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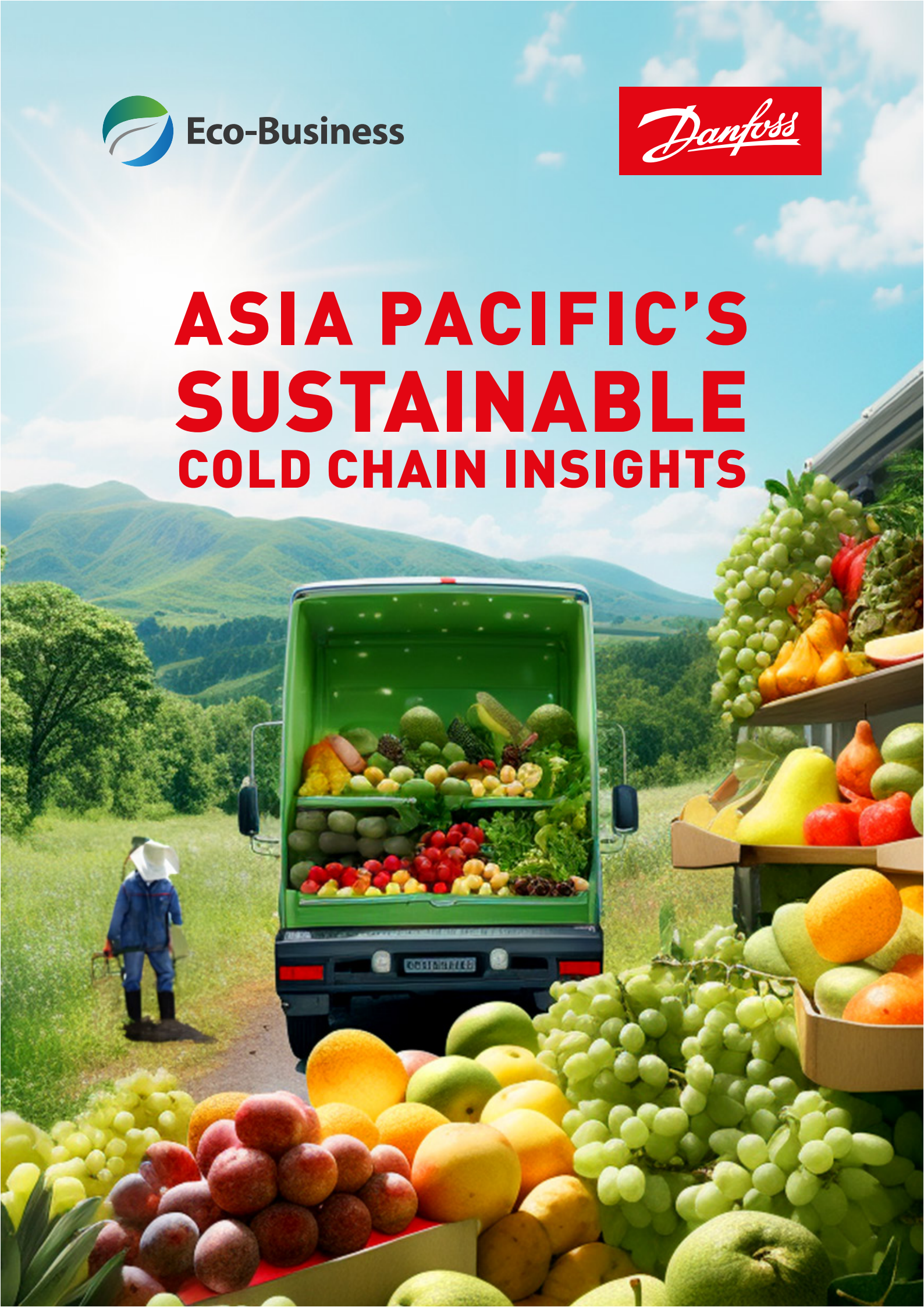
ASIA PACIFIC'S SUSTAINABLE COLD CHAIN INSIGHTS



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DANFOSS FOREWORD:

THE HEAT IS ON

At the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change, 63 countries signed a pledge to slash cooling-related emissions by at least 60 per cent below 2022 levels over a span of 26 years. The Cooling Pledge, which is the first global effort focused on mitigating the impact of cooling on climate change, aims to spur the transformation of the cold chain industry towards more energy-efficient, connected, and sustainable systems.

