# Opportunities for Supply Chain Decarbonization in APEC Economies

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# Overview

The 21 members of Asia Pacific Economic Cooperation (APEC) have positioned the region's leading multilateral trade and economic forum to drive innovative approaches to reduce global carbon emissions. In 2020, APEC Economic Leaders affirmed in the Putrajaya Vision 2040[1] that "We will promote economic policies, cooperation and growth which support global efforts to comprehensively address all environmental challenges, including climate change, extreme weather and natural disasters, for a sustainable planet."

The Bogor Goals, which preceded the Putrajaya Vision as APEC's long-term objective, focused most of APEC's workstreams on reducing barriers to trade and investment. The focus on sustainable development and addressing environmental challenges called for in the Putrajaya Vision 2040 marks a significant addition to the scope of APEC's agenda.

In the years following the announcement of the Bogor Goals in 1994, APEC members developed a structure for working groups and committees optimized for discussions on trade and investment issues. That structure exists today, and while many APEC groups are addressing sustainability issues from a sectoral perspective, APEC lacks a means of addressing sustainability in a holistic and coordinated manner such as a single "sustainability working group."

As the region's leading multilateral trade and economic forum comprised of diverse economies, APEC is well positioned to use the lens of decarbonization throughout the supply chain to focus and implement decarbonization policies. Modern supply chains are multinational, involve a diverse range of industries and suppliers, and are governed by a range of international jurisdictions. It is important for businesses and governments to work together to decarbonize the supply chain since no single company or government can tackle this challenge alone. Additionally, APEC can leverage its capacity building role to support developing economies, so they are not left behind in a race to reduce greenhouse gas emissions.

To encourage greater cooperation among APEC's existing working groups on the sustainability agenda, this publication explores the potential for the supply chain to serve as an effective organizing principle for APEC to develop and implement decarbonization policies while remaining focused on pressing trade issues in the region.

This publication is not a piece of original research, nor is it intended to provide an exhaustive list of trends, technologies, or policy solutions for supply chain decarbonization. Instead, using a supply chain lens, over ten chapters, contributors identify a range of decarbonization opportunities that could be accelerated through collaboration among APEC members. The final chapter proposes that APEC members consider applying this supply chain lens in its approach to holistically addressing the climate change agenda set forth by APEC Leaders in the Putrajaya Vision 2040.

[1] Putrajaya Vision 2040: https://www.apec.org/meeting-papers/leaders-declarations/2020/2020_aelm/annex-a

# Section Summaries

## Raw Materials & Inputs

Chapter one explores supply chain decarbonization solutions as they relate to the extraction and production of raw materials and inputs required for the manufacturing of usable and consumable goods. Considering APEC's workstreams and expertise, three major focus areas are identified in this chapter: low-carbon energy extraction and production; low-carbon mineral extraction; and agriculture, marine, forest and livestock resource management. Specific decarbonization strategies under these focus areas include coal-to-gas energy transition, clean and alternative energy, sustainable and efficient mining practices and technologies, climate smart agriculture and responsible forestry management.

## Logistics

As one of the largest sources of carbon emissions across APEC economies, decarbonizing the transportation and logistics sector will play a critical role in broader supply chain decarbonization efforts. While work is already underway in APEC to address these challenges, public-private partnerships are increasingly necessary to develop alternative and low-carbon fuels, including sustainable aviation fuel, biodiesel, hydrogen, electric battery technology and infrastructure, advanced technologies and smart urban planning, and sustainable transportation infrastructure. Successful development and implementation of these technologies and strategies will need to account for the unique challenges of decarbonizing consumer transportation versus vehicle fleets.

## BCG Perspective: Design & Manufacturing

Chapter three offers an overview of the Bio-Circular-Green (BCG) Economic Model and how it can be utilized to accelerate regional decarbonization. In particular, the BCG concept, a significant deliverable for Thailand's APEC host year, provides a model for economies to align production, consumption, distribution, processing and recycling practices with sustainability considerations while maintaining supply chain efficiency. Therefore, the BCG model and its associated concepts lay out potential principles to promote the design and manufacture of products in a sustainable manner.

## Retail & Consumer Use

With retail and consumer use occurring at the downstream end of a supply chain, efforts made by businesses to decarbonize scope 3 emissions have the potential to influence broader decarbonization efforts by suppliers upstream along the supply chain. However, businesses face three major barriers when attempting to decarbonize downstream activities: obtaining accurate product data and traceability; raising consumer awareness; and engaging in sustainable forms of product packaging. To respond to these obstacles, policymakers should develop multifaceted approaches that educate consumers on sustainably produced products while incentivizing upstream businesses in supply chains to adopt sustainable practices.

## Waste Management & Circular Economy

Existing waste management practices and policies suffer from a variety of shortcomings, including underdeveloped infrastructure, lack of consumer awareness and the inability of existing waste regulations to differentiate between garbage and secondary raw materials. To mitigate these shortcomings, a Circular Economy approach can minimize the carbon footprint and maximize the reuse, remanufacturing, and recycling of goods and materials if implemented effectively. As an information sharing, policy coordination, and capacity building forum, APEC can promote sustainable waste management practices through the development of Circular Economy principles and standards.

## Cross Cutting Theme – Supporting A Just & Realistic Transition

In developing economies and for micro, small, and medium enterprises (MSMEs), the challenges involved in decarbonizing are even greater given, on average, the capacity and resource constraints these organizations face in transitioning to low-carbon future. In response, the just transition concept seeks to build a framework that supports efforts to protect the environment while including communities and disadvantaged groups under the umbrella of climate justice, environmental justice, and energy justice. Within APEC, initiatives focused on capacity building, technological scalability, and support for a realistic and low-carbon energy transition can help ensure regional decarbonization does not jeopardize the economic security of developing economies and MSMEs.

## Cross Cutting Theme – Finance & Markets

As economies and businesses look to decarbonize their supply chains, financial markets and institutions will play an important role in funding and supporting the transition towards a low-carbon future. Specific solutions from a financial perspective include encouraging transparent climate-related financial disclosures, developing carbon markets, and redirecting capital to low carbon activities. Public-private collaboration will also be necessary to provide a framework under which an orderly transition can occur and to provide incentives to encourage companies and financial institutions to implement recommendations from sustainability alliances.

## Cross Cutting Theme – Science-Based Metrics

MSMEs, businesses, governments, consumers and financial institutions depend on accurate and transparent reporting and monitoring data to effectively measure carbon emissions along the supply chain. Chapter eight serves as a resource guide for information on existing metrics and indexes that are utilized across the APEC region while recognizing the need for greater harmonization around reporting standards and terminology. While not exhaustive, the list offers a baseline for APEC to explore common themes and obstacles that could inform the development of a potential supply chain decarbonization index.

## Cross Cutting Theme – Sustainability & Trade

Building on past deliverables such as the environmental goods list, APEC is positioned to be a leader in exploring ways to leverage trade policy to address the climate crisis. Several policy steps that APEC can

take to begin harnessing trade policy's power as a tool to drive better environmental outcomes includes defining the scope of environmental goods and services, facilitating the creation of a new carbon accounting paradigm, identifying sectors where more supply chain visibility and traceability are needed, and establishing an information sharing mechanism on critical mineral supply chains.

## Utilizing APEC As An Instrument For Regional Decarbonization & Recommendations For APEC Officials

Given the importance of supply chains to regional economic integration in the Asia-Pacific region, APEC could usefully develop a "supply chain decarbonization lens" to assess progress of its work on sustainability and expand its efforts to address regional climate challenges.

To support the decarbonization of supply chains, therefore, it is recommended that APEC:

a) Build on existing work on sustainability to create more specific and tangible projects that will promote reform in member economies in the future.

b) Take forward work in areas, such as SMEs and food security, where Ministers have agreed on commitments.

c) Put in place both commitments and work programs in key areas such as digital policies, science, technology and innovation, skills, transport, investment and standards and conformance.

d) Develop indicators and taxonomies that will permit progress of such work to be measured and assessed. These should be developed in conjunction with the private sector to allow business to develop Environment, Social, and Governance (ESG) criteria to promote responsible investments in the future.

e) Establish an appropriate coordination mechanism like a supply chain decarbonization framework to take forward APEC's future work on sustainability, ensuring that such a mechanism is equipped with appropriate expertise. Those involved with coordination should be encouraged to adopt a "regional supply chain decarbonization lens" as one means of assessing the progress of their work.

# Section 1: Raw Materials & Inputs

*Tanner Krueger*

Although the concept of circular economy has challenged the notion of where a supply chain begins, the extraction of natural resources, materials, and energy required to produce a good is commonly recognized as the beginning of global, regional, and local supply chains. The extraction of these resources is especially important in the Asia-Pacific region, which is responsible for 57 percent of total global extraction[2]. While these resources support the development and growth of APEC economies, the practices required to extract and process natural resources into usable goods and materials can emit significant amounts of carbon emissions and contribute to the worsening impacts of climate change.

Therefore, mitigating the carbon emissions at this stage in the supply chain will help ensure that efforts to decarbonize the production, manufacturing, transport, and consumption of goods are not undermined by the carbon produced from acquiring the basic inputs, raw materials and energy, at the beginning of global supply chains. APEC's strength as an information sharing and consensus building forum can support this decarbonization process by addressing common investment, policy, and technological barriers from across the region. Additionally, APEC stakeholders can utilize their expertise to identify and share solutions and best practices that promote the transition to low-carbon supply chains without negatively impacting regional economic growth and development.

## Low-Carbon Energy Extraction And Production

### Fossil Fuels

Ninety percent of global carbon dioxide emissions come from the production and use of fossil fuel energy. [3] Therefore, transforming the energy industry to be a lower carbon emitting industry is a key focus for decarbonizing supply chains. Although most economies are in the early stages of decarbonizing their energy systems, momentum to further these efforts has only accelerated among policymakers and the private sector in the Asia-Pacific.

Since fossil fuels will remain an important part of the region's energy mix due to its affordability and existing infrastructure, innovative policies and technologies will be crucial for decarbonizing these energy sources and production processes. One such strategy among APEC economies is support for the coal-to-gas transition. Recent findings by the International Energy Agency indicate that on average, coal-to-gas transitions reduce emissions by 50 percent when producing electricity and are relatively cost effective in economies, such as the United States, which has existing gas-fired power plants and domestic access to natural gas or liquified natural gas. However, increased private sector investment and the establishment of carbon pricing mechanisms are necessary in economies where the price of coal is cheaper and coal infrastructure is more abundant.[4] Additionally, the coal-to-gas transition can support the gradual decarbonization process in economies that are not able to make the jump from fossil fuels to clean energy

[2] UN Global Resource Outlook (2019).
[3] UN Climate Ambition: Renewable Energy (2021).
[4] IEA The Role of Gas in Today's Energy transitions (2019).

in the near-term. Further decarbonization can be achieved by increasing energy efficiency and operational efficiency of natural gas extraction.

Among other technologies, the private sector is exploring the development of carbon capture, utilization, and storage (CCUS) as a potential solution to mitigating the carbon dioxide emissions from energy extraction and production. While CCUS projects have been developed and implemented on a smaller scale, large-scale implementation has yet to be pursued due to the limits of existing technology and high costs associated with such projects. Despite these current limitations, APEC economies have launched programs to explore the feasibility of large-scale CCUS projects and reduce the technological and financial barriers. For instance, the National Energy Technology Laboratory, in partnership with the U.S. Department of Energy, is working to develop efficient and low-cost CCUS technologies through its Carbon Management Program.[5]

## Clean and Alternative Energy

Even with these efforts to decarbonize fossil fuels, the development of alternative and renewable energy is necessary to achieve significant decarbonization of the energy sector in the long-term. Renewable energy sources and technologies, including solar photovoltaics, wind, geothermal, advanced power storage, modernized electricity grids, next generation biofuels, ocean energy, and hydrogen energy, have high potential to accelerate the decarbonization of the Asia-Pacific's energy systems. However, since most of these technologies and energy sources are not as up-to-scale as fossil fuels, the World Economic Forum recommends that policymakers and the private sector implement the following enablers to support clean energy growth:

1. Set and improve carbon pricing, green certificates, and transparent pricing mechanisms.

2. Stimulate private-public partnerships and international cooperation to support investment opportunities and accelerate technological development.

3. Lower barriers to trade and investment in low-carbon and energy-efficient technologies.

4. Plan smarter infrastructure, including distributed energy systems and digitalization of energy technologies.[6]

Lastly, reducing inefficient fossil fuel subsidies can mitigate market distortion in favor of fossil fuels and create a more competitive environment for the adoption of alternative and clean energy sources.[7] As this issue continues to gather more attention among policymakers, APEC officials have already begun to share information and best practices concerning inefficient fossil fuel subsidies within APEC's energy workstreams.

[5] NETL Carbon Management Program
[6] WEF Scaling Technologies to Decarbonize Technologies White Paper (2015).
[7] OECD Update On Recent Progress In Reform Of Inefficient Fossil-Fuel Subsidies That Encourage Wasteful Consumption 2021 (2021).

## Low-Carbon Mineral Extraction

Minerals, such as copper, nickel, and cobalt, are necessary components of decarbonization in two substantial ways. First, the production of low-carbon and clean energy technologies, such as electric vehicles and solar photovoltaics, relies on the extraction of minerals and rare earth metals. Second, inefficient mining practices and extraction technologies can increase the carbon and environmental footprint of a supply chain.

Starting with the first point, the World Bank estimates that the production of processed minerals could increase by 500 percent by 2050 to meet the growing demand for clean energy technologies and over three billion tons of minerals will be needed to deploy the required amount of clean energy technologies to achieve a below 2°C future. Even with expanded mineral recycling and reuse capabilities, mining will still be necessary to meet the anticipated demand for producing these technologies.[8] Since the demand for clean energy and low-carbon technologies is projected to grow considerably over the next few decades, effective decarbonization strategies will need be needed to offset the carbon emissions associated with mineral extraction.

As such, policymakers and the private sector should focus efforts on reducing the inefficiencies and overall carbon output of mining practices. Decarbonization options for mining operations include improving operational efficiency, transitioning equipment to run on sustainable fuels, adopting hydrogen fuel cell and battery electric vehicles, and using low-carbon energy and electricity.[9] Additionally, the expansion of urban mining, or the recycling of minerals and materials for reuse, has the potential to extend the lifespan of minerals and precious metals. Urban mining is not only more cost effective than virgin mining, but it is also less energy intensive when effectively utilized. However, in most economies, adequate infrastructure, technological capabilities, and public awareness for wide-scale urban mining have not been established. There is also a lack of "collection and treatment" regulations concerning e-waste.[10] Public-private partnerships could be an effective means to develop, finance, and build the necessary capacity for urban mining to be widely accessible and both environmentally and economically cost effective. As an information sharing platform, APEC could serve as a venue for hosting public-private dialogues on this issue.

