

KEEP IT COOL:

HARNESSING COLD STORAGE TO REDUCE FOOD LOSS & SUPPORT
SUSTAINABLE FOOD SYSTEMS IN EMERGING ECONOMIES



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Efficiency for Access Coalition

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INTRODUCTION

OCTOBER 2023

Efficiency for Access Coalition

Food loss and waste is a global challenge with significant economic, environmental, and social implications. Approximately one-third of all food produced is lost or wasted¹, resulting in staggering environmental impacts and economic losses.

The latest data from the Food and Agriculture Organization (FAO) reveals that 14% of food is lost in the supply chain. This wastes a quarter of the water used in agriculture, contributes to 8-10% of global greenhouse gas emissions, and squanders a land mass the size of China. The economic cost of food loss and waste amounts to around \$1 trillion annually².

This issue affects both the global economy and has profound consequences at the local level, as it compromises farmer incomes and livelihoods. In 2023, the world faces serious food security challenges, with approximately one in ten people remain malnourished³. With a growing population and the increasing demand for access to nutritious food, one critical aspect of reducing food loss and waste is the efficient and sustainable management of the cold chain.

The 'cold chain' refers to a series of activities and processes involved in the transportation, storage, and handling of perishable goods under controlled temperature conditions. A complete cold chain involves multiple stakeholders in the supply chain. For example, in the agricultural context this would include farmers, aggregators, transportation companies, warehouses, and processing centres. Different technologies are used across the cold chain from post-harvest pre-cooling, pack house technologies, cold storage (e.g., walk-in cold rooms), ripening chamber, refrigerated or 'reefer' vehicles and retail refrigeration.

Recently, there has been a surge in diverse initiatives funded and implemented by a variety of stakeholders who are becoming increasingly cognizant of the cold chain's importance in agriculture, trade, environment, and health. These initiatives align with one or several Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), and SDG 12.3 (Responsible Consumption and Production). However, these initiatives often operate in silos focusing on specific stages or technologies. As a result, the efforts become disjointed, lacking coordination and synergy within the cold chain, which ultimately reduces their overall effectiveness.

To effectively tackle food loss and waste in the cold chain, it is crucial to bring together the activities and expertise of these diverse initiatives. Additionally, there is a growing interest in the productive use of energy, particularly in the context of renewable and clean energy solutions. Cold storage technologies present an opportunity to leverage this interest by aligning with the goals of sustainable energy access and promoting energy-efficient solutions in the cold chain.

This technology trend brief explores the role of cold storage in reducing food loss and enhancing food security. Most potential cold storage users live in low- and middle-income countries (LMICs) and rely heavily

1. UNEP. (2022). Why the global fight to tackle food waste has only just begun. <https://www.unep.org/news-and-stories/story/why-global-fight-tackle-food-waste-has-only-just-begun>.

2. FAO. (2022). Tackling food loss and waste: A triple win opportunity. Food and Agriculture Organization of the United Nations. Rome, Italy. <https://www.fao.org/newsroom/detail/FAO-UNEP-agriculture-environment-food-loss-waste-day-2022/en>.

3. Ibid

on agriculture. In these economies, food loss is estimated to reduce incomes by at least 15% for 470 million smallholder farmers and downstream value chain actors⁴. Cold stores, in particular walk-in cold rooms, are very energy-intensive and expensive technologies that require reliable electricity supply. In LMICs, this precondition is often not met, and capital and running costs for cooling solutions are generally too high for the target users. Despite increasing interest in cold storage technologies, their deployment, particularly in LMICs, has been slow, often resulting in underutilization, stranded assets, and failed investments. Inadequate infrastructure, technological challenges, and limited access to affordable and clean energy have hindered the widespread adoption of cold storage solutions.

Cold storage technologies play a crucial role in preserving food freshness, preventing spoilage, and extending shelf life, but it is essential that they do so in an environmentally sustainable manner. A 2018 study⁵ that evaluated the forecasted projections for meeting global cooling demand emphasised the need to urgently revise our approach to cooling solutions. The data unequivocally showed that the escalating demand for cooling far surpasses the IEA's suggested 'energy budget' for cooling in its 2°C Scenario by more than 50% (6,300 TWh)⁶. This signifies a looming environmental crisis if we continue down the business-as-usual path.