According to the United Nations Environment Programme, meeting the targets set by the pledge would cut cooling emissions by 3.8 billion tonnes of carbon dioxide equivalent throughout the programme's run and drastically reduce expenses for the power sector and end-users of cooling systems.

Danfoss supports the Cooling Pledge, which, with a target date of 2050, takes on a long view.

Asia Pacific's diverse geopolitical and socioeconomic realities and needs mean that starting points for establishing sustainable cold chain ecosystems vary across countries that aim to provide cooling without heating up the planet.

The cold chain industry is responsible for about 3 to 4 per cent of global greenhouse gas emissions. This is set to increase. With food demand forecast to rise by at least 60 per cent by 2050, shifting towards sustainable cooling systems will play a key role in limiting the impact of such systems on our climate.

While the adoption of technologies and practices that are sustainable, scalable, and secure is critical, equally paramount is ensuring that all stakeholders carefully consider their capacities and limitations in achieving so. Solutions must cater to those who are capable of shifting to sophisticated green cooling systems and to individuals who have taken the initial steps in their sustainability journeys.

The role of energy efficient cooling across the food value chain in meeting climate goals cannot be overemphasised due to refrigeration's heavy reliance on electricity. While governments are striving to optimise energy use with an array of strategies and policies that are contained in national cooling action plans, more needs to be done.

Stronger policies, regulations and incentives, and more investment in energy efficiency, are a must for the world to meet both future energy and nutritional needs and in achieving net zero emissions by 2050.

With cooling demand expected to triple and sectoral greenhouse gas emissions seen to double by then, the need to take action - and responsibility - is clear. As the need for cooling continues to rise amid warmer temperatures, an expanding global population and rising income, the world must transition to near zero emission cooling that is already possible with readily available technologies.

There is no doubt that the targets set by the Cooling Pledge require a drastic transformation in the way the cooling sector uses and produces energy.

Whether the commitment will make a significant difference in the fight against emissions - which is also ultimately a fight for human survival - the next 26 years depend on the action that the cooling industry and its stakeholders take today.

Jan Schoemaker,
Regional President of
Danfoss Asia Pacific Region

SUSTAINABLE COLD CHAIN:
Enabling and enhancing Asia's food security

Zakri Zulkurnain, lead researcher
Jennee Grace U Rubrico, independent researcher

As the world grapples with increasing food insecurity amid rapid climate change, the cold chain industry is under immense pressure to strike a balance between sustainable growth and feeding the planet's population.

Rarely do most people stop to think twice about the hot milk in their morning coffee or the crisp salad greens they purchase on their way to the office.

In reality, the only reason these products – along with other critical items such as vaccines, antibiotics, and temperature-sensitive pharmaceutical goods such as drugs to treat deadly illnesses – maintain their freshness when transported across cities is the result of carefully choreographed, temperature-controlled logistics known as cold chain.

Cold chain is when the temperature of perishable products is managed to maintain their quality and safety from the point of origin, through the distribution chain, to the final consumer.

The global cold chain industry was valued at over US$270 billion in 2023 and is expected to grow at a compound annual growth rate of 18.6 per cent from 2023 to 2030, reaching a revenue forecast of US$892 billion by 2030, according to a 2023 report from Grand View Research.

The energy needed to power the refrigeration throughout the cold chain to ensure that goods do not perish, however, is often overlooked. The cold chain industry, with its energy consumption and high global warming potential of refrigerants, is responsible for 3 to 4 per cent of global greenhouse gas (GHG) emissions[1].

As food demand is expected to rise by at least 60 per cent by 2050[2] and the world tries to limit the increase in global temperatures to 1.5°C above pre-industrial levels in line with the Paris Agreement, the need for cold chain ecosystems to grow efficiently and sustainably is crucial to meeting food refrigeration requirements.

Each year, 14 per cent of the food produced for human consumption is lost and 17 per cent is wasted[3]. In 2017, the lack of proper refrigeration systems resulted in 526 million tons of wasted food – enough to feed one billion people[4], according to the Food and Agriculture Organization, the specialised agency of the United Nations that leads international efforts to defeat hunger and improve nutrition and food security.