## Agriculture, Marine, Forest, And Livestock Resource Management

The extraction and management of agricultural, marine, forest, and livestock resources are another significant source of carbon dioxide emissions within a supply chain. Decarbonizing these industries and processes is especially important given the scale of their operations in the Asia-Pacific.

### Climate Smart Agriculture

Agriculture, including crops, fisheries, and livestock, is responsible for 19-29 percent of total global greenhouse gas emissions.[11] To minimize these emissions, climate smart agriculture (CSA) has emerged as an effective strategy in both developed and developing economies by integrating traditional farming

[8] World Bank, Climate-Smart Mining (2020).
[9] McKinsey & Company, Creating the Zero-Carbon Mine (2021).
[10] National University of Singapore (2022).
[11] World Bank, Bringing the Concept of Climate-Smart Agriculture to Life (2018).

techniques with innovative technology. Rather than a one-size fits all approach, CSA is often developed to reflect, and respond to, the opportunities and barriers faced on the local and regional level.

In the case of Australia, Central Queensland University recently completed a review of the development and adoption of CSA technologies and practices in Queensland, Australia. CSA approaches that have already reduced greenhouse gas emissions, or could if adopted, in Queensland include:

1. Digital field monitoring equipment that promotes efficient energy and fertilizer use and detects greenhouse gas emissions.

2. Identifying and developing nutrient-rich and climate resilient crops that reduce the food requirement for livestock and loss of crops to climate events.

3. Australian carbon farming, which is the process of managing soil, animals, vegetation, and water/irrigation in the best practical way to increase carbon storage and reduce emission.

4. Zero tillage/minimum tillage practices, supported by enhanced data from digital monitoring, which reduce the amount of emissions released from breaking up soil.[12]

Comparably, the United Nations Food and Agriculture Organization (FAO) launched the Sustainable Rice Landscape Initiative[13] in Viet Nam in 2018 and seeks to improve the sustainability of rice production and resource use efficiency. Utilizing a public-private partnership approach, the initiative will promote the adoption of proven climate best practices and innovative technologies to reduce the environmental footprint of rice, as well as link farmers to markets. Similarly, FAO's climate-smart fisheries and aquaculture programs promote the use of digital tools and advanced technologies to decarbonize fishing vessels and coastal management practices that protect natural carbon sinks, such as mangrove systems and seaweed farms.[14]

In both cases, CSA is viewed as an innovative approach to bridge the gaps between the environment, economy, technology, and needs of local farmers and food producers. However, the World Bank identified the lack of training and awareness of CSA as the single largest barrier to its wide-scale adoption.[15] To overcome this barrier, public-private partnerships can help spur investment and dissemination of information that support capacity building efforts and awareness of CSA.

## Forestry Management

Not only do forests have the potential to absorb and store about one tenth of the global carbon emissions projected for the first half of this century, but they also provide 75 percent of the world's freshwater and contain over 80 percent of terrestrial biodiversity.[16] Given the importance of forest ecosystems, the

[12] Central Queensland University (2021).
[13] FAO, The Sustainable Landscape Rice Initiative (2022).
[14] FAO, Climate-Smart Fisheries and Aquaculture (2022).
[15] World Bank, Bringing the Concept of Climate-Smart Agriculture to Life (2018).
[16] UN Sustainable Consumption and Production of Forest Products (2018).

sustainable management and production of forestry products is a crucial part of decarbonizing supply chains and minimizing the global carbon footprint.

Reforestation and afforestation are two of the most common strategies economies and the private sector are implementing to lessen the environmental impacts of logging. In the Asia-Pacific, China's reforestation and afforestation programs accounted for more afforestation than the rest of the world combined for many years. Additional policies and actions that can be taken include:

1. Improvements in forest governance to reduce the extent of illegal logging.

2. Expand and improve the transparency of forest certification schemes.

3. Adopt purchasing policies aimed at sourcing sustainably produced wood products.

4. Adopt zero or net-zero deforestation targets in supply chains.[17]

Although APEC does address forestry management issues, such as illegal logging and associated trade, future workstreams on forest certification schemes and public-private partnerships focused on sustainably sourced wood products can help strengthen existing regional decarbonization strategies.

[17] UN Sustainable Consumption and Production of Forest Products (2018).

# Section 2: Transportation & Logistics

*Tanner Krueger*

A fundamental element of a supply chain is the need to move goods and materials from resource extraction and production to consumer use and finally a form of post-consumer processing. The geographic diversity of the Asia-Pacific requires that supply chains in the region to rely on a variety of transport systems, including air, maritime, road and rail. However, reliance on fossil fuels, inefficient and outdated technologies, and inadequate infrastructure has resulted in the transportation sector contributing roughly 20 percent of total CO2 emissions in the Asia-Pacific.[18] Thus, mitigating the carbon footprint of the transportation sector will play a central role in decarbonizing supply chains and attaining a low-carbon future for APEC economies.

APEC economies are well-equipped to address these challenges by leveraging technologies, including alternative and low-carbon fuels, electric vehicles, advanced and sustainable transportation infrastructure sustainable, and encouraging public and private fleet modernization. Public-private partnerships will play a key role in sharing best practices, encouraging research and development, incentivizing the adoption of low-carbon technologies, and closing the technological and infrastructure gaps in developing economies and rural communities. Although APEC can draw from a wide range of strategies, practices. and technologies to achieve a low-carbon future, the solutions and policies identified in this chapter are options that APEC is well equipped to explore further based on existing and emerging workstreams.

## Alternative & Low-Carbon Fuels

While there are a significant number of alternative and low-carbon fuels in development to reduce carbon emissions in the transportation sector, this section will focus on sustainable aviation fuel, biodiesel and renewable diesel, hydrogen and electrification as some of the most beneficial alternatives to traditional fossil fuels.

### Sustainable Aviation Fuel

Sustainable aviation fuel (SAF) is often produced from alternative feedstocks, such as cooking oil, plant oils, municipal waste, waste gases and agricultural residues, making its associated carbon emissions 70 percent less than petroleum-based jet fuels, on average. Moreover, the International Air Transport Association (IATA) estimates that SAF could account for 65 percent of aviation emissions reductions by 2050.[19] However, certification schemes and policy frameworks for SAF production and use are relatively underdeveloped compared to other fuel sources. Policymakers can alleviate these barriers to wide-scale SAF use by adopting globally recognized sustainability standards, expanding incentive frameworks, supporting SAF R&D and de-risking investment, and utilizing industry expertise and experience.

[18] IEA https://www.iea.org/regions/asia-pacific
[19] International Air Transport Association Fact Sheet on SAF https://www.iata.org/en/iata-repository/pressroom/fact-sheets/fact-sheet---alternative-fuels/

## Biodiesel & Renewable Diesel

Produced from similar feedstocks as SAF, biodiesel and renewable diesel offer low-carbon alternatives to diesel produced from crude oil. Compatible with trucks, trains and ships that typically rely on petroleum-based diesel, these diesel alternatives reduce greenhouse gas emissions and produce less particulate matter. Additionally, economies with a large agriculture sector have been readily able to utilize existing resources, such as plant-based oil and waste from crops, for use in biodiesel production. While renewable diesel is less carbon intensive and offers more climate benefits than biodiesel since it is produced through a standalone process that does not involve mixture with petroleum-based diesel, there is evidence that the transition to biodiesel opens a pathway for greater sustainability efforts. In the case of Malaysia, the National Energy Efficiency Action Plan 2016-2025 and the Nationally Determined Contribution to the Paris Agreement offer a set of actions for the Malaysian government to transition towards renewable feedstock and begin to develop renewable diesel infrastructure based on current biodiesel production.[20] However, greater cooperation with the private sector is needed to attract the investment and expertise required to develop the technology and infrastructure to expand renewable diesel production.

## Hydrogen Fuel

In addition to biodiesel and renewable diesel, hydrogen fuel can serve as an effective means to decarbonize heavy-duty land transportation, maritime shipping and rail transportation. Hydrogen fuel produced from clean energy, such as geothermal, hydropower, solar and wind, offers a zero-carbon alternative to traditional fuel sources and is thought of as an ideal fuel for long-haul trade and shipping routes due to the lower demand for refueling as compared to electric batteries. Despite these benefits, greater adoption of hydrogen fuel is hindered by high costs associated with R&D and the lack of extensive hydrogen refueling stations and storage facilities. To lower the costs of hydrogen fuel, policymakers and industry leaders could collaborate to develop harmonized standards and establish carbon pricing mechanisms to provide greater market clarity, especially among the shipping industry.[21]

## Electric Battery Technologies

While SAF, biodiesel, renewable diesel and hydrogen are emerging as the preferred alternative fuel sources for long-haul shipping, electric battery technology offers advantages for small to medium-sized heavy-duty trucks and commercial vehicles that remain close to charging infrastructure in urban areas or along short transport routes. In fact, the World Economic Forum estimates that the electrification of urban commercial fleets, including fleet operators and facilitators, could mitigate more than 70 percent of urban mobility emissions and remove 50 percent of urban air pollution.[22] Since electric vehicles require longer charging cycles and are limited by distance due to battery capacity and weight, further R&D is needed before electric battery technology can become a viable solution for long-haul shipping.

Electric battery technology is emerging as a reliable low-carbon option for private transportation purposes. As businesses increasingly count employee commutes in their scope 3 emissions, reducing the carbon footprint of personal and public transportation will be an important element of decarbonization strategies. On the policy side, the APEC Policy Support Unit identified the following options to encourage

[20] https://www.researchgate.net/publication/357716532_Renewable_diesel_as_fossil_fuel_substitution_in_Malaysia_A_review
[21] Stanford Workshop on Decarbonizing Heavy Duty Transportation
https://energy.stanford.edu/sites/g/files/sbiybj9971/f/decarbonizing_heavy-duty_transportation_workshop_brief_1.pdf
[22] World Economic Forum https://www.weforum.org/agenda/2021/02/how-electric-fleets-can-fuel-decarbonisation-efforts-zeuf/

the adoption of electric vehicles (EVs) across the region: implement purchase incentives for consumers; provide vehicle usage incentives; develop charging infrastructure; and raise consumer awareness on the long-term benefits of EVs. The U.S. and China have already implemented vehicle usage incentive policies that offer free parking for EVs, access to carpool lanes or reduced tolls.[23] These incentives are especially important considering the higher purchase costs of EVs in most economies. For instance, the average EV costs approximately $10,000 USD more than the overall industry average within the U.S.[24] and consumers in Indonesia can expect to pay nearly double for an EV as compared to a gas-powered vehicle.[25] Incentives are a crucial policy tool for encouraging EV usage and expanding the market share of EVs as viable competitors to gas-powered vehicles throughout APEC economies.

# Advanced & Sustainable Transportation Infrastructure

As economies and businesses build new transportation infrastructure and upgrade existing facilities to meet the growing demand for low-carbon solutions and alternative fuels, decarbonization considerations will need to be top of mind during the construction and operational phases of airports, ports, rail and land transportation networks.

## Low-Carbon Construction

Utilizing sustainable construction practices and low-carbon materials are crucial to avoid built-in carbon emissions when building or upgrading transportation facilities. Sustainable construction materials, such as net-zero CO2 concrete or CO2-free steel, can drastically reduce the carbon footprint of construction materials. For instance, paving roads with asphalt containing rubber from recycled tires could lower CO2 emissions by around 30 percent when compared with conventional asphalt.[26] Beyond sustainable materials, digital tools like digital twins and five-dimensional building-information modeling (5D BIM) could be leveraged to optimize construction processes and reduce unnecessary carbon emissions from rework, inefficient equipment usage and resource wastage. Additionally, deploying energy-efficient equipment and sourcing energy from renewable sources will further mitigate carbon emissions.

## Digital Technologies & Operational Efficiency

Digital technologies and tools are vital in transitioning all forms of transportation infrastructure to achieve a low-carbon future. Examples include:

- Optimized movement sequencing, smart metering and clean energy solutions can reduce emission from airports.

[23] APEC PSU Report https://www.apec.org/publications/2022/09/policy-options-for-decarbonising-transportation-in-apec
[24] CNBC https://www.cnbc.com/2021/12/29/electric-vehicles-are-becoming-more-affordable-amid-spiking-gas-prices.html#:~:text=Electric%20vehicles%20tend%20to%20have,to%20internal%20combustion%20engine%20vehicles
[25] PROSPERA https://prospera.or.id/navigating-the-green-revolution-electric-vehicles/#:~:text=Indonesians%20can%20currently%20expect%20to,still%201.4%20times%20as%20expensive
[26] McKinsey Report on Sustainable Infrastructure https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/built-to-last-making-sustainability-a-priority-in-transport-infrastructure

- Digitalization of the shipping industry, such as deployment of cloud, IoT technology and advanced analytics tools to optimize freight scheduling and routing.

- Optimization of road maintenance through data analytics to reduce traffic jams on heavily used roadways.

- Automation of truck and crane equipment to minimize waiting times for shipping lines. In some cases, digitizing port infrastructure led to an 80 percent drop in air pollution.[27]

- Automated railway speed control systems that reduce power consumption by optimizing the speed of a train, which increases the operational capacity of the railway line.

Public-private partnerships will once again be important to the overall development, adoption and maintenance of digital technologies in the transportation sector. Private sector expertise, skills, R&D and investment can support infrastructure development and maintenance, whereas policymakers can set clear digital standards for transportation technologies and create a regulatory environment that encourages investment in future infrastructure projects in developing economies and rural communities.

## Fleet Modernization & Decarbonization Aspirations

Given the growing demand and importance of addressing climate-related challenges in the APEC region, decarbonizing private sector, public and personal transportation is a critical step towards achieving supply chains. Not only are private sector and public sector fleets responsible for the movement of goods across the region, but personal transportation is increasingly viewed as a determining factor in accounting for direct and indirect emissions of a supply chain. The development of alternative and advanced fuels, electric battery technologies, and digital and sustainable infrastructure are all important elements for economies to support the modernization of transportation fleets and reduce supply chain emissions from upstream and downstream sources.

