while the NZE Scenario sets out the pathway required to achieve net-zero globally by 2050.

also highlighting the need to diversify the clean energy supply chain, boost investment from emerging economies, and develop innovative financing instruments to lower the cost of capital.

Dr. Kazutomo Irie, President of the Asia-Pacific Energy Research Center (APERC), noted the inefficiency of fossil fuel-based power generation and the urgent need for an efficient, CFE transition. Recognizing the diverse challenges posed by the differing economic conditions of economies in the APEC region, he suggested that international cooperation and knowledge sharing should be used to explore customized decarbonization strategies, including the phasing down of coal-fired power plants.

Dr. Priyantha Wijayatunga, Senior Director of Energy of Asian Development Bank (ADB), emphasized the importance of tailoring decarbonization strategies to reflect the economic and energy conditions of each economy. In particular, he emphasized that the Asian Development Bank (ADB) ensures recipient economies are not utilized as testing grounds for unproven technologies. He noted ADB's efforts to advance clean energy expansion by strengthening reliable grids with commercialized technologies and facilitating private investment. He reiterated that stable financing, well-structured project design, and the establishment of trust-based networks are key elements in the decarbonization process.

Ms. Analeigh SUH, Research Associate at BloombergNEF (BNEF), highlighted hydrogen and CCUS as key decarbonization technologies, noting that hydrogen is effectively utilized in certain sectors and that CCUS presents promising cost potential. She also emphasized the declining cost trend in clean energy and the critical role of stable policy support, stressing that even high-potential technologies, such as offshore wind, may remain underutilized in the absence of a well-structured institutional framework.

Throughout these discussions, the panelists emphasized that reliable access to technology, innovative financing structures, international cooperation and knowledge sharing, and policy continuity and investment stability are essential to make decarbonizing the global power sector a reality.

Session 2. Policy Trends for Expanding Power Generation from Diverse Carbon-Free Energy

Session 2 featured presentations and discussions on governments' policy directions to expand CFE technologies. The presentations and panelists included experts from major economies in APEC, including China; Malaysia; US; Viet Nam, who introduced policy efforts to expand the supply of CFE power sources and integrate them into the grid in the APEC region, identified challenges, and explored various solutions

The session featured Mr. LEE Daeyoun, Head of Department of Electricity Policy Research of KEEI, who presented the current status and prospects of CFE technologies in Korea, the Korean government's policies to integrate CFE technologies into the electricity grid, and future issues and challenges.

According to the announcement, the Korean government is implementing a range of policies focused on power grid transformation to achieve carbon neutrality by 2050 and meet its Nationally Determined Contribution (NDC) target by 2030. In the power sector, Korea has set carbon emission reduction targets of 45.9% by 2030 and more than 93% by 2050.

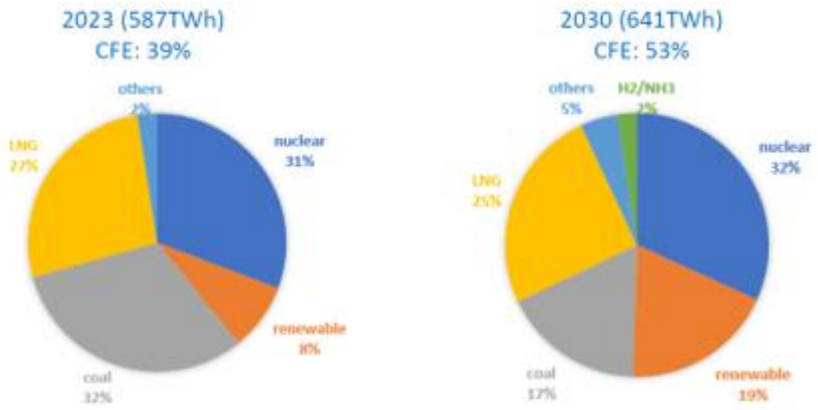

Figure3 . Current status and outlook of Korea's power mix
Source: KPX, MOTIE

He introduced three representative policies to integrate CFE technologies into the power grid. First, the 'Power grid innovation policy' announced in December 2023 was established with three targets with the vision of "realizing a power grid system that supports the expansion of CFE technologies and adequate power supply". The first goal is to reduce core transmission facility construction period by 30%, the second is a 10% reduction in transmission line construction scale (distribution benefits), and the last is a double increase in grid flexibility. Specifically, the policy aims to rapidly build the high-voltage direct current (HVDC) backbone network, involve local governments and residents in the expansion of local power grids, and maximize the capacity of existing power grids. This will promote flexible grid operation, including the introduction of a bidding system to solve the problem of overcapacity and enhance the predictability of renewable energy.