Food wastage, which encompasses both loss and waste, was also responsible for emissions amounting to a whopping one gigaton of CO_2 equivalent[5]. Discarded food does not only contribute to food insecurity; resources that were used in producing, processing, preparing, storing and disposing the commodities – including the land, energy, and other inputs – are also squandered[6]. Meanwhile, the usage of food cold chain equipment emitted another 261 million tons of CO_2 equivalent into the atmosphere[7].

Refrigeration's heavy reliance on electricity exacerbates climate change as fossil fuels continue to consume more than 80 per cent of the world's generated power[8].

Equipment that regulate temperature use refrigerants, such as HFCs, which are a group of synthetic gases primarily used for cooling and refrigeration. HFCs also have a high global warming potential, which is a measure used to evaluate the potential impact of a GHG on global warming over a specific time, usually 100 years. For instance, the most common HFC found in domestic fridges, HFC-134a, has a global warming potential 1,470 times that of CO_2 over a 100-year timeframe[9].

HFCs remain in use even as countries are at various stages of phasing down their consumption in line with the Kigali Amendment.


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18 OZ CLAMSHELL
5.49
Driscoll's
Dole
Strawberries • Fraises
ASPARAGUS
Broccoli
Baby Spinach

HYDROFLUOROCARBONS

The Montreal Protocol is an international treaty that entered into force in 1989 for the phasing out of ozone-depleting substances, focusing on chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), in response to the diminishing of the atmosphere's ozone layer, which is responsible for protecting the planet against the sun's ultraviolet rays. These controlled substances were often used as refrigerants.

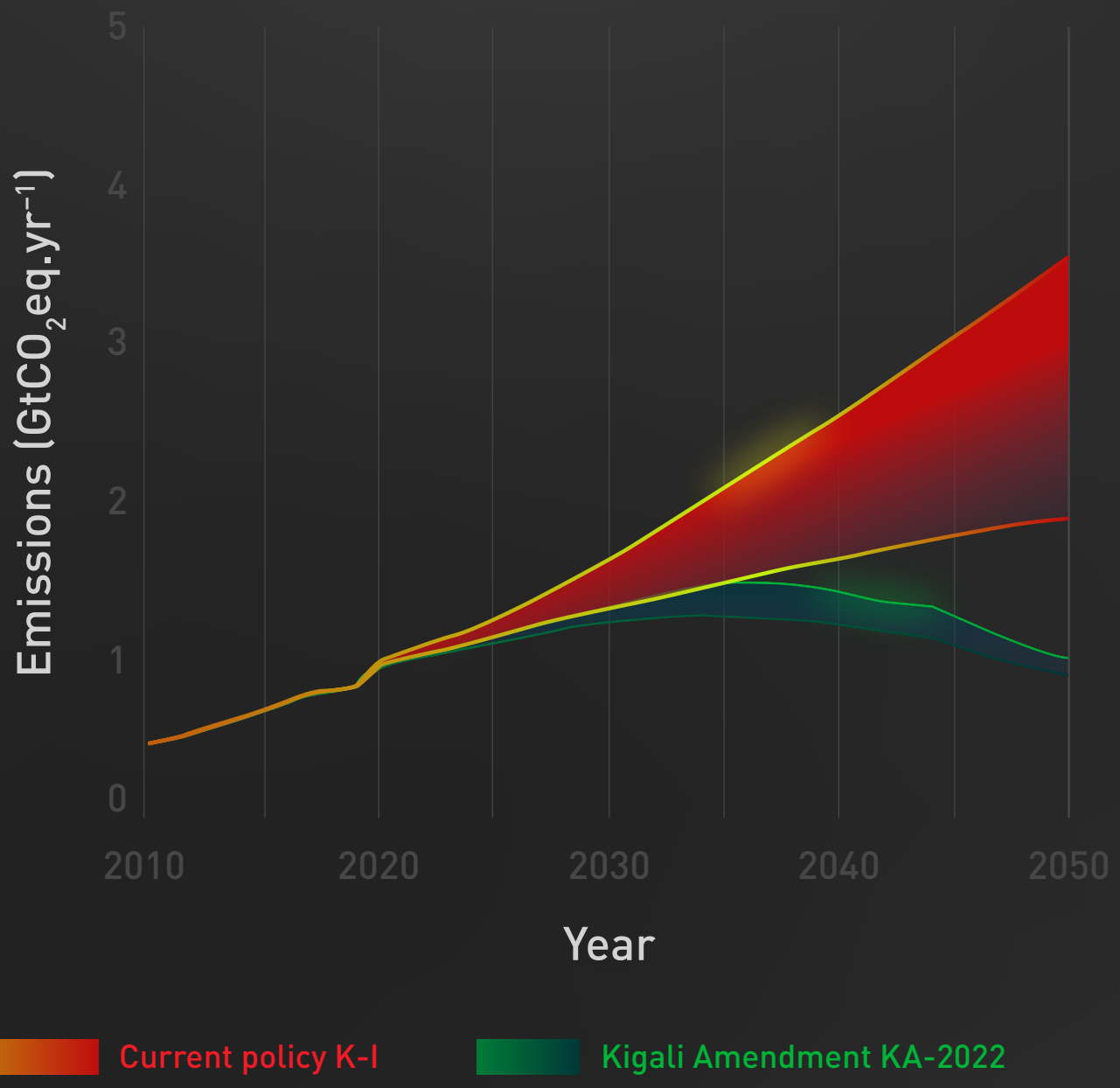
The Kigali Amendment to the Montreal Protocol, which entered into force in 2019, expanded the scope of controlled substances to include HFCs which were commonly adopted as refrigerants to replace CFCs and HCFCs.