[27] McKinsey Report on Sustainable Infrastructure https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/built-to-last-making-sustainability-a-priority-in-transport-infrastructure

# Section 3: BCG Perspective – Design & Manufacturing

*Dr. Twarath Sutabutr*

This chapter offers insights into the Bio-Circular-Green (BCG) concept and how it can be applied to support the decarbonization of supply chains across the Asia-Pacific region. In particular, the BCG concept, a significant focus during Thailand's APEC host year in 2022, provides a model for economies to align production, consumption, distribution, processing and recycling practices with sustainability considerations while maintaining supply chain efficiency. Therefore, the BCG model and its associated concepts lay out potential principles to promote the design and manufacture of products in a sustainable manner.

## The Post Pandemic Opportunities In Battling Against Global Warming

The COVID-19 pandemic has posed enormous challenge to societies and economies across the world. The pandemic countermeasures that have been implemented globally have resulted in changes on how people live and how business is conducted. The first immediate priority for governments so far has been to deal with the health crisis and save lives while minimizing economic impact. With the post-pandemic in sight governments are putting plans in place to stimulate economic recoveries, however, we must not lose sight of the importance of other challenges: the battle against climate change. Like the pandemic, climate change is an existential threat posing severe risks to individuals, society, and the economy in longer-term, as exemplified by the increasing frequency and intensity of extreme weather events around the world.

Government efforts to kick-start economies post-pandemic may open new opportunities in continuing battling against global warming. Needing to deliver on COP-26 and net-zero pledges, governments can reassess their plans, taking into consideration lessons-learned and global trends resulting from the pandemic. The disruption of **global supply chains**, which created tremendous impacts on businesses and consumers globally, is one example of the many opportunities the pandemic presents toto reconsider and update the decarbonization policies of the new era of the global supply chain.

## The Importance Of Global Supply Chain Decarbonization And Opportunities For APEC Economies

The recent disruptions and shocks to global supply chains have resulted in substantial impact to global businesses. Many multinational corporations and governments are now considering measures to prevent future supply chain disruptions. On July 20, 2022, for example, the US Department of State released a joint statement on cooperation on global supply chains between the U.S. and seventeen partner economies on the occasion of the Supply Chain Ministerial Forum. The eighteen participating economies agreed on four global supply chain principles: transparency, diversification, security, and sustainability. The fourth principle, sustainability, was intended to encourage global sustainability as well as meeting objectives related to the United Nations framework Convention on climate change UNFCCC and the Paris agreement.

Addressing carbon emissions related to global supply chains is a critical part of achieving net zero targets. A report by World Economic Forum (WEF) released in January 2021 estimated that global supply chains in eight industries (food, construction, fashion, fast-moving consumer goods, electronics, automotive, professional services and freight) account for more than 50% of global emissions. For companies with long supply chains, the end-to-end emissions are much higher than the direct emissions in their own operations (so-called Scope 1 and 2 emissions). Therefore, minimizing emissions from supply chains can greatly benefit the companies and the governments in achieving their carbon targets. To do so will require multinational corporates to redesign their supply chains as well as governments implementing policies and incentives to support decarbonization efforts. In addition, transitioning to net-zero supply chains would not markedly increase costs for consumer. A WEF report also estimated that around 40% of all emissions in these supply chains could be abated with readily available and affordable technologies (cost <€10 per tonne of CO2 equivalent), such as circularity, efficiency and renewable power – with only marginal impact on product costs. Even with net-zero supply-chain emissions, end-consumer costs would increase by 1–4% at the most in the medium term.

## The Importance Of APEC Economies And Their Opportunities

With 56% of the world's GDP and 38% of the world's population, APEC economies play a critical role on the global stage. Economic diversification among APEC members makes this region suitable for the development of efficient supply chains for global goods and services in the eight key industries identified in the WEF report. APEC, as an organization, provides an excellent venue for member economies to collaborate effectively on supply chain decarbonization efforts, on a multilateral basis. In addition, APEC economies currently and collectively have set internal ambitious targets in decarbonizing energy sectors, as well as adopting models such as the Bio-Circular-Green Model (BCG Model) currently proposed by Thailand, all of which have the potential to support supply chain decarbonization efforts. The BCG Model will be announced at the next APEC Summit hosted by Thailand in November 2022 to foster sustainable economic growth by maximizing the benefits of green and renewable energy resources. Thus, the BCG model could serve as a tool to move the region's energy transition policy towards a low carbon society by using advanced and pragmatic technologies for clean energy sources with their supply chain together with energy efficiency toward decarbonization and net-zero goals.

Ongoing efforts to decarbonize APEC supply chains will also help move APEC economies closer to their carbon neutrality targets. According to the latest APEC Energy Demand and Supply Outlook (8$^{th}$ Edition-2022), the APEC aggregated CO2 emissions is reduced from 18,372 million tonnes in 2050 in Reference scenario to 7,029 million tonnes in the carbon neutral scenario. Therefore, additional emission reductions from supply chain activities will certainly help economies to getting more closer to carbon neutrality achievements.

## The Bio-Circular-Green Model (BCG Model) Philosophy And Its Role To Support The Global Supply Chain Decarbonization

The BCG concept encompasses different related terms, which are: "Bio-economy," "Circular economy," and "Green economy." The Bio economy refers to the "production and use of renewable biological resources as well as economic activities at micro and macro scale, related to the invention, development, production and use of biological products and processes." This includes the production of food and non-food agricultural crops, and the technological processes that turn them into food, feed, bio-based

products, agrofuels, and bioenergy. The Circular economy refers to the "production and consumption of goods through closed loop material flows that internalize environmental externalities linked to virgin resource extraction and the generation of waste including pollution.'' In a circular economy, resource use is improved by minimizing the extraction of natural resources, maximizing waste prevention and mitigation, and optimizing the environmental, social, material, and economic values throughout the lifecycles of materials, components, and products. The Green economy refers to the "production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities...." The green economy also aspires to growth in income and job opportunities that must be driven by public and private investments. **Thus, the BCG concept can be defined as a model of production, consumption, distribution, processing, and reuse of resources in an efficient and sustainable way across the whole supply chain to achieve prosperity for all and raise the economic level while preserving the environment from pollution and not exposing future generations to significant environmental risks or ecological scarcities.** Therefore, the Bio-Circular-Green concept aligns closely with decarbonization of global supply chains as identified by WEF report, and is fully align with APEC Putrajaya Vision 2040 and Aotearoa Plan for Action, as well as with the recent Supply Chain Ministerial Forum initiated by the U.S.

## Considerations And Policy Recommendations For APEC Economies

The BCG Model can be utilized as a tool to overcome challenges and barriers to APEC economies' efforts to decarbonize global supply chains. According to proposal from Thailand in the APEC EWG 63 meeting, three areas of actions could be exploited to leverage the model, which are 1) the policy, regulations, and incentives to support R&D and investment in BCG, 2) participation and engagement from stakeholders in BCG, and 3) knowledge sharing and capacity building in BCG. These three implementing principles are aligned and applicable with the challenges of the supply chain decarbonization. As supply chain decarbonization efforts necessarily involve various levels of business and government sectors, multi-level and multilateral cooperation is essential. Key considerations and policy recommendations for further exploration of supply chain decarbonization with the BCG Model including:

1) **The recognition of importance and benefits of supply chain decarbonization**, both by private sector actors that comprise supply-chains and governments of the economies in which the supply chains operate. This could be in the form of initiatives from either public or private sector representatives who wish to meet the carbon targets and improve the sustainability of the supply chain. Such initiatives could lead to development of policy concept and actions at different magnitudes ranging from pilot projects to full-scale multi-level actions.

2) **The multi-economy cooperation**. Most major supply chains include operations across multiple economies. Thus, effective decarbonization efforts will require greater cooperation, such as through data-sharing and enhanced transparency, to ensure the entire supply chain is decarbonized upstream and downstream. APEC, as a capacity building and information sharing forum, can support these efforts by bringing together government and private sector experts from across the region to share best practices.

3) **Commitments from the government to drive for supply chain decarbonization**. Successful supply chain decarbonization efforts require the involvement of various parts of government. Therefore,

political commitments from the highest levels of government are necessary. The results, if achieved, not only benefit governments seeking to meet specific emissions goals but also support the competitiveness of local businesses that aiming to highlight their sustainable business practices and be selected as partners in global supply chains.

4) **Government support for the participation of businesses involved in supply chains.** Supply chain decarbonization efforts will require support for businesses at the ground-level of the chain, for instance a farmer in a food supply chain, or the small local SME in an automotive industry supply chain. These segments require financial and technical capacity-building support from large corporations and governments to ensure SMEs are equipped the information and technology required to reduce their carbon emissions.

5) **The investment and transfer of BCG technology to decarbonizing activities in the supply chain**. Supply chain decarbonization inevitably requires investment and technology transfer. This could range, for example, from the technology in high-tech agriculture to the investment in infrastructure of the fuel-for-the-future such as hydrogen for the transportation of the food products. Another example could be the circularity industry of the automobile and electrical appliance supply chains, or even the technology and investment in CCS-CCUS for these chains.

6) **The systematic target-setting and reporting of decarbonizing activities.** Actions and activities in decarbonizing supply chain are diverse and often fragmented as they are dealing with interdependent layers of operations. A well-designed and systematic assessment and reporting mechanism is also important to monitoring and stewarding the decarbonization programs to successful and beneficial outcomes.

# Section 4: Retail And Consumer Use

Professor Naubahar Sharif

To achieve supply chain decarbonization all participants along the supply chain must be mobilized to reduce global greenhouse gas (GHG) emissions.[28] Businesses fully committed to decarbonizing their supply chains must add retail and consumer use to the decarbonization agenda. This objective relates to Scope 3 emissions assessments, which are the most complex to tackle. Scope 3 assessment applies to indirect emissions (that is, emissions that do not emanate from companies' own operations), with the greater proportion of companies' carbon footprints sub-divided into 3a) upstream contributions from raw materials and other inputs procured by firms, including transportation of these supplies as well as business travel; and 3b) downstream contributions from the distribution and utilization of products made by focal companies, including emissions associated with transportation and disposal (World Economic Forum 2021; Plan A Academy 2020).

Sarra (2022) estimates that, in one large APEC economy—Canada—the retail sector is the source of 10.5% of GHG emissions. Regarding consumer use, Hertwich and Peters (2009) and Ivanova et al. (2016) estimate that GHG emissions attributable to household consumption account for between 58% and 72% of the total carbon footprint. Retail and consumer use occur at the downstream end of the supply chain, so decisions associated with, and efforts made on these two fronts have the potential to influence broader decarbonization efforts by suppliers upstream along the supply chain.

There is a pressing need to extend decarbonization efforts to retail and consumer use, but in this respect, businesses face three major barriers: obtaining accurate product data and traceability, raising consumer awareness, and engaging in sustainable forms of product packaging. Each of these challenges is discussed below:

## Accurate Product Data And Traceability

To calculate a retail product's total GHG emissions along the supply chain, it is necessary to obtain emissions data from retailers and all upstream suppliers as well as consumers (Scope 3 emissions). Frei and Betti (2021) argue that supply chain decarbonization depends on collecting detailed, convenient, and traceable carbon emissions information. Currently, such carbon emissions data are erratic and of varying quality.

In the absence of primary data, firms rely on emissions factors provided by reputable organizations to estimate a product's Scope 3 emissions (Downie and Stubss, 2012). Because carbon labels are not regulated, however, companies sometimes develop their own methodologies to calculate their products' supply chain emissions (Wolfrom, 2021). This leads to wide variation in the estimated values of carbon

[28] To assess supply chain decarbonization efforts, the GHG Protocol has emerged as the gold standard. The GHG Protocol was developed jointly in 2008 by the World Resources Institute and the World Business Council for Sustainable Development. The protocol comprises three levels of emissions assessments: Scopes 1, 2, and 3. Scope 1 is concerned with direct emissions from companies' own operations. Scope 2 applies to indirect emissions, based on electricity and other forms of energy (steam, heat, cooling) acquired by focal companies.

footprints. There is evidence that firms exaggerate their decarbonization efforts by attaching misleading carbon footprint labels to their products (Delmas and Burbano, 2011).

The objectivity and credibility of carbon footprint labels could be enhanced by third-party verification. For example, product carbon footprint labels certified by the Carbon Trust reflect two measures of product carbon footprints. A "business-to-business" measure reflects the total GHG emissions associated with a product, from raw material extraction and production to the factory gate, while "business-to-consumer" measures reflect the total GHG emissions associated with a product from raw materials extraction, production, distribution, and use to disposal. To ensure credibility, the measurements are audited by carbon-footprint experts.

A range of other public or private organizations in the US, Japan, Thailand, and the Republic of Korea provide third party-certified labels. Most of these organizations evaluate product carbon footprints according to major accounting standards, such as PAS 2050 and ISO14040/ISO14044, while some organizations calculate carbon footprints using unspecified life-cycle assessment methods (Liu et al, 2016). As a result, the underlying assumptions and methodologies vary considerably, making it possible for multiple organizations to issue multiple carbon footprint measurements for a single product type (Liu et al., 2016; Brenton et al., 2009).

Combining decarbonization with digitalization could facilitate the transition to supply chain transparency through market-based solutions. Among large multinationals in particular, a vision has been emerging in which every product is embedded with a QR code and/or an RFID tag that enables firms as well as consumers to identify a product's place of origin, environmental and carbon footprints, impact on biodiversity, manufacturing suppliers, intermediaries involved, and even the profiles of workers who contribute to manufacturing and distributing the product (Frei and Betti, 2021). Unfortunately, turning such a visionary idea into a thriving, real-world product data-tracking system faces the challenge of low infrastructural readiness, requiring costly investments to improve the relevant architecture.

Ultimately, it is unlikely that relying on external organizations to estimate a product's Scope 3 emissions, third-party verification, or dependence on third party-certified labels will prove sufficient to realize supply chain decarbonization goals. Despite their best intentions, firms may inadvertently contribute to the ongoing climate and environmental crisis (Frei and Betti, 2021). From an upstream point of view, firms may procure raw material from suppliers with subpar environmental records. From a downstream point of view, companies can hardly monitor, let alone control, consumers' product-use patterns. In other words, businesses are 'left in the dark' as to whether consumers utilize their products sustainably.

In some APEC economies, the ranks of private-sector actors (most notably technology start-ups) that are seeking to utilize, leverage, and scale up traceability as a new business model are growing. One example is FishCoin, a Singaporean-based start-up that seeks to build a traceability framework in the fishery industry using blockchain technology and to scale it up through reward-based incentives to persuade fishermen and other industry actors to provide information openly about every catch.