Another key grid integration policy is the Energy Storage Systems (ESS) Industry Development Strategy, which was announced in October 2023. In this strategy, the government outlined a plan for the composition of the short-term and long-term energy storage mix, with the key objective of gradually increasing the capacity of both short-term and long-term energy storage facilities by 2036. Specifically, it aims to expand short-term storage of 0.5h to 3.66 GW by 2036, long-term storage of 4h to 4.22 GWh, 6h to 15.58 GW, and 8h to 1.05 GW.

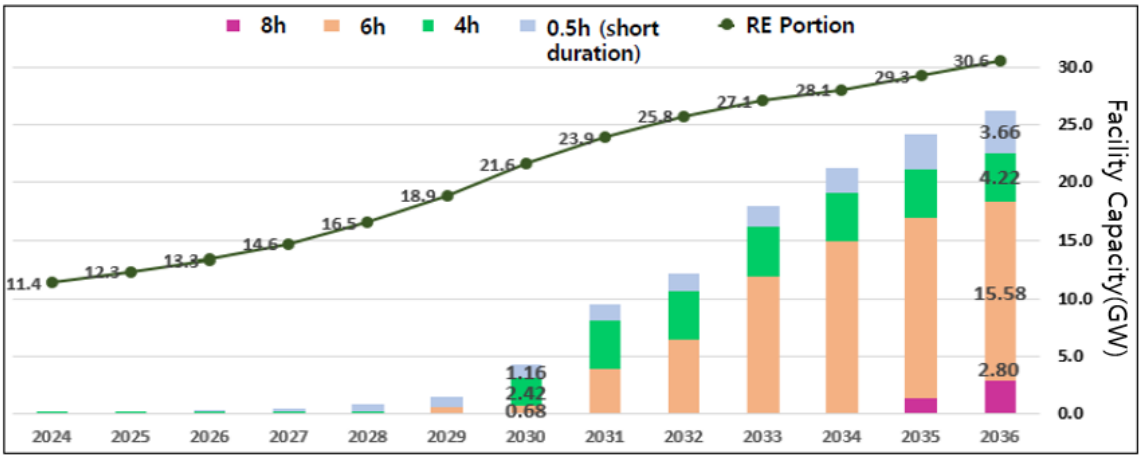

Figure4 . Proposed energy storage mix of ESS industry development strategy (Oct, 2023)
Source: MOTIE(Oct 11, 2023), ESS industry development strategy

Table2 . Energy Storage mix plan of the Korea (Oct, 2023)

Time	Short duration	Long duration			Pumped Hydro
	0.5h	4h	6h	8h	
'24~'26	0.05	0.065	0.095	-	-
'27~'30	1.16	2.42	0.68	-	-
'31~'36	3.66	4.22	15.58	1.05	1.75

Source: MOTIE(Oct 11, 2023), ESS industry development strategy

In addition, the strategy proposes accelerating the expansion of ESS storage capacity beyond the initial timeline to preemptively secure the required capacity by 2030. It also includes plans to establish a dedicated ESS market, develop a technology roadmap, and enhance safety management systems.

Lastly, the Special Law on Power Grid Expansion, currently under legislative review by the Korean government, aims to facilitate the timely expansion of major power grid infrastructure, streamline permitting procedures and establish a compensation framework for local communities. This legislation is intended to provide a legal foundation for resolving conflicts related to grid expansion while ensuring a stable and reliable power supply.

Meanwhile, key domestic challenges related to the grid integration of CFE technologies include opposition from local residents in areas where grid infrastructure is planned and the financial constraints of the Korea Electric Power Corporation (KEPCO). Local opposition remains a major factor delaying grid expansion projects, underscoring the need for legal and financial support from the government to facilitate timely construction. Additionally, KEPCO has faced significant financial deficits from 2021 to 2023, accumulating losses of approximately KRW 43 trillion due to electricity being supplied below cost despite rising energy prices. Furthermore, an estimated KRW 56 trillion in additional investment is required for grid expansion. These financial constraints pose a significant risk to the sustainability of grid reinforcement policies, highlighting the urgent need for government intervention and structural reforms to ensure long-term energy security.

Panel Discussions on Session 2

The panel featured experts from major APEC economies, including China; Korea; Malaysia; US; Viet Nam, who discussed the technologies and strategies being implemented to expand renewable energy and drive decarbonization across the region. During the discussion, the panelists emphasized that advancing the energy transition requires a multifaceted approach, highlighting the importance of CFE technologies, financing mechanisms, knowledge sharing, and international cooperation. They collectively agreed that these elements are crucial to accelerating the shift toward a low-carbon future in APEC member economies.