While HFCs do not deplete the ozone, they are powerful greenhouse gases that contribute to climate change. Based on the phaseout schedule, the Kigali Amendment is expected to significantly reduce emissions of HFCs (please refer to the graph on the following page), causing emissions to drop to around 1 gigatons of CO_2 equivalent per year by 2050[10]. In absence of the Amendment, HFC emissions are projected to increase by at least two to three times its current rate. This would also mean significantly limiting the contribution of HFCs to global surface temperatures.

The continued expansion of technologies that use high GWP refrigerants could easily negate potential emission reductions from food loss and waste avoidance, according to the Asian Development Bank Institute (ADBI), an Asian think tank and a subsidiary of the Asian Development Bank focused on identifying effective development strategies for Asia and the Pacific, and on providing support to ADB member countries in managing development challenges[11]. As global cold chain is poised to grow 18.6 per cent annually between 2022 and 2030[12], the sector must identify ways of greening operations.

Technologies that help reduce the cold chain's carbon emissions, however, already exist. In this report developed in partnership with Danfoss, Eco-Business discusses Asia Pacific's cold chain landscape and viable solutions that can benefit commerce, communities and the climate. This paper will report on the current sustainable cold chain landscape in Asia-Pacific, the structural challenges to adoption, the opportunities and technologies available, and how policies governing cold chain have developed.

Projected global HFC emissions based on the Kigali Amendment



Global total HFC emissions (excluding HFC-23) ($GtCO_2eq.yr–1$) projections based on a current policy scenario K-I (Kigali Independent) and the scenario following the phasedown schedule of the Kigali Amendment (KA-2022). Adapted from Velders, G. J. M. et al., 2022.

COLD CHAIN CHALLENGES

Asia Pacific's cold chain market is expected to grow by 11 per cent between now and 2025, driven by a rising middle class, demand for convenience, an expansion of pharmaceuticals owing to an ageing population, and increasing demand for perishable goods, including fruits, vegetables, dairy products, meat, and seafood, among others, and Covid-19 booster vaccines[13]. The demand for premium products such as fresh seafood and fine wines is also increasing, driven by rising disposable incomes and a shift in dietary habits among the region's large population base, which accounts for roughly 60 per cent of the global population.

Sustainable cold chain systems in Asia-Pacific are vital, given the region's warmer weather, which can make it easier for food to spoil; a burgeoning population of 4.3 billion[14], and its vulnerability to extreme weather conditions and climate change, said Lee Poh Seng, associate professor, National University of Singapore, and executive director, Energy Studies Institute[15].

There are three main advantages to developing sustainable cold chain systems, according to Teddy Monroy, Philippines country representative of United Nations Industrial Development Organisation (UNIDO). Firstly, it prevents the release of methane (a potent greenhouse gas) from food loss and wastage; secondly, it reduces direct emissions from pollutant refrigerants; and thirdly, it reduces indirect emissions from more efficient energy use[16].