To effectively address the challenges of food loss and waste, cold storage technologies must align with the goals set forth in international agreements such as the Paris Agreement on climate change and the Montreal and Kigali amendments. These agreements emphasize the need to reduce greenhouse gas emissions and phase out the use of harmful refrigerants.

This calls for advancing towards more sustainable and energy-efficient cold storage technologies in alignment with international climate agreements. Adopting energy-efficient and low-emission cold storage solutions can help mitigate climate change and protect the ozone layer, while simultaneously ensure food security by reducing food loss and waste.

This brief provides insights on the state of the cold chain market in LMICs, and highlights innovative technologies, partnerships, and business models that have the potential to transform the cold chain landscape. To provide comprehensive insights, this brief draws upon the experiences of four organizations at the forefront of this field:

4. Carbon Trust and Kigali Cooling Efficiency Program, Net Zero Cold Chains for Food. (2020). https://prod-drupal-files.storage.googleapis.com/documents/resource/public/Net_zero_cold_chains_for_food.pdf.

5. University of Birmingham. (2018). Clean Cold Report. University of Birmingham. <https://www.birmingham.ac.uk/Documents/college-eps/energy/Publications/2018-clean-cold-report.pdf>

6. Ibid.

Wageningen University & Research has developed a postharvest assessment method, which identifies key areas of food loss in the supply chain and suggests interventions to minimize waste. Their research provides valuable guidance for reducing food loss and improving the efficiency of the cold chain.

Efficiency for Access through a competition-based approach and research and development grants, stimulates demand and innovation for cold storage in off- and weak grid areas in Sub-Saharan Africa and South Asia. Their efforts aim to identify suitable business models and technologies for efficient cold storage and effective food loss management.

Global Food Cold Chain Council is an independent not-for-profit industry organization that seeks to simultaneously reduce food waste, and related greenhouse gas emissions in the processing, transportation, storage, and retail display of cold food by expanding and improving access to energy efficient low-global warming potential technology.

Champions 12.3 is a coalition of global leaders who are all committed to supporting SDG12.3 which aims to halve food waste and reduce food loss by 2030. The Champions 12.3 coalition develops and drives a number of initiatives which are targeted at tackling specific issues and problems with the food system, thereby reducing food loss and waste.



Efficiency for Access is a global coalition of 20 donor organizations promoting energy efficient appliances as a potent catalyst in clean energy access efforts. Founded in 2015, Efficiency for Access aims to scale up markets and reduce prices for super-efficient, off- and weak-grid appropriate products, support technological innovation, and improve sector coordination. Efficiency for Access is co-managed by CLASP and Energy Saving Trust and has projects in 62 countries.





SUMMARY FINDINGS & RECOMMENDATIONS

SUMMARY FINDINGS & RECOMMENDATIONS

This brief outlines the opportunities and challenges in the field of cold storage, emphasizing the need for a multi-sectoral approach to achieve sustainable cold chain development. Particularly:



THOROUGH EXAMINATION OF ALTERNATIVES

Underutilized investments often stem from a lack of thorough examination of competing and alternative solutions. Private sector-led cold chain solutions for agriculture are subject to market forces, including competition from alternative technologies and practices like greenhouse cultivation or optimized transportation methods. Understanding the market's willingness to pay for premium quality crops and off-season availability is key to determining the viability of cold chain investments.



CONTINUOUS SUPPORT FOR INNOVATION

Early-stage companies developing ground-breaking technologies and innovative business models require sustained support for testing, learning, and refining products and business approaches. Conducting research and running programs successfully requires extensive collaboration across different sets of stakeholders such as trade associations, technical experts, academia, industry actors across multiple value chains, financing & investment institutions, and governments.



FIELD EVALUATION IS CRITICAL FOR EVALUATING TECHNICAL PERFORMANCE

The cold chain market, while nascent, is witnessing the emergence of adaptable walk-in cold room solutions suitable for first-mile applications. However, technical performance can vary significantly from rated specifications. Rigorous field evaluation is crucial to ensure reliability and efficacy.



