Study on Sustainable Supply Chains in the APEC Region

APEC Committee on Trade and Investment

May 2026

Asia-Pacific
Economic Cooperation

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APEC Project: CTI 103 2024A

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APEC#226-CT-01.8

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Executive Summary

This report on sustainable supply chains in the Asia-Pacific Economic Cooperation (APEC) region outlines the evolving landscape of global supply chains, driven by the increasing integration of international trade and the increasing interest in environmental sustainability. While global supply chains have been associated with economic growth, concerns have also been raised about their possible environmental impacts, particularly with regard to carbon emissions. In this context, regulatory initiatives and shifting consumer expectations are among the factors encouraging consideration of more sustainable practices.

This study aims to strengthen knowledge and collaboration on sustainability within APEC's supply chains by conceptualizing what can contribute to sustainable supply chains, reviewing existing APEC projects, evaluating environmental policies in the APEC region and identifying enabling conditions for the widespread adoption of sustainable practices.

While there is no universally accepted definition, the concept of sustainable supply chains can be defined, for the purposes of this report, as one that integrates environmental, social and economic sustainability into its operations. This includes reducing negative environmental impact, adhering to fair labor practices and ensuring long-term economic viability.

Among the various components of sustainable supply chains, this report focuses on the environmental sustainability. This focus is driven by the growing importance of sustainable supply chains, spurred by environmental concerns and an increasingly stringent regulatory environment. This report highlights APEC's various projects aimed at enhancing supply chain resilience and sustainability, noting that while progress has been made, more robust and targeted efforts are needed for economies that seek to align with the global shift towards a more resource efficient economy.

Global policies like the Greenhouse Gas Reduction Strategy by the International Maritime Organization (IMO) are also impacting supply chains, particularly in the context of APEC economies. These policies are pushing companies to adopt cleaner technologies, improve energy efficiency and engage in sustainable practices to remain competitive.

To address global policy challenges related to, pollution and environmental degradation within

APEC, this report underscores the importance of GHG emissions reduction, energy efficiency and the circular economy. Energy efficiency reduces carbon footprints while enhancing competitiveness. A circular economy fosters resource efficiency, minimizes waste and strengthens economic resilience. By incorporating these elements into their supply chains, we expect that APEC economies can create long-term value, strengthen resilience and meet the increasing demand for sustainability.

To identify strategies for achieving sustainable supply chains, this report delves into the approaches adopted by both international organizations and individual APEC economies. Initially, the report examines the strategies employed by various international organizations to promote sustainable supply chains. It focuses on the United Nations Industrial Development Organization (UNIDO), the World Bank, the Organisation for Economic Co-operation and Development (OECD), the United Nations Global Compact and the World Trade Organization (WTO). The report finds that these organizations are collectively working to advance sustainable supply chains by addressing environmental impacts, fostering collaboration among stakeholders and implementing practical measures.

The report also examines the strategies adopted by APEC economies towards sustainable supply chains, focusing on the People's Republic of China and the Republic of Korea. The Republic of Korea has implemented several policies aimed at fostering sustainable supply chains by reducing GHG emissions and mitigating the environmental impact of economic activities. These efforts focus on three key components: GHG emissions reduction, energy efficiency and promoting the circular economy. Notable initiatives include the Carbon Neutrality by 2050 goal, support for SMEs in high-emission sectors to reduce emissions in manufacturing and the development of a balanced, energy mix that ensures sustainability.

The People's Republic of China has demonstrated multiple policy initiatives in fostering sustainable supply chains, particularly focused on reducing environmental impacts and promoting the circular economy. A key initiative is the Circular Economy of EV Batteries, which focuses on the reuse and recycling of lithium batteries from electric vehicles.

The report concludes with potential policy recommendations for consideration by APEC economies, proposing an initiative for environmentally sustainable supply chains within APEC economies. This includes promoting three key components of sustainable supply chains: GHG emissions reduction, energy efficiency and the circular economy. We propose the APEC economies can support this goal by establishing forums and workshops for knowledge sharing, creating a Sustainable Supply Chain Fund and developing a handbook for small and medium-sized enterprises to enhance sustainability in their operations. These APEC-wide measures aim to foster resilience and sustainability in supply chains, aligning with both regional and global sustainability goals.

[DISCLAIMER: The contents of this report are based on the authors' research and the reports of various international organizations and economies examples cited. The views expressed by the authors, international organizations, and economies cited does not necessarily reflect of the consensus view of APEC economies. This report and the analyses contained therein is for discussion purposes only.]

I. Introduction

A. Background

In the past decade, global supply chains have emerged as a primary driver of international trade, fostering economic growth and job creation worldwide (Park et al., 2023). Reductions in international trade costs, both direct and indirect, have enabled the globalization of production processes, leading to the widespread adoption of a global division of labor. This has resulted in a more fragmented production landscape, with different stages of production undertaken in locations that offer the most competitive combination of cost, quality and skillset availability.

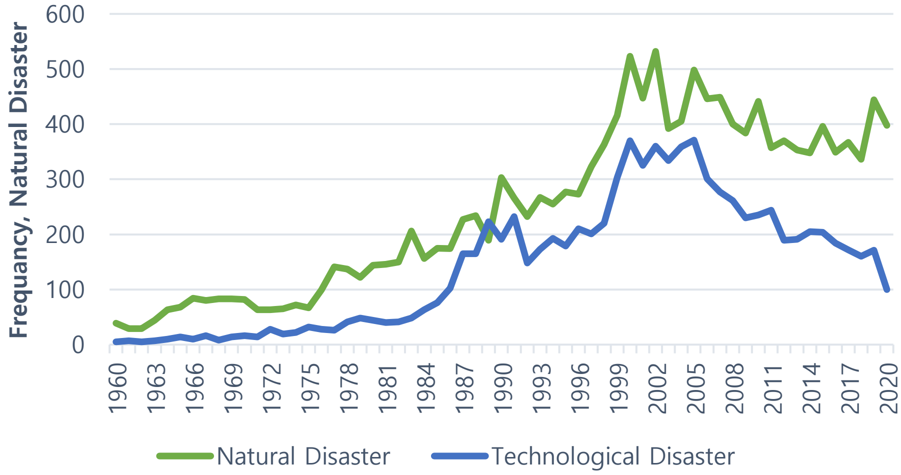
While the globalization of production has yielded undeniable economic benefits, concerns regarding its environmental footprint are rising.(Elhedhli & Merrick, 2012) In response, a confluence of regulatory and consumer pressures is pushing for a more sustainable approach. Many economies are implementing stricter environmental standards (Sauvage, 2014) with consumers increasingly demanding transparency and eco-friendly practices throughout the product lifecycle. This evolving landscape presents a significant challenge for companies, who must now balance cost-effectiveness with environmental responsibility while navigating an increasingly complex regulatory framework.

Changing weather patterns are one of the challenges to global supply chains, as its impacts manifest in the form of extreme weather events, rising sea levels and disruptions to ecosystems. These disruptions can lead to infrastructure damage, production delay and transportation disruptions, ultimately impacting the flow of goods and services across supply chains.

To illustrate the impact of these environmental fluctuations, consider the increasing frequency and intensity of natural disasters. These events pose a significant threat to global supply chains, as they can disrupt critical infrastructure, such as ports, roads and power grids. For instance, the 2011 Tohoku earthquake and tsunami caused an estimated USD200-300 billion in damage to Japanese infrastructure, disrupting production and logistics for numerous industries (Danninger & Kang, 2011).

[Figure 1-1] Global Occurrence of Natural and Technological Disaster (1960-2020)

(Unit: Number of Occurrence)



Source: Han et al., 2021p.68. Author's calculation based on EM-DAT global disaster dataset.

While technological advancements have contributed to a decline in the number of technology-related disasters, natural disasters remain a persistent threat. The 2010 Eyjafjallajökull volcanic eruption in Iceland caused widespread air travel disruptions, costing airlines billions of dollars and impacting global trade (Gertisser, 2010). Similarly, the 2011 Southeast Asian floods caused extensive damage to manufacturing facilities and transportation networks in Thailand, disrupting supply chains for multinational corporations (Boonyabancha & Archer, 2011).

The intertwined nature of environmental changes, the green economy, and international trade and investment underscores the anticipated impact on global supply chains, which have been the driving force behind decades of global growth. As natural disasters intensify and the green economy gains momentum, supply chains face the dual challenge of adapting to a more sustainable and resilient future while maintaining their efficiency and competitiveness.

Numerous APEC economies actively participate in global supply chains, recognizing the need for environmentally sustainable policies. The transition to a green economy presents both opportunities and challenges for APEC economies, as it necessitates a comprehensive approach that encompasses technological advancements, regulatory frameworks and stakeholder collaboration.

At the heart of this transformation lies the critical role of businesses, the primary actors in production processes. Businesses must embrace sustainable practices, invest in eco-friendly technologies and collaborate with supply chain partners to reduce their environmental footprint. Governments play a pivotal role in facilitating this transition by providing supportive policies, such as tax incentives, research and development funding and infrastructure investments.

B. Objective of the Study

This study seeks to strengthen knowledge and collaboration on sustainability and climate resilience within APEC's supply chains. To achieve this objective, the research delves into the concept of sustainable supply chains and analyzes the current environmental policies impacting APEC member economies. Additionally, the study reviews existing APEC initiatives related to supply chains. Leveraging this analysis, the research will propose concrete policy recommendations that incentivize the widespread adoption of best practices, environmentally friendly technologies and investments across APEC economies.

The study will employ a four-pronged approach to achieve its objectives:

- ***Conceptualize Sustainable Supply Chains***: This step will involve defining and establishing a clear understanding of what constitutes a sustainable supply chain within the context of APEC economies.
- ***Review Existing APEC Supply Chain Projects***: The study will comprehensively examine existing APEC projects and initiatives related to supply chains to identify potential synergies and areas for improvement.
- ***Evaluate Global Environmental Policies and Regulations***: This phase will assess the current landscape of global environmental policies and regulations that impact supply chains within APEC economies.
- ***Identify Enabling Conditions for Achieving Sustainable Supply Chains***: Based on the preceding analyses, this step will determine the key conditions and factors necessary to facilitate the widespread adoption of sustainable practices within APEC's

supply chains.

- ***Delve into Best Practices in International Organization and APEC Economies:*** The study will analyze the strategies of various agents towards sustainable supply chains, including firm-level case studies.

II. Concept of Sustainable Supply Chains

A. Definition

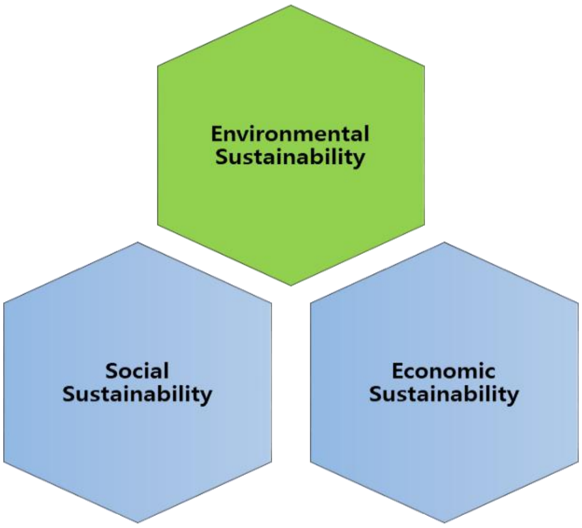
A universally accepted definition of sustainable supply chain remains elusive. Consequently, there is a need, for the purpose of this report, to re-examine and redefine the concept of sustainable supply chains, drawing inspiration from the principles outlined in the United Nations Global Compact. (United Nations Global Compact & BSR, 2015)

> *"Supply chain sustainability" is the management of environmental, social and economic impacts, and the encouragement of good governance practices throughout the lifecycles of goods and services. – United Nations Global Compact*

The United Nations Global Compact (UN Global Compact) emphasized the critical components of a sustainable supply chain, including environmental responsibility, social sustainability and economic sustainability.

Based on these fundamental components, sustainable supply chains can be defined as the integration of environmental, social and economic factors into the management of supply chains. This encompasses reducing environmental impacts, improving labor conditions and promoting economic inclusivity across all stages of the supply chain. It aims to ensure that products are produced under fair working conditions, with minimal environmental harm and in a manner that supports long-term economic development.

[Figure 2-1] Key Components of Sustainable Supply Chains



To achieve a sustainable supply chain, the following initiatives are essential:

- ***Environmental Sustainability***: Prioritizing the reduction of negative environmental impact by implementing sustainable practices such as optimizing energy usage, minimizing carbon emission and utilizing low-emissions energy sources.
- ***Social Sustainability***: Identifying and managing business impacts, both positive and negative, on people.
- ***Economic Sustainability***: Ensuring the long-term viability of the supply chain through efficient operations, cost management, innovation.

- ## The Importance of Sustainable Supply Chains

In recent years, the importance of sustainable supply chains has grown significantly. Three key factors are driving this shift.

Firstly, the environmental impact of global supply chains has become one of the pressing concerns. A major contributor to greenhouse gas emissions, these networks are a critical focus for ensuring supply chain resilience. For instance, the Climate Action 100+ initiative identified that multinational enterprises (MNEs) and their supply chains are responsible for a staggering 60% of global industrial carbon emissions (UNIDO, 2023, p. 13). This data underscores the urgent need for sustainable practices throughout the supply chain to reduce overall environmental footprint.

Secondly, recent global turbulence has exposed the vulnerabilities of traditional supply chains. Natural disasters, the COVID-19 pandemic and economic volatility has created a ripple effect of disruptions. Issues like inflation, fluctuating energy costs have highlighted the need for greater resilience and sustainability within these networks. Sustainable practices can help build a more robust supply chain infrastructure, better equipped to weather future disruptions.

Finally, the regulatory landscape is shifting towards increased accountability for businesses. A wave of mandatory due diligence legislation is emerging in some regions. These regulations, targeting specific sectors or issues, require companies to identify and mitigate potential environmental and human rights risks within their supply chains.

Additionally, some economies have introduced mandatory ESG reporting frameworks to enhance businesses' transparency and accountability (UNIDO, 2023, p. 21). This evolving regulatory landscape, coupled with growing consumer awareness and brand reputation concerns, creates a strong incentive for businesses to prioritize sustainable supply chain practices.

B. Sustainable Supply Chains in the Context of APEC Economies

To comprehend the perception and advancement of sustainable supply chains within APEC economies, examining past projects implemented in these regions offers a valuable starting point.

The APEC has initiated a series of projects aimed at enhancing the resilience and sustainable of supply chains within the Asia-Pacific region. These initiatives span across various domains including resilience to global disruptions and Small and Medium-sized Enterprises (SMEs) participation, each spearheaded by different working groups and proposing economies.