> **"The cold chain ecosystem is a litmus test on green industrialisation and decoupling economic productivity from GHG emissions"**
>
> **Teddy Monroy,**
> UNIDO Country Representative, Philippines

"The cold chain ecosystem is a litmus test on green industrialisation and decoupling economic productivity from GHG emissions," he said[17].

The regional development of cold chain is uneven, with wealthier markets able to attain economies of scale that justify energy-efficient investments on one end, and developing markets struggling to see returns on investments on the other.

While developing countries may benefit from the use of more energy-efficient natural refrigerants, the high costs of coolants – coupled with the comparatively smaller facilities found in developing nations – are still impediments, according to Amanda Brondy, vice president of International Projects at the Global Cold Chain Alliance, an organisation that focuses on food chain education and training and maximising food production.

Similarly, disparate climate conditions in the region that span tropical, subtropical and temperate zones need to be considered when transitioning to green cold chain systems, as economically disadvantaged countries tend to be situated in the hotter parts of the world, the ADBI said, noting that this will disproportionately affect marginalised communities the most, it added.

"This is an undue burden to start with, as developing countries are the ones who are the least responsible for – and least able to respond to – the impacts of climate change," the Tokyo-based think tank observed.

Starting points also vary. In Indonesia, "green cold chain has been an issue since 2020", but development has been hampered by the Covid-19 pandemic, Indonesian Cold Chain Association (ARPI) chairman Hasanuddin Yasni said[18].

According to data from the Global Cold Chain Alliance, Indonesia's refrigerated warehouse storage capacity has grown by 37 per cent between 2016 and 2020 (see Table 1). However, Yasni noted that this is being outpaced by the growth of demand.

Table 1: Cold Storage Capacities

Country	Refrigerated Warehouse Storage Capacity, million m^3 (2016)	Refrigerated Warehouse Storage Capacity, million m^3 (2018)	Refrigerated Warehouse Storage Capacity, million m^3 (2020)	M^3 per urban resident (2020)
India	141.13	150.23	150	0.328*
Australia	6.04	1.87	8.37	0.382
China	107	105	130.95	0.157
Cambodia	n/a	n/a	0.18	0.046
Indonesia	3.87	n/a	5.31	0.035
Japan	n/a	37.61	39.26	0.339
Philippines	n/a	2	2.4	0.043
South Korea	12	n/a	0.06	0.005
Vietnam	n/a	3.87	2.57	0.074

GCCA's market development index, measured in cubic metre of cold storage capacity per population in urban areas, is used for country comparison. Countries with market development index levels below 0.1 are grouped among the countries with the lowest refrigerated capacity.

*Given India's large rural population, its market development index is likely overstating the adequacy of the national needs for refrigeration.

The Philippines currently lacks sufficient infrastructure to store and preserve frozen products, which could have implications for the food and agriculture sectors.

For example, the country has only met 35 per cent of the national requirement for frozen warehouses, 40 per cent for four-wheeled refrigerated transport, and five per cent for two-wheeled refrigerated transport.

The Philippines Cold Chain Roadmap, launched in 2020, aims to address this gap by increasing the country's current cold storage capacity by 10 per cent to 15 per cent annually, with a target of adding an additional 50,000 pallets annually.

From a cold chain perspective, pallets refer to the platforms or structures used to support and transport goods within the cold chain logistics system.

High electricity rates, heavy dependence on fossil fuels, and unreliable power supply also weigh on green cold chain initiatives, said Anthony Dizon[19], president of the Cold Chain Association of the Philippines (CCAP).

There is also a need for capacity building and increased investments in vocational centres to address the lack of talent available to install and maintain green cold chain systems[20].

ENABLING POLICIES AND OTHER DRIVERS

Government policies governing cold chain currently vary across Asia Pacific. While some countries have cooling action plans that streamline regulations on energy efficiency and mandate the use of low GWP refrigerants, others merely follow general environmental regulations.

India, one of the first in the region to release a national cooling action plan, integrates goals across all sectors and outlines strategies to attain sustainable cooling. It aims to (i) reduce cooling demand across sectors by 20 to 25 per cent by 2037-38, (ii) reduce refrigerant demand by 25 to 30 per cent by 2037-38, (iii) reduce cooling energy requirements by 25 to 40 per cent by 2037-38, (iv) promote research on "cooling and related areas"; and (v) train and certify 100,000 servicing sector technicians in 2023[21].