HOLISTIC APPROACH TO COLD CHAIN DEVELOPMENT

To unlock the full economic, social, and environmental benefits of sustainable cold chain expansion, it is imperative to consider all aspects of the cold chain, from first-mile applications through processing, distribution, and utilization. Additionally, transitioning to low-Global Warming Potential (GWP) refrigerants and incorporating renewable energy sources is essential for a comprehensive and sustainable approach.



PUBLIC SECTOR INVESTMENT IS CRUCIAL

Public sector investment is especially crucial for value chains that support domestic and regional markets where private sector-led models may not be commercially viable. Targeted public sector intervention is pivotal in establishing the necessary infrastructure and enabling environments that will catalyse the growth of the cold chain sector, enhance food security, and reduce post-harvest losses on a larger scale.

THE COOL MOVE INITIATIVE: THE CENTRAL DIGITAL HUB FOR COLD CHAIN INVESTMENTS

Recognizing the importance of convening stakeholders in the energy and agriculture sectors, and the importance of sharing knowledge and learning in this field, these organizations have come together to form the Cool Move Initiative.

The Cool Move Initiative aims to be the central digital hub for cold chain investments in emerging markets, driven by data and market insights, geared for scalable impact. Through robust data analytics, it connects global institutions, funds, and philanthropic entities with local integrated value chain projects and businesses. Its core pillars—business development, data collection, financing mechanisms, sustainable technology, and government engagement—create an environment conducive to cold chain venture success. Our overall ambition is to ensure that projects are not only aligned with market demands, but also founded on robust, evidence-based models, ultimately driving progress and sustainability in the cold chain sector.

Collaboration is vital for the Cool Move Initiative's success. We invite partners who share our vision and are eager to contribute to the cold chain sector's growth and sustainability in emerging markets. Whether you're a funder, private sector entity, project implementer, or a changemaker, join us in making a substantial impact on reducing food losses, enhancing food security, and driving economic growth. For inquiries, contact us at FoodLossAndWaste@wri.org.



Wageningen University & Research

THE COLD TRUTH: UNCOVERING THE SECRETS OF (UN)SUCCESSFUL COLD CHAINS

INTRODUCING THE POSTHARVEST ASSESSMENT METHOD

GROWING INTEREST FOR COLD CHAINS & WHITE ELEPHANTS

While there has been increasing uptake of cold chain technologies in countries like India, Kenya and Nigeria, there are also several examples of failed and underutilized investments. These technologies were placed to facilitate socio-economic development but ended up as “white elephants”. This raises the question, what is the secret of successful cold chain investments?

The cold chain experts of Wageningen University & Research have studied over 50 cold chain investments to evaluate critical aspects of success such as: selection of technology, the business model, financing mechanisms, extension and advisory services, maintenance, and ecosystem conditions (such as policy). One of the key insights from these studies is the need for differentiation between the different applications for cooling (see Box 1).

One of the common denominators of underutilized investments in the cold chain, is the fact that competing and/or alternative solutions (other than cold chain technologies) are not studied to the right extent before investments are made. While cold chain technologies are seen from an impact perspective - such as environmental, climate and food security, it is important to note that most cold chain solutions for agriculture are private

sector led and are therefore exposed to the forces of the market, including competition.

For example, in the case of tomatoes, extending the production season by the introduction of (plastic) tunnel greenhouse might prove to be cheaper (and more competitive) than the construction of cold chain infrastructure to extend their shelf-life. For climacteric fruits, which ripen after harvest, as an alternative to cooling, shelf-life extension can also be achieved by harvesting them in an early maturity stage and improving transportation practices in local and regional markets. Bananas, pineapples, mangoes, and tomatoes are good examples of crops that can be transported in ambient

“We need cooling to keep our children healthy, vaccines stable, food nutritious, energy supply stable, economies productive, and environment clean”.