Dr. Bingqi JIAO, Deputy Director of the NEA of China, stated that China continues to invest in non-fossil fuel energy sources, including wind, solar, biomass, and nuclear power, with non-fossil energy accounting for 36% of the total power generation mix as of 2023. While these investments have significantly increased the share of non-fossil fuels, rising electricity demand and supply volatility caused by extreme weather events remain major challenges in the energy transition.

Ms. Kavitha KOLANDAI, Assistant Secretary of Ministry of Energy Transition and Water Transformation (PETRA) of Malaysia, announced that Malaysia has set a target to increase

its share of renewable energy to 70% by 2050. The economy is currently heavily dependent on fossil fuels and is implementing various programs to reduce energy consumption, with a focus on improving energy efficiency and demand management. However, energy security, affordability issues, and lack of private sector participation were cited as major challenges, and the potential introduction of nuclear power noted to be under review to address public acceptability issues.

Ms. Jenifer Wolin, Director of the Department of Energy Office and Energy Attaché at the US Embassy in Seoul, explained that as of now, fossil fuels account for 60% of the US electricity mix, while clean energy comprises 22% and nuclear power 19%. The US has plans to triple its share of nuclear power generation and is actively advancing R&D and investment in various decarbonization technologies, including hydrogen, CCUS and ESS. However, insufficient transmission capacity and an aging power grid remain significant challenges, highlighting the need for enhanced technology and knowledge sharing, as well as strengthened R&D collaboration at the APEC level.

Lastly, Ms. Thi Thuy NGUYEN, Official at the Ministry of Industry and Trade of Viet Nam, outlined Viet Nam's plans to expand offshore wind power capacity to 6,000 MW by 2030 and halt the construction of new coal-fired power plants from 2035. She identified renewable energy storage technologies and the development of legal frameworks as key challenges in the economy's energy transition. Additionally, nuclear power was excluded from the plan due to concerns over public acceptability. She further emphasized the importance of APEC's support in advancing emerging technologies, including CCS and ammonia, as well as human resource training, knowledge sharing, and financial assistance to facilitate the region's low-carbon transition.

All panelists agreed that international cooperation at the APEC level is crucial in supporting economies to achieve their decarbonization goals. In particular, they emphasized the importance of technology development, financing mechanisms, experience sharing, and policy alignment, which can collectively accelerate the energy transition across member economies.

Session 3. Efforts to Expand and Strengthen the Role of Carbon-Free Energy in Private Sector

Session 3 featured presentations and panel discussions on the private sector's efforts to expand carbon-free power sources and strengthen its role. Ms. LIM Eun-Jung, Manager of Korea Chamber of Commerce and Industry (KCCI), presented "The Need for and Challenges of CFE procurement from Industry Perspective", sharing examples of how major economies and global companies are working to expand the use and investment in carbon-free power sources.

According to the presentation, the Korean industry is actively exploring various strategies to achieve greenhouse gas reduction targets and promote sustainable development through CFE procurement. The speaker highlighted key risks and the current regulatory landscape from an industry perspective, emphasizing the need for policy support and infrastructure enhancements to facilitate renewable energy expansion and carbon emission reductions in the industrial sector.

In this context, the industry views decarbonization as essential for maintaining competitiveness in global supply chains. CFE technologies play a critical role not only in achieving carbon neutrality but also in strengthening ESG management, complying with

increasingly stringent carbon regulations in major export markets, and meeting the expectations of both domestic and international investors.