## Consumer Awareness

Consumer awareness inevitably plays a role in achieving product data accuracy and traceability in the context of prodigal consumer spending.

Consumers are the ultimate decision-makers in purchasing sustainable products as well as in consuming, recycling, and disposing of products sustainably. Their preferences and decisions provide incentives for all other actors upstream along supply chains. These preferences and decisions reflect consumer perceptions and information (Marchand, 2010; Rezai et al., 2013; Figueroa-Garcia, 2018), so consumer awareness is central to the success of supply chain decarbonization efforts. Sustainable consumption therefore requires consumer education, which consists of information dissemination and inspiration (McGregor, 2005), to raise awareness of responsible consumption and waste management practices. Studies show that social, cultural, and demographic factors significantly influence environmental awareness and concern among consumers (Chekima et al., 2016; Panzone et al., 2016).

Furthermore, consumers do not form a monolithic group, as salient characteristics such as socio-economic status, income, educational attainment, and social-cultural values vary considerably. Such differences raise barriers that complicate efforts to raise consumer awareness.[29] Barros (2015) illustrates how consumers articulate an attitude characterized by bounded rationality, whereby they are concerned primarily with day-to-day and cost-of-living issues rather than with broader macroscale issues.

The above considerations illustrate that no 'one-size-fits-all' approach adopted by firms and other stakeholders will effect widespread change in consumer behavior. Companies must therefore consider the backgrounds of both consumers (especially regarding social status) and industries; for example, solutions that suit fast fashion may differ widely from those that fit the food industry (Fabinyi and Liu, 2014; Zhang et al., 2021). Moreover, outcomes depend to a considerable extent on how such solutions are framed, even within the same consumer group or industry.[30]

For consumers with sufficient awareness of sustainability, the bottleneck is the availability of up-to-date information to help them distinguish between green and non-green products. A significant proportion of consumers in both developed and developing economies lack the knowledge needed to make environmentally informed consumption decisions (Young, 2008), as many overestimate or underestimate the sustainability of various packaging materials (Herbes et al., 2018; Boesen et al. 2019; De Feo et al., 2022) and misperceive the information presented on carbon footprint labels (Brécard, 2017). Imperfect information greatly increases the incidence of greenwashing among firms—i.e., making a show of

[29] To illustrate this point, we note that Fabinyi and Liu (2014), based on a fieldwork investigation of seafood consumption in Beijing, found social status to be a major determinant of consumer attitudes to product use, with awareness especially low among middle-class consumers. In a separate study on consumer attitudes to fast fashion in the UK, Zhang et al. (2021) also found that employment status correlates with awareness but does not significantly affect consumer decision-making; in other words, despite greater awareness, consumers may still purchase fast-fashion products while acknowledging that doing so is not fully sustainable.

[30] One example is demonstrated by Soma et al. (2020), in which they found that awareness of food waste is significantly higher among study participants who were provided with financial payouts and gamification benefits (through interactive games) than among focus-group discussion participants. Moreover, Septianto et al. (2020) report that study subjects exhibited greater awareness of food waste when food advertisements were complemented with 'gratitude-for-having' messages in combination with loss-framing arguments (e.g., how their behaviors could generate additional environmental damage). These studies align with the argument in Barros (2015) that conforming to social norms may, in certain contexts, be preferred to earning financial rewards.

environmental concern while largely avoiding environmentally sound practices (Delmas and Burbano, 2011; Brécard, 2017).

As the supply chain decarbonization process matures and contributes to the flow of a circular economy, environmental awareness and understanding of recycling must be enhanced to motivate and enable consumers to accept greater responsibility for decarbonizing supply chains (Neves and Marques, 2022). Source separation and recycling behaviors depend on consumer knowledge (Keramitsoglou and Tsagarakis, 2013; Babaei et al. 2015). Sidique et al. (2010) show that recycling education that enhances households' awareness of the importance and benefits of recycling, efficient recycling methods, and the availability of recycling facilities increases recycling rates.

Sibbel (2009) recommends that education for sustainability be incorporated into higher education curricula to improve graduates' consumption and waste-management patterns. UNEP (2010) points out that existing course content related to sustainable consumption is fragmented and based on obsolete scientific models and data, so policymakers need to ensure that instructors are trained systematically and that the associated curricula are effectively developed. In addition, successful education for sustainability also requires the linking of formal and informal educational approaches as well as integrating top-down and bottom-up approaches through partnerships between diverse groups of stakeholders, e.g., governments, NGOs, businesses, and academia (IGES, 2011).

A growing number of organizations have recently begun utilizing insights gleaned from behavioral sciences—also known colloquially as 'nudging'—into their policymaking intervention strategies, as notably exemplified by the bottom-up application of behavioral insights by various government agencies in Singapore (Kok, 2017).

## Packaging

In the largest APEC economy—the United States—containers and packaging generated 82,220 thousand tons of solid waste in 2018, representing 28.1% of all municipal solid waste in the economy. As a result of efforts to promote sustainability, 51,750 tons of this solid waste was either recycled or combusted with energy recovery, while the remaining (34,470 tons) was landfilled (US EPA, 2020). Yet the concept of sustainable packaging goes beyond just recycling and energy recovery. Sustainable packaging involves reasonably minimizing the environmental impacts caused by packages along the entire supply chain, i.e., from sourcing, manufacturing, and transportation to recycling.

According to the Sustainable Packaging Coalition (2019), sustainable packaging:

- Is beneficial, safe, and healthy for individuals and communities throughout its life cycle
- Meets market criteria for performance and cost
- Is sourced, manufactured, transported, and recycled using renewable energy
- Optimizes the use of renewable or recycled source materials

- Is manufactured using clean production technologies and best practices
- Is made from healthy materials throughout the life cycle
- Is physically designed to optimize materials and energy
- Is effectively recovered and utilized in biological and/or industrial closed-loop cycles

Progress towards sustainable packaging depends critically on retail and consumer use. On the one hand, retailers face uncertainties regarding how consumers respond to new sustainable packaging design, potentially reducing sales (Gustavo, 2018). Faced with tradeoffs between price, quality, and sustainability, consumers generally prefer less sustainable alternatives (Olson, 2013). Vella (2018) shows that the primary obstacles to sustainable packaging include risks involved with charging a premium and false popular perception about sustainability, both of which can weaken demand. On the other hand, the average consumer is often unable to evaluate the sustainability of packaging. For instance, many consumers perceive plastic polyethylene terephthalate (PET) bottles and aluminum cans as are similarly sustainable, but the global warming impact of aluminum cans is higher (Boesen et al., 2019), while Herbes et al. (2018) demonstrate that consumers generally misunderstand biobased packaging and underestimate its sustainability. For this latter reason, the issue of sustainable packaging and consumer education and awareness only gains added salience. Indeed, the average consumer is barely aware of what makes packaging sustainable.

In response to the global plastic waste problem, fast-moving consumer-goods companies, packaging manufacturers, and upstream-material firms have recently been redefining how they package their products. These efforts range from business-model to material science-based innovations. Some illustrative examples (Berg et al., 2020):

- Creating a new business model centered on maximizing container reuse, as notably shown by Algramo, a Chile-based start-up that allows consumers to refill their sauce bottles, detergent bottles, and other personal care products at special dispensing stations
- Replacement of plastic-based packaging with materials based on metal and/or glass
- Use of fiber-based packaging in place of traditional polymers
- Development of flexible paper-based packaging solutions with water-resistant coatings
- Substitution of multi-material plastics by mono-material components to maximize recycling rates (given the difficulties involved in recycling the former)

As emphasized here, decarbonizing supply chains depends on educating all stakeholders, but ultimately consumers play the most critical role because manufacturers, suppliers, and retailers respond most immediately to consumer demand. Thus, policymakers must develop multifaceted approaches that

persuade consumers to demand sustainably produced products marketed in sustainable packaging while incentivizing businesses upstream along supply chains to adopt sustainable practices.

# Section 5: Waste Management & Circular Economy

*Adina Renee Adler*

Unlike existing linear economy models, Circular Economy moves away from a "make-use-dispose" model to proactively reintegrate used products and materials into productive commerce. It does so via 'reverse' supply chains that extract materials from society rather than mines, thereby preserving the planet from resource extraction and the resulting excess emissions as well as protecting the environment from unnecessary pollution. Circular Economy also entails a conscious approach to manufacturing that considers both post-use management (e.g., recyclability) and the use of recycled materials in the 'forward' supply chain for production. Both considerations advance Circular Economy's objective of preserving natural resources while also empowering communities through localized economic growth, jobs creation, environmental justice, innovation, and social awareness of the consumption/environmental nexus.

Below, we discuss the primary factors currently contributing to environmental seepage and degradation, outline the key principles and objectives of Circular Economy, and discuss policy steps that APEC can take to help put the principles of Circular Economy into practice.

## Shortcomings In Recycling And Waste Management Policy And Practice

Environmental seepage and degradation — on land and in rivers and oceans — results from a combination of factors. The primary cause is the deficiency of waste management infrastructure in developing economies, which results in poor waste collection, transportation, processing, trash disposal and used goods recycling. This lack of infrastructure, in combination with low levels of consumer awareness about the health and environmental benefits of throwing one's trash in a bin, has resulted in excessive litter and the famous Pacific Garbage Patch.

But a lack of waste management infrastructure is not the only factor contributing to environmental degradation. The exponential increase in the volume and types of products and materials that are used both in household waste generation and industrial/commercial generation has also played a role. In the absence of adequate infrastructure to handle such an influx, this increase had led to significant environmental harm.

In most developed economies, nearly all scrap generated from industrial/commercial operations is easily recyclable. In fact, a perfect Circular Economy already exists for metals and paper grades collected from the shop floor or retail outlets. But that is often not the case in developing economies, where factories are less likely to be located in close proximity to recycling centers, and the resulting regulatory and transportation costs create major disadvantages for the Circular Economy. However, on the consumer side, product innovations to meet discerning consumer demand has resulted in a vastly wider selection of unique goods that require end-of-life management. The volume of such goods, as well as the variety of their design, is often too much for existing infrastructure, which was often built to accommodate a different era of end-of-life goods.

Existing domestic and international waste regulations also pose a major impediment to the Circular Economy and thus inadvertently create seepage. Underlying this problem is the casual and regulatory use

of the "waste" nomenclature to refer both to garbage and secondary raw materials, a conflation that is reflected in policy language around the world. The U.S. Resource Conservation and Recovery Act (RCRA), for instance, defines solid waste as "any garbage or refuse, sludge from wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, resulting from industrial, commercial, mining, and agricultural operations, and from community activities."[31] The definition of waste in China's Law on the Prevention and Control of Environmental Pollution Caused by Solid Waste — "objects and substances…that have lost their original use value or have not lost their use value but have been discarded or abandoned"[32] — similarly implies that anything we no longer want should first and foremost be handled like trash.

Finally, despite advances in how we think about — and approach — creating a Circular Economy, many producers and consumers still tend to think about the global economy as a linear process: commodities move along a one-way value chain until they reach their final destination. At the end of this unidirectional conveyor belt lies waste — the inevitable byproducts of this steady churn of value creation. In the context of this linear economy, calling something "waste" does not merely signify that it is the byproduct or leftover of some other process — it suggests that the product is valueless, having reached the end of life as a useful commodity.

## What Does A Circular Economy Model Require?

Transitioning to an understanding of the global economy based on the Circular Economy model will require an applied understanding that waste is not part of the Circular Economy. Under a Circular Economy model, previously used, cast-off, and obsolete goods and materials that are recyclable and for which a market exists are reintegrated into the manufacturing supply chain as a secondary raw material input with a much greener footprint than freshly mined, virgin materials. There is great value in that scenario.

The APEC Policy Support Unit clearly lays out challenges and opportunities for the transition to a Circular Economy in its Policy Brief No. 30.[33] To build on those ideas, a successful Circular Economy requires the following public and private actions, both domestically and internationally:

- Goods manufacturers must establish sustainability commitments that are both sincere and achievable. This creates consumer trust in purchasing sustainable goods while also leading to manufacturers making a true impact on the environment.

- There must be a ready supply of high quality, secondary raw materials that is affordable enough to allow manufacturers to achieve their sustainability commitments and reduce their reliance on virgin material extraction.

[31] 42 U.S.C. §6901 et seq. (1976): https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-regulations#nonhaz

[32] Law of the People's Republic of China on the Prevention and Control of Environmental Pollution Caused by Solid Wastes, 2020: http://www.xinhuanet.com/politics/2020-04/30/c_1125925247.htm (unofficial translation)

[33] APEC Policy Briefing No. 30: "Circular Economy: Don't let Waste go to Waste," January 2020. https://www.apec.org/publications/2020/01/circular-economy---dont-let-waste-go-to-waste

- Manufacturers must design products to incorporate sustainability, including end-of-life management. Producers can use lifecycle and economic analyses to find ways to transition away from the most environmentally harmful resources. Materials that use less water, degrade more quickly, are easily reusable and may even have better performance should always be considered as a replacement for virgin feedstock.

- There must be demand among manufacturers for secondary raw material inputs given their economic and environmental superiority. Recycling is like any other manufacturing process: goods are produced for a customer, and more customers means more incentive to produce a given good. Increasing demand for recycled commodities, such as through eco-design and government incentives, will spur more recycling and thus increase the availability of secondary raw materials for future use.

- Governments must commit to enhancing reverse supply chain and waste management infrastructure to facilitate the proper separation of secondary raw materials from trash and ensuring that used goods and materials get to recyclers and manufacturers wherever they may be located. Underlying this green supply chain is an improved societal understanding that secondary goods and materials have value and are usable, thereby generating jobs and spurring innovation in a way that waste does not.

## Minimizing Waste And Maximizing Recyclability

With the support of governments, consumers and producers can take immediate action to achieve a Circular Economy, minimizing waste and maximizing the reuse, remanufacture and recycling of goods and materials, including packaging. APEC Policy Brief No. 30 identifies several of the following initiatives:

Eco-Design Standards: It is critical that producers design goods with sustainability in mind, regardless of whether the impetus for this change comes from government regulation (as is under development in the European Union) or voluntarily driven by changes in consumer consciousness (i.e., e-commerce delivery packaging). Specifically, consumers can do this by incorporating the mechanisms to manage a good at the end of its original use into its design. This principle, known as “eco-design,” allows producers to create goods that are easy to dismantle, using components and materials that are easy to segregate and which can easily be reused or recycled to create the next generation of technology. These eco-designed goods should also incorporate recycled content in their fabrication to reduce or eliminate the need to mine virgin commodities.