EXCERPT FROM COOL COALITION⁷

7. <https://coolcoalition.org/about/overview-and-history/>

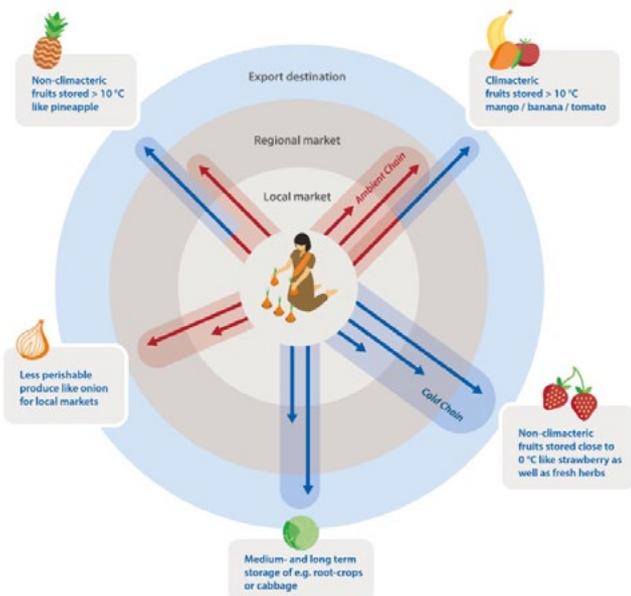


COOLING AS AN END PRODUCT OR AS A MEANS TO EXTEND SHELF LIFE

For effective cooling solutions, it is critical to not only acknowledge the different applications of cooling but also differentiate them. To illustrate this, we compare cooling for buildings with cooling in the agri-food chain. Keeping buildings cool contributes to creating a conducive living environment and preventing lethal heatwaves. Cooling in this case is the 'end product' delivered.

In contrast, cooling fruits and vegetables is aimed at extending their shelf life, a 'means' to extend the time and distance from farm to market. Recognizing that cooling for agriculture is a means rather than an end product, one needs to consider the competing forces for the cold chain. For certain crops extending the time to market can also be achieved by other means other than cold storage technologies e.g., improving the production through crop planning, irrigation or greenhouses.

Figure 1. Ambient- or cold chain applications for different crop-market combinations. Source: Postharvest Assessment Methodology (2022) of Wageningen University & Research: <https://edepot.wur.nl/582556>



chains and are therefore a competing force for the cold chain in local and regional markets. Figure 1 provides guidance on the need for cold chains through a crop-market approach.

As another example, the viability of cold chain investments, and especially their level of sophistication, is highly dependent on the market. Recognizing that cold chains add costs to the crops (even when it reduces losses), one should consider which markets are willing to pay the premium for higher quality crops or its availability off-season. This is one of the reasons why the uptake of cold chains for export markets is generally easier than cold chains for local food markets. Figure 2 shows the connection between the market and technology sophistication.

GUIDING SUCCESSFUL INVESTMENTS IN COLD CHAIN

To better guide investments in cold chain infrastructure, the experts of Wageningen University & Research have developed a postharvest assessment methodology (PHAM). By bringing together all the lessons learned from successful and failed investments in cold chain, the method aims to guide users to make more informed decisions on the viability of cold chain investments in the agri-food chain.

Figure 2. Agri-food system Development model. Source: Wageningen (2021), Rwanda energy-efficient cold chains project (commissioned by the World Bank)

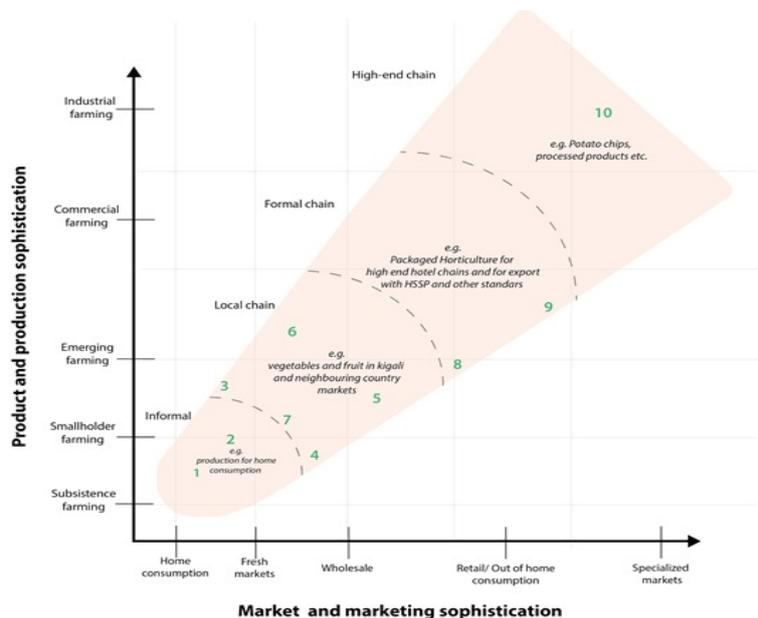


Figure 3. Example of an assessment of climate conditions, from the postharvest assessment methodology. Assessing the climate is important to inform on the viability of cold chains and potential energy supply.