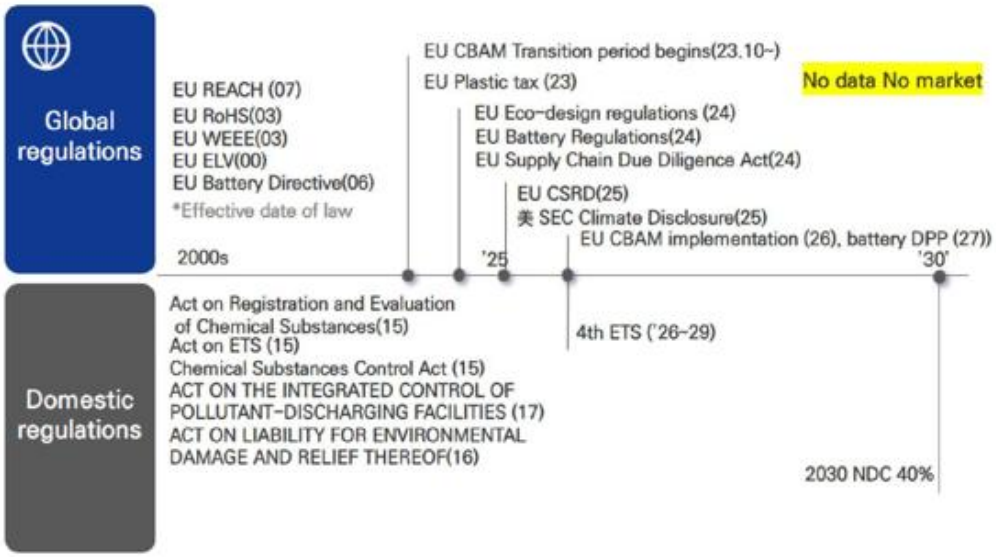

Figure5 . Regulatory trends on carbon emissions
Source: KCCI Presentation (Sep 5, 2024)

The main challenges to CFE procurement were identified as supply reliability issues, cost burdens, lack of policy support, and technology gaps. One major challenge is the intermittency of renewable energy generation and the limitations of the existing power infrastructure, which make it difficult for industries to secure a reliable energy supply. Additionally, the high cost of CFE procurement imposes a significant financial burden on industries, particularly small and medium-sized enterprises (SMEs). The industry also faces a lack of institutional support to facilitate the transition to CFE and has called for increased tax incentives and subsidies to ease the financial strain. Finally, a skills gap in research and development (R&D) was highlighted, as industries require greater technical capacity to introduce to maximize the utilization of CFE technologies.

To address these challenges, key solutions include expanding policy support, investing in technology development, and establishing collaborative platforms. Governments will need to enhance tax incentives and financial assistance while strengthening cooperation with industry to facilitate the adoption of CFE technologies. In particular, tax credits play a crucial role in lowering the levelized cost of energy (LCOE), making CFE technologies more accessible and economically viable. While major economies are actively expanding energy investment tax credits, Korea currently lacks a comparable incentive for energy investments. For example, the US has committed USD 391 billion to energy security and climate change mitigation through the Inflation Reduction Act (IRA), aiming to increase tax credits for clean energy investments from 6% to 30%. This initiative is designed to boost domestic manufacturing capacity by securing renewable energy supply chain facilities within the US Meanwhile, in May 2023, the European Union (EU) introduced the RepowerEU policy, allocating EUR 10 billion over five years (until 2027) to support clean energy investment, enhance energy security, and strengthen the continent's renewable energy infrastructure. Additionally, the EU has implemented the Net-Zero Industry Act as a countermeasure to the US IRA, further reinforcing its commitment to accelerating clean energy deployment.

Additional recommendations to support industrial decarbonization include increasing investment in renewable energy storage technologies and smart grid systems to enhance grid

stability and efficiency. Furthermore, establishing a collaborative platform between industry, government, and academia can facilitate technology and information sharing, promote best practices, and enable industries to benchmark global advancements in clean energy adoption.

Procuring CFE technologies is essential for ensuring the sustainable development of industries and enhancing global competitiveness. However, to achieve this, key challenges such as supply security, cost burdens and policy limitations must be addressed. A collaborative approach between government and industry will be critical in overcoming these obstacles and advancing toward global net zero/carbon neutrality targets.

Panel Discussions on Session 3

The panelists discussed the efforts and challenges faced by industries in scaling up CFE technologies and transitioning to clean energy. They emphasized their commitment to achieving global net zero/carbon neutrality targets through institutional improvements and international cooperation, while exploring ways for the private sector to collaborate in this transition. Additionally, the panelists agreed on the importance of standardization and certification at the APEC level to facilitate the adoption of CFE technologies and ensure a consistent regulatory framework across member economies.

Mr. Chung Ki-Suk, Vice President and Team Leader at SAMSUNG C&T, provided an overview of the company's CFE utilization efforts, emphasizing its commitment to transitioning 100% of its electricity consumption to renewable energy by 2030. In the construction sector, the company is actively developing low-carbon concrete, while in the fashion sector, it is expanding the adoption of carbon-free technologies through the use of recycled materials. Additionally, as part of its hydrogen and renewable energy commercialization efforts, he underscored the need for establishing international standards for hydrogen business development. He further suggested that designing systems based on standardized frameworks would facilitate the adoption of carbon-free technologies across economies, making implementation more efficient and scalable.