[Table 2-1] APEC's Supply Chain Projects

Project Name	Year	Forum/Working Group	Proposing Economy
Retailing Services - Potential for and Challenges to Enhancing SME Participation in Supply Chains in APEC	2012	Group on Services (GOS)	Indonesia
Environmental Performance and Energy Efficiency of Supply Chains - Carbon Footprint Proposal (Phase 1): Study to Develop a Methodology for Ocean-Going Vessels	2013	Transportation Working Group (TPTWG)	Canada
Research and Assessment of Prospects for Development of An Integrated Information Tool to Stimulate Involvement of SMEs of the Asia-Pacific Region into the Global Trade System, Global Production and Supply Chains	2013	Small and Medium Enterprises Working Group (SMEWG)	The Russian Federation
Workshop on Micro, Small and Medium Enterprises (MSMEs) and the Role of Trade Secrets in Securing Financing and Integration into Global Supply Chains	2015	Intellectual Property Rights Experts Group (IPEG)	United States
Implementing Workshop on Work Life Quality and Quality Growth under Global Supply Chains in APEC Economies	2016	Human Resource Development Working Group (HRDWG)	Chinese Taipei
Stock-take of APEC Projects Promoting the Resilience of Supply Chains in the Asia-Pacific Region	2017	Transportation Working Group (TPTWG)	The United States
Building Resilient Supply Chains 2020: Survey and Analysis	2020	Committee on Trade and Investment (CTI)	Australia
Toward Building Resilient Supply Chains - A Possible Role of Investment Policy	2020	Committee on Trade and Investment (CTI)	Japan
Increasing Pandemic Preparedness and Prevention in the Asia-Pacific Region through Improving Health Supply	2022	Health Working Group (HWG)	The United States

Chains			
APEC Workshop on Strengthening Supply Chains Resilience for Economic Recovery	2022	Economic Committee (EC)	People's Republic of China
Literature Review on Cooperation of Data Flows and Cross-Border Payments to Support Digitalized Supply Chains among APEC Economies	2023	Committee on Trade and Investment (CTI)	People's Republic of China

Source: APEC Homepage. https://aimp2.apec.org/sites/PDB/default.aspx

One of initiating projects is the "Retailing Services - Potential for and Challenges to Enhancing SME Participation in Supply Chains in APEC," proposed by Indonesia in 2012 under the Group on Services (GOS). This project explores the potential for small and medium-sized enterprises (SMEs) in the retail sector to participate more effectively in supply chains across the APEC region, identifying key barriers and proposing strategies to overcome them. Similarly, the 2013 project "Research and Assessment of Prospects for Development of An Integrated Information Tool to Stimulate Involvement of SMEs of the Asia-Pacific Region into the Global Trade System Global Production and Supply Chains," proposed by the Russian Federation under the Small and Medium Enterprises Working Group (SMEWG), aims to create an integrated information tool to enhance SMEs involvement in global production and supply chains.

The United States also proposed the 2017 "Stock-take of APEC Projects Promoting the Resilience of Supply Chains in the Asia-Pacific Region" under the Transportation Working Group (TPTWG), which reviews APEC projects aimed at enhancing supply chain resilience, identifying best practices and lessons learned. In 2020, Australia proposed "Building Resilient Supply Chains 2020: Survey and Analysis" under the Committee on Trade and Investment (CTI), providing a comprehensive survey and analysis to assess supply chain vulnerabilities and propose strategies for enhancement. Similarly, Japan's 2020 initiative, "Toward Building Resilient Supply Chains - A Possible Role of Investment Policy," also under CTI, explores the role of investment policy in building resilient supply chains and suggests policy measures to support sustainable investment in supply chain infrastructure.

The role of trade secrets in securing financing and integration into global supply chains for Micro, Small and Medium enterprises (MSMEs) was addressed by the United States in the

2015 "Workshop on MSMEs and the Role of Trade Secrets," under the Intellectual Property Rights Experts Group (IPEG).

Recent initiatives have also addressed the challenges posed by the COVID-19 pandemic. The 2022 project "Increasing Pandemic Preparedness and Prevention in the Asia-Pacific Region through Improving Health Supply Chains," proposed by the United States under the Health Working Group (HWG), aims to enhance health supply chains to improve pandemic preparedness and prevention. In the same year, the People’s Republic of China proposed the "APEC Workshop on Strengthening Supply Chains Resilience for Economic Recovery" under the Economic Committee (EC), focusing on strategies to bolster supply chain resilience as part of post-pandemic economic recovery efforts.

Lastly, the 2023 project "Literature Review on Cooperation of Data Flows and Cross-Border Payments to Support Digitalized Supply Chains among APEC Economies," proposed by the People’s Republic of China under the Committee on Trade and Investment (CTI), reviews existing literature on the cooperation of data flows and cross-border payments. This project identifies gaps and proposes solutions to enhance digital integration, supporting the transition to more digitalized supply chains.

These projects collectively aim to address the multifaceted challenges faced by supply chains in the APEC economies. By leveraging collaborative efforts across different working groups and proposing economies, APEC strives to build more integrated, efficient and resilient supply chains.

Within the identified supply chain initiatives, two projects demonstrably align with the principles of sustainable supply chain management. One significant project is the "Environmental Performance and Energy Efficiency of Supply Chains - Carbon Footprint Proposal (Phase 1)," proposed by Canada in 2013 under the Transportation Working Group (TPTWG). This initiative aims to develop a methodology to measure the carbon footprint of ocean-going vessels, thereby improving environmental performance and energy efficiency within maritime supply chains.

Additionally, Chinese Taipei's 2016 project under the Human Resource Development Working Group (HRDWG), "Implementing Workshop on Work Life Quality and Quality Growth under

Global Supply Chains in APEC Economies," focuses on improving work-life quality and achieving quality growth within global supply chains.

While recent APEC projects have addressed a broad range of supply chain issues, the growing global momentum towards a green economy necessitates a more robust approach from APEC. Specifically, there is a need for a targeted initiative that fosters the development and implementation of "environmentally sustainable supply chain practices" related across APEC member economies.

This is because many economies in APEC acknowledge the importance of sustainable supply chains, with economies committed to reducing carbon emissions and achieving sustainability within supply chains. The table in the document details the net zero targets and their legal status for various APEC member economies. This overview highlights the varied timelines and legal frameworks adopted by these economies in their pursuit of net zero emissions.

[Table 2-2] APEC's Pledge for Net-Zero Emissions

Economy	Net Zero	Status
Australia	2050	In Law
Brunei Darussalam	-	-
Canada	2020	In Law
Chile	2050	In Law
People's Republic of China	2060	In policy document
Indonesia	2060	Proposed/In Discussion
Japan	2050	In Law
Republic of Korea	2050	In Law
Malaysia	2050	In Policy Document
Mexico	-	-
New Zealand	2050	In Law
Papua New Guinea	2050	In Policy Document
Peru	2050	In Policy Document
The Republic of the Philippines	-	-
The Russian Federation	2060	In Policy Document
Singapore	2050	In Law
Thailand	2065	In Law
The United States	2050	In Policy Document
Viet Nam	2050	In Policy Document

Source: https://zerotracker.net/

Australia has set its net zero target for 2050, which is enshrined in law, demonstrating a strong legislative commitment to achieving this goal. Similarly, Canada has already established its net zero target for 2020, also codified into law, indicating its proactive approach in addressing carbon emissions early on. Several other APEC economies, including Chile; Japan; Korea; New Zealand; and Singapore, have also committed to achieving net zero by 2050, with these targets being incorporated into their respective domestic laws. This legal backing signifies a robust framework for implementing and monitoring progress towards these goals.

the People's Republic of China and Indonesia have set their net zero targets for 2060. In Indonesia, this target is currently under discussion and has not yet been formalized into law, reflecting an ongoing policy development process. The People's Republic of China, on the other hand, has included its 2060 target within policy documents, indicating a strategic plan to achieve this long-term goal. Papua New Guinea; Peru; the United States; and Viet Nam have all documented their net zero targets for 2050 within policy documents, suggesting a policy-driven approach to achieving these emissions reductions. This approach allows for strategic planning and coordination across various sectors to meet the set targets. The Russian Federation has set its net zero target for 2060, included in policy documents, indicating a planned and strategic approach towards achieving carbon neutrality. Meanwhile, Thailand has set a more extended target date of 2065, which is backed by legislation, demonstrating a commitment to a gradual transition to net zero emissions.

However, some APEC economies, such as Brunei Darussalam; Mexico; and the Republic of the Philippines, have not provided specific net zero target dates or formalized their commitments in law or policy documents. This absence highlights areas where further development and commitment may be necessary to align with regional and global sustainability goals.

All in all, the table reflects a range of commitments and approaches among APEC economies towards achieving net zero emissions. While several economies have set ambitious targets backed by legal frameworks, others are still in the process of defining and formalizing their goals. These varying timelines and legal statuses underscore the need for continued collaboration and support within the APEC framework to achieve sustainable supply chains and overall environmental sustainability.

III.Global Policies on Sustainable Supply Chains

In response to pressing environmental concerns, numerous economies, including within APEC regions are actively working to establish eco-friendly production environments. The landscape of the global supply chain is being significantly influenced by the implementation of various international environmental policies. Notable examples include:

- ***International Maritime Organization (IMO)'s Greenhouse Gas Reduction Strategy for International Shipping***: Reducing greenhouse gas emissions from international shipping.

A. IMO: Greenhouse Gas Reduction Strategy for International Shipping

1) Backgrounds and Objective

On 7 July 2023, the International Maritime Organization (IMO) adopted the "2023 IMO Strategy on Reduction of GHG Emissions from Ships", to achieve carbon neutrality in the sector by 2050. The IMO sought to align with efforts towards a future where maritime transport operates with significantly reduced greenhouse gas emissions.

2) Obligations and Scope

First, it establishes a net-zero greenhouse gas emissions target for international shipping by or around 2050. To achieve this, a phased approach outlines interim targets, including utilizing low- and zero-carbon fuels for 5-10% of the total energy mix by 2030 and achieving at least a 70% reduction in total greenhouse gas emissions by 2040 compared to 2008 levels.

Recognizing the varying circumstances of different economies, the strategy allows for a flexible approach when setting targets and implementing policies.

- **2030 Target**: Uptake of zero or near-zero GHG emissions technologies, fuels, and/or energy sources to represent at least 5%, striving for 10% of the energy used by international shipping by 2030.
- **2030 GHG Reduction Target**: Reduce total greenhouse gas emissions by at least 20% (with efforts towards 30%) compared to 2008 levels by 2030.
- **2040 GHG Reduction Target**: Achieve at least a 70% reduction in total greenhouse gas emissions (with efforts towards 80%) compared to 2008 levels by 2040.

Secondly, the strategy calls for the implementation of stricter fuel oil standards and greenhouse gas pricing mechanisms (Jegou et al., 2023). These measures incentivize a shift towards cleaner fuels by progressively limiting the use of fossil fuels and assigning a cost to emitted greenhouse gases. To maximize impact, the strategy promotes a combined approach utilizing both methods. The implementation is scheduled possibly to enter into force on March 2028, preceded by an impact assessment and discussions on specific measures.

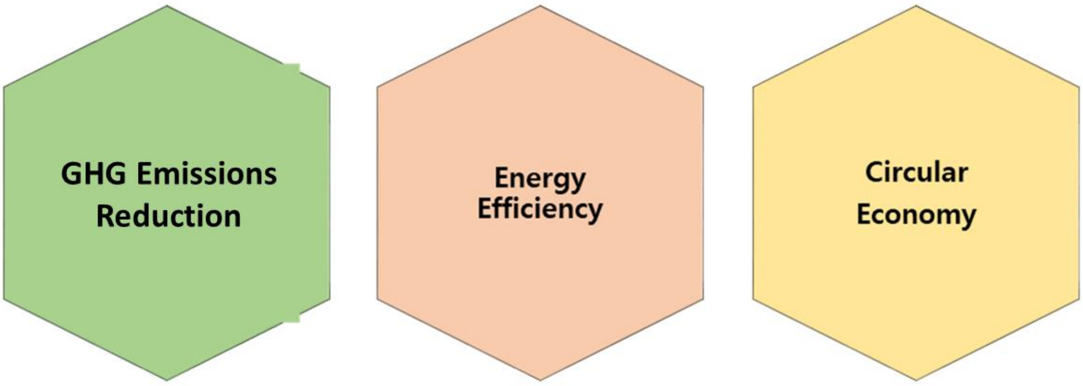
3) Assessment and Implication for APEC economies

While the IMO's greenhouse gas reduction strategy for international shipping sets ambitious goals, achieving them hinges on overcoming significant challenges: securing financial and technical support for developing economies, fostering enhanced international cooperation and regulatory alignment, accelerating the development and affordability of new technologies, and ensuring the continued competitiveness of the shipping industry in pursuit of global climate objectives.

IV. Facilitating Environmental Sustainability in Supply Chains

Within the Asia-Pacific Economic Cooperation (APEC) forum, member economies increasingly recognize the vital importance of sustainable supply chains. They understand that long-term economic prosperity and environmental well-being are interconnected. However, the region faces significant threats from environmental degradation. To address these challenges and foster resilient and sustainable supply chains within APEC, this research highlights the crucial role of GHG emissions reduction, energy efficiency and the circular economy.

[Graph 4-1] The Components for Environmental Sustainability in Supply Chains



Restoring and building a sustainable supply chain through GHG emissions reduction, energy efficiency and the circular economy is not only a moral imperative but also a strategic necessity. These components provide businesses with the tools to mitigate risks, reduce costs, comply with regulations, enhance competitiveness and meet the growing demand for sustainability from consumers and investors alike. By integrating these elements into their supply chains, companies can create long-term value, ensuring their operations are resilient, responsible and profitable in the face of global challenges.

A. GHG Emissions Reduction

GHG emissions reduction refers to reducing carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions within the supply chain. This is important for ensuring long-term economic viability as regulatory and consumer pressures increase.

- **Regulatory Compliance**: Governments are increasingly implementing stringent regulations aimed at reducing carbon emissions.
- **Investor Appeal**: Investors are increasingly prioritizing Environmental, Social and Governance (ESG) factors. Companies with ESG strategies are more likely to attract investment. BlackRock, for example, has emphasized that climate risk is investment risk, influencing many companies to adopt aggressive GHG emission reduction targets.

B. Energy Efficiency

Energy efficiency in the supply chain refers to the optimization of energy use by using less energy while delivering the same service and lower operating costs (Marchi & Zanoni, 2017, p.2). It is one of the key elements of sustainability, helping companies reduce their environmental impact while improving profitability.

- **Reduced Carbon Footprint**: Improving energy efficiency directly contributes to GHG emissions reductions by lowering the amount of energy required. For example, the use of energy-efficient machinery and vehicles in manufacturing and logistics reduces fuel consumption and emissions.
- **Enhanced Competitiveness**: Companies that invest in energy efficiency are better positioned to compete in markets where energy costs are high or where energy is a significant portion of operating expenses. This is particularly true in energy-intensive industries like manufacturing and logistics.

C. Circular Economy

The circular economy is an economic system that aims to minimize pollution and waste, extend product lifecycle and enable broad sharing of physical and natural assets. In the context of supply chains, it involves designing products and processes that enable the reuse, recycling and regeneration of materials.