STEP 5: ASSESS CLIMATE CONDITIONS

The country has two rainy seasons: a main season and a short season. There are also two dry seasons in between. There are some differences in production seasons between different regions.

Irrigation is practiced on a small scale, especially for fruit and vegetable production. Still, most of the F&V production is rain-fed. A price dip can be noticed during the harvest periods when supply is abundant. There is hardly any storage for fruit and vegetables available, and it is only suitable for extending shelf life for a maximum of one week.

Fruit mostly have a single harvest window and are transported when price differentiations and availability justify it. Price information is not transparent, nor can consumers afford high prices. This limits availability to some extent. Consumers also change from one fruit to another according to availability and season.

There are no mountainous areas, so natural cooling/ventilation with night air is hardly possible. Sunshine is abundant but not in the main rainy season when electricity is required for cooling.

The postharvest assessment method consists of 18 steps that cover essential aspects to consider before making investments in cold chain infrastructure. The considerations include the actual objective (such as climate mitigation and food security), the intended market for the crops, the climate conditions (see Figure 3), the value chain, policy environment, competing forces, determining the technology sophistication and influence by third parties. PHAM has various applications in the agricultural sector, including identifying areas of improvement in postharvest management practices, comparing postharvest losses across different settings, and evaluating the effectiveness of postharvest interventions.

While still in development, future iterations of the postharvest assessment method are aimed at supporting investors to conduct due diligence on cold chain investment plans. The guide will enable potential investors, including banks, multilaterals, and other development organizations, validate if holistic considerations have been made for more viable business models.

CONCLUSION

To achieve the envisioned impacts on climate, livelihood and food loss prevention, the efficiency and success rates of cold chain interventions need to be improved. The postharvest assessment methodology is a valuable method for assessing the feasibility of postharvest interventions in various settings. Using the methodology can improve the effectiveness of cold chain interventions and prevention of mis-investments.

Considering the dynamics of cold chain and rapid developments in this field, we recommend that cold chain stakeholders and the development community create regional Community of Practices, where all stakeholders can share their resources, successes, failures and lessons learned. These forums can be used to agree on mutual research and an innovation agendas that will improve the impact of cold chains in LMICs.



Efficiency for Access Coalition

BRR-ILLIANT SOLUTIONS: INNOVATIONS IN COLD STORAGE TECHNOLOGY SUPPORTED BY EFFICIENCY FOR ACCESS TECHNOLOGY & BUSINESS MODEL INNOVATION

The transformative potential of cooling technology for smallholder farmers across Asia, South America, and Africa, where global food loss is concentrated, has been widely documented. An estimated 40% -50% of food perishes before it reaches the consumer in Sub-Saharan Africa⁸.

Modern cooling solutions can improve economic outcomes and increase business competitiveness for smallholders by reducing post-harvest loss and opening high-value regional and global markets. Extensive, reliable cold chains can also improve food security, with the potential to increase the production of perishable food crops in emerging economies by up to 14%, or over 200 million tons annually⁹. Regrettably, these technologies are beyond the reach of many farmers due to cost, availability, and a lack of access to consistent electricity supply. The commercial market for distributed energy cooling solutions for agriculture remains in its infancy; very few companies that sell cold chain systems have been able to address the cost barrier or navigate the complex set of stakeholders in the sector. This creates uncertainty and risk for investors, making it harder for companies to access capital to scale, and discourages new market entrants.