Following this, Mr. JO Yun-Taek, Senior Researcher at POSCO Research Institute (POSRI), outlined POSCO’s efforts to expand the use of CFE through the purchase of green premiums and Renewable Energy Certificates (RECs), while also exploring the option of direct power purchase agreements (PPAs). In the long term, the company aims to become completely off-grid by utilizing a combination of liquefied natural gas (LNG) and clean hydrogen. However, he noted that the high cost of renewable energy generation and the limited availability of PPAs remain significant challenges. Additionally, he emphasized that at the APEC level, economies with strong renewable energy capacity should take the lead in establishing standards and certification schemes to facilitate the broader adoption of CFE.

Meanwhile, Mr. Seon-Wook Kim, Director of the Carbon Free Alliance (CFA), explained that the Carbon Free Energy Initiative—launched as part of Korea’s global outreach efforts—is being implemented through an open platform aimed at decarbonizing corporate electricity use and expanding Scope 1 and 2 emissions reductions. He emphasized the importance of establishing a certification scheme and strengthening the skills base related to zero-carbon energy. To support this, the CF Alliance has formed a global working group dedicated to developing an international certification framework for CFE.

Finally, the speaker of the Korea Chamber of Commerce and Industry (KCCI) highlighted that renewable energy sourced from abroad is not recognized as part of a company’s domestic performance. To address this issue, KCCI emphasized the need for revitalizing discussions at the APEC level on renewable energy trading and crediting mechanisms to facilitate cross-border recognition and utilization of renewable energy.

The panel discussion highlighted the importance of institutional improvements and international cooperation in scaling up CFE technologies and facilitating the transition to renewable energy. In particular, establishing standardization and certification schemes at the APEC level was identified as a crucial foundation for economies to achieve their zero-carbon targets more efficiently. These efforts will support APEC economies in advancing their sustainable energy transition and achieving global net zero/carbon neutrality goals.

Session 4. Trends in Innovative Carbon-Free Energy(CFE) Technologies in Power Sector

Session 4 included presentations and panel discussions on innovative technologies for CFE in the power sector. In addition to renewable energy, the session highlighted emerging CFE technologies such as small modular reactors (SMRs), hydrogen/ammonia and CCS. A panel discussion followed, focusing on sharing best practices for the application and implementation of these technologies.

Mr. Hun-Jik Chung, Principal Researcher at the Korea Institute of Energy Technology Evaluation and Planning (KETEP), delivered a presentation on "Technology Trends in Clean Thermal Power Generation with Hydrogen and Ammonia." In his presentation, Dr. Chung provided insights into global trends in hydrogen and ammonia co-generation, as well as current developments and policy directions in Korea.

Dr. Chung first outlined global technology trends in hydrogen and ammonia-based clean thermal power generation. In the US, the Biden administration has allocated 11% of its R&D budget to hydrogen gas turbines, and as of 2020, 50% of gas turbines sold were designed to operate on hydrogen fuel. In Japan, the government announced the "NZ Green Growth Strategy" as part of its 2050 Net-Zero goal, setting a target of 20 million tons (MT) of hydrogen consumption per year by 2050. A notable development is Japan-led research on ammonia gas turbine technology, which aims to enhance efficiency by eliminating the ammonia (NH_3) cracking process. This approach addresses challenges related to liquid hydrogen storage and transportation losses, such as boil-off gas (BOG) issues. Meanwhile, the EU is advancing toward 100% hydrogen use through a phased fuel transition, with a goal of achieving "Zero-CO_2" emissions by 2030.

In addition, leading global companies such as GE, Siemens, and Mitsubishi Heavy Industries (MHI) are developing combustors capable of blending 50% hydrogen fuel, designed for both retrofitting existing gas turbines and integrating into new models. Other companies are actively developing and piloting small-scale, 100% hydrogen gas turbines ranging from 1 MW to 16 MW, while large-scale 100% hydrogen-fueled combustors are targeted for development by 2030.

Meanwhile, Korea is actively promoting the development and commercialization of clean thermal power generation technologies using hydrogen and ammonia as part of its strategy to achieve carbon neutrality. These technologies are expected to play a crucial role in accelerating the transition from fossil fuel-based energy to a decarbonized energy system.

To effectively transition to CFE, it is essential for Korea to establish a power mix suited to its domestic energy landscape. The 10th Basic Plan for Electricity Supply and Demand, released in January 2023, outlines a strategy to convert aging coal-fired power plants into LNG-based facilities. Additionally, medium- and long-term targets for hydrogen and ammonia power generation have been set for 2030 and 2036, under the framework of the Clean Hydrogen Energy Portfolio Standards (CHPS). Building on this, the Working Committee draft (May 24, 2023) of the 11th Basic Electricity Supply and Demand Plan proposes increasing

hydrogen-ammonia power generation capacity from 13 TWh (as outlined in the 10th Basic Plan) to 15.5 TWh by 2030, reinforcing Korea's commitment to expanding its clean energy portfolio.