Standards for Products and Inputs: Going beyond eco-design, standards-setting bodies could develop international standards for sustainably made products, such as in the use of substitute materials, renewable energy sources in production facilities, supply chain transparency and water usage. For material inputs, unified international quality standards could be developed based on market demands, technological capability, and risk assessment. This would create more uniformity in secondary raw materials, resulting in more regulatory certainty for material processors and increased supply for producers. It would also help stem the illegal trade of non-compliant waste.

Reverse Supply Chains: In tandem with continued public education about the real economic and environmental benefits of recycling, governments must invest in building out basic take-back, collection and transfer infrastructure. These investments will reduce reliance on landfills and open burn sites as a primary disposal solution, as well as facilitate the easy transfer of end-of-life goods and materials to recycling and manufacturing centers that can recycle, dismantle, reuse, or refurbish them. It also has the added economic benefit of creating jobs and economic opportunity for low-skilled workers.

Recycled Content Use: There is a pressing need to correct the enduring misperception that goods made from recycled materials are of an inferior quality than their non-recycled counterparts. These perceptions are not based in fact, and they hinder progress in the production and use of sustainably made products. Governments can help build market confidence in the quality of goods made from recycled materials by increasing public procurement of such products, as well as by incentivizing the use of recycled materials in production processes.

Standardized Labeling: Standardized labeling improves the public's awareness of sustainability and helps consumers understand the steps that they can take to contribute to sustainability through recycling. Labeling on energy efficient products are awarded through a certification process that incorporates transparency, science and risk-based assessment, such as the ENERGY STAR labels on appliances.[34] They are a perfect model for developing bin labeling and "sustainably-made" product labels that promote sustainability and help to create truth in advertising.

Environmentally Sound Waste Management and Recycling: International and domestic regulations must account for the environmentally sound management (ESM) of end-of-life products. Currently, there are few instances of rigorous implementation and enforcement of such regulations around the world. To protect the environment and prevent seepage into the marine environment, green supply chains must consider not only the forward and reverse delivery of goods and materials but also the proper handling of industries' waste by-products.

## Recommendations For APEC

Ultimately, the Circular Economy will succeed in driving positive environmental outcomes when it is supported by a policy framework that facilitates both forward and reverse supply chains. That includes leveraging public-private funding for recycling, waste management and eco-design, as well as trade agreements that facilitate transboundary reverse supply chains. These efforts will be aided by common definitions of eco-goods, harmonized eco-design, resource material standards and supply chain transparency, such as traceability platforms.

Specifically, the following initiatives would establish APEC's leadership on Circular Economy and further Thailand's Bio-Circular-Green goals, the Putrajaya Vision 2040, and the Aotearoa Plan of Action — all of which make resilient and sustainable supply chains a core priority.

1. Develop Circular Economy principles that establish a common understanding of what constitutes the Circular Economy. These principles should include concrete definitions of key Circular

[34] https://www.energystar.gov/

Economy terms (e.g., recycling, secondary raw material, scrap, waste, sustainability) to ensure policy alignment; identify the need for Circular Economy and sustainable supply chains; identify incentives for the use of recycled content and refurbished/remanufactured products; and promote opportunities for technical assistance.

A subset of this effort is to consider changes to the harmonized tariff codes for secondary raw materials and used/reusable goods to distinguish them from low- and no-value trash, thereby facilitating their use in manufacturing.

2. Develop common principles for forward and reverse supply chains and the end-of-life management of e-waste and plastics that require unique solutions and align with international agreements.

3. Develop standards for eco-design, sustainably made products, labeling and secondary raw material input quality.

# Section 6: Cross-Cutting Theme – Supporting A Just And Realistic Transition

*Professor Naubahar Sharif*

With urgency induced by climate-change-related events, climate action has gained increasing traction over the last two decades. Decarbonization—as a core component of 'climate action'—has become a focal point of attention. Economies, corporations, cities, localities, and other stakeholders are working to drastically reduce their carbon-dioxide emissions. In recent years, particularly since the Paris Agreement goals were formulated in late 2015, decarbonization efforts have expanded both to address internal efforts by organizations to 'green' their own activities and also to encompass the broader web of suppliers (or supply chains) and other relevant sources from which these organizations procure the resources they need to run their businesses. This has given rise to the idea of 'supply chain decarbonization'.

To assess such supply chain decarbonization efforts, the Greenhouse Gas (GHG) Protocol has emerged as the gold standard. The GHG Protocol, developed jointly in 2008 by the World Resources Institute and the World Business Council for Sustainable Development, comprises three levels of emissions assessments: Scope 1, Scope 2, and Scope 3. Scope 1 is concerned with direct emissions from companies' own operations. Scope 2 addresses indirect emissions, based on electricity and other forms of energy (steam, heat, cooling) that are acquired by focal companies. Scope 3 is concerned with the biggest proportion of companies' carbon footprints, which is sub-categorized into two categories. Scope 3a) covers upstream emissions that are associated with raw materials and other inputs procured by firms, including transportation of these supplies as well as business travel. Scope 3b) covers downstream emissions associated with the distribution and utilization of products made by focal companies, including transportation and disposal (World Economic Forum 2021; Plan A Academy 2020).

In practice, supporting a just and realistic transition in supply chain decarbonization is difficult, for a multitude of reasons. McKinsey and Company (Spiller 2021) identified five major challenges: 1) lack of stakeholder consensus over carbon-counting standards, which are themselves often prone to accounting manipulation; 2) reliance on secondary data with (sometimes serious) uncertainties surrounding their accuracy; 3) uncertainties during the process of transition to decarbonizing; 4) difficulties faced in building inter-stakeholder networks to support and sustain decarbonization efforts; and 5) resources required to consistently sustain decarbonization efforts. Similarly, the World Economic Forum with Boston Consulting Group (World Economic Forum 2021) identified three broad categories of challenges: 1) lack of transparency, 2) challenges to execution, and 3) limited stakeholder support and government backing.

In developing economies and for microscale, small, and medium enterprises (MSMEs), the challenges involved in decarbonizing are even greater given, on average, the capacity and resource constraints these organizations face in transitioning to low-carbon and, eventually, net-zero futures. These challenges range from limited absorptive capacity regarding the latest technologies to inadequate institutional capacity to enforce regulations (especially those relating to climate action) as well as a tendency for the relevant core technologies to be concentrated in a small number of (mostly) developed economies (Dechezlepetre et al., 2011; Dechezlepetre et al., 2013).

Despite these challenges, the issue cannot be avoided. Firms in developing economies and MSMEs everywhere are potentially significant players in global supply chain decarbonization. According to World Bank data (World Development Indicators 2022), developing economies' share of global GHG emissions rose from 60.5% in 2008 to 67.2% in 2018. And, according to the British Business Bank (2021), MSMEs are responsible for 30% of total emissions and 50% of business-driven emissions.[35]

Global supply chain decarbonization will not occur without a just and realistic transition. McCauley and Heffron (2018) define a just transition as "a fair and equitable process of moving towards a post-carbon society". This means 1) fair distribution of environmental burdens and energy accessibility during the transition, 2) sufficient community engagement and involvement in the transition, and 3) compensation for economic losses and remediation of environmental damage after the transition. Similarly, Wang and Lo (2021) explain that a just transition should consider employment opportunities, exposure to environmental and climate risks, the burdens and benefits of energy services, the implications of the socio-technical transition, governance strategies, and public perception. Achieving a realistic framework for the transition requires considering social-technical constraints, such as a lack of capacity and incentives to innovate technologies, public opposition, and shortages of skilled labor and materials (Cotterman et al. 2021). Monyei et al. (2019) argue, moreover, that the transition should not exacerbate energy poverty, insecurity, or dependence. No plan that ignores these factors stands a chance of succeeding.

The emergence of this concept of a just and realistic transition is closely linked to the growing recognition that any transformation efforts—as in supply chain decarbonization—will inevitably provide significant benefits to the environment and support the growth of a net-zero economic model while simultaneously disadvantaging and displacing workers and communities associated with industries that have long been viewed as major contributors to climate change, especially fossil-fuel-intensive industries (Cha, 2020; Harrahill and Douglas, 2019; Healy and Barry, 2017; Wang and Lo, 2021; Wang and Lo, 2022). Scholars studying the just-transition idea seek to build an actionable framework that both supports efforts to protect the environment and addresses disruptions of the labor force and communities in the impacted industries while acting under the umbrella of climate justice, environmental justice, and energy justice (Heffron, 2021).

This article offers policy recommendations for achieving a just and realistic transition to a low-carbon global supply chain by focusing on three perspectives: 1) *capacity building* for firms in developing economies and MSMEs that will enable them to participate in supply chain decarbonization on an equal footing with large firms in developed economies, 2) measures applied to ensure a just and realistic *transition to low-carbon energy* during the process of supply chain decarbonization, and 3) *technological scalability* to facilitate supply chain decarbonization.

## Capacity Building

Supply chain decarbonization is highly complex and entails a widespread systemic shift, with its impacts—contingent on the varying circumstances facing key stakeholders—highly distinctive and often unequal across economies, or even among cities/localities, organizations, and industries within a single economy.

[35] Although these figures represent the situation in the UK, they nevertheless give some insight into the role and responsibilities of MSMEs in decarbonization.

Instead of advocating for one-size-fits-all, global-scale rapid action, which may not always align with just-transition objectives, there is a need for capacity-building initiatives and 'niche' transition projects that commence at the local level (Hanna and Victor, 2021; Geels et al., 2017). Such programs enable policymakers and stakeholders elsewhere to assess the advantages and pitfalls as well as to replicate and calibrate their actions in accordance with the unique circumstances that differentiate societies and institutions.

Presently, global emphasis on capacity-building projects concentrates primarily on cities/regions (c.f. Bernstein and Hoffmann, 2018; Hultman et al., 2020), as notably displayed by the Electric Vehicle Network of C40 and the 'We Are Still In' coalition of states, cities, businesses, and civil society organizations in the United States. In contrast, the role of MSMEs, especially those that operate in developing economies, has not been adequately discussed. This gap is particularly ironic given the fact that these enterprises account for most of the jobs, and economic activities, in those economies.

Moreover, decarbonization success hinges crucially on MSMEs' collective capacities to embark on these transition processes. Linking these businesses to the decarbonization agenda is no easy feat.[36] Moreover, other exogenous shocks, most importantly the COVID-19 pandemic, have been shown to undermine many MSMEs' decarbonization plans (Lin et al., 2022).

Open resources for MSMEs, e.g., the economy-specific and sector-specific accounting tools that are available through the GHG Protocol and the free online courses on reducing carbon emissions through better strategies, governance, and supply chain management offered by Climate Fit, are plentiful. Some multinationals have also formed alliances, e.g., 1.5°C Supply Chain Leaders, to collaborate with MSMEs to reduce supply chain emissions. Collaborations include experience-sharing and technical advice as well as favorable loans and financial arrangements (WSP, 2020; Mendiluce et al., 2022).

Governments can also play an important role in enhancing the capacity of MSMEs to participate in supply chain decarbonization. First, policymakers can improve the knowledge and skills that MSMEs need to calculate and report their carbon inventories by keeping MSMEs informed about the existence of open resources and toolkits, or even by redesigning and simplifying existing resources and toolkits according to the needs of local MSMEs across sectors. Second, government can encourage large local companies to serve as pioneers and exemplars of supply chain decarbonization. Third, policymakers can provide subsidies to incentivize firms to take part in supply chain decarbonization. Fourth, governments can act as coordinators to stimulate collaboration between large companies and MSMEs.

Data provide the key to supply chain decarbonization. It is challenging enough for firms in developed economies to calculate and share supply chain emissions data (Spiller, 2021), but it is even more challenging for firms in developing economies to perform these tasks because they typically do not know how to calculate and report even Scope 1 and Scope 2 emissions, let alone Scope 3 emissions. Nevertheless, NGOs and governments of developed economies provide guidelines, emissions-factor

[36] A recent survey conducted by the SME Climate Hub, a UK-based NGO comprising over 200 SMEs, demonstrates that the highest barriers an overwhelming majority of these firms face include: 1) lack of resources (68%), 2) insufficient funding (48%), 3) missing the 'right skills' (63%), 4) the presence of more urgent priorities (42%), 5) inadequate financial incentives (66%), and 6) lackadaisical government emissions-measuring standards (64%) (Jouven and Schmidt, 2022).

databases, and user-friendly toolkits for GHG emissions accounting and reporting. These open resources can be easily transplanted to developing economies after translation and some parameter modification.

Additionally, when pursuing Scope 3 emissions reduction, downstream purchasers in developed economies need Scope 1, 2, and 3 emissions data from upstream suppliers in developing economies. Therefore, downstream purchasers in developed economies are interested in providing carbon accounting and reporting assistance to upstream producers in developing economies. Large firms headquartered in developed economies may also provide technical or financial support for upstream firms that operate in developing economies to improve their emissions-reduction capacity (WSP, 2020; Mendiluce et al., 2022).

Another serious concern is that it may be unrealistic to expect developing-economy firms to decarbonize because they lack the technical capacity and financial resources they need to reduce emissions. Currently, the Science Based Targets initiative focuses mainly on emissions reduction (Science Based Targets initiative, 2021), yet practical decarbonization targets for firms that operate in developing economies should emphasize both economic growth and emissions reduction. Given the remarkable national and regional income differences that separate developed from developing economies, it is more realistic to set heterogeneous decarbonization targets that reflect regional developmental stages to ensure that MSMEs can operate on equal footing. When pursuing Scope 3 decarbonization, for example, some large companies are willing to set heterogeneous criteria based on the varying capacities of their business partners (WSP, 2020).

## Energy Transitions

Decarbonization depends to a considerable extent on energy transition, as proxied by initial adoption of low-carbon sources of energy (e.g. natural gas as a transitional solution), followed by an eventual shift into zero-carbon renewable energy, such as wind, solar, geothermal, and, more recently, emerging technologies involving ocean wave motion, nuclear fusion, and hydrogen. Equitable distribution of such forms of energy across the world remains however more of an aspiration than a reality, in part because of significant discrepancies in technological and policy capacities between developed and developing economies that obstruct cross-border transfer of climate change–related technologies (Dechezlepetre et al., 2011; Dechezlepetre et al., 2013).