- **Resource Efficiency**: The circular economy promotes the efficient use of resources by designing products for longevity, reparability and recyclability. This reduces the demand for virgin materials and lowers the environmental impact of resource extraction and processing.
- **Waste Reduction**: By adopting circular practices, companies can significantly reduce waste. For instance, China has developed comprehensive policies for the collection, recycling, and reuse of EV lithium batteries. Extended Producer Responsibility (EPR) requires manufacturers to take back spent batteries, fostering reuse in energy storage products and recycling valuable metals.
- **Economic Resilience**: A circular economy approach makes supply chains more resilient to resource scarcity and price volatility. By relying less on finite resources and more on regenerative practices, companies can better manage risks associated with raw material shortages and fluctuating prices.

V. Recommendations from International Organizations

In this chapter, we will discuss the strategies employed by International Organizations to foster sustainable supply chains within their respective organizations.

A. UNIDO

The United Nations Industrial Development Organization (UNIDO)'s recent efforts to promote sustainable supply chains are comprehensively documented in numerous reports. One publication, "UNIDO and Sustainable Supply Chains" (August 2023), provides a detailed analysis of the complexities and challenges inherent in contemporary global supply chains, with a particular focus on the environmental and social implications of globalization. In this report, UNIDO's pivotal role in transitioning these supply chains into sustainable, equitable, environmentally friendly and economically inclusive systems is highlighted.

1) Global Context and Challenges

As outlined in the report, the UNIDO acknowledges that globalization has fostered intricate supply chains, with approximately 80% of global trade dependent on these networks. However, UNIDO highlights that the complexity of these supply chains can lead to suboptimal production conditions, particularly regarding environmental impact. For example, the textile industry contributes to 20% of global wastewater annually, exacerbating environmental degradation.

In response to these challenges, the UNIDO notes that governments have enacted new regulatory requirements, such as due diligence legislation focused on human rights and environmental impacts. While the UNIDO acknowledges the necessity of such regulations, it also expresses concern that they may pose significant challenges for small and medium-sized enterprises (SMEs) in developing economies, potentially creating trade barriers and limiting their participation in global markets.

2) The Role and Approach

UNIDO aims to facilitate the transformation of global supply chains by focusing on several key areas:

- **Value Addition**: UNIDO works to enhance the incomes of producers, especially at the early stages of supply chains, by promoting product diversification and value addition. An example is the use of Agro-Industrial Parks, which attract investments in agro-processing, thereby creating jobs, increasing farmers' incomes and boosting export revenues.
- **Standard Compliance**: UNIDO assists economies in building institutional and policy

capacities to meet international standards. For instance, in Peru, UNIDO strengthened the infrastructure, supporting coffee and cocoa producers in complying with technical standards, enabling them to sell at premium prices.

- **Skills Development**: UNIDO enhances skills required for participation in sustainable supply chains. For example, in the textile and leather industries, UNIDO has helped adopt safer production practices, improving occupational health and safety. Through the Public-Private Development Partnership (PPDP) and Market Development Systems (MDS) approaches, UNIDO provides training on Environmental, Social and Governance (ESG) matters.
- **Resource Efficiency**: UNIDO promotes sustainable supply chains by encouraging circular economy practices and Eco-Industrial Parks. In the southern Mediterranean, for example, UNIDO supports changes in production and consumption patterns through tools and services aimed directly at the private sector.
- **Sustainable Investment**: UNIDO advances economically inclusive supply chains by focusing on SME development. Tools like the Computer Model for Feasibility Analysis and Reporting (COMFAR) and gender equality investment strategies are used to strengthen investment promotion in Africa, the Caribbean, and the Pacific.

The UNIDO emphasizes the need for international agencies to foster sustainable supply chains through a three-tiered approach: global, national and local levels.

- **Macro & Global**: UNIDO acts as a global convener, bringing together diverse stakeholders from various sectors and economies to promote sustainable supply chains. This includes facilitating discussions and collaborations that address global challenges.
- **Meso (Domestic/Regional)**: UNIDO assists governments in analyzing policies and developing guidelines to comply with new due diligence requirements. This includes harmonizing sustainability regulations and simplifying them for better understanding and implementation.
- **Micro (Local)**: At the local level, UNIDO focuses on supplier development and

capacity building. This helps companies, particularly in developing economies, to meet sustainability standards and benefit from the transition to sustainable production.

Furthermore, the UNIDO proposes collaborating closely with a diverse range of partners, including UN agencies such as the International Labour Organization (ILO), International Trade Centre (ITC), OECD, industry associations, multinational corporations and Multi-Stakeholder Initiatives (MSIs) like Fairtrade International. Such collaborative efforts are crucial for effectively addressing the challenges prevalent in global supply chains.

3) Key Projects and Case Studies

One of the prominent projects by UNIDO lies in Morocco automotive sector. In collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and with funding from German Federal Ministry for Economic Cooperation and Development (BMZ), UNIDO is improving trade compliance and competitiveness in Morocco's automotive industry. The initiative focuses on enhancing sustainability reporting and monitoring mechanisms among local SMEs to prepare them for future due diligence regulations.

This example illustrates how International Organizations like the UNIDO approach and implement projects related to sustainable supply chains. This case study, while it is not within the APEC region, highlights broader international practices and frameworks that may offer relevant insights or models for APEC economies by contextualizing APEC's efforts within the wider global landscape.

B. World Bank

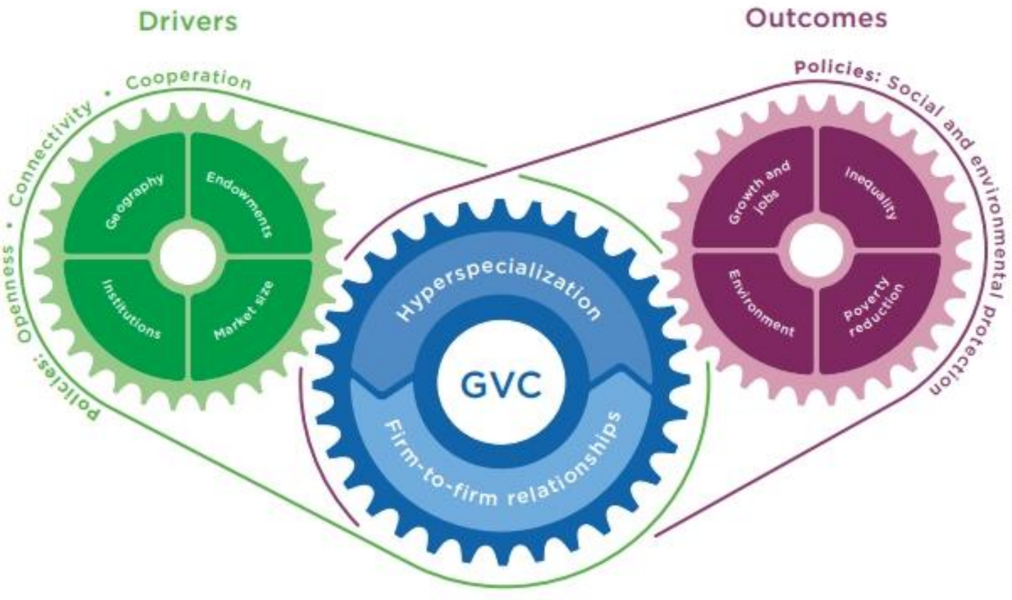
The World Bank offers an in-depth view on Global Value Chains (GVCs) in its publication, ‘Trading for Development in the Age of Global Value Chains (The World Bank, 2020).’ Despite a recent slowdown in GVC expansion, trade continues to drive prosperity. While GVCs have fostered growth, created jobs and helped reduce poverty, they have also been associated with increased inequality and environmental degradation. Consequently, the World Bank stresses that the advantages of participating in GVCs can be sustained if participants focus on improving social and environmental protections.

1) Global Context and World Bank's Approach

Hyper-specialization and strong firm-to-firm relationships enhance production efficiency along value chains, leading to increased productivity and income growth. GVCs contribute to higher income and more productive employment, which can also help reduce poverty (See Figure 5-1). However, issues such as poor working conditions, safety concerns and environmental impact have raised public awareness and calls for improvement.

The World Bank emphasizes that GVSs can support environmentally sustainable production models if economies implement suitable measures, including proper pricing, regulations and cooperative arrangements. Effective coordination among domestic regulators, international development organizations and the private sector is essential to tackle the challenges associated with GVCs.

[Figure 5-1] Global Value Chains



Source: The World Bank, 2020

2) Supply Chain's Impact on the Environment

GVCs often have a greater environmental impact compared to standard trade, but they also drive innovation, leading to the development of less environmentally damaging products and processes. The World Bank examines the overall environmental impact of GVCs through three dimensions: the scale effect, the composition effect and the technique effect.

The scale effect highlights that as GVCs expand and economic activity grows, adverse environmental impacts tend to increase. This is due to higher waste production and increased shipping activities, which further escalate environmental costs. More intensive transportation, including the frequent movement of goods over long distances, contributes to higher CO_2 emissions. While the maritime sector contributes approximately 2% of global CO_2 emissions, it remains an important area for GHG emissions reductions, particularly given its role in transporting over 80 percent of global trade by volume. Additionally, the amount and type of waste generated during production and transport of goods from the source to the consumer, can be influenced by GVCs. (The World Bank, 2020, p.123)

The composition effect addressed how tasks are distributed globally. As environmental regulations become stricter in some economies, there may be a shift of more polluting tasks to economies with looser standards. This shift can lead to environmental benefits for economies with stricter regulations while increasing environmental cost for those with less stringent standards. For developing economies, the composition effect highlights the difficult challenge of balancing the need for climate action with ongoing socio-economic development.

The technique effect describes how knowledge transfer, high rates of innovation and market concentration within GVC networks can foster the development of more environmentally friendly technologies and higher environmental standards. This effect has led to the creation of innovative environmental products, such as those related to low-emissions energy and electric vehicles.

3) Policies for Sustainable Supply Chains

The World Bank highlights the importance of policy measures to address the negative social and environmental impacts of GVCs and to encourage the adoption of environmentally friendly technologies for sustainable supply chains. Key policy recommendations include:

- **Supporting Economic Inclusion**: Policies should facilitate the distribution of jobs and earnings generated through GVC participation, ensuring that women and youth are included and benefit from these opportunities.
- **Labor Adjustment Support**: In advanced economies, labor adjustment policies are necessary to support workers affect by factory closures due to GVC involvement, helping then transition to new employment opportunities.
- **Environmental Impact Mitigation**: Policies should aim to reduce negative environmental impacts and foster the adoption of green technologies. These efforts can be enhanced through global cooperation to directly address environmental issues and align trade agreements with environmental goals.
- **Improving Transparency**: Standardized international data on the environmental

impacts of firms within GVCs can reveal poor production and operational practices, providing incentives for firms to adopt better practices and improve their environmental performance.

Integrating environmental sustainability into production and governance models necessitates a multifaceted approach involving appropriate pricing, regulations and cooperative arrangements. Key strategies include:

- **Regulatory Policies**: Domestic policies can address externalities associated with supply chain activities, such as ensuring clean water, preventing overfishing and over-farming, curbing emissions and reducing reliance on disposable goods.
- **International Cooperation**: Global agreements, like the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), can be leveraged to implement and enforce common environmental regulations across economies.
- **Incentivizing Green Practices**: Promoting green goods and environmentally friendly production methods can be supported through, multilateral trade agreements focused on environmental goods, encouraging firms to adopt eco-industrial parks (EOPs) and providing standardized ratings to assess and to incentivize firms based on their environmental performance, including through environmental pricing.

C. OECD

The Organisation for Economic Co-operation and Development (OECD) emphasizes the need for collaborative actions involving governments, business and other organizations to promote the sustainable development of global supply chains. By providing a common framework applicable to global enterprises, the OECD encourages companies to systematically identify, assess and mitigate negative impacts associated with their operations and supply chains.

1) Global Context and OECD's Approach

Amid rising environmental and social risks in the supply chain, there has been a public consensus that these challenges demand prompt action from both the public and private sectors. Recognizing that businesses can significantly contribute to economic, social and environmental sustainability by minimizing the adverse impacts of their operations and supply chains, the OECD has developed due diligence guidance to provide practical support to global enterprises. The OECD has developed several sector-specific guidance to help companies identify risks to society and the environment in sectors such as minerals, garments and footwear, and agriculture.

2) Approach on Sustainability in Agriculture Supply Chains

Above all, "OECD-FAO Guidance for Responsible Agricultural Supply Chains (2016)" emphasizes recommendations on environmental due diligence. Given that climate change and environmental degradation pose growing threats to global food security, and that agriculture businesses face increasing public pressure to mitigate adverse environmental impacts, this guidance is crucial (OECD, 2016).[1] It aims to assist enterprises in adhering to international standards for responsible business conduct within agriculture supply chains by mitigating risks related to environmental, social and human rights impacts.

The businesses operating within agricultural supply chains encompass both upstream and downstream sectors, spanning from the provision of agricultural inputs to production, processing, transportation, marketing, distribution and retail. Depending on their position within the supply chain, these enterprises encounter varying risks, as illustrated in Figure 5-2.

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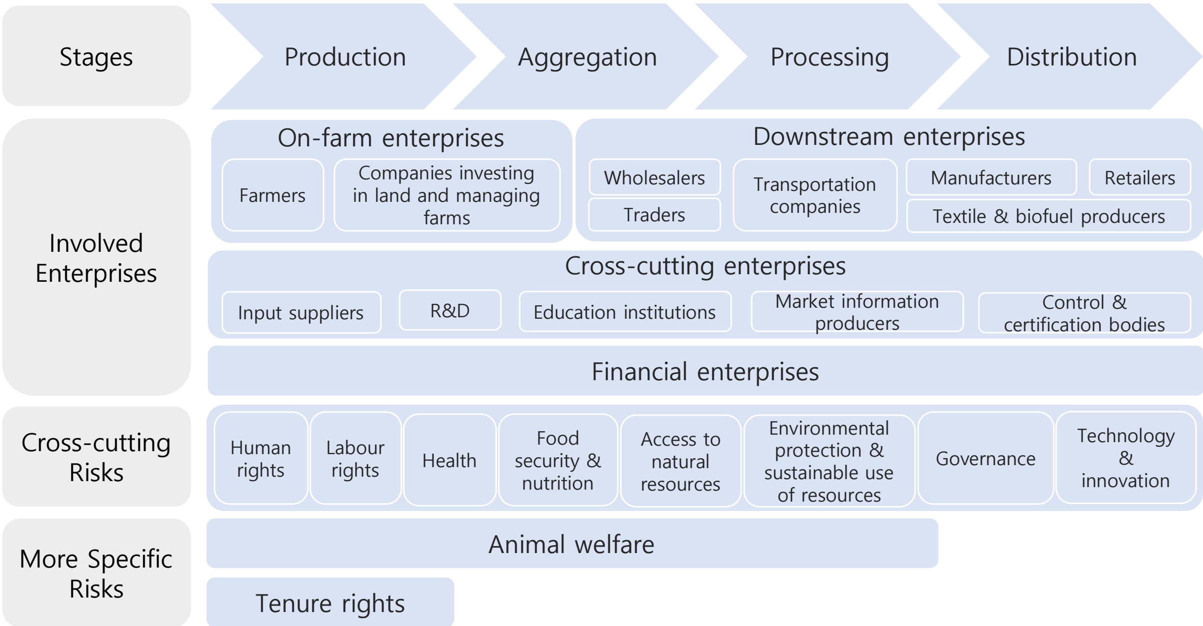
[1] The Guidance was developed jointly with the United Nations Food and Agriculture Organization (FAO).