Table3 . Projected power generation capacity by sources

구분			Nuclear	Coal	LNG	Renewable	LCF	Etc.	Total
2030 NDCs('21)	2030	TWh	146.4	133.2	119.5	185.2	22.1	6.0	612.4
		Share	23.9%	21.8%	19.5%	30.2%	3.6%	1.0%	100%
10th Energy plan('23.1)	2030	TWh	201.7	122.5	142.4	134.1	13.0	8.1	621.8
		Share	32.4%	19.7%	22.9%	21.6%	2.1%	1.3%	100%
11th Energy Plan('24.5)	2030	TWh	204.2	111.9	160.8	134.8	15.5	10.6	641.4
		Share	31.8%	17.4%	25.1%	21.3%	2.4%	1.6%	100%
	2038	TWh	249.7	72.0	78.1	230.8	38.5	32.5	701.7
		Share	35.6%	10.3%	11.1%	32.9%	5.5%	4.0%	100%

Source: Ministry of Trade, Industry and Energy (Jan, 2023; May, 2024), The 10th Basic Plan of Long-Term Electricity Supply and Demand; The Draft of 11th Basic Plan of Long-Term Electricity Supply and Demand

In the field of demonstration research and technology development for hydrogen-ammonia hybrid power generation, large-scale demonstration projects are currently underway. A 150MW and 300MW gas turbine demonstration study utilizing 50% hydrogen hybridization technology is scheduled for completion by 2027.

Additionally, several R&D projects are in progress to support the commercialization of clean hydrogen, including:

- The construction of a hydrogen gas turbine test facility in Boryeong
- The development and demonstration of small- and medium-sized carbon-free hydrogen gas turbines
- The development and demonstration of 20% ammonia blending technology

The announcement concluded with several key recommendations for the future development of hydrogen-ammonia power generation. To reduce carbon dioxide emissions from coal-fired power plants, it is essential to consider gradually phasing down coal-fired power generation, transitioning to ammonia fuel, and integrating CCUS technology.

Additionally, developing a comprehensive strategy for hydrogen supply and imports is crucial, particularly in relation to LNG-hydrogen combined cycle power plants, as the utilization of liquefied hydrogen is becoming an increasingly important consideration. If an ammonia-based infrastructure is established as a hydrogen carrier, further evaluation will be needed to determine how it can be efficiently utilized when liquefied hydrogen imports increase in the future.

Lastly, ensuring the economic feasibility of green hydrogen and ammonia will be a critical challenge. In particular, rising electricity prices were highlighted as a key factor that must be carefully addressed in future planning and policy development.

Panel Discussions on Session 4

The panel discussed the progress and challenges associated with various CFE technologies, including CCUS, hydrogen/ammonia, ESS and small modular reactors (SMRs). The panelists examined key factors such as economic feasibility, reliability, regulatory frameworks, and the role of international cooperation in advancing these technologies. In particular, they emphasized that enhanced global collaboration and the establishment of standardized frameworks are essential to facilitate the wider deployment of these technologies across economies.

Dr. LEE Ho-Seob, Director General of the Korea CCUS Association, stated that approximately 40 million tons of carbon are currently being processed using CCUS technology worldwide. In Korea, ongoing research focuses on carbon capture from coal-fired power generation and projects such as the Donghae Gas CCS initiative. However, several challenges hinder the widespread adoption of CCUS technology, including legal uncertainties, economic feasibility, and a lack of public acceptance. Dr. Lee emphasized the importance of collaboration between high-emission economies and those with significant carbon storage capacity, as well as the need to strengthen CCUS cooperation within the APEC region. He also noted that the widespread deployment of CCUS technology could accelerate if government support is legally institutionalized and reinforced.

Dr. KANG Young-Taec, Director of the Korea Hydrogen Alliance (H2KOREA), stated that hydrogen power generation will primarily rely on green hydrogen, with some local governments already planning demonstration projects for hydrogen blending. However, he highlighted geographical constraints and high costs as key challenges, noting that most of the hydrogen used in Korea will need to be imported. Additionally, regulatory inconsistencies between economies and the absence of unified clean hydrogen standards have been identified as major barriers to the widespread adoption of hydrogen technology. To overcome these challenges, Dr. Kang emphasized the importance of regulatory harmonization across the region and the establishment of global standards for clean hydrogen, which would facilitate the broader deployment of hydrogen technology and enhance international cooperation in the sector.