> **"Policies should not only incentivise but mandate sustainable practices, with strict enforcement and penalties for non-compliance"**
>
> **Professor Lee Poh Seng,**
> Associate Professor, National University of Singapore (NUS) Mechanical Engineering

China aims to make cooling systems in commercial buildings 30 per cent more energy efficient, improve the average efficiency of cooling system by 25 per cent, increase the market share of green and efficient products by 40 per cent, and save 400 billion kWh annually by 2030[22].

Similarly, Cambodia's national cooling action plan[23] has short, mid, and long-term targets for reducing cooling demand and improving energy efficiency in building space cooling, food cold chain, healthcare cold chain, mobile air conditioning, and process cooling.

Bangladesh's national action plan also encompasses space cooling, refrigeration and the cold chain, as well as air-conditioning and refrigeration in transport and the service sector.

The Philippines' National Cold Chain Industry Roadmap focuses on ensuring food security and the promotion of investments in the sector while also encouraging industry players to adopt energy-efficient systems[24].

The sector in the Philippines is also governed by the Energy Efficiency and Conservation Law[25], which mandates private entities with an annual energy consumption of 500,000 kilowatt-hours and above to have an energy management system.

The law allocates incentives and grants for energy-efficient projects. Other countries in the region that are expected to come out with cooling action plans include Sri Lanka, Thailand and Vietnam[26].

In Indonesia, ARPI has crafted national standards for warehousing and delivery systems for frozen food and temperature controls for storing vegetables and fruits[27], with tax allowances for compressors, condensers and evaporators being discussed, according to Hasanuddin.

Following their governments' lead, business establishments are also assessing their own carbon footprint and embarking on their own sustainability journeys. Initiatives aimed at improving the sustainability of cold chain in the region could be stricter given the scale of the challenge, NUS's Lee noted.

"Policies should not only incentivise but mandate sustainable practices, with strict enforcement and penalties for non-compliance," he said.

Industry players, however, warn against over-regulation. "While we do not want to underestimate the importance of these regulatory requirements, we see that at some point [they] could be restrictive to industry growth and discouraging to prospective [foreign] investors," CCAP's Dizon cautioned.

GREENING THE COLD CHAIN

Current efforts at developing a sustainable cold chain in Asia Pacific comprise implementing energy-efficient solutions and adopting technologies that use natural refrigerants, which have less of an impact on the planet than fluorocarbons.

Natural refrigerants occur in nature's biological and chemical cycles without human intervention. These materials include ammonia, CO_2, natural hydrocarbons, water and air.

The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE)

Woolworths, for instance, began shifting away from synthetic coolants to natural cooling systems for the supermarket's operations after learning that refrigerant gas leaks were its second biggest source of emissions after its electricity consumption.

Since 2018, the company has been installing transcritical CO_2 systems, which are cooling and refrigeration systems that use CO_2 as the refrigerant.

While CO_2 is a greenhouse gas, the gas can also be compressed into a liquid form and used for cooling. Transcritical CO_2 systems are considered more energy efficient than traditional HFC systems[28] for their stores' refrigeration and heating, cooling and air conditioning (HVAC) needs. The company said that in stores where the system has been installed, emissions have been cut by 100 tonnes of CO_2 equivalent per branch per year[29].

As part of its transition plan, Woolworths has set a goal to be powered by 100 per cent renewable energy by 2025. Singapore's largest supermarket chain, NTUC Fairprice[30], has also started designing energy-efficient refrigeration into its stores, with 76 per cent of its outlets accommodating automated temperature monitoring and energy-saving systems as of 2022.

Meanwhile, South Korean retailer Lotte Shopping has installed refrigerated showcase doors in Lotte Mart and Lotte Super branches to ensure the safety of products and prevent cold air leakage[31]. Lotte Mart operates hypermarkets, while Lotte Super is the hyper-local distribution channel.

There is, a strong business case for companies to embrace more sustainable technologies. For Woolworths, energy consumption is currently at "the most efficient point with the lowest energy intensity per square meter of trading area", according to Dario Ferlin, National Sustainable Engineering manager at Woolworths, an Australian retailer which also operates stores in New Zealand.

Shifting to natural refrigerants early has also limited Woolworths' exposure to volatile prices as the supply of synthetic refrigerants has decreased in line with Australia's HFC phasedown, he said. Meanwhile, contracting power from renewable sources via purchase power agreements allows the company to hedge against the cost fluctuations of fossil fuels, Ferlin added.