[Figure 5-2] Enterprises Involved and Risks at Various Stages of the Agricultural Supply Chain



Source: Restructured by the author based on OECD, 2016

To test the practical application of the guidance report, the OECD launched several pilot projects with volunteer companies and industry initiatives. Conducted jointly with the United Nations Food and Agriculture Organization (FAO), one pilot project involved 27 companies and seven industry initiatives from February 2018 to October 2019. Another notable example, as part of the EU-OECD-ILO "Responsible Supply Chains in Asia" program, was carried out with companies in Myanmar (agriculture and seafood sector); the Philippines (food sector); Thailand (agriculture sector); and Viet Nam (seafood sector) from September 2019 to December 2020.

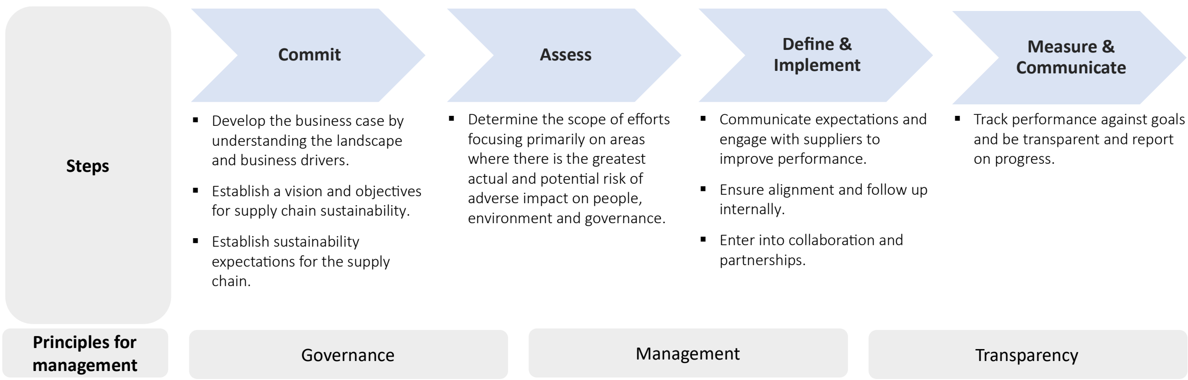
D. UN Global Compact

The UN Global Compact offers guidance through 'Supply Chain Sustainability: A Practical Guide for Continuous Improvement (United Nations Global Compact & BSR, 2015),' which details practical steps companies can follow to develop sustainable supply chains. An advisory group established under the UN Global Compact contributes to shaping the overall strategy on supply chain sustainability. This group ensures that the guidance material, along with various tools and resources, remains comprehensive and effectively meets the needs of businesses.

1) Global Context and UN Global Compact's Approach

According to the UN Global Compact (United Nations Global Compact & BSR, 2015), supply chain sustainability involves managing environmental, social and economic impacts while promoting good governance practices throughout the entire lifecycle of goods and services. The goal is to create, protect and enhance environmental, social and economic value for all stakeholders involved in the supply chains. As a result, sustainable supply chain management is increasingly recognized as a crucial aspect of corporate sustainability. However, given the complexity of this area, practical steps are necessary for companies to follow.

[Figure 5-3] Practical Steps for Companies to Achieve Sustainable Supply Chains



Source: United Nations Global Compact & BSR, 2015

The principles of the UN Global Compact can serve as a foundation for companies to advance corporate sustainability and support broader sustainable development goals. As depicted in Figure 5-3, the guidance outlines steps companies can take to achieve sustainable supply chains, focusing on three key principles for effective supply chain sustainability management: governance, transparency and engagement.

2) Ten Principles on Sustainable Supply Chains

The UN Global Compact encourages businesses to adhere to its ten principles and advance sustainable development goals. To foster effective sustainability practices across global supply chains, as shown in Figure 5-4, these ten principles are closely linked to the concept of sustainable supply chains.

[Figure 5-4] The 10 Principles of the UN Global Compact and their Policy Areas

<table>
<tr><th>Areas</th><th>Principles</th><th colspan="2">Policy Areas</th></tr>
<tr><td>Human Rights</td><td>▪ Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights; and
▪ Principle 2: make sure that they are not complicit in human rights abuses.</td><td rowspan="2">▪ Forced labor
▪ Child labor
▪ Working hours
▪ Wages & benefits
▪ Humane treatment
▪ Nondiscrimination & equality
▪ Freedom of association & collective bargaining
▪ Occupational health & safety
▪ Emergency preparedness
▪ Occupational injury & illness
▪ Fire safety</td><td rowspan="2">• Building structure & integrity
• Industrial hygiene
• Leave entitlements
• Freedom of speech
• Human trafficking
• Privacy
• Minority rights
• Right of specific stakeholder groups: indigenous people, women, children, older workers, workers with disabilities, migrant workers.</td></tr>
<tr><td>Labor</td><td>▪ Principle 3: Business should uphold the freedom of association and the effective recognition of the right to collective bargaining;
▪ Principle 4: the elimination of all forms of forced and compulsory labor;
▪ Principle 5: the effective abolition of child labor; and
▪ Principle 6: the elimination of discrimination in respect of employment and occupation</td></tr>
<tr><td>Environment</td><td>▪ Principle 7: Businesses should support a precautionary approach to environmental challenges;
▪ Principle 8: undertake initiatives to promote greater environmental responsibility; and
▪ Principle 9: encourage the development and diffusion of environmentally friendly technologies.</td><td>▪ Material toxicity and chemicals
▪ Raw material use
▪ Recyclability & end of life of products
▪ Greenhous gas emissions</td><td>▪ Energy use
▪ Water use & waste water treatment
▪ Air pollution
▪ Biodiversity
▪ Deforestation</td></tr>
<tr><td>Anti-corruption</td><td>▪ Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.</td><td>▪ Conflict of interest
▪ Gifts, meals & entertainment
▪ Bribery & kickbacks</td><td>▪ Accounting & business records
▪ Protecting information
▪ Fair competition
▪ Reporting misconduct</td></tr>
</table>

Source: Restructured by the Author Based on the United Nations Global Compact & BSR, 2015

Supply chains can have significant environmental impacts, particularly in economies with lax environmental regulations, substantial price pressures and abundant natural resources. Therefore, businesses should proactively address these environmental impacts by implementing appropriate precautionary policies.

3) Notable Initiatives Relevant to Sustainable Supply Chains

In addition to its guidance materials, the UN Global Compact has developed several initiatives, either independently or in collaboration with other organizations. These initiatives aim to address specific issues by building on the ten principles. Some of the key initiatives related to environmental issues include:

- **Caring for Climate (C4C)**: This initiative aims to enhance the role of businesses in tackling climate change. It provides a framework for business leaders to implement practical climate solutions and influence public policies. Key focus areas include improving energy efficiency, reducing the carbon footprint of products, services and processes and building capacity to adapt to climate change within operations and supply chains.
- **CEO Water Mandate (CWM):** This initiative helps companies develop and implement water sustainability policies and practices. By mobilizing business leaders to advance water sustainability solutions across their operations and supply chains, it aims to address the global water crisis effectively.
- **Food and Agriculture Business Principles (FAB):** This initiative offers principles for sustainability in food and agriculture, covering critical issues such as food security, health and nutrition, human rights, good governance, environmental stewardship and economic viability throughout the entire value chain.

E. WTO

The core objectives of the World Trade Organization (WTO) are to raise standards of living, ensure full employment and a large and steadily growing volume of real income and effective demand, and expand the production of and trade in goods and services, while allowing for the optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect and preserve the environment and to enhance the means for doing so in a manner consistent with their respective needs and concerns at different levels of economic development. The connection between trade and environment protection is well-established, as these goals are embedded in the Preamble of the Marrakech Agreement, which is founding agreement of the WTO. The WTO Members have long acknowledged the necessity of coordinating efforts among international institutions to tackle global environmental challenges in full conformity with the WTO rules and obligations. The WTO has also underscored that enhanced international cooperation strengthens the climate change adaptations, and the WTO can improve the climate resilience of supply chains through more open, predictable and diversified trade (WTO, 2022).

1) Global Context and WTO's Approach

Recalling that sustainable development and environmental protection are among the objectives of the WTO, it acknowledges that international trade and trade policy can contribute to environmental and climate objectives. The WTO supports environmental sustainability through its specialized committees and bodies, such as the Committee on Trade and Environment (CTE), which serves as a platform for dialogue on trade and environmental issues.

2) WTO Contributions to Environmental Protection

The WTO acknowledges that the climate change-related extreme weather events can reduce productivity, increase trade costs and cause supply chain disruptions. (WTO, 2022) Agriculture is particularly vulnerable to environmental fluctuations, but manufacturing sectors that rely on climate-sensitive inputs, are labor-intensive and are highly integrated into global value chains can also be at risk.

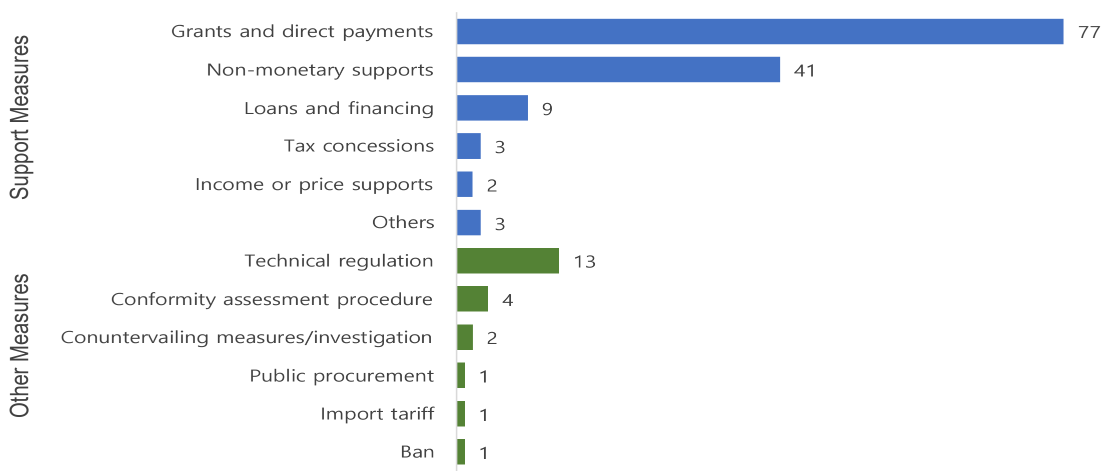
The WTO recognizes that international trade can play an important role in climate risk prevention and reduction in the following ways:

- **Investment in Climate Measures**: Trade can generate economic gains that allow economies to allocate financial resources towards climate change measures. It also supports climate adaptation efforts.

- **Access to Essential Goods and Services**: Well-designed trade policies can ensure access to essential goods and services, aiding in economic recovery after climate-related shocks.
- **Food Security Improvement**: Trade contributes to food security by enhancing food availability, nutrition, access and utilization.
- **Market Opportunities for Climate Solutions**: Global value chains can create new market opportunities for climate adaptation solutions, facilitating spread and development of technologies that aid in adaptation to climate change.

As of 2020, a review of environmental notifications submitted by WTO members shows that 161 measures can related to climate change adaptation. These measures primarily consist of support measures (such as grants, direct payments and non-monetary support) flowed by technical regulations (See Figure 5-5).

[Figure 5-5] Climate Change Adaptation Measures notified to the WTO (2009-2020)



Source: Climate Change Adaption and Trade – Policy brief, (WTO, 2022).

Consequently, international cooperation on trade is crucial for improving environmentally cautious policy. Although only a limited but growing number of trade agreements currently address climate issues, the WTO can support these efforts by promoting transparency and predictability in trade policies. Specifically, the WTO enhances the climate resilience of supply chains by lowering trade barriers, simplifying customs procedures and promoting transparency and predictability in trade policies. Additionally, by supporting capacity building, technical cooperation and the implementation of Aid for Trade projects, the WTO assists developing economies to strengthening their climate-resilient trade capacity and infrastructure.

VI. Best Practices of Sustainable Supply Chain in APEC Region

In this chapter, we will examine the individual approaches of APEC economies towards sustainable supply chains. Three economies have been selected for analysis: the Republic of Korea and the People's Republic of China.

A. The Republic of Korea

In direct alignment with fostering sustainable supply chains, the Republic of Korea has set multiple policy objectives which aim to reduce greenhouse gases and mitigating the environmental impact of economic activity. As mentioned above, achieving sustainable supply chains requires three facilitating components, **GHG emissions reduction**, **energy efficiency** and the **circular economy**. These three components, or each specific aspects of these components are all found in individual policies that the Republic of Korea has set to reduce its carbon emissions. Notable policies, are:

- **Carbon Neutrality by 2050:** The Republic of Korea's initiative to achieve carbon neutrality by 2050, in accordance with the Nationally Determined Conditions.

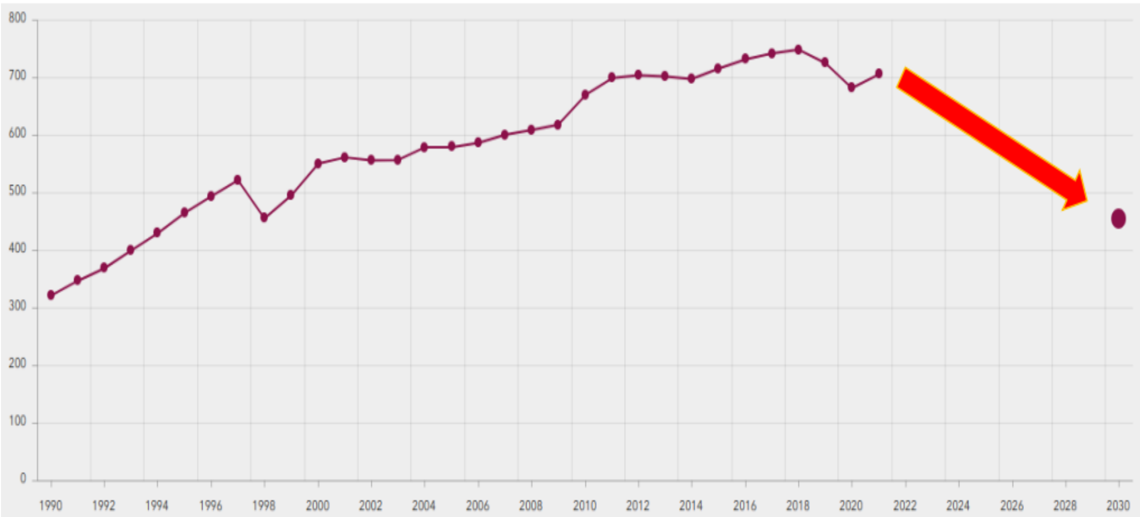
- **GHG Emissions Reduction of Manufacturing though SMEs:** The Republic of Korea's initiative to support SMEs which are engaged in high-carbon emission sectors.
- **Developing a Balanced Energy Mix:** The Republic of Korea's initiative to produce energy which is cleaner, yet also sustainable.