Dr. YEON Sun-Hwa, Principal Researcher at the Korea Institute of Energy Research (KIER), emphasized the critical role of ESS in energy storage and power grid stabilization, noting that the global ESS market is expanding rapidly. However, she pointed out that safety concerns and the stability of raw material supply chains remain key challenges for ESS deployment. In particular, she highlighted the limitations of lithium-ion batteries and the need to accelerate the development of next-generation battery technologies to enhance efficiency and sustainability. To address these challenges, Dr. Yeon stressed the importance of international cooperation in reducing costs and standardizing ESS technology. She also noted that efforts to standardize grid stabilization technologies are currently underway in collaboration with the IEA.

Mr. Hun-Jik Chung identified the high cost of hydrogen and ammonia, as well as the long-term use of existing facilities, as major challenges in the energy transition. He emphasized the importance of prioritizing the development and verification of domestic technologies, which can later be exported to international markets. To achieve this, he highlighted the need to strengthen domestic technical capabilities while fostering international cooperation, ensuring that Korea remains competitive in the global clean energy sector.

Mr. NA Jang-Hwan, Senior Researcher at the i-SMR Development Agency, highlighted that the development of Small Modular Reactors (SMRs) is a complex challenge that requires balancing technological innovation and regulatory compliance.

He emphasized the necessity of adhering to high safety standards while ensuring economic viability, which demands substantial government funding and policy support. Through the advancement of SMR technology, he explained, the agency aims to develop a sustainable energy solution that ensures both safety and affordability, contributing to the broader clean energy transition.

Overall, the panel emphasized the importance of economic feasibility, reliability, regulatory frameworks, and international cooperation in the development and deployment of carbon-free technologies. In particular, the panelists agreed that strengthening international cooperation and establishing standardized frameworks are essential to addressing the challenges. These efforts will be key to accelerating the adoption of carbon-free technologies and ensuring their long-term sustainability.

4. Conclusions

The APEC CFE Workshop underscored the critical need for a comprehensive and multi-pronged approach to achieving power sector decarbonization. As the global energy transition accelerates, discussions reaffirmed that technological innovation, international cooperation, policy support, and private sector engagement must be strategically aligned within the APEC region to effectively tackle the pressing challenges of climate change.

The workshop highlighted that realizing global net-zero and carbon neutrality goals requires coordinated efforts among economies, industries, and policymakers to advance technology deployment, policy frameworks, and investment mechanisms. Through discussions, five key themes emerged as critical factors in accelerating the transition to a CFE system:

1. **Global trends and technology innovations** – The rapid deployment of clean energy technologies and the role of emerging CFE technologies.

2. **Policy and infrastructure development** – The necessity of robust policies and grid modernization to support the clean energy transition.

3. **International cooperation and standardization** – The importance of harmonizing regulations and establishing common technical standards.

4. **The role of the private sector** – The need for stronger incentives and financing mechanisms to scale up corporate CFE adoption.

5. **Challenges and opportunities of innovative technologies** – The potential of innovative solutions such as small modular reactors (SMRs) and clean hydrogen, and the barriers to their commercialization.

1) Global trends and technology innovations

The rapid expansion of clean energy technologies has demonstrated significant progress. As of 2023, global investment in the clean energy sector reached nearly USD 2 trillion, driven by technological advancements and policy support, bringing decarbonization goals closer to reality. In particular, developments in grid infrastructure and energy storage technologies are playing a critical role in mitigating the intermittency of renewables and enhancing the reliability and efficiency of clean energy systems.

However, key challenges remain. The record-high greenhouse gas emissions in 2023 indicate that expanding clean energy deployment alone is insufficient to fully address the climate crisis. This underscores the growing importance of diverse CFE technologies, including hydrogen blending, ammonia-based power generation, CCS, nuclear power and advanced ESS.

- Hydrogen and ammonia power generation present opportunities to decarbonize existing fossil fuel-based power plants, offering a transitional pathway toward cleaner energy.
- CCS technology is emerging as a viable solution for reducing large-scale industrial emissions, particularly in hard-to-abate sectors.
- Nuclear power remains a critical component of the clean energy mix, providing stable, large-scale and dispatchable power to complement intermittent renewables.

- ESS is increasingly recognized as key infrastructure for decarbonization, addressing grid stability challenges associated with variable renewable energy sources.

To achieve deep decarbonization, continued technological innovation, investment and policy support will be required to accelerate the deployment of CFE technologies and drive a resilient, sustainable energy transition across APEC economies.