Implementing Smart Systems for Optimising Cooling Efficiency

Danish company Danfoss, which aims to mitigate climate change through the solutions it sells and the way it runs its business, offers a service that helps retailers attain operational efficiency, improved asset performance, and energy efficiency -- the Alsense Food Retail. According to the company, the cloud-based system provides insights and recommendations backed by real-time data from stores, which in turn help retailers manage refrigeration, HVAC and other assets more efficiently and reduce energy costs and food waste.

UNIDO's "Global Partnership for Improving the Food Cold Chain in the Philippines"[32] project, which is funded by the Global Environment Facility, takes on a broader scope as it aims to identify, develop and stimulate the growth of low-carbon, energy-efficient refrigeration technologies and business practices in the country.

"There are many opportunities to improve the sustainability of the cold chain starting from implementing energy management systems, using renewable energy sources, converting to energy-efficient and natural refrigerant technologies, and adopting technologies that ensure the freshness and quality of food being transported," Monroy said of the project.

According to Monroy, the expected direct emissions from the 233 cold chain facilities responsible for pallet positions in the country are estimated to reach 11.13 million metric tons of CO_2 equivalent by 2030. Pallet positions refer to the locations within a racking system where a product pallet can be stored. Despite 90 per cent of industrial refrigeration in the country already utilising ammonia, a natural refrigerant, Monroy highlighted that the facilities in the country are not operating at their maximum efficiency.

Commercial refrigeration is still dominated by R404a, an HFC refrigerant. However, isobutane, a flammable hydrocarbon refrigerant that has a GWP of less than one, is becoming more popular, he added.

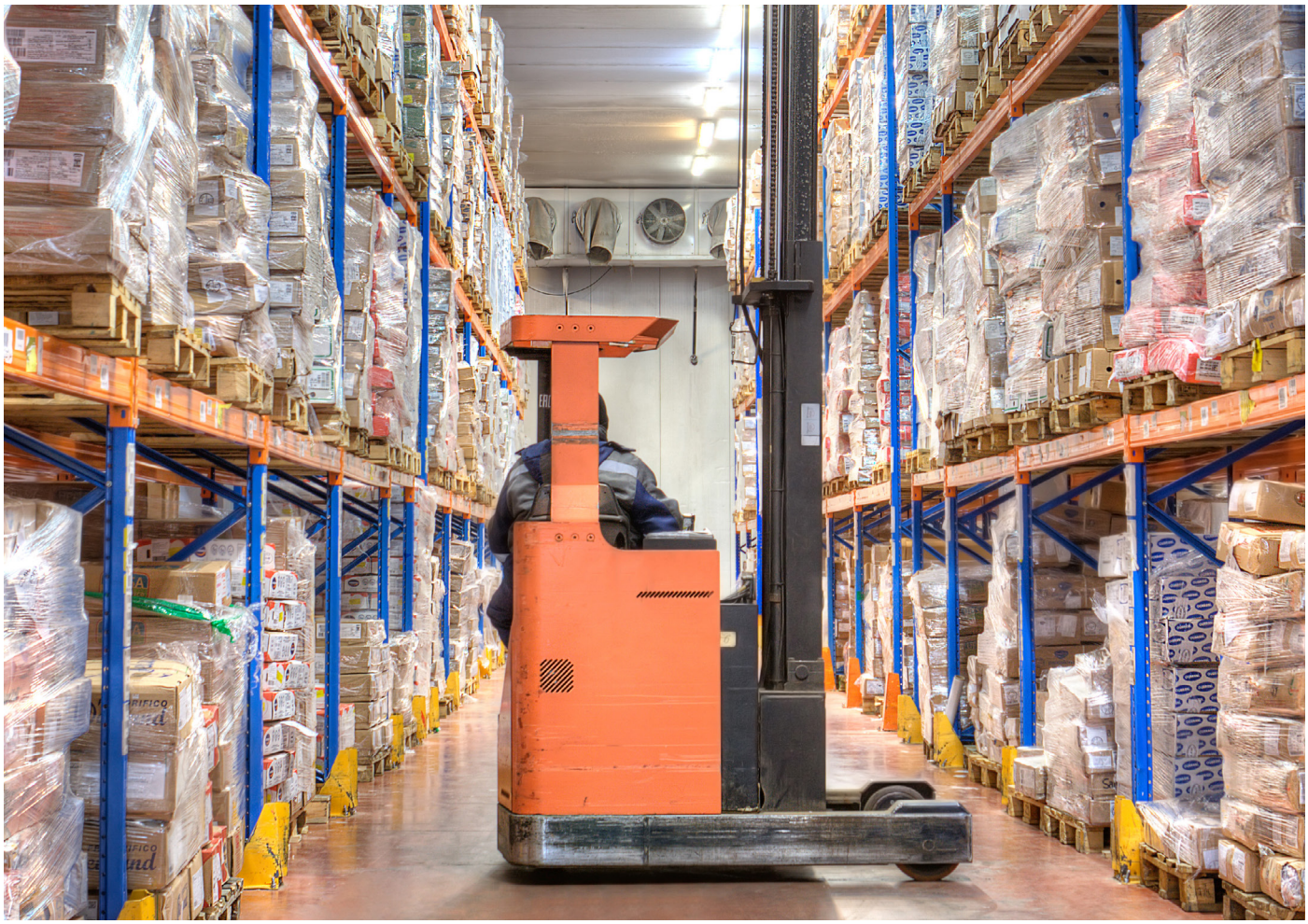
CCAP, a project participant, raised concerns over the lack of funding for the replacement of current systems. UNIDO has indicated that it provides financing assistance and is working with the government on incentives, including tax breaks and duty-free importation of equipment.