Another important question is whether decarbonization will exacerbate or relieve energy poverty in developing economies. Energy poverty, which appears predominantly in developing economies (Sovacool, 2012), manifests in “the absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign energy services to support economic and human development” (Reddy et al., 2000). In 2010, 95% of the 1.3 billion people who were detached from the electricity supply resided in Asia and sub-Saharan Africa (González-Eguino, 2015). If supply chain decarbonization reduces the supply while increasing the price of energy, it will limit energy access in developing economies.

Three governmental measures can simultaneously alleviate energy poverty and reduce GHG emissions. The first is adopting a gradual rather than disruptive approach to replacing traditional power-generation sources with renewable energy (Monyei et al. 2019). During the transition period, the coexistence of

carbon-intensive energy and green energy could guarantee the stability of the energy supply and the affordability of energy prices.

The second means of simultaneously alleviating energy poverty and reducing emissions involves enhancing power-network and system efficiency (Cantarero, 2020). Power shortages in developing economies often reflect insufficient maintenance, substandard grid connectivity, and technology backwardness (Al-Sumaiti and Salama, 2014). Even with excess capacity, suboptimal power-system design can reduce energy production (Xia et al., 2020). Therefore, improvements in technology and management could substantially increase energy outputs without significantly increasing inputs or emissions.

Third, promoting citizen involvement in and awareness of the energy transition can also help to reduce both poverty and emissions (Cantarero, 2020). Consulting proactively with affected stakeholders (Lo, 2021) as well as incorporating social and normative values that acknowledge and honor diversity in communities, especially those affected by clean-energy transition processes, whether through collaboration with indigenous communities (Velasco-Herrejon et al., 2022) or localized framing (Cha and Pastor, 2022), can facilitate a just energy transition. Low citizen involvement and awareness enables weak governance and even corruption to harm the energy sector (Haas, 2008), in turn generating inequity in energy accessibility (Cantarero, 2020). Citizen participation in energy planning could protect community interests and encourage equitable sharing of the benefits of renewable energy (Thapar et al., 2017). Involved citizens are also less vulnerable to the energy poverty trap in virtue of which low-income citizens who suffer from poor energy accessibility experience high energy prices, perpetuating their poverty (Groh, 2014). Moreover, decentralized energy planning could enhance public awareness of the importance of renewable energy and foster more responsible energy-consumption behaviors (Devine-Wright, 2007).

Within the APEC context, this approach is demonstrated by the case of China's photovoltaic poverty alleviation (PVPA) initiative, in which affected villages held extensive consultative sessions with solar PV developers regarding the socialization of benefits as well as transparent disclosure of relevant information (Lo, 2021). With respect to localized framing, Cha and Pastor (2022)—through their case studies of coal-mining communities affected by the energy transition in the US—emphasized the importance of perceiving such communities in ways that go beyond conventional descriptions that characterize them as 'extractive' and 'polluters' but also to understand the complex historical pathways that shape their normative values. This approach has also been advocated for by Velasco-Herrejon et al. (2022), who emphasize the benefits of epistemological diversity in conceptualizing clean-energy projects.

Nevertheless, governments should not lose sight of the critical long-run implications of energy planning. As developing economies are experiencing urbanization and formulating their energy consumption portfolios, earlier adoption of renewable and smart energy systems will reduce the future cost of decarbonization (Fay et al. 2015). For instance, an earlier transition to electric vehicles will significantly reduce GHG emissions along the supply chain (Cantarero, 2020). China, an emerging economy, has managed to secure a leading position in producing electric buses (Hanna and Victor, 2021). Likewise, developing economies with abundant agricultural resources, such as Malaysia, could rely on bioenergy to reduce GHG emissions and relieve energy poverty (Idris et al., 2021). Some developing economies may also adopt the Smart Energy System (SES) approach (Lund et al., 2017), which considers the synthetic impact of multiple sectors, e.g., electricity, heating, cooling, manufacturing, construction, and transportation, to enhance long-run energy efficiency (Cantarero, 2020).

## Technological Scalability

Eventually, complete decarbonization will be possible only through ambitious scaling-up efforts. In this setting, scalability means extending applications of what were originally niche technologies into the mainstream. Existing scaling-up efforts, especially in the proliferation of net-zero technologies, can be driven by various sources— pioneering economies (Hanna and Victor, 2021), subnational entities within a economy (Bernstein and Hoffmann, 2018), or individual companies (World Economic Forum, 2021). In the context of regulation-driven scalability, decarbonization can be achieved along multiple pathways, whether through bottom-up learning (Geels et al., 2017), polycentric governance through which the efforts of multiple stakeholders in a given society are coordinated (Geels et al., 2017), or a strong, top-down approach, as demonstrated by China's ambitious efforts to achieve carbon neutrality through massive investments in renewable energy (Lo, 2021).

Limited attention has been paid to the role that MSMEs, especially those the operate in developing economies, could play in scaling up decarbonization plans. MSMEs need to address four prerequisites to successfully implement such plans. First, these companies will need adequate financial incentivizes to embark on such systemic shifts, whether in adopting new technologies, reskilling/upskilling their existing employees, or compensating for short-term losses they incur during the transition process. Second, governments—in consultation with relevant businesses (whether large firms or MSMEs), universities and research institutes, and various civil society organizations—must build national consensus regarding effective measures for use in carbon-emission accounting exercises. Third, in helping MSMEs adopt green technologies, governments may also need to consider variations in these companies' absorptive capacity; ramping up support in the form of applied R&D schemes or tripartite strategic research consortia (ideally university–industry–government partnerships) will be crucial in enabling these enterprises to implement effective decarbonization agendas. Schemes adapted from successful programs such as US-based Small Business Innovation Research (SBIR) grants can serve as a useful model for policymakers to consider.

Finally, MSMEs' ability to embed digitalization into their business practices must be enhanced, enabling them to track their inventories, manage their transaction volumes, and monitor their Scope 1, 2, and 3 carbon emissions more effectively. Some economies have, as part of their post-COVID economic recovery packages, begun to dually incorporate green- and digital-transition policy support for MSMEs, as demonstrated by the European Union (European Parliament, 2020) and South Korea (Farand, 2020). In the context of the developing world, continuing cross-economy cooperation in deploying green technologies—possibly in the form of patent pools or patent pledge schemes—will accelerate this process, especially in a post-COVID world.

There is another dimension to scalability: that is, technical scalability. Digital technologies (such as cloud computing and the blockchain) have the potential to facilitate the scaling up of capacity for supply chain emissions accounting and reporting (KPMG 2020). The following are examples of supply chain pilot projects with this potential:

1) Arçelik, Siemens, and Dow have established a simulated supply network for an Arçelik washing machine. In the network, accurate supply chain emissions data are shared among producers. The system is characterized by peer-to-peer data exchange, decentralized storage, aggregation of product-specific carbon footprint data, and a common interface and data model for interoperability. This project facilitates comprehensive analysis of the main contributors to network members' carbon footprints and realistic

decarbonization target-setting. The World Economic Forum is incubating new partnerships to scale up this idea (World Economic Forum, 2022).

2) CO2NNEXTM is a digital platform developed by Mitsubishi Heavy Industries and IBM to reinforce supply chain emissions data–sharing. This project utilizes emerging blockchain and AI technologies to consolidate and visualize supply chain emissions data. Moreover, this approach ensures objectivity, fairness, and information security while also enabling supply and demand optimization for achieving net-zero targets earlier (Mitsubishi Heavy Industries, 2021).

3) Seven global companies and the World Economic Forum have released a proof of concept—the Carbon Tracing Platform (COT). Based on distributed ledger technology, the platform enables end-to-end tractability of embedded GHG emissions from mines to final products (WEF, 2020).

4) atma.io is developing a cloud solution to trace supply chain GHG emissions. For each product covered, the system generates a digital identity that is uploaded to the cloud. Connecting to the cloud, sports retailers can easily access the carbon footprints of the products they market (Chaffo, 2022).

To leverage technical scalability, governments, inter-governmental organizations, NGOs, and multinationals could first provide financial incentives to encourage firms to develop and join digital emissions data-sharing platforms. It is also important to consolidate existing fragmented small-scale platforms into large-scale global platforms to realize economies of scale. With better technology and more abundant resources, governments and firms in developed economies should play leading roles in building such large and inclusive data-sharing systems, enabling firms in developing economies and MSMEs to participate in supply chain decarbonization at a reasonable cost.

Digitalization also spawns technologies that can improve energy efficiency and reduce GHG emissions. Some examples include microgrids (Guan et al, 2010; Shahidehpour and Clair, 2012), coupled renewable energy and storage systems (Barelli et al., 2018; Hemmati, 2018), smart charging for electric vehicles (Van Der Kam, 2015), and demand-side management of the energy sector (Meyabadi and Deihimi, 2017). These technologies could prove pivotal in the decarbonization of the supply chain.

# Section 7: Cross Cutting Theme - Finance And Markets

*The U.S. Committee for the Pacific Economic Cooperation Council*

This section reviews how financial markets and institutions can support an economy's decarbonization, including a transition away from high carbon emitting activities linked across firms through their supply chains. In particular, the financial sector can support this transition in at least three areas:

1) By encouraging climate-related financial disclosures,

2) By supporting the development of carbon credit markets, and

3) By directing lending toward corporate activities that are aligned with decarbonization pathways.

## The Need For Transparent Emissions Reporting

Public authorities should encourage firms that issue debt and equity in the capital markets to disclose their greenhouse gas (GHG) emissions, including Scope 1, Scope 2, and where material, Scope 3 (which includes the emissions of other companies within the firm's supply chain). Each government's disclosure standards should align where appropriate with the global framework for climate-related financial disclosures as developed by the Task Force on Climate-Related Financial Disclosures (TCFD) and as recently extended by the International Sustainability Standards Board (ISSB), established by the International Financial Reporting Standards Foundation (IFRS). A common global disclosure standard allows investors and firms with international supply chains to make like-for-like comparisons across competitors producing similar final goods and supplies offering similar inputs to production.

Financial institutions should encourage Small and Medium Enterprises (SMEs) and private company clients to similarly report on their climate-related risks and GHG emissions. In this way, financial institutions can extend the carbon emissions transparency to the many firms that do not participate in public capital markets but are nonetheless critical to the overall economy in general and global supply chains in particular.

## Development Of Carbon Markets

Backed by the International Monetary Fund, the World Bank, and the Organization for Economic Co-operation and Development (OECD), a growing number of economies are adopting carbon pricing schemes, in the form of an emissions trading system (ETS) or a carbon tax. The key difference between the two approaches is that with carbon taxes, the price of emissions is set by the government, whereas an ETS is priced through a market mechanism. With an ETS, however, policymakers have less control over the extent to which emissions are reduced.

Financial institutions can support the development of carbon markets – both voluntary and state created – which implicitly put a price on carbon and align incentives across the supply chain. For example, by joining alliances like the Taskforce on Scaling Voluntary Carbon Markets (TSVCM), financial institutions

can support the scaling up of voluntary carbon markets. Convened in September 2020, the TSVCM has grown and issued a set of recommendations and solutions. More precisely, it has found six key areas where efforts are required to achieve 'a large, transparent, verifiable, and robust voluntary carbon market.' The Taskforce goes on to say, 'these themes are establishing core carbon principles, core carbon reference contracts, infrastructure, offset legitimacy, market integrity, and demand signaling[37]'. Such a voluntary carbon market will provide a productive forum to support the path toward net-zero emissions through nature-based solutions and cost-competitive technologies and through investment in new, expensive technologies that will address the hardest sectors to decarbonize.

## Financial Institutions Can Proactively Seek To Redirect Capital To Low Carbon Activities

Enhanced transparency and clearer market signals provide financial institutions with the data and information they need to help finance the transition to a low carbon economy. Transparency and verifiable evidence on emissions can also help financial institutions actively seek and identify low-carbon investment opportunities and facilitate investment projects that help companies and sectors transition to lower carbon means of production—for example, climate technology and solutions, new infrastructure for a low-carbon economy, or addressing risks associated with new zero-carbon activities. Financial institutions could also decide to prioritize loans to firms with low and/or declining emissions over loans to firms with high and/or non-diminishing emissions.

Specific guidance on how financial institutions should consider prioritizing their lending practices in support of this transition has been developed by the Glasgow Financial Alliance for Net Zero (GFANZ). According to GFANZ[38], financial institutions can meaningfully contribute to the decarbonization of the economy and global supply chains through the following four approaches: i) financing the development and scaling of net-zero technologies or services to replace high-emitting sources; ii) increasing their support for companies that are already aligned to a 1.5 degrees C pathway, iii) enabling high and low-emitting real-economy companies to align business activity consistent with a 1.5 degrees C pathway for their sector, and iv) accelerating managed phaseout of high-emitting assets through early retirement.

## Need For Public-Private Sector Collaboration To Achieve Action At Scale

In line with recommendations from international organizations like the OECD, central governments play a critical role in defining and developing a national climate framework with sector-specific transition plans. According to the OECD, an effective decarbonization strategy consists of a comprehensive policy mix, including complementary policies that do not directly target a reduction in emissions but provide the enabling economic and social conditions to do so[39]. While making these commitments and providing the framework under which an orderly transition can occur, governments should provide incentives as well as support companies and financial institutions to follow recommendations from sustainability alliances such as GFANZ.

[37] Taskforce on Scaling Voluntary Carbon Markets Final Report, January 2021
[38] Please refer to GFANZ publications available here
[39] OECD Economic Policy Paper, A Framework to Decarbonise the Economy, February 2022

# Section 8: Cross Cutting Theme – Development Of Science-Based Metrics

*Tanner Krueger*

As economies, businesses and financial institutions look to decarbonize supply chains, access to reliable data becomes increasingly important for stakeholders to measure progress and identify barriers to further decarbonization. However, a regionally recognized supply chain decarbonization index based on harmonized standards and metrics does not yet exist within APEC. To potentially inspire such an index, this chapter serves as a resource guide for information on existing indexes, metrics and databases that measure carbon emissions and other environmental impacts across a multitude of economic sectors and organizations. While not exhaustive, the list offers a baseline for APEC to explore common themes and obstacles that could inform the development of a potential supply chain decarbonization index.

## APEC Energy Database (*APEC Expert Group On Energy Data And Analysis*)

Under the APEC Energy Working Group, the APEC Expert Group on Energy Data and Analysis (EGEDA) is responsible for collecting energy data on the APEC region and managing the operation of the APEC Energy Database. The APEC Energy Database serves as a comprehensive and consistent source of energy-related data for all APEC economies and identifies trends in energy supply and demand. Focusing on the environmental impacts of energy production and consumption, APEC economies voluntarily submit their economy-wide data on CO2 emissions to the database. Users wishing to access this data can view economy-wide CO2 emissions, CO2 emissions by energy source and CO2 emissions by sector.