2) Policy and infrastructure development

Robust policy support and grid infrastructure development are essential for the effective integration and reliable operation of CFE within power systems. Recognizing this need, Korea has introduced the "Power Grid Transformation Policy" and the "ESS Industry Development Strategy" as best practices to enhance grid flexibility and expand energy storage capacity, thereby supporting the broader deployment of renewable energy.

However, challenges remain in implementing these initiatives effectively. Local opposition to grid expansion projects and insufficient funding for grid investments continue to pose significant barriers to the successful realization of these policies. Addressing these obstacles will require strategic policy interventions, stakeholder engagement, and increased investment in grid modernization to ensure a stable and resilient power infrastructure that can support a CFE transition.

3) International cooperation and standardization

International cooperation and technology standardization are essential to addressing economic, technical, and regulatory barriers in the transition to CFE. APEC economies are advancing renewable energy deployment through tailored approaches that align with their respective energy landscapes. However, the lack of standardization and certification frameworks for hydrogen and CCUS technologies has been identified as a key challenge.

Strengthening regional cooperation on standardization will be crucial in facilitating technology diffusion, reducing costs, and expanding market access for CFE technologies. Future regional collaboration efforts should focus on harmonizing regulatory frameworks, aligning technical standards, and fostering knowledge-sharing initiatives to accelerate the adoption and scalability of emerging clean energy technologies across APEC economies.

4) The role of the private sector

The private sector plays a pivotal role in advancing decarbonization and scaling up CFE adoption. Procuring CFE has become an integral part of corporate ESG strategies, essential not only for environmental sustainability but also for maintaining competitiveness in global supply chains. With stricter carbon regulations in major export markets and growing sustainability demands from investors, integrating CFE is no longer optional—it is a strategic necessity for business resilience and long-term growth.

However, several barriers hinder private sector adoption of CFE:

- High costs associated with CFE procurement pose a significant challenge, particularly for small and medium-sized enterprises (SMEs).
- The intermittency of renewable energy creates uncertainty in energy supply chains, making reliability a key concern.

- Limited institutional and policy support further restricts widespread industry adoption.

To overcome these challenges, a comprehensive policy framework is needed to:

- Expand tax incentives to offset high upfront costs.
- Strengthen financing mechanisms to facilitate investment in clean energy infrastructure.
- Accelerate technology development to enhance the affordability and efficiency of CFE.

Scaling up CFE adoption will not only enhance corporate sustainability but also contribute to global net-zero/carbon neutrality targets. Achieving this will require strong collaboration between governments and the private sector to establish supportive institutional frameworks and targeted financial mechanisms that enable a seamless energy transition.

5) The challenges and opportunities of innovative technologies

Innovative CFE technologies such as small modular reactors (SMRs) and clean hydrogen are increasingly recognized as key solutions for decarbonizing the power sector. These technologies have the potential to reduce reliance on fossil fuels, enhance energy security, and support the transition to a sustainable energy system. However, their widespread deployment faces significant technical and economic challenges.

- Small Modular Reactors (SMRs): While SMRs offer a scalable and reliable clean energy solution, their adoption is hindered by high safety requirements and substantial initial investment costs. Overcoming these challenges requires strong policy support from governments and international collaboration on technology standardization.
- Clean Hydrogen: The success of hydrogen as a clean energy source depends on reducing the cost of green hydrogen production, developing robust storage and transportation infrastructure, and harmonizing regulations across economies to facilitate trade and investment.

For these technologies to become both affordable and reliable, continued investment in research and development (R&D) is essential, alongside increased private sector participation and the establishment of global collaboration platforms to foster innovation. Additionally, policy incentives are needed to drive market adoption.

To accelerate commercialization, efforts must also focus on enhancing market competitiveness while simultaneously fostering public awareness and acceptance. Strengthening stakeholder engagement will be critical to ensuring broad societal support and smooth integration of these technologies into the energy landscape.

In Conclusion

In conclusion, achieving power sector decarbonization requires a comprehensive and integrated approach, built on clear policy direction, sustainable technology development, and international cooperation. Governments must ensure long-term policy stability, while

addressing technological and financial barriers through collaborative mechanisms with the private sector. Simultaneously, strengthening international standardization and cooperation will be essential in accelerating the energy transition across APEC economies.

Given the urgency of the climate crisis, decarbonization is no longer just an environmental goal, but a critical necessity for economic and social sustainability. APEC economies have a key role to play in leading global efforts toward net-zero, leveraging collaboration, innovation and collective action to build a more sustainable and resilient energy future.

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