In recognition of these barriers, [Efficiency for Access](#) (EforA), through its Low Energy Inclusive Appliances (LEIA) programme and with support from UK Aid and

IKEA Foundation, designed and launched the Global LEAP Off-Grid Cold Chain Challenge (OGCCC) in 2018 - the first-ever competition focused explicitly on identifying energy-efficient cold storage solutions appropriate for use within energy constrained settings for smallholder farmers in Sub-Saharan Africa.

The first stage of the competition evaluated existing products or prototypes from around the world to identify the most promising technology solutions and business models. Nominations were received for products planned for deployment in Tanzania, Uganda, Kenya, Rwanda, Nigeria, Ghana, Senegal, Sierra Leone, and Burkina Faso. Participants provided an extensive suite of information on the product technical specifications,

Extensive, reliable cold chains can also improve food security, with the potential to increase the production of perishable food crops in emerging economies by up to 14%.

8. Cooling for Food, Nutrition and Agriculture | Sustainable Energy for All," accessed April 17, 2023, <https://www.seforall.org/chilling-prospects-2022/food-nutrition-and-agriculture>.

9. IIR, The Role of Refrigeration in Worldwide Nutrition. 5th Informatory Note on Food and Refrigeration, 2009.

deployment plans, the nature and maturity of their business, their distribution strategy, as well as sustainability considerations. A shortlist of companies was then selected to progress to the second stage of the competition, receiving small grants to help defray the deployment costs of their cold rooms. Products underwent rigorous field-testing consisting of technical performance captured through remote monitoring equipment and qualitative surveys administered on site and over the phone. These field data were analyzed, reviewed, and evaluated by a panel of expert judges drawn from relevant sectors.

At the time, solar-powered cold storage technologies were still very nascent, and the pioneering companies dealt with a variety of technical and operational challenges. Of the ten shortlisted finalists that progressed to stage two of the competition, only four were able to deploy their solutions successfully – ColdHubs (Nigeria), Ecozen Solutions (Kenya), FreshBox (Kenya) and EcoLife (Uganda)¹⁰. The rest of the companies struggled with challenges that included: difficulties for international companies to find local partnerships, logistical challenges and unclear regulatory framework that delayed product importation, and financial challenges that limited their operations.

Following the first OGCCC round, EforA's Research & Development Fund launched an open call later in 2018 aimed at supporting a pipeline of next generation disruptive technologies suited to off- and weak-grid contexts. The call sought proposals for projects demonstrating affordable, low-carbon, circular and inclusive solutions, with an increased focus on early-stage, horizon technologies (a proven funding gap in the sector) that could enable energy access for the

poorest and most vulnerable people. Eight projects were awarded non-repayable grants including two projects specifically focusing on cooling¹¹. Given the high demand for R&D funding for cooling, in 2019, EforA launched a targeted funding call to support the development of cooling technologies including refrigerators, fans and cold chain solutions. Thirteen projects received R&D grants including ColdHubs, Smart Villages Research Group and Solar Cooling Engineering, amongst others. These grants were catalytic for the cold storage companies to improve their product efficiency and performance.

Based on the success of the inaugural OGCCC competition, a follow-on competition was held in 2022 expanding to South Asia, with support from DOEN, IKEA and Good Energies Foundations, as well as UK Aid. The second round of the competition involved a detailed survey of participants to deepen insights into their business model and commercial operations, along with the development of a [Buyer's Guide](#) providing details on the performance of winning and finalists' cold chain technologies demonstrated growth in the number and quality of cold chain market actors over time.

In the first competition (2018), just ten of 29 nominations were approved to proceed to the rigorous field evaluation processes, while in the second round (2022) 17 nominations proceeded out of 24 total. In addition, the second round of the competition demonstrated an overall increase in the operational capacity among these early movers. Whereas in 2018, only four of the ten nominations approved for the field-testing process were able to deploy their solutions successfully, in 2022, 12 participants out of 17 approved successfully deployed their solutions.