1) Carbon Neutrality by 2050

① Policy Objectives

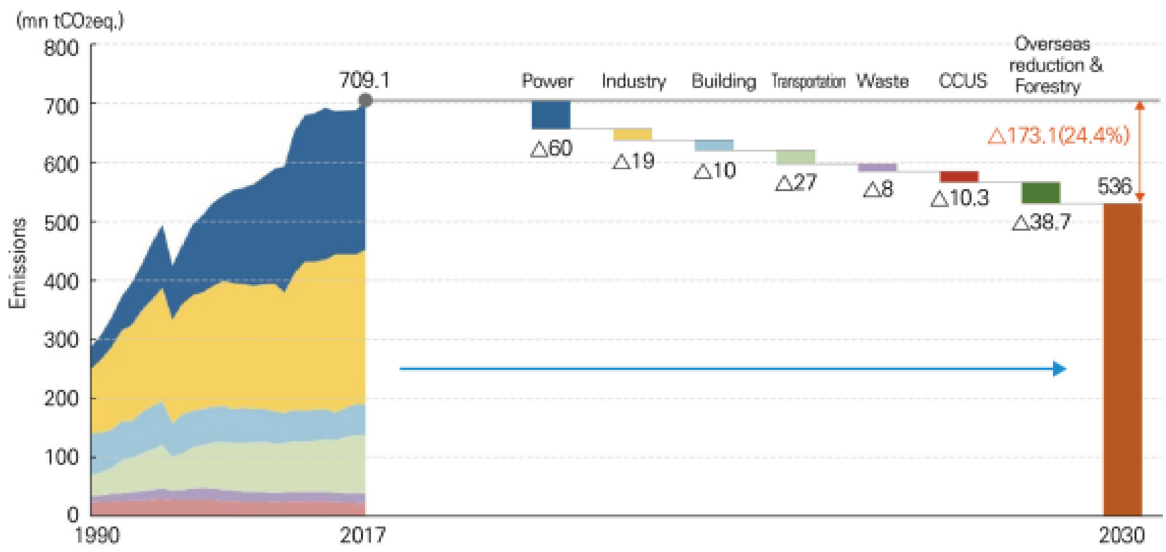
From 2020, the Republic of Korea set Carbon Neutrality to be a major agenda. On December 2020, the Republic of Korea, being the world's 13th largest greenhouse gas (GHG) emitter, submitted its updated Nationally Determined Contributions (NDC) to the UNFCCC, pledging to reduce carbon emissions by 40% from 2018 to 2030 and reach carbon neutrality by 2050. In addition, the Republic of Korea presented **its 2050 Vision of Korea's Carbon Neutrality Strategy.** These relatively recent policy objectives reflected the Republic of Korea's commitment the Paris Agreement of 2015, which require the entire international community to reduce greenhouse gases while aiming to hold the global average temperature increase to 2 °C above preindustrial levels and limit the temperature increase to 1.5 °C.

[Figure 6-1] The Republic of Korea's Reported GHG Emissions vs NDC Targets



Source: https://climatedata.imf.org

[Figure 6-2] Korea's 2030 GHG Reduction Targets



Source: 2050 Carbon Neutrality Strategy of the Republic of Korea (Republic of Korea, 2020).

[Table 6-1] Key Objectives of the 2050 Vision of Korea's Carbon Neutrality Strategy

1	Expanding the Use of Clean Power and Hydrogen Across All Sectors
2	Improving Innovative Energy Efficiency
3	Commercial Deployment of Carbon Removal and Future Technologies
4	Scaling up the Circular Economy to Improve Industrial Sustainability
5	Enhancing Carbon Sinks

Source: 2050 Carbon Neutrality Strategy of the Republic of Korea (Republic of Korea, 2020).

Each objective of the Republic of Korea's Carbon Neutrality Strategy, except for carbon sinks, are in direct alignment to foster sustainable supply chains. Expanding clean power and improving energy efficiency echo the energy efficiency component of sustainable supply chains. Commercial deployment of carbon removal and future technologies, while not confined to, relies on the application of advanced technology, such as hydrogen vehicles to reduce the Republic of Korea's GHG emissions or smart factories. Scaling up the circular economy, again, relies on the Republic of Korea's capacity of recycling, or methane gas recovery at landfills.

The key elements of the 2050 Vision for Carbon Neutrality were adjusted in 2023, with the National Framework Plan for Carbon Neutrality and Green Growth. The Framework Plan maintained the mid-to long term goals at 40%, but brought adjustments to each sector outlined.

[Table 6-2] Key Changes of the Framework Plan of 2023 of Carbon Neutrality

Sector	Description	2018	2030 Previous	2030 Adjusted
Transition	Expanding Nuclear Power Plants[2] and Renewable Energy (RE100)	269.6	149.9 (44.4%)	145.9 (45.9%)
Industry	Improving the K-ETS and support technical development	260.5	222.6 (14.5%)	230.7 (11.4%)
Transportation	Eco-friendly transition of Land, Air and Sea	98.1	61.0 (37.8%)	61.0 (37.8%)
Waste	Reduce waste sources and facilitate resource circulation.	17.1	9.1 (46.8%)	9.1 (46.8%)
Carbon Capture and Storage	Provide legislative support and tech development.	-41.3	-10.3	-11.2
International Reduction	Implement international projects	(-)	-33.5	-37.5

Source: National Framework Plan for Carbon Neutrality of Korea (Presidential Commission on Carbon Neutrality and Green Growth, 2024).

Again, the three components of the sustainable supply chain, GHG emissions reduction, energy

[2] EU taxonomy rules have accepted nuclear power to be a clean source of sustainable energy on Feb 2022. More details will be provided in later sections of this segment.

efficiency and the circular economy are all mentioned in the Framework Plan of 2023. Leaning on technical development, such as hydrogen vehicles to achieve energy efficiency, as well as focusing on the circular economy by facilitating waste management, are aligned with the fostering of the circular economy. One notable difference in the new Framework Plan, however, is implementing nuclear energy to provide cleaner sources of power to the Republic of Korea's economic activities.

② Policy Background

While the Republic of Korea has set green policies from 2008 with the Green Growth Initiative, scaling up these polices and meeting the requirements set by international community demanded extended time periods and multiple initiatives. The Republic of Korea's original NDCs, which were first submitted to the UNFCCC in 2016, did not meet the requirements of the international community. However, updates the NDC, and policy adjustments in carbon neutrality, as well as voices from both the domestic and the international community moved the Republic of Korea to present policies to reduce GHG emissions.

[Table 6-3] The Republic of Korea's Green Growth Policies

2008-2014	Introduction of **Green Growth Policies**	Low Carbon Green Growth as a New Growth Engine (2008) National Strategy and Framework Plan for Green Growth (2009) Framework Act on Low Carbon Green Growth Enacted (2010) Act on Allocation and Trading of GHG Emission Permits Enacted (2012) COP18 to host Green Climate Fund (GCF) Secretariat in Incheon (2013)

		2020 NDC Target Established (2014)
2015-2019	**Scale-up** of Climate Change Response Policies	K-emission Trading Scheme Launched (2015) 2030 NDC Target & Roadmap Established (2015-16) 1st Framework Plan for Climate Change Response Established (2016) 2030 Roadmap Revised (2018) 2nd Framework Plan for Climate Change Response Established (2019)
2020-2024	**Carbon Neutrality** as a Major Agenda, Laying Institutional Foundations	Korean New Deal (Digital and Green New Deal) Announced (2020) 2050 Carbon Neutrality Vision Declared (2020) Carbon Neutrality Green Growth Framework Act Enacted (2022)

Source: Strategic Roadmap for Korea's Green Transition: Challenges and Pathways (Kim, 2024).

International initiatives from major economies, especially from key allies, pushing for the green transition from 2021, and such as the European Union advocating for RE100 (using 100% of renewable energy) fostered an enabling environment for the Republic of Korea to set its agendas for Carbon Neutrality. Carefully formulating its policies from March 2019, with stakeholders from the political and corporate sector as well as representation from civil societies, the Republic of Korea released the finalized agenda in October 2020. Moving from an 'adaptive' reduction to a 'proactive' reduction, the Republic of Korea declared to the international community that it was aiming for Carbon Neutrality by 2050. An additional factor was the Republic of Korea's confidence in its advanced sector, such as batteries, hydrogen, waste management (circular economy) and energy storage systems, by using technology to reduce its carbon emissions (Ryoo, 2021) .

③ Policy Implementation

[Figure 6-3] Article 1 of the Framework Act on Carbon Neutrality and Green Growth

The purpose of this Act is to strengthen policy measures to reduce greenhouse gases and adapt to climate change for preventing serious impacts of climate crisis, to resolve economic, environmental and social disparity that may arise in the course of transition to a carbon neutral society, and to foster, promote, and revitalize green technology and green industry for a harmonious development of the economy and environment, thereby improving the quality of life of present and future generations, protecting the ecosystem and climate system and contributing to the sustainable development of the international community.

In 2021 the Republic of Korea's 21st National Assembly passed the Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis (Carbon Neutrality Act), which made the Republic of Korea 14th economy to codify carbon neutrality and carbon reduction into law. The Framework, which acts as the legal justification for the Republic of Korea to focus its agenda on green growth, climate change and energy policies, requires updates on a five-year basis. This act is pivotal for achieving carbon neutrality, having the government to adhere to the principles laid out in the law.

[Table 6-4] Articles on Components of Sustainable Supply Chains

Carbon Reduction	Article 8: (1) The Government shall set a national medium- and long-term greenhouse gas emission reduction target (hereinafter referred to as "mid-to long-term reduction target") to reduce national greenhouse gas emissions by a ratio prescribed by Presidential Decree to the extent of not less than 35 percent from the 2018 levels by 2030.
Energy Transition	Article 30: (1) In order to cope with climate crisis, the

	Government shall formulate and implement policies to support energy conversion by local governments, such as devising measures to distribute and expand new and renewable energy in each region in accordance with the basic principles prescribed in Article 3.
Circular Economy	The Government shall formulate and implement policy measures which include the following matters, to minimize the input of energy and resources by improving the sustainability of products and establishing the circular networks of abandoned resources, thereby revitalizing an eco-friendly economic system to simultaneously realize the preservation of the ecosystem and mitigation of greenhouse gas emissions (hereafter in this Article referred to as "circular economy"):

The Framework, being the basic guideline for carbon reduction, clearly states the three facilitating components for sustainable supply chains. Policies for carbon reduction, energy transition and the circular economy are all required by the framework, enabling the Republic of Korea to reach for its goals for sustainable supply chain.

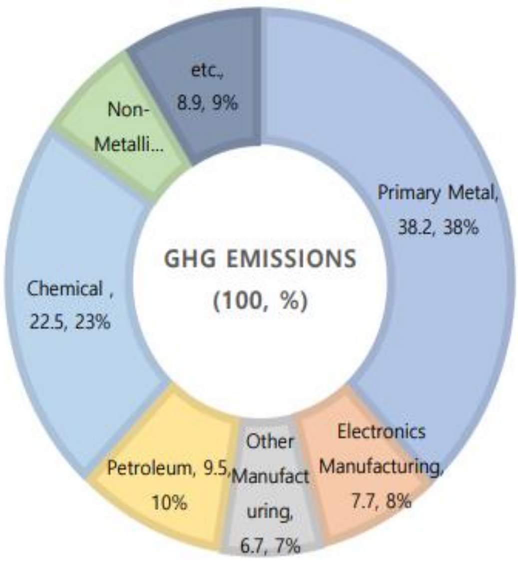
In addition to the Framework Act, the Constitutional Court in Sept 2024, ruled that the Republic of Korea's Framework Act required adding quantitative reduction targets from 2031 and 2049 to reach carbon neutrality. This is one of the first rulings of its kind in the APEC region, where the Judicial Branch has also spoken for government policies for climate change, declaring that the Framework Act must be revised until February 2026 with the quantitative targets included. This ruling shows how all three branches of the Republic of Korea have taken their own steps not only carbon reductions, energy transitions and fostering the circular economy, but also, sustainable supply chains.

2) GHG Emissions Reduction of Manufacturing Through SMEs

① Policy Objectives

As a manufacturing-oriented economy, the Republic of Korea has set objectives to reduce greenhouse gas emissions from its manufacturing sector, by promoting sustainable supply chains though Small and Medium Enterprises (SMEs). Targeting the direct and indirect carbon emissions in intensive emitting sectors, such as steel, petrochemical, construction and indirectly semiconductors, these policy objectives to reduce the GHG emissions for its supply chains and foster sustainable practices are in direct alignment with achieving sustainable supply chains.

[Figure 6-4] Breakdown of Greenhouse Gases by Industry in the Republic of Korea



Source: KDI – Strategic Roadmap for Korea's Green Transition: Challenges and Pathways (Kim, 2024).

The above picture illustrates how the vast majority of GHG emissions in the industry sector stem from steel, petrochemical and manufacturing from electronics. These sectors are major drivers of the Republic of Korea economy, and in line with the Carbon Neutrality Initiative, the

Republic of Korea has pushed its agenda to support SMEs to provide technical support, research & development and financial assistance.

In 2021, the Republic of Korea released the SME Carbon Emission Support, which outlined the objectives for GHG emissions reduction of SMEs. The government outlined three major objectives, a) Support for high-carbon SMEs to transition to low-carbon, b) Foster Green Start-ups and c) expand ESG Management across SMEs. One year later, in 2022, the Republic of Korea presented the SME ESG Promotion, which not only facilitated expansion of ESG Management, but also outlined objectives for funding for SMEs to transition from high-carbon to low-carbon, and creating a system to accurately measure carbon emissions though measuring, reporting and validating. These objectives clearly reflect the Republic of Korea's initiative to fostering sustainable supply chains, by directly supporting the SMEs that are directly involved in sectors that cause the environmental impact.

② Policy Background

With the Republic of Korea's industry being a manufacturing-based industry, its carbon emissions, direct and indirect, mainly stem from its core capacities, such as steel, petrochemical, construction, machinery and indirectly, semiconductors. The vast majority of these industries produce high levels of carbon emissions. Such examples are, but not limited to: the uses of cokes (fuel for the steel industry), calcination of limestone (major component of cement production) and thermal cracking of naphtha (used in the petrochemical industry) (Republic of Korea, 2020).