Given the successful tracing of energy-related CO2 emissions, the APEC Energy Database could serve as a model to develop an APEC database that monitors the CO2 emissions produced by supply chains across economies on a voluntary basis.

Access the APEC Energy Database:
https://www.egeda.ewg.apec.org/egeda/database_info/index.html

## World Development Indicators (*The World Bank)*

The World Development Indicators is a collection of officially recognized internationally comparable statistics about global development on local, regional, and global levels. The environment-related indicators explore progress on many of the environment targets set by the 2030 Agenda for Sustainable Development, including biological diversity, reforestation, clean electricity production and reduced GHG emissions. While data for the environmental indicators are standardized to the best extent possible to enable cross-economy comparisons, the World Bank does note the lack of standardized reporting at the local and economy level does create challenges for accurately collecting data and organizing information within agreed-upon metrics and definitions.

Access the World Development Indicators:

https://datatopics.worldbank.org/world-development-indicators/

## Climate Watch (*World Resources Institute*)

Climate Watch is an open data platform managed by the World Resources Institute that compiles dozens of datasets for users to analyze economies' climate progress and commitments under the Paris Agreement. More specifically, the platform provides information on historical GHG emissions data, tracks net-zero targets and explores national determined contributions (NDCs) to reduce GHG emissions. A useful feature of this platform, as compared to others, is the ability to review historical GHG emissions as well as access modeling predictions for future scenarios. The Climate Watch modeling includes scenarios based on varying economic sectors, energy-use type and specific environmental impacts, such as GHG emissions or global warming.

Access Climate Watch: https://www.wri.org/initiatives/climate-watch

## Global Reporting Initiative Standards (*Global Reporting Initiative*)

The Global Reporting Initiative (GRI) Standards are the world's most widely used standards for sustainability reporting among businesses, investors, policymakers and civil society. The GRI Standards enable organizations to publicly disclose their most significant impacts on the environment and how these impacts are being managed. This allows for greater global comparability of environmental impacts and supports information users in making informed assessments about an organization's contribution to sustainable development. Most importantly, encouraging the public disclosure of environmental impacts through similar reporting standards and metrics results in transparent and accessible information for all relevant stakeholders. Moreover, the GRI Standards are designed to be modular, meaning organizations can report based on common environmental standards, sector-specific standards or topic-specific standards to account for the varying environmental impacts and actions between different sectors.

Access the GRI Standards: https://www.globalreporting.org/standards/

## The Science Based Targets Initiative

The Science Based Targets initiative (SBTi) is a partnership between CDP, the United Nations Global Compact, World Resources Institute and the World Wide Fund for Nature that provides assistance to companies and financial institutions setting and tracking emissions reduction targets. High-level objectives of the SBTi include identifying best practices in emissions reduction targets, providing companies with independent assessment and validation of reduction targets, and tailoring net-zero pathways to the specific challenges and circumstances of varying sectors.

Additionally, the recently developed SBTi Corporate Net-Zero Standard is the world's first framework for aligning corporate net-zero targets with climate science. The initiative includes guidance, criteria and recommendations for companies to set science-based net-zero targets consistent with limiting global temperature rise to 1.5°C. Consistent with other initiatives and indexes identified in this resource guide, the SBTi seeks to improve the transparency of carbon reporting standards and mitigate

miscommunication between stakeholders by providing a single access point for the reporting and monitoring of emissions data.

Access an overview of SBTi: https://sciencebasedtargets.org/

## The Sustainability Insight System (*The Sustainability Consortium*)

The Sustainability Insight System (THESIS) is managed through The Sustainability Consortium, an independent non-profit organization jointly administered by Arizona State University and the University of Arkansas. THESIS utilizes science-based Key Performance Indicators (KPIs) to identify environmental hotspots and highlight opportunities to help retailers, manufacturers and suppliers achieve greater sustainability within a consumer product supply chain. Common environmental hotspots include energy consumption, land use and deforestation, transportation-related emissions, packaging materials and waste management. Furthermore, The Sustainability Consortium believes THESIS reduces inefficient communication and reporting standards among supply chain stakeholders by providing clear data and specific actions businesses can take towards mitigating hotspots, which they identify as one the most pressing challenges to accurately reporting, and reducing, the carbon footprint of supply chains.

Access an overview of THESIS: https://sustainabilityconsortium.org/thesis/

## The Global GHG Accounting And Reporting Standard For The Financial Industry (*Partnership For Carbon Accounting Financials*)

The Global GHG Accounting and Reporting Standard for the Financial Industry offers the first global, standardized approach to measure and report financed emissions in alignment with the GHG Protocol, provider of the world's most widely used GHG accounting standards. By equipping financial institutions with harmonized methods to measure financed emissions, the metric enables them to:

- Assess climate-related risks in line with the Task Force on Climate-related Financial Disclosures.
- Set science-based targets using the sectoral decarbonization approach developed by the Science Based Targets initiative.
- Report to stakeholders with the Carbon Disclosure Project.
- Inform climate strategies and actions to develop innovative financial products that support the transition toward a net-zero emissions economy.

Access the Global GHG Accounting and Reporting Standard for the Financial Industry: https://ghgprotocol.org/global-ghg-accounting-and-reporting-standard-financial-industry

## Environmental Reporting & Monitoring in Action

According to the 2021/2022 ESG Progress Report of Merck (known as MSD outside the United States and Canada), the company's scope 1, 2 and 3 emissions reduction targets are verified by the Science Based Targets initiative. Additionally, Merck utilizes the GRI Standards, Sustainability Accounting Standards Board and UN Sustainable Development Goals to independently and publicly disclose their environmental impacts and progress based on widely recognized standards and science-based data[40].

MSD also reports annually to CDP (formally the Carbon Disclosure Project), a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts. The company responds to questionnaires for Climate Change, Water Security, and Forests.

The Task Force on Climate-related Financial Disclosures (TCFD) has developed a framework to help public companies and other organizations disclose climate-related risks and opportunities. In 2021, MSD began performing a TCFD gap analysis and will be conducting a scenario-planning analysis to examine which parts of the business are at highest risk due to climate change, and the costs associated with them.

As business shift their focus towards environmental challenges, transparent reporting and clearly defined standards become increasing important to ensure all stakeholders have access to reliable data. Such data and independent verification also provide businesses with accurate information that can better guide their sustainability goals and identify operational barriers.

[40] Merck (known as MSD outside the United States and Canada) 2021/2022 ESG Progress Report https://www.merck.com/stories/merck-publishes-2021-2022-esg-progress-report/

# Section 9: Cross Cutting Theme – Sustainability And Trade

*Adina Renee Adler*

Trade policy is a tool that can complement UNFCCC efforts to reduce global carbon emissions—but it must be deployed strategically. The APEC Committee on Trade and Investment recognizes that trade policy has always overlapped with environmental policy, although that overlap is not always made explicit in trade agreements.

As the free flow of goods across international borders has increased in the past half century, so, too, has the carbon emissions created by that exchange. In recent years, free trade agreements (FTAs) negotiated by several APEC members (for example the Canada, New Zealand, the United States, and others) have included environmental provisions designed to offset this increase and address the downstream environmental impacts of freer trade, including provisions to combat illegal logging, promote forest conservation, improve air quality monitoring, harmonize energy performance standards, and liberalize environmental goods tariffs.

To date, however, trade policy has been underutilized as a tool to contribute to an overall global reduction in carbon emissions. With climate now at the forefront of global policy deliberations, APEC can become a leader in using trade policy to address the climate crisis by creating more sustainable and resilient supply chains.

## The Trade Toolbox

Trade policy presents a range of tools to help drive better environmental outcomes within and across borders. For example, economies can incentivize the uptake of environmental goods and technologies by lowering or eliminating tariffs and other regulatory impediments on those goods and technologies (as well as their inputs), thereby making those technologies cost-competitive with dirtier alternatives and more affordable for developing economies. Economies with high environmental standards can also use trade policy to level the economic playing field between themselves and their competitor economies, whose lower environmental standards and lower costs of compliance give their domestic industries a competitive advantage. Further, trade policy can incentivize corporations to build product fabrication capacity in economies that are committed to building greener economies, as well as to source materials from those committed economies.

## Carbon Border Adjustment

Economies are developing and implementing carbon border adjustment (CBA) policies that tax imported goods based on their carbon content. The purpose of CBAs is to equalize the environmental performance of domestic and imported goods, while removing the economic incentives to engage in environmental arbitrage in regions with lower standards. Complying with stricter emissions standards and deeper investments in environmental technologies leads to far more favorable environmental outcomes. Doing so does come at a cost, but coordination among economies can help incentivize decarbonization in EITE products.

When it comes to tariff reduction or elimination, the APEC List of Environmental Goods was the first of its kind. However, subsequent efforts to define and liberalize environmental goods have fallen short. This provides an opportunity for further study into defining environmental goods for which trade liberalization translates into more widespread adoption of that technology and results in real positive environmental outcomes.

Trade agreements of the future need to reimagine environmental chapters that implement our vision for a carbon-free future. Provisions need to facilitate trade in lower carbon products, address and incentivize climate laggards, and provide incentives and capacity building for developing economies who are committed to meeting their climate targets. Agreements can set green government procurement standards, enhance transparency and interoperability of emissions reporting for traded products, promote the Circular Economy, set procedures for environmental impact assessment, and address the underlying causes of marine pollution. An initiative to watch is the Singapore-Australia "Green Economy Agreement"[41] announced in 2021. They intend to negotiate an agreement that could accelerate the green technology transition and create jobs in green industries by combining environmental, trade and economic policy to improve oversight and the ability to fight climate change.

More work is needed to build efficient and compliable supply chain systems of transparency and traceability. A number of APEC members partner on seafood traceability, but there are opportunities to expand this model into other industries. Specific areas could include partnering to eradicate forced labor in supply chains including for solar products and fisheries, and to increase transparency in supply chains for forestry products, critical materials, and carbon emissions. Standards could be set to ensure the interoperability, monitoring and enforcement of emerging e-marketplaces and traceability systems that track the movement of used and reusable materials and goods and ensure environmentally sound management and efficient incorporation into manufacturing.

An unprecedented volume of critical minerals will be required to meet net zero energy and sustainability goals. Critical minerals are necessary for a wide range of environmental goods, clean energy technologies,

[41] "Singapore-Australia Green Economy Agreement: Propelling our Sustainable Future", October 2021: https://www.dfat.gov.au/geo/singapore/singapore-australia-green-economy-agreement/singapore-australia-green-economy-agreement-propelling-our-sustainable-future

semiconductors, information technologies, etc. A collaborative roadmap would aid in resource security and efficiency, particularly in decarbonizing sectors. Efforts could include regional clean energy resource balancing; short-term supply security strategies including support for cleaner mining and processing approaches; design standards for circularity; research & development and marketing of resource efficient substitutes; and recycling standards and reverse supply chain trade facilitation policies.

## Recommendations for APEC

Trade policy has an expansive yet underappreciated role to play in combating climate change. In the near term, APEC economies can take several concrete policy steps to begin harnessing trade policy's power as a tool for driving better environmental outcomes:

1. Define the **scope of environmental goods and services** and consider a trade arrangement that facilitates free, sustainable trade. The scope and definition of environmental goods should be grounded in an empirical appraisal of trade's value as an engine of technology acquisition.

2. Facilitate the creation of a **new carbon accounting paradigm**, in alignment with the harmonized tariff system, to enhance interoperability and accelerate decarbonization in coordination with APEC partners. The framework should allow private and state actors to report their GHG emissions to a GHG program. The GHG program would measure and compile emissions reports and facilitate interoperable, 'apples-to-apples' carbon accounting methodologies for traded goods. Such transparent and comparable methodologies would serve as the basis for national or regional border adjustment policies.

3. Identify sectors where **more supply chain visibility and traceability** are needed to improve labor, environment, human health, and economic security outcomes. That could include setting GHG reporting standards and enhancing the interoperability, monitoring, and enforcement of e-marketplaces and traceability schemes that track the movement of used and reusable goods and materials.

4. Establish an **information sharing mechanism and develop a roadmap on critical mineral supply chains.** The roadmap could track short-term supply security strategies as well as long-term supply needs, directs research & development towards sustainable material substitutes, facilitates reverse supply chains for material reuse, and helps create global standards for cleaner mining and processing.

# Section 10: Utilizing APEC as an Instrument for Regional Decarbonization & Recommendations for APEC Officials

*Rory McLeod*

Many of the previous sections have put forward actions that can be taken by the private sector to promote decarbonization of regional supply chains. Other chapters point to the need governmental action to facilitate and incentivize supply chain decarbonization. APEC as an organisation has only recently begun working intensively on climate change and other sustainability issues but appears now poised to make up for lost time.

In 2020, APEC Leaders endorsed the Putrajaya Vision 2040 with one of its objectives being to "promote economic policies, cooperation and growth which support global efforts to comprehensively address all environmental challenges, including climate change, extreme weather and natural disasters, for a sustainable planet". The 2021 Aotearoa Plan of Action to implement the Putrajaya Vision sets out a range of collective and individual actions to achieve this objective as well as calling for the development of indicators to evaluate progress. In 2022, Thailand is promoting a standalone statement for Leaders' consideration, to support the Bio-Circular-Green (BCG) Economy as an approach for achieving an inclusive, balanced and sustainable recovery from COVID-19, long-term resilient economic growth, and environmental and climate objectives. Individual APEC fora and sub-fora are looking to take forward Leaders' aspirations on environmental and sustainability issues. A list of APEC Leaders and Ministerial commitments to date is attached as Annex 1.As reflected in the collective actions of the Aotearoa Plan of Action, there are four key policy areas where governments have a core role to play in promoting the decarbonization of regional supply chains. These are:

- *Trade and investment policies* to liberalize trade in environmental goods and services, promote efficiency enhancing trade facilitation policies and to develop green investment policies;

- *Structural reform policies* to promote competitive and innovative markets to facilitate competition from green technologies. This includes the development of regulatory interventions to ensure price signals reflect the true costs of resource consumption. These can be backed up by other regulatory reform measures in such areas as performance standards;

- *Finance policies that strengthen the private sector's climate-related disclosures and risk management, support the development carbon trading markets, introduce (where appropriate) carbon taxes, and phase out on environmentally harmful subsidies (particularly inefficient fossil fuel subsidies*);

- *Sectoral, industry and innovation policies* to ensure that adequate infrastructure is available for the uptake of green technologies as well as work with the private sector (and particularly with SMEs) on pathways to the adoption of such technologies. In this area, the promotion of digital technologies that facilitate supply chain decarbonization are of particular importance.