"The challenge in adopting new technology is having a reputation of being a high-risk investment, so the project provides a subsidy to lower the risk and encourage others to leapfrog in benefiting from these new technologies," Monroy explained.

Meanwhile, Lee cites Japan as a regional model for sustainable food chains as the country has merged advanced technologies with comprehensive training programmes, strict standards and supportive policies.

He noted that this combination has led to the successful development of cold chain systems that cater to both urban and rural demand.

Beyond the region, he considers the Netherlands a global leader for having integrated advanced technologies that incorporate the Internet of Things and artificial intelligence into systems for real-time monitoring and control of temperatures to enhance efficiency and ensure the quality and safety of food products.



DECARBONISING COLD CHAIN: EMERGING TRENDS IN APAC

Asia-Pacific is in varying stages of adopting technologies and strategies to expand cold chain capacity and facilitate decarbonisation. Efforts are focused on steering away from energy-intensive systems and high-GWP refrigerants that are potent contributors to climate change.

A growing number of countries in the region have crafted policies that phase down HFC use, provide incentives for green technologies, and mandate climate-friendly standards for refrigeration. More countries are expected to follow suit, driven by international commitments, stakeholder demands, company values, and consumer preferences.

A global call for countries to voluntarily commit to cutting their cooling-related emissions by 68 per cent below 2022 levels by 2050, which was made during the 28th edition of the Conference of Parties this month, is expected to further accelerate efforts to make refrigeration more efficient.

Similarly, a pending piece of legislation in the United States Congress – aimed at enhancing agricultural infrastructure in markets that receive goods from the world's leading food exporter – is expected to stimulate the expansion of cold chain capacity in emerging markets upon its enactment into law[33].

Meanwhile, having strong industry groups – such as those present in Indonesia, the Philippines and South Korea[34] – is expected to give cold chain actors a voice as the industry navigates complexity[35]. Given the diverse socioeconomic and geographical realities of countries in the region, there can be no cookie-cutter solution in the transition towards sustainable cold chain systems. But with the vast array of green technologies and services that are now available, solutions that address the specific requirements of different markets are within reach.

"What will be exciting is to see how each country identifies and resolves challenges," Brondy said.

KEY FINDINGS

1 There is a need to decouple the growth of cooling demand from climate change impact with sustainable cold chain solutions

2 Regional development of sustainable cold chain is uneven while vulnerabilities to food loss is higher in warmer climates

3 Comparatively higher cost of natural refrigerants and inability to attain economies of scale are key challenges to adopting sustainable solutions

4 Technological solutions for sustainable cold chain are being implemented by corporations across Asia-Pacific, focused on optimising energy efficiency (e.g., through the use of smart systems) and lowering carbon emissions with alternative and natural refrigerants

5 National legislation and policies are emerging across Asia-Pacific to facilitate and encourage sustainable cooling

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