In 2019, the Republic of Korea's direct and indirect carbon emissions from its entire industry, (including mining, energy, etc.) were 209.1 million tons. In 2020, 103.44 million tons were from the mining and SMEs from the manufacturing industry. Therefore, targeting these sectors was crucial for enabling sustainable supply chains.

[Table 6-5] Carbon Emissions by Industrial Sectors in the Republic of Korea (2020)

	Sector	Conglomerates		SMEs		Total	
		Emissions[3]	Percent (%)	Emissions	Percent (%)		
1	Metal	123.5	51.3	8.9	8.6	132.4	38.5
2	Chemical	38.9	16.2	30.4	29.6	69.3	20.1
3	Petroleum	32.2	13.4	2.0	2.0	34.2	10.0
4	Etc.	5.0	2.1	23.0	22.3	28.0	8.1
5	Electronics	20.4	8.5	5.9	5.7	26.3	7.6
6	Non-Metallic Minerals	12.1	5.0	10.3	10.0	22.4	6.5
7	Pulp & Paper	2.5	1.0	7.7	7.5	10.2	3.0
8	Food & Beverages	1.6	0.7	7.6	7.4	9.2	2.7
9	Vehicles	3.4	1.4	3.9	2.7	7.3	2.1
10	Textiles	0.8	0.3	3.3	3.2	4.1	1.2
Total		240.5	100.0	103.0	100.0	343.5	100.0

Source: E. Kim & Lee, 2023.

However, it is essential to highlight the policy background for targeting towards SMEs and not large conglomerates or big firms. The above graph illustrates how a larger portion of carbon emissions are caused by conglomerates in the metal and petrochemical sector. However, SMEs also took a significant portion of emissions in sectors such as non-metallic minerals (cement) or paper or food and beverages, as well as the automobile and textile industry. In addition, SMEs also showed weakness in energy efficiency, creating more carbon emissions compared to conglomerates per energy usage, at a ratio of 1:1.6 (E. Kim & Lee, 2023).

Differences in capacity with environmental-friendly technologies also highlighted a difference

[3] 1,000,000 CO_2 eq.

with SMEs. The vast majority of technology that enabled carbon reductions, such as renewable energy or energy storage, generated profits that went to mid-large to large conglomerates, at about 70%.

These differences highlighted how the policy for GHG emissions reductions needed to be directed into SMEs. Less energy efficiency and weaker technological capacities required the government to focus on interventions to assist SMEs rather than conglomerates.

③ Policy Implementation

Against this backdrop, the Republic of Korea has taken leading steps to support its Small and Medium Enterprises (SMEs) to reduce carbon emissions. Each line ministry has taken its own projects to implement policies to support SMEs.

From 2021, the Republic of Korea has launched the Support for Carbon Neutrality for SMEs, and detailing transitions from high carbon emissions to low emissions, incubating green start-ups and encouraging ESG for SMEs.

In 2022, Promoting ESGs for SMEs was launched, creating business loans for SMEs for climate and energy transitions, while creating a system for MRVs. Although multiple line ministries have launched their own projects, most fall into the framework of a) building facilities, b) research & tech development and c) funding support. Notable examples are from the Ministry of Trade, Industry and Energy (MOTIE), such as the Construction of Clean Factories in Industrial Complexes, Carbon Neutral Pioneering Plant Support, Loans for Carbon Neutral Pioneering Plants.

[Table 6-6] Projects for SMEs for Carbon Reduction Support by MOTIE (2022)

Project Name	Project Details	Ministry
Construction of Clean Factories in Industrial Complexes	Provide Clean Factories to SMEs in manufacturing industries.	Ministry of Trade, Industry and Energy
Carbon Neutral Pioneering Plant Support	Support for identifying business sites, demonstrating and implementing carbon-neutral plants, targeting SMEs with high carbon emissions.	
Loans for Carbon Neutral Pioneering Plants	Loans based on SMEs with R&D for Carbon Emissions	

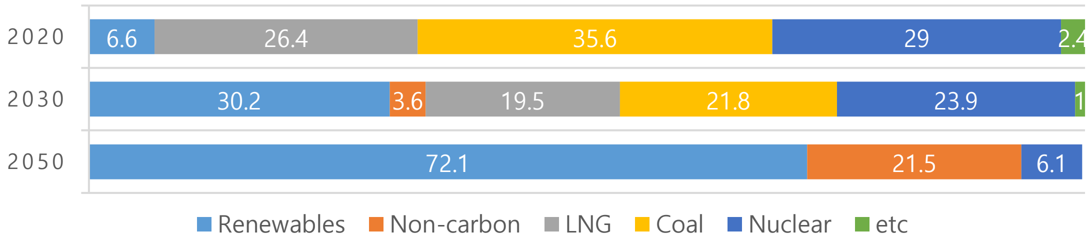
Source: Greenhouse Gas Inventory and Research Center of Korea, 2023; E. Kim & Lee, 2023.

3) Developing a Balanced Energy Mix

① Policy Objectives

In June 2019, the Ministry of Trade, Industry and Energy released the 3rd Energy Master Plan, outlining objectives to reduce its energy consumption by 14.4% by 2030, 17.2% by 2035 and 18.6% by 2040. Two years later, in response to the revised NDCs that were submitted in 2021 and declaring Carbon Neutrality 2050, the Republic of Korea launched the Energy Carbon Neutrality Innovation Strategy, which detailed mid to long term projections and strategies to its domestic energy mix.

[Figure 6-5] Korea's Projections for its Energy Mix (Unit: %)



Source: Ministry of Trade, Industry and Energy of Korea, 2021

The Energy Carbon Neutrality Innovation Strategy outlined four main objectives to achieve GHG emissions reduction of the Republic of Korea's energy mix.

[Table 6-6] Objectives of the Energy Carbon Neutrality Innovation Strategy

1	Accelerate the transition to a clean energy system
2	Build the foundation to catalyze the energy transition
3	Support the creation of new growth engines for the energy future
4	Strengthening a seamless net-zero transition

Source: Energy Carbon Neutrality Innovation Strategy, Dec 2021.

While the objectives of the Energy Carbon Neutrality Innovation Strategy provide a policy roadmap for the Republic of Korea's energy mix until 2050, one notable point was integrating ammonia and hydrogen to have an integral role in renewable energy. The strategy outlined 13.8% to 21.5% to be sourced from hydrogen and ammonia powered turbines by 2050. These sources were expected to replace power generated from coal and LNG.

In January 2023, the Republic of Korea released the 10th Basic Plan for Electricity Demand and Supply. This was an overhaul of the 3rd Energy Master Plan and the Energy Carbon Neutrality Innovation Strategy. The new Basic Plan outlined a drastic change of renewable energy to reduce carbon emissions. Expectations from hydrogen and ammonia powered turbines were dulled, while nuclear power consisted of 32.4% of total energy sources in 2030. Although renewable sources, such as solar and wind power were also expected to perform at higher levels compared to the status quo, nuclear power still was expected to produce the most amount of energy for the Republic of Korea.

[Table 6-7] Korea's Energy Volume and Forecast by Source (unit: TWh, %)

	Nuclear	Coal	LNG	Renewable (Solar & Wind)	Hydrogen Ammonia	Others	Total
2018	133.5	239.0	152.9	35.6	0	9.7	570.7
	23.4%	41.9%	26.8	6.2%	0%	1.7%	100.0%
2021	158.0	198.0	168.4	43.1	0.7	9.4	577.5
	27.4%	34.3%	29.2%	7.5%	0.1%	1.6%	100.0%
2022	176.1	193.2	163.6	53.2	0.9	8.4	595.3
	29.6%	32.5%	27.5%	8.9%	0.1%	1.4%	100.0%
2023 (Proj.)	188.3	196.4	150.0	59.6	-	5.3	599.6
	31.4%	32.8%	25%	9.9%	-	0.9%	100.0%
2030 (Target)	201.7	122.5	142.4	134.1	13	8.1	621.8
	32.4%	19.7%	22.9%	21.6%	2.1%	1.3%	100.0%
2036 (Target)	230.7	95.9%	62.3	204.4	47.4	26.6	667.3
	34.6%	14.4%	9.3%	30.6%	7.1%	4%	100.0%

Source: Ministry of Trade Industry and Energy of Korea, 2023.

With the abovementioned Basic Plan for Electricity Demand and Supply, emphasis on nuclear energy and renewable energy became the two main pillars for producing clean energy to the Republic of Korea's economy and its supply chains. With the EU taxonomy rules accepting nuclear power to be a clean source of sustainable energy, the Republic of Korea has leveraged its own nuclear power plants to be a valuable source for GHG emissions reductions (European Commission, 2022).

For renewable energy, the Basic Plan has pushed the timeframe for a target of 30% from 2030 to 2036. This is because the Republic of Korea seeks to expand facilities of renewable power production at a faster rate than increasing the power grid and energy storage facilities. As a result, limiting renewable power production until the power grid infrastructure is able to catch up to provide constant, sufficient power is a constraint.

While there was a shift in methodologies for achieving GHG emissions reductions by originally relying on unconventional renewable sources such as ammonia and hydrogen to nuclear power, the main idea for an energy transition to clean sources for power still remain consistent with achieving sustainable supply chains.

② Policy Background

The Republic of Korea, ranking seventh in energy consumption, has pursued reducing carbon emissions from energy production. The vast majority of its energy production focused on older coal power plants and Liquefied Natural Gas (LNG, at about 50~60%). In order to achieve carbon neutrality, the Republic of Korea needed to set specific goals to meet its updated Nationally Determined Conditions.

[Table 6-8] Carbon Emissions by Sectors in the Republic of Korea

Sector	1990	1995	2000	2005	2010	2015	2018	2019	2020	2021
Energy	**240.3**	**352.0**	**411.6**	**469.3**	**564.7**	**599.0**	**630.7**	**609.6**	**568.1**	**587.7**
Industry	20.4	43.1	50.9	54.6	53.0	54.5	55.8	52.2	45.8	51.4
Agriculture	21.0	22.8	21.4	20.7	22.1	21.0	21.1	21.0	21.2	21.4
LULUCF[4]	-37.9	-32.2	-60.1	-56.3	-56.1	-46.6	-40.3	-37.7	-37.9	-37.8
Waste	10.4	15.8	18.9	16.8	15.4	16.9	17.4	16.5	16.7	16.1
Net Emissions	292.1	433.8	502.7	561.5	655.1	691.3	725.0	699.2	654.4	676.6

Source: Greenhouse Gas Inventory and Research Center of Korea, 2023.

[4] Land Use, Land-Use Change and Forestry

The National Inventory Report of 2023 illustrates the significance of the carbon emissions that the energy sector has on the Republic of Korea. From the 1990s, the energy sector has been the number one source for carbon emissions. Even as of 2021, the energy sector has accounted for about 86% of carbon emissions. This data illustrates not only the importance but also that it is imperative for policy interventions to be implemented for reducing GHG emissions in the energy sector. As sustainable supply chains aspire for clean supply chains, including the energy used for production of its goods, policies for a cleaner source of energy, which are in turn used to produce goods and services in the Republic of Korea, were formulated.

③ Policy Implementation

As mentioned above, according to the 10^{th} Basic Plan for Electricity Demand and Supply, the Republic of Korea has placed nuclear power to bear the burden of the energy transition for cleaner energy. It has placed its emphasis on the low costs of nuclear fuel as well as the stability of nuclear power plants. In addition, it has extended its lifespan of its nuclear reactors, as well as resuming the construction of four new 1,400 MW reactors (The Saeul 3 & 4 and the Shin-Hanul 3 & 4). Operating 25 nuclear reactors with a capacity of 24.7GWh, the Republic of Korea is the sixth with the world, with utilization rates of 80% from tight safety inspections.

The Republic of Korea has also invested in developing small module nuclear reactors (SMR), to replace current coal powers with a lifespan of 80 years. Advanced models of SMRs using soluble-boron-free (SBF) nuclear fuel (Nguyen et al., 2019), or high-assay low-enriched uranium (HALEU) [5]and passive infinite cooling (PX) safety systems (Yi et al., 2016).

[5] HALEU refers to uranium that is enriched to between 5% and 20% of U-235, which is higher than the levels used in conventional reactors (usually up to 5%). Higher enriched uranium allows nuclear fuel to be used for longer periods, in addition to efficiency and compatibility with advanced cooling systems.

[Figure 6-6] Map of the Republic of Korea's Nuclear Reactors, Operating/Planned

Source: World Nuclear Association, The Republic of Korea

Efforts in SMR development have been led by the Korea Hydro & Nuclear Power Co. (KHNP). Small modular nuclear reactors, known as Gen 4 reactor concepts, are considered to be safer after the recent accident in Fukushima, Japan. Designed to be safer with more compact with simpler designs and less dependent on active control systems, they are designed with heat exchangers and cooling geometry inside the reactor pressure vessel. These designs would eliminate the possibility of an accident due to failure of coolants, (Loss of Cooling Accidents)[6] such as Fukushima.

[6] In case of failure of power failure or an accident, the reactors are designed so that by using gravity and pressure differences, cold water (stored in a separate tank) is injected into a heat exchanger surrounding the core. Once the pressure is equalized, water flows back to the tank, ensuring continuous cooling with gravity.

4) Case Study: POSCO International

[Figure 6-7] POSCO's Green Procurement Policy

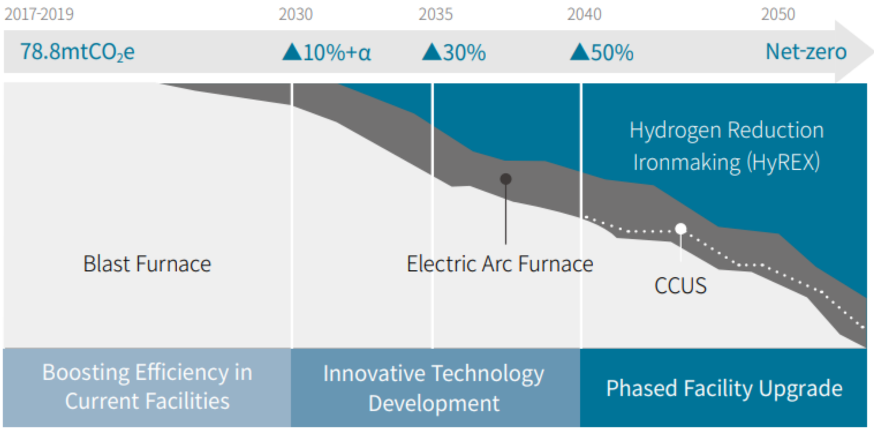
Purpose: This policy aims to prevent the waste of resources and environmental pollution while abiding by applicable laws and regulations in the entire business conduct of POSCO INTERNATIONAL. This policy illustrates the definition of green products, the scope of procurement, basic guidelines and action plans to support effective policy implementation Action Plans: A. We shall perform regular supply chain ESG assessments* and mitigate our environmental impact in relation to business operations, and shall not do business with suppliers/partners identified for environmental risk as a result of such assessment. (* ESG assessment according to the 'Supplier ESG checklist' and others) B. We shall do business with suppliers that consider the environmental impact of their operations (workshop, production site) in terms of protecting ecosystems, preserving bio species, conserving water resources and managing chemical substances. C. We shall do business with suppliers/partners that abide by our NDPE (No Deforestation, Peat, Exploitation) policy and produce and process products that are free from deforestation, peat destruction and exploitation of people and communities.