In addition to APEC, the APEC Business Advisory Council (ABAC) is advancing sustainability priorities from a range of private sector perspectives. For instance, ABAC has established a Sustainability Working Group from its membership with the objective of building a net-zero economy and promoting a green recovery in APEC. ABAC's 2021 Report to Leaders stressed that in seeking to work with governments in combatting climate change, business relies on governments to implement appropriate carbon taxation and pricing regimes as part of a set of interconnected actions to support these policies. ABAC put forward a set of "Climate Leadership Principles for Business" which stressed the importance of Economic, Social and Governance (ESG) criteria in guiding future investment decisions. Individual principles are:

1. Emissions *reduction* by individual businesses aided by measurement, the adoption of targets and properly resourcing decoupling from fossil fuels;

2. Support for behavioural and technological *adaptation* to support the business community based on adequate risk assessment on the effects on supply chains, the recognition of the future importance of ESG investments and championing relevant technological advancements particularly in the area of digitization;

3. A *just transition* for those most negatively affected by the region's changing climate.

The rest of this section will examine how APEC work in each of these areas is progressing in response to calls from APEC Leaders. While such work is clearly taking place in a broader sustainability context, a focus on decarbonization of regional supply chains should provide encouragement to take such work forward, particularly as supply chains exemplify regional economic integration at its deepest level. Possibilities for working jointly with business and other stakeholders will be examined given that such cooperation will be fundamental to achieving the objectives set out for this work. The section will conclude with recommendations on future APEC work on supply chain decarbonization.

## Trade and Investment Policies

APEC's work on trade and investment can make an important contribution to the process of supply chain decarbonization. Most obviously, the reduction of tariff and non-tariff barriers on environmental goods and services can speed the introduction of relevant technologies and skills throughout the region. But just as important, efforts to promote trade facilitation have the potential to reduce the resources needed to distribute inputs and final products by lowering transport, storage and distribution costs and associated carbon emissions. Work on customs cooperation is particularly important to improving the efficiency of such processes, particularly through the deployment of digital technologies such as paperless trading. Similarly work on standards and conformance has the potential to reduce the use of standards as technical barriers to trade (TBTs) in the trade of environmental goods. Meanwhile standards can also be employed in wider context to drive innovation in carbon markets through such devices such as emissions standards. Investment policies also have a role to play both in ensuring that current investment regulations do not inhibit competition from more sustainable technologies and products as well as promoting their adoption through the provision of appropriate investment incentives.

There is evidence that APEC's Committee on Trade and Investment (CTI) and its sub-groups have made a good start in responding to agreed collective actions under the Aotearoa Plan of Action. In 2021, the CTI

held a policy discussion on "Trade Related Policies to Promote Trade in Environmental Products and Technologies, including Regulatory Issues, Contributing to Global Carbon Neutrality"[42]. This was followed by the CTI's Market Access Group releasing a study scoping new and emerging environmental goods[43]. In the area of environmental services, APEC's Group on Services also commissioned a major scoping report on trade in environmental services.[44] The CTI's Sub-Committee on Customs Procedures has done a significant amount of work on improving supply chain predictability and connectivity in the APEC region including harmonization of customs procedures between APEC economies and by encouraging paperless trade[45] and digitalization of customs processes.

Based on the foundation of existing work which contributes to supply chain decarbonization, future challenges faced by the CTI and its sub-committees include the following:

- Move beyond scoping reports on trade in environmental goods and services to strategies for reducing the trade barriers identified in each area;

- Expand the work on customs supply chain predictability and connectivity, particularly in the area of digitization of customs processes;

- Move to develop concrete standstill and roll-back commitments in the area of fossil fuel subsidies;

- Initiate work in key CTI sub-committees particularly in such areas as standards and investment policies to promote supply chain decarbonization.

New issues on supply chain decarbonization could arise in future. For example, the EU plans to introduce carbon border adjustment mechanisms (CBAMs), i.e. carbon tariffs which would define a role for trade in the fight against climate change. Due to be introduced in 2026, tariffs would be imposed where the carbon emissions involved in imports are greater than the emissions involved in domestic production. Concern has been expressed elsewhere that the tariffs will comprise "green" trade barriers and be inordinately complex for exporters to the EU to comply with once implemented, particularly those from developing economies. The implications for the WTO and multilateral and regional trading systems of these tariffs will also need to be examined. APEC has the institutional capability to carry out its own assessment of this potentially far-reaching but also contentious trade policy instrument, with a view to reaching consensus where possible on the relevant issues.

## Structural Reform Policies

Almost all elements of APEC's work on structural reform are of relevance to the decarbonization of supply chains. Competition policies that promote competitive markets can in turn spur innovation and efficiency improvements with respect to competition from green technologies. Consumer policies can empower consumers to select green goods and services. Regulatory policies can create improved price signals in

[42] See apec.org/groups/committee-on-trade-and-investment for a link to the papers presented at this policy dialogue
[43] APEC CTI Market Access Group, *Scoping Study on New and Emerging Environmental Goods*, December 2021
[44] APEC CTI Group on Services, *Environmental Services in the APEC Region*, May 2021
[45] APEC CTI Sub-Committee on Customs Procedures, *Analysis and Pathways for Paperless Trade*, March 2022

markets. This can be achieved through such mechanisms as reductions in environmentally harmful (particularly inefficient fossil fuel) subsidies[46] and the introduction of green taxes. Work on property rights is also important, particularly with respect to emissions trading schemes while non-price regulatory policies (such as pollution or resource use limits as well as performance standards) can be used in support of pricing policies. Finally, public sector governance efforts can promote institutional and capability development within governments to achieve effective implementation of green reforms.

When APEC Structural Reform Ministers met in June 2021, they endorsed a new structural reform instrument, the Enhanced APEC Agenda on Structural Reform (EAASR), which emphasized developing new approaches to structural reform to promote sustainability. Ministers also instructed the Economic Committee to prepare the 2022 APEC Economic Policy Report (AEPR) on the subject of "Structural Reform and a Green Recovery from Economic Shocks". At the time of drafting of this section, the AEPR had not been finalized but it is expected to cover all the relevant elements of structural reform listed as well as providing recommendations in each area. The process of APEC member economies contributing to this report has revealed that most are only beginning to think about how structural reform can be used to achieve sustainable growth.

The challenge for the Economic Committee will be to follow up on this year's AEPR to promote further work on structural reform and sustainability in each of the policy areas it covers. Further, as emphasised in the EAASR, it will need to work with member economies to provide for "just transitions" for those most negatively affected by the necessary transitions to low-carbon or zero carbon economies. It will also need to work closely on these issues with other parts of APEC such as the CTI and the Finance Ministers' process as well as with sectoral fora in such areas as energy, transport and science technology and innovation.

## Finance Policies

There are a range of finance policies that can support supply chain decarbonization. For example, improvements to financial market regulation are required in such areas as disclosure and ensuring the management of climate risk. Access to green finance is of importance particularly to ensure that financial institutions do not treat green investments as unduly risky when compared to investments in more traditional activities. Finance ministers and officials also have a role in ensuring fiscal policies are in place to discipline environmentally harmful subsidies (particularly fossil fuel subsidies) and to introduce green taxes where warranted.

APEC Finance Ministers strongly support the call by APEC Leaders to intensify APEC work on sustainability, particularly in the area of combatting climate change. In their 2021 Statement, they stressed the need for Senior Finance Officials to work closely with other parts of this work, particularly with the Economic Committee on the 2022 APEC Economic Policy Report on Structural Reform and a Green Recovery from Economic Shocks. They also noted the need to support the transition to a low greenhouse gas emissions future through greater funding priority for such work and through more innovative forms of financing including partnerships with the private sector.

[46] In December 2021, the CTI also published a report on "Options for Taking Forward a Potential Voluntary Standstill Commitment on Fossil Fuel Subsidies" in response to the instruction from APEC Ministers Responsible for Trade in June 2021. The study indicated that for the nine APEC members covered, the emissions reductions that could be achieved through gradually removing all efficient and inefficient fossil fuel subsidies over the period 2021-25 would be around 2% of economy-wide CO2 emissions on average from 2025.

In response to the call from Finance Ministers, APEC Senior Finance Officials, spearheaded by 2022 APEC host economy Thailand, initiated a work program on development of an ecosystem which promotes the concept of sustainability and best practices in sustainable finance. In June 2022, Thailand hosted a seminar to help scope out this work program. This covered the topics of developing the eco-system for sustainable finance in capital markets and of sustainable finance taxonomies and transition finance frameworks for emerging economies including price-based carbon mitigation measures.[47] It will be important to keep up the momentum of this work program and to expand it to new issues of importance such as the provision of finance for green infrastructure.

ABAC has also been active in the field of sustainable finance. Under the Asia-Pacific Financial Forum (APFF), ABAC oversees the recently established Sustainable Finance Development Network (SFDN) with support from the APEC Finance Ministers. Key priorities of the SFDN include financing the transition to sustainability, encouraging the development of effective carbon emissions trading markets, promoting financial transitions for MSMES and financing sustainable infrastructure. Along with the Finance Minister's Process, its challenge will be to sustain the promising start that APEC has made in the field of green finance policies. This will require both groups to work to develop more specific projects, to collaborate effectively across other parts of the APEC system and to ensure that such collaboration involves effective cooperation between business and governments.

## Sectoral, Industry and Innovation Policies

APEC has established fora that cover a wide range of sectoral policies that are of relevance to supply chain decarbonization. Such groups cover sectors such as energy, transport, food security and the digital economy. Relevant fora are also in place that cover industry and innovation policies in such areas as MSMEs, skills development and science and technology. Each of these groups have a role to play in responding to the call of APEC Leaders to comprehensively address all environmental challenges, particularly climate change, extreme weather and natural disasters.

However, progress within these groups has to date been mixed. The Energy Working Group (EWG) has taken up the role of a pioneer on sustainability within APEC. The Group's Strategic Plan 2019-23 puts significant stress on such issues as energy sustainability, phasing out inefficient fossil fuel subsidies, new technologies to improve energy efficiency, the development of cleaner energy sources and improving the regulation of markets to provide for more sustainable outcomes. The EWG has also developed a comprehensive work program to provide for tangible activities in each of these areas.[48] As such, it is something of an exemplar of what APEC cooperation can achieve in these areas.

Other Groups meeting subsequent to APEC's Leaders' endorsement of the Putrajaya Vision have committed, at Ministerial Level, to taking action on sustainability issues in future. These include commitments at the APEC Food Security Ministerial Meeting in August 2021 and the APEC Small and Medium Enterprises Ministerial Meeting in October 2021. (See Annex 1.) In 2021, Food Security Ministers adopted the APEC Food Security Roadmap 2030 and subsequently in 2022, endorsed the APEC Food

[47] Press release by Thai APEC Study Center, June 2022
[48] APEC Energy Working Group, *EWG Strategic Plan 2019-23*, EWG Secretariat, May 2019

Security Implementation Plan for the Roadmap that establishes a framework and specific action items for APEC's food security workstream (including in the field of sustainability).

Other relevant APEC fora, however, appear to have not yet begun to respond to the call by APEC Leaders. These include the APEC Human Resources Development Working Group (in the area of skills development to promote a sustainable transformation), the Policy Partnership for Science, Technology and Innovation and the Digital Economy Steering Group. The latter two groups are of particular concern given the central roles that innovation and digital technologies must play in the push to reduce carbon emissions.

## Conclusion and Recommendations

This chapter has shown that APEC carries out work in a wide range of areas – trade and investment, structural reform, finance and sectoral, industry and innovation policies – that could contribute to the decarbonization of supply chains. Until recently, APEC was slow to embark on such work. However, spurred by the commitments on environmental sustainability contained in the Putrajaya Vision and the Aotearoa Plan of Action, many APEC fora and sub-fora have already begun embarking on relevant projects or are committed to do so in future. A few, however, have not yet taken up the challenge.

Given the economic risks posed by environmental threats such as climate change, APEC's work on sustainability is now urgent and should be given the highest priority. Particular attention should be given to key areas such as reducing fossil fuel subsidies, putting in place appropriate price signals for carbon through such mechanisms as emissions trading schemes and green taxes and the use of digital technologies to reduce carbon emissions. It will be important to work in cooperation with business and other stakeholders on these issues, particularly to develop indicators and taxonomies that will allow business to establish ESG criteria that will promote responsible investment decisions in future.

Given the importance of supply chains to regional economic integration in the Asia-Pacific region, APEC, as the region's leading multilateral trade and economic forum, could usefully develop a "supply chain decarbonization lens" to assess progress of its work on sustainability. This could form part a wider cross-organization coordination mechanism for APEC's work on sustainability that will in due course need to be put in place. Establishment of this mechanism will be challenging given the wide range of expertise that will need to be brought to bear.

Moreover, modern supply chains are multinational, involve a diverse range of industries and suppliers, and are governed by a range of international jurisdictions. It will be important for businesses and governments to work together to decarbonise the supply chain since no single company or government can tackle this challenge alone.

To support the decarbonization of supply chains, therefore, it is recommended that APEC:

f) Build on existing work on sustainability to create more specific and tangible projects that will promote reform in member economies in future. Priority should be given to work on facilitating trade in environmental goods and services, trade facilitation, clean energy and structural reform to promote appropriate price signals for carbon through such mechanisms as emissions trading schemes and environmental taxes;

g) Take forward work in areas, such as SMEs and food security, where Ministers have agreed commitments but where specific work programs have yet to be established;

h) Put in place both commitments and work programs in key areas such as digital policies, science, technology and innovation, skills, transport, investment and standards and conformance where little work appears to be taking place as yet;

i) Develop indicators and taxonomies that will permit progress of such work to be measured and assessed. These should be developed in conjunction with the private sector to allow business to develop ESG criteria to promote responsible investments in future;

j) Establish in due course an appropriate coordination mechanism to take forward APEC's future work on sustainability, ensuring that such a mechanism is equipped with appropriate expertise and incorporates quantifiable objectives. Those involved with coordination should be encouraged to adopt a "regional supply chain decarbonization lens" as one means of assessing the progress of their work.

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