Examples from the private sector from the Republic of Korea is POSCO, one of the world's leading steel production company. POSCO has increased its funding for environmentally friendly initiatives by 30% by 2025 from 2021.

POSCO has been active in reducing the GHG emissions within its supply chains, releasing its own carbon neutrality roadmap by utilizing in green technology. Such short-term strategies involve using low carbon fuels, 'electric arc furnace mixing' technology[7], or 'top-bottom blown converter technology' aimed at increasing the utilization of steel scrap in the converter to decrease its carbon emissions.

[Figure 6-8] POSCO's Carbon Neutrality Roadmap

[7] This method reduces the amount of molten iron used in the converter by mixing molten iron from the blast furnace and molten steel from the electric arc furnace.



Source: (POSCO, 2023).

It has also added environmental compliance as a criterion for its suppliers. POSCO refers this as a Supplier Relationship Management, providing incentives to higher ranking achievers with preferred bidding benefits and exempted from down payment requirements (ESG Purchasing System). POSCO evaluates its vendors with different criterion[8], with ESG being one of them. The lower ranking suppliers are required to make adjustments, with repeated low rankers being removed from the supply chain by being unable to participate in bidding for extended periods.

B. People's Republic of China

The People's Republic of China, in fostering sustainable supply chains, has developed policy initiatives to reduce the environmental impact through **carbon footprint** and the **circular economy**. The most notable policies that the People's Republic of China displayed were:

- **Carbon Neutrality Though Carbon Footprints:** The People's Republic of China's initiative to achieve dual carbon goals of peak carbon 2030 and carbon neutrality by

[8] Credit rating, Late Shipment Rate (%), Price competitiveness, Quality, ESG, POSCO Compliance Programs, Deductions for safety incidents.

2060.

- **The Circular Economy of EV Batteries:** The People's Republic of China's initiative to foster a circular economy with lithium batteries found in EVs, by reusing and recycling.

1) Carbon Neutrality Though Carbon Footprints

① Policy Objectives

To strengthen the management of carbon emissions throughout product lifecycles and support the dual carbon goals — carbon peaking by 2030 and carbon neutrality by 2060 — the Ministry of Ecology and Environment (MEE) of the People's Republic of China, in collaboration with 14 other ministries, has developed the "Implementation Plan for Establishing a Carbon Footprint Management System." The plan sets out specific goals and expectations for building a robust product carbon footprint system.

The key objectives of the Implementation Plan set phased targets for the carbon footprint management system. By 2027, the preliminary phases of the system are expected to be completed, including the release of a domestic general standard for product carbon footprint accounting aligned with international norms; the development of approximately 100 product-specific carbon footprint accounting standards; the initial construction of a carbon footprint factor database; the launch of carbon labeling, certification, and tiered management systems; and progress in aligning key product regulations with international standards.

In addition, by 2030, the Implementation Plan aims to refine and expand the system. Targets include the development of approximately 200 product-specific carbon footprint accounting standards; the completion of a comprehensive, high-quality, carbon footprint factor database; the full implementation of labeling, certification, and tiered management systems; and the deepened integration of Chinese standards with international rules, including active participation in global carbon footprint rulemaking.

[Table 6-15] Implementation Plan for Establishing a Carbon Footprint Management System

1. General requirements Guided by Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, we will fully implement the spirit of the 20th CPC National Congress, thoroughly implement Xi Jinping's Thought on Ecological Civilization and the spirit of the National Ecological and Environmental Protection Conference, and fully, accurately and comprehensively implement the new development concept based on the new development stage, build a new development pattern, strengthen the concept of system, clarify the direction and measures, and follow the principle of gradual progress. Starting from the carbon footprint of products, we will improve domestic rules, promote international connection, establish a unified and standardized carbon footprint management system, promote the rule system with both Chinese characteristics and international influence, actively participate in global carbon pricing and climate governance, and help the green and low-carbon transformation of the economy, high-quality development and the construction of a beautiful China. Adhere to the goal-oriented and coordinated implementation. Focus on the goals and tasks of carbon peak and carbon neutrality, clarify the construction goals, implementation paths and key tasks of the carbon footprint management system, strengthen the coordinated implementation of work, guide enterprises to transform into low-carbon, promote the transformation and upgrading of industrial chains and supply chains, and enhance green and low-carbon competitiveness. Adhere to active action and pragmatic cooperation. Based on domestic conditions and development stage, we will accelerate the construction of a carbon footprint management system, cultivate a green and low-carbon production and lifestyle, strengthen international exchanges on carbon footprint accounting rules for key foreign trade products, promote experience sharing and pragmatic cooperation, and actively participate in the formulation of international rules. Adhere to government guidance and market dominance. Give full play to the decisive role of the market, guide and encourage all market players to actively participate in carbon footprint data reporting, rule-making, labeling and certification, international exchanges and other work, better play the role of the government, and create a multi-party carbon footprint work pattern. Adhere to innovation-driven, and try first. Promote collaborative innovation in technology and policies, guide the digital and intelligent development of carbon footprints, improve data quality, ensure data security, and encourage qualified regions, industries, and enterprises to take the lead in carrying out pilot work on carbon footprints of key products and actively promote them.

② Policy Background

The People's Republic of China's efforts to build a carbon footprint management system stem from multiple interconnected factors.

To begin with, international trade has evolved. Trade partners like the European Unions, as well as other major economies are increasingly demanding exporters, such as the People's Republic of China to adhere to regulations that require measuring and verifying the carbon content of goods. These new standards have become not only obstacles, but also expectations for the People's Republic of China to keep its position as global manufacturing hub in key global markets. In addition, the People's Republic of China's own commitments for carbon neutrality has led to the creation of a system that track carbon footprints. Growing consumer expectations for environmental and sustainable awareness, from inside and outside the People's Republic of China, are also pushing for carbon footprints. Lastly, the People's Republic of China's priorities of industrial policies, with an emphasis on technology, efficiency, and low carbon, require tools for accounting carbon emissions. These factors have led carbon footprint to be strategically imperative for not just the People's Republic of China's environmental agenda, but the broader goals of the global market and advancing economic modernization.

① Policy Implementation

The Implementation Plan identifies four major tasks for establishing and implementing the People's Republic of China's carbon footprint management system. These tasks are laid out to create a robust system for developing and applying carbon footprint management.

To begin with, the Implementation Plan (The People's Republic of China, 2024) calls to establish a robust carbon footprint management system. Specifically, this includes several coordinated steps, such as publishing a general standard for carbon footprint accounting for products in alignment with international norms in addition to issuing specific accounting standards for key products, such as electricity, steel, cement, hydrogen, lithium batteries and new electric vehicles. The People's Republic of China will also develop a domestic database for carbon footprints, with priority over sectors such as energy, raw materials, and transportation. These will be built with contributions from research institutes and private enterprises. Carbon labeling and certification systems will also be created, with details for certification procedures and categories which are applicable. In addition, a grading system with tiered management will assist private firms assess and improve their carbon footprints and supply chain emissions. Lastly, the People's Republic of China will explore mechanisms for phasing disclosure of carbon footprint data, to ensure data security and intellectual property rights.

In addition, the Implementation plan calls for a multi-stakeholder collaborative framework. To achieve this, the People's Republic of China would emphasize its policy integration by including carbon footprint in trade, fiscal, financial, and industrial policies. In other words, carbon footprints are aligned with evaluations for green supply chains, emissions trading schemes, and assessments on environmental impact. Financial institutions would also be encouraged to incorporate data from carbon footprints into green finance, ESG assessments and investment due intelligence. These will be expanded to integrating data and carbon footprint criteria into public procurement, such as sectors as electronics, home appliances and automobiles, with state-owned enterprise leading the way for adopting low carbon products. Pilot programs at the local government level for testing innovative polices and tools, emphasizing public consumption, green mobility and carbon inclusion. Private firms in key industries for export are also encouraged to develop digital carbon footprint management systems, create accounting standards and align with international standards. Central state-owned enterprises, industry associations and leading private firms will be mobilized to pioneer carbon labeling, platforms for disclosure, and international cooperation.

To promote international mutual trust in carbon footprint rules, the People's Republic of China aims to respond actively in growing global carbon-related trade policies by monitoring developments, engaging in dialogues bilaterally and multilaterally by addressing obstacles faced by export-oriented industries. Additional effort will be allocated to focus on accelerating the local and international recognition of carbon footprint and accounting standards, with goals to achieve mutual recognition of mutual recognition of methodologies, certification standards, and qualifications with major trading partners. Emphasis will be placed on enhancing cooperation with Belt and Road economies through joint development of carbon footprint standards and mutual recognition of labels. The People's Republic of China also seeks to expand its role in shaping international rules by participating in global standard-setting bodies such as the ISO, UNESCO, and WTO, particularly in sectors like lithium batteries, photovoltaics, and new energy vehicles. To support these efforts, research institutions, industry associations, and enterprises will be encouraged to deepen international collaboration in database development, standardization, professional training, and data security, ensuring alignment and interoperability with global systems.

Lastly, to enhance capacity building for carbon footprints, the People's Republic of China seeks to target workforce development, data quality, and the integrity of institutions. This includes expanding professional training though certified institutions, such as universities and vocational programs to offer special curriculums with collaboration from both the private and public sector. In additions, evaluations for carbon footprint and certifications would be enhanced to meet international standards, with regulation and penalizing fraudulent practices. State of the art technology, such as big data, blockchain, and the Internet would be used to increase the accuracy, traceability and the interoperability of data for carbon footprints. Inter-verification with domestic emission trading systems and licensing systems will be promoted, with data sharing and monitoring at the industrial level. Enhanced supervision of data flows to ensure safeguarding data security and intellectual property, as well as legal oversight of foreign technological transfers, as well as establishing monitoring risk and emergency response mechanisms will also be developed.

Safeguards to ensure effective implementation would be set up to ensure institutional coordination and policy integration. With leadership from the Ministry of Ecology and Environment and the National Development and Reform Commission, the People's Republic of China will focus on aligning domestic and international initiatives, monitor progress regularly, promote active participation of local governments, private industries. Expert groups for guiding industries, enhance capacity building, and supporting execution at regional levels. Communications to the public, focusing on policy interpretation, technical training and showing best practices in international forums to share the People's Republic of China's experience in carbon footprint governance will be utilized.

[Table 6-18] Main Tasks of the Implementation Plan for Establishing a Carbon Footprint Management System

Establish and Improve Carbon Footprint Management System	1. Publishing a general standard for product carbon footprint accounting.
	2. Publishing standards for carbon footprint accounting rules for key products.
	3. Establishing and perfecting a database of product carbon footprint factors.
	4. Establish a product carbon labeling certification system.
	5. Establishing a system for grading and managing the carbon footprint of products.
	6. Explore the establishment of a carbon footprint information disclosure system.
Build a Multi-Stakeholder Collaborative Framework	7. Strengthen policy support and synergy.
	8. Increase financial support.
	9. Enriching and expanding the promotion and application scenarios.
	10. Encourage local pilots and policy innovation.
	11. Encourage enterprises in key industries to conduct early and pilot tests.
Promote International Alignment and Mutual Recognition	12. Actively responding to international carbon-related trade policies.
	13. Promoting international docking of product carbon footprint rules.
	14. Promote the exchange and mutual recognition of product carbon footprint rules with the "Belt and Road" economies.

	15. Actively participating in the formulation of international standards and rules.
	16. Strengthen international exchanges and cooperation.
Enhance Capacity Building	17. Strengthen capacity building for product carbon footprint accounting.
	18. Standardize product carbon footprint professional services.
	19. Strengthen the training of product carbon footprint professionals.
	20. Strengthen the quality of product carbon footprint data.
	21. Establishing a support and guarantee system for measuring the quality of product carbon footprint data.
	22. Strengthen product carbon footprint data security and intellectual property protection.
Safeguards	(i) Strengthening integration and coordination
	(ii) Enhanced implementation
	(iii) Strengthening publicity and interpretation

Source: (The People's Republic of China, 2024)

2) The Circular Economy of EV Batteries

① Policy Objectives

[Table 6-19] Circular Economy Promotion Law

Article 1 This Law is enacted for the purpose of promoting the development of circular economy, improving the efficiency of resource utilization, protecting and improving the environment and realizing sustainable development. Article 2 The circular economy referred to in this Law refers to the general term for the activities of reduction, reuse and resourcing in the process of production, distribution and consumption. The reduction referred to in this Law refers to the reduction of resource consumption and waste generation in the process of production, circulation and consumption. The reuse referred to in this Law means that the waste is directly used as a product or continues to be used as a product after repair, renovation or remanufacturing, or all or part of the waste is used as a component of other products. Resourcefulness, as referred to in this Law, refers to the use of wastes directly as raw materials or the recycling of wastes. Article 3 The development of circular economy is a major strategy for the economic and social development of China, and shall follow the guidelines of integrated planning, rational layout, local conditions, focus on effectiveness, government-promoted, market-led, enterprise implementation and public participation.

Source: (The People's Republic of China, 2008)

The Circular Economy Promotion Law (The People's Republic of China, 2008), enacted in 2008 was one of the early frameworks to establish the circular economy in the People's Republic of China. The law establishes the circular economy to be promoted as major strategy for economic and social development. It emphasizes reducing resource consumption, promoting recycling and reuse, and minimizing waste throughout all sectors, including electric vehicle batteries. It also emphasizes the People's Republic of China to formulate industry policies and to provide a supporting role as technical guidance.

The 14th Five-Year Plan for Circular Economy Development (2021-2025) (The People's Republic of China, 2021), acknowledges that the People's Republic of China's circular economy is still faced with low resource output efficiency in key industries. Therefore, the Five-year plan outlines objectives for increased capacity for recycling key resources, with the output rate about 20% higher, while energy and water consumption will be 13.5% and 16% lower than 2020. The Plan enhances processing of renewable resources, specifically mentioning waste power batteries. The plan also mentions traceability and standard echelon utilization of power batteries.

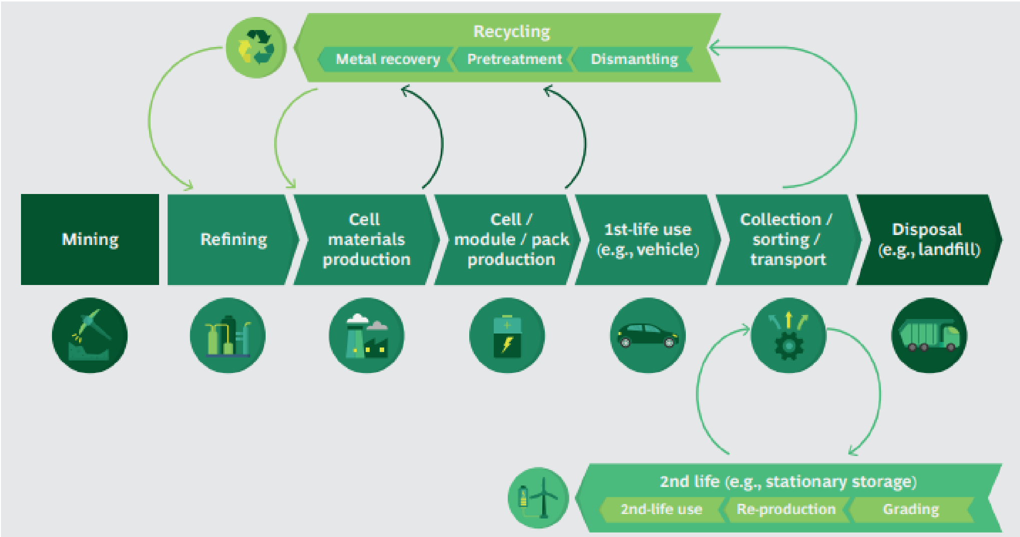
② Policy Background

The circular economy, denotes a supply chain, that at the end of a product's lifespan, a product or its materials are recycled and reused back into production. This not only reduces the environmental impact of the potentially disposed product, but also fosters a sustainable consumption of limited resources which are critical to the production of certain products.

The advent of Electric Vehicles, or EVs has also created a parallel market with fuel cells, which in turn, has led to the issue of the need to mitigate the environmental impact of the disposal of these fuel cells once they have reached the end of their lifespan. (Normally 70% of its charging capacity) These requirements have led multiple government initiatives to make sure that the environmental impact is reduced to a minimum, while delaying or preventing the potential resource depleting of critical minerals required for the production of these fuel cells, such as lithium, cobalt or nickel.

Fuel cells can either be recycled, by extracting the lithium, cobalt and nickel, resulting in new batteries, or re-using them into different products, such as energy storage products or uninterrupted power supplies (UPS). The latter has proved to be easier, as the dismantling fuel cells without causing a fire hazard has proven to be difficult, with Green Eco-Manufacture (GEM) and the Guangdong Brunp Recycling Technology Co. (BRUNP) (with CATL) being one of the few companies in the world to be able to do so.

[Figure 6-20] The Circular Economy of EV Batteries



Source: The Case for a Circular Economy in Electric Vehicle Batteries

However, recycling EV Battery proposes three main challenges. To begin with, obtaining sufficient quantities poses a challenge, as batteries have long timelines. As of now, 78% comes from scraps from gigafactories and EV Batteries will not become a significant source until 2030 (Green Car Congress, 2022). In addition, improving the economics of processing less expensive metals, as valuable cobalt batteries are being replaced with relatively inexpensive lithium iron phosphate (LFP). Lastly, further reducing the environmental impact by fostering sustainable supply chains though GHG emissions reductions, energy efficiency and a circular economy have all been challenges not just for the People's Republic of China, but also for other economies as well.

③ Policy Implementation

Because the first wave of EVs that were put into production are now approaching the end of their lifespan (2022-3), there is need to make sure that the supply of excess dead batteries is dealt with.

The People's Republic of China has shown notable progress in fostering a circular economy for recycling and re-using its fuel cells. The People's Republic of China is unique in that, it has a regulatory system which sets the responsibility of collecting dead fuel cells to the producers. This concept, known as Extended Producer Responsibility (EPR), places the burden on the producers to recollect their batteries after the product has reached its lifespan. Therefore, fuel cell companies have created their own EPR models to recycle the dead fuel cells after their lifespan, aiming to increase its collect rates to 95%.

[Table 6-21] Current EV battery Recycling Policies Comparison

	People's Republic of China	**EU**	**The United States**
Create cross-cutting market enablers	Introduced a traceability system for the management of EV battery recycling	EU Battery Regulation introduced Battery Digital Product Passport	
Reshape economic incentives		EU Taxonomy Regulation guides investments into sustainable EV battery manufacturing & recycling	Provides subsidies & tax credits for near-shoring battery recycling; subsidies for recycling infrastructure development
Harmonize &	Makes automotive	EU Battery	

strengthen existing measures	original equipment manufacturers (OEMs) responsible for battery recycling; defines guidelines for battery recycling	Regulation introduced material-specific recycling & recycled content standards; producer responsibility for end-of-life batteries	

Source: World Economic Forum, 2023

In order to the People's Republic of China to foster a sustainable supply chain for EV Batteries, from 2016, policymakers began setting the legal foundations.

The Interim Measures for the Management of Recycling and Utilization of New Energy Power Vehicle Battery set the policies for producers to be mandated to take Extended Producer Responsibility. This includes collecting, storing and safely disposing of end-of-life batteries.

[Table 6-22] Interim Measures for the Management of Recycling

and Utilization of New Energy Power Vehicle Battery, Notable Articles

Article 3	In the production, use, utilization, storage and transportation of waste power storage batteries generated in the process should be recycled in accordance with the requirements of these measures.
Article 4	The Ministry of Industry and Information Technology, together with the Ministry of Science and Technology, the Ministry of Environmental Protection, the Ministry of Transportation, the Ministry of Commerce, General Administration of Quality Supervision, Inspection and Quarantine, the Energy Bureau in their respective areas of responsibility for the recycling of power accumulators for management and supervision.
Article 5	The implementation of the extended producer responsibility system, automobile manufacturers bear the main responsibility for power battery recycling, the relevant enterprises in the recycling of power batteries to

	fulfil the corresponding responsibilities in all aspects of power battery recycling, to ensure the effective use of power batteries and environmental protection disposal. Adhere to the concept of the full life cycle of the product, follow the principle of organic unity of environmental benefits, social benefits and economic benefits, and give full play to the role of the market.
Article 7	Power battery manufacturers should adopt standardized, universal and easy to dismantle the product structure design, negotiation and open power battery control system interfaces and communication protocols and other relevant information conducive to recycling, the fixed parts of the power battery can be removed, easy to recycle the design.
Article 9	Battery manufacturers should work with automobile manufacturers, in accordance with domestic standards for the production of power storage batteries for coding, automobile manufacturers should record new energy vehicles and their power storage battery code corresponding information. Battery manufacturers, automobile manufacturers should be uploaded in a timely manner through the traceability information system power battery code and new energy vehicles and related information
Article 10	The automobile manufacturer shall entrust the new energy vehicle sellers and other new energy vehicles through the traceability information system to record the traceability information of the new energy vehicles and all the owners, and in the automobile user manuals to clarify the power battery recycling requirements and procedures and other relevant information.
Article 13	Automobile manufacturers and end-of-life automobile recycling and dismantling enterprises shall cooperate, sharing power storage battery dismantling and storage technology, recycling service outlets, as well as end-of-life new energy vehicle recycling and other information. Recycling service outlets should track the end-of-life recycling of new energy vehicles in the region, can be collected through recycling or repurchase and other ways to collect end-of-life new energy vehicles dismantled under the power storage battery.

	End-of-life new energy vehicles recycling and dismantling, should be in line with the requirements of the relevant domestic end-of-life automobile recycling and dismantling rules, regulations and standards.

Source: (The People's Republic of China, 2018a).

The articles mentioned above not only establish legal responsibility for producers to recover the batteries after they need to be disposed, but also require establishing traceability systems to manage batteries for the entire lifecycle.

The Interim Provisions on the Management of Traceability of Recycling and Utilization of New Energy Vehicles Power Battery (The People's Republic of China, 2018c), requires information of traceability at all stages from manufacturers, automakers and recyclers to record and document throughout the lifecycle of the battery.

Guidelines on Construction and Operation of Power Battery Recycling Service Network for New Energy Vehicles (The People's Republic of China, 2019) defines the requirements for facilities for recycling batteries, such as safety standards.

Measures for the Administration of Echelon Utilization of Power Batteries in New Energy Vehicles (The People's Republic of China, 2018b), lays out the standards for secondary use of batteries with testing and certification to test safely and encouraging companies to innovate in new technologies for second-life batteries.

3) Case Studies: GEM & Huayou Cobalt

GEM (Green Eco-Manufacture)(Yang, 2023), is rated as the number one[9] leader in recycling end of life EV batteries. GEM, began its roots in 2001 from recycling small batteries, which later expanded to various electronic waste. GEM's factories are able to recycle over 90% of lithium, demonstrating hydrometallurgical extraction techniques far superior to competitors.

[9] As of Nov 2022, 88 companies in the People's Republic of China were authorized for EV battery recycling.

GEM is known for its collaboration with producers such as Mercedes-Benz, Toyota, BYD and Volkswagen.

Currently, GEM has built 19 recycling treatment plants in in the People's Republic of China, as well as in Indonesia; Korea; and South Africa, eight of which are focusing on end-of-life batteries. GEM's recycling has accounted for more than 10% of the People's Republic of China's volume of end-of-life batteries. At the same time, GEM also has five battery manufacturing centers.

[Figure 6-23] GEM's Value Chain of Power Batteries

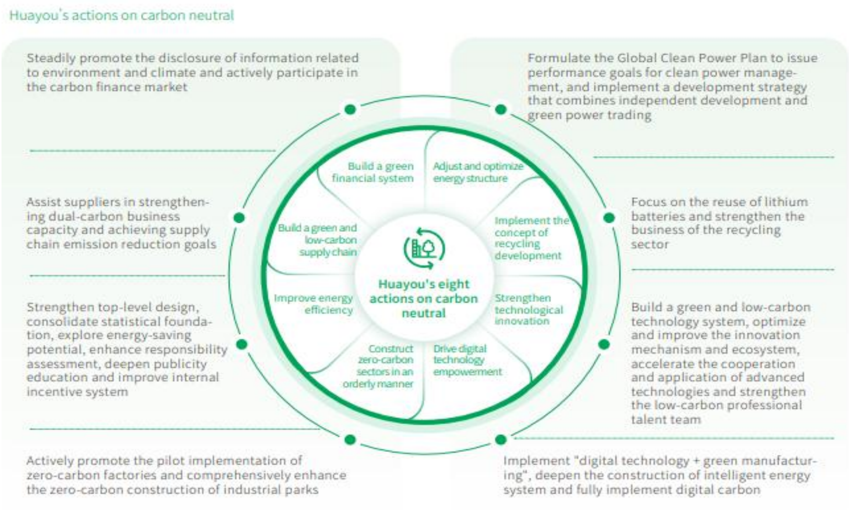
Source: https://en.gem.com.cn/Products/info.aspx?itemid=5841

In addition, Huayou Cobalt has also become a major player in all three facilitating components of sustainable supply chains. Originally a massive player in providing the world's cobalt supplies, Huayou Cobalt has grown to create a low-carbon ecosystem for lithium batteries, collaborating with brands such as BMW, Volkswagen, Toyota, FAW, Chang'an, GAC, SAIC and NIO. Facilitating GHG emissions reductions, Huayou Cobalt aimed to reach carbon neutrality from materials in 2030 and strive to achieve carbon neutrality for the entire supply chain by 2050.

For energy efficiency, Huayou Cobalt has taken multiple steps across the entire supply chain.

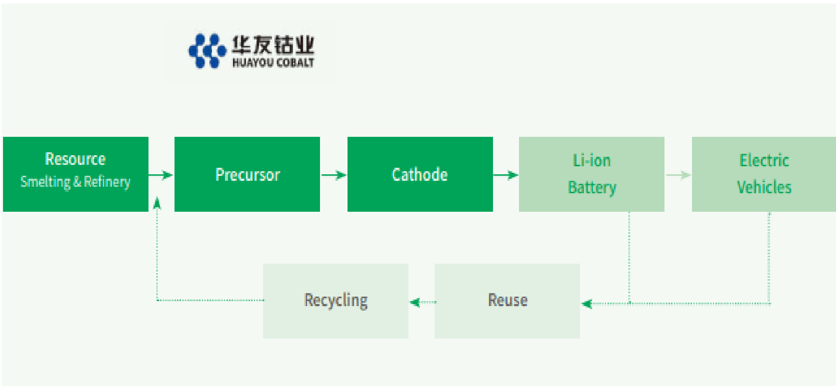
From utilizing photovoltaic projects to generate power, purchasing clean electricity across the globe, using energy storage systems, improving building designs, building zero-carbon factories or investing in energy microgrids to create a new Energy Storage Town in collaboration with Toyota Motor Corporation.

[Figure 6-24] Huayou Strategies for Carbon Neutrality



Source: Huayou Cobalt 2023, Environmental, Social and Governance Report

[Figure 6-22] Huayou Recycling's Circular Economy



Source: Huayou Cobalt, 2023

For the circular economy, Huayou Cobalt, in response to policies to foster traceability, was one of the world's first to complete a digital end-to-end monitoring for the "recovery, sorting, R&D, manufacture, operation and monitoring" of decommissioned batteries. At the same time, Huayou Cobalt has also participated in creating industry standards for recycling, reuse, environmental protection and safety of power batteries.

VII. Policy Recommendations

The proliferation of supply chain-related policies at the domestic level may pose challenges to global trade and economic stability. As individual economies implement their own regulatory frameworks, the potential for fragmentation and uncertainty may increase, potentially disrupting global supply chains and hindering international commerce. To address these concerns and advance APEC's goal of strengthening the global multilateral system, APEC economies can consider promoting sustainable global supply chains by establishing a new vision for "Sustainable Supply Chain Development."

To achieve this, this research paper proposes the following initiatives for Environmentally Sustainable Supply Chains in APEC Economies, for future consideration by economies.

Possible Initiatives for Environmentally Sustainable Supply Chains in APEC Economies

This initiative seeks to advance sustainability within the supply chains of APEC economies through a multi-faceted approach under the framework of "**Promoting Environmentally Sustainable Supply Chains**."

- **APEC-wide commitment:** We propose that APEC economies formally agree to promote GHG emissions reductions, energy efficiency and the circular economy from a supply chain perspective. Promoting these goals within APEC supply chains aligns with growing global efforts toward responsible business conduct and environmental sustainability. Such a statement would demonstrate adherence to responsible sourcing and sustainable practices throughout the region. A specific statement and mechanism will be formulated and addressed in the future by incorporating feedback from the economies.

- **Regular Fora and Workshops:** To facilitate knowledge sharing and collaboration, we recommend establishing regular fora and workshops for firms and policy makers within APEC economies. This would play a crucial role in fostering knowledge exchange and collaboration between businesses and policymakers, accelerating progress towards sustainable practices. Sessions would focus on environmental issues, regulatory changes impacting supply chains and best practices for achieving environmentally sustainable supply chains. APEC has established platforms, such as SCFAP III, which includes a section on green supply management. Regular workshops and fora can be effectively implemented through a collaborative approach.
- **Development of APEC's Handbook on Sustainable Supply Chain:** Recognizing the unique challenges faced by small and medium-sized enterprises (SMEs), the initiative proposes developing a practical handbook specifically geared towards enhancing in their supply chains. This handbook would provide SMEs with clear and accessible guidance on implementing responsible sourcing practices and improving environmental sustainability throughout their operations.

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