10. UK Aid-funded Off-Grid Cold Chain Challenge winners announced (efficiencyforaccess.org).

11. <https://efficiencyforaccess.org/grant-winners>

Table 1: Snapshot Profile—Product Deployment in Kenya, OGCCC 2022

	TREE_SEA.MALS	FRESHBOX	ENTERPRISE VENTURE	ECOZEN SOLUTIONS	SOLAR COOLING ENGINEERING
Deployment Location (County, Village)	Nairobi, Shauri Moyo	Narok, Maasai Mara	Embu, Gachuriri	Kajiado, Oloitoktok	Kiambu, Thika
Use application	Meat for local market (beef, goat mainly)	Fresh groceries for local consumption	Horticulture products for expoert market - Broccoli	Horticulture products for export market - French Beans	Horticulture products for export market - Herbs (Basil, Mint)
User type	Small market vendors for meat	Eco-Lodge	Individual farmer	Smallholder farmers' cooperative under East Africa Growers	Individual farmer
Business Approach	Pay-as-you-store	Credit-deposit with installment	Credit-deposit with installment	Lease with option to own	Credit-deposit with installment
Additional Notes	Security, space & digital platform tracking product performance & track payments		Mobility, & digital platform tracking product performance, flexible for use with varied energy supply sources	Offer backup generator + crates as part of leasing package, mobility & flexible for use with different energy supply sources	

RESULTS & IMPACT

Cold storage solutions are costly and beyond the reach of most individual smallholder farmers. Companies must navigate a multitude of barriers to successfully establish sustainable and scalable cold chain enterprises serving first mile markets, and initiatives like OGCCC are crucial to better understand the barriers and identify opportunities to overcome them. Coupled with R&D grants, EforA's efforts filled a major gap in the current smallholder cold chain market ecosystem, allowing for broad outreach to global actors and motivating them to develop cooling technologies that cater to underserved markets. In addition, EforA's support has helped companies launch and test products in field conditions, and to establish important local partnerships in new markets. In the process, supported companies have also increased their knowledge and understanding of the broader market landscape. Furthermore, by rewarding the most appropriate technologies, and promoting their associated business models, to donors and other market stakeholders, EforA's efforts act as a useful market intelligence tool to generate data and information to better understand a company's operations, setup, and complexities of the business environments they exist in.

Some key lessons learnt include:

- **Competition-based approaches are an effective way to collect valuable market intelligence and provide insights into effective business models** that can increase affordability and access to complex and energy intensive technologies: To overcome the affordability barrier, companies participating in OGCCC are implementing a combination of business approaches (i.e., up-front cash sale, credit with instalment payment options, Cooling as a Service models, and lease-to-own options) to increase affordability for their customers in different value chains and customer segments. OGCCC collected an extensive set of market intelligence about these various commercial strategies concluding that export markets, and other high-end retail markets, present the only financially viable supply chains for current first-mile cold storage providers, particularly those operating in Africa. Significant increases in investment and supply chain development are required to make cold storage viable as a driver of increased food security and local value chains. This is partly evidenced by the increased dialogues and investment commitments by organizations such as the World Bank¹² and initiatives such as [Africa Centre of Excellence for Sustainable Cooling and Cold-chain \(ACES\)](#)¹³.

12. "New Program to Scale Up Efficient, Clean Cooling in Developing Countries," World Bank, accessed April 24, 2023, <https://www.worldbank.org/en/news/press-release/2019/04/24/new-program-to-scale-up-efficient-clean-cooling-in-developing-countries>.

13. "Africa Centre of Excellence for Sustainable Cooling and Cold Chain," accessed April 24, 2023, <https://coolingafrica.org/>.

- **Field testing initiatives are crucial to enable companies to test and refine their product designs,** as companies lack the resources to implement robust field performance assessments in-house. Though the cold chain market remains highly nascent, there is a small yet growing range of walk-in cold room solutions with sophisticated designs that are appropriate for first-mile use cases. 72% of systems by 2022 OGCCC participants were adaptable across off-grid, weak-grid, and on-grid energy supplies. However, overall technical performance was highly variable, with significant deviations from the rated specifications provided by suppliers. Deploying cold storage technologies in remote, energy-constrained areas presents significant technical and logistical challenges. A longer evaluation period makes it easier for companies to navigate the logistics of field deployment and provides some cushion for unexpected technical issues. Reliable test partners and technical implementation support is critical to successfully evaluating system performance.
- **Continuous support to early-stage companies who develop ground-breaking technologies and/ or innovative business models are key to enable testing, learning, and re-designing of their products, and improvements of their business models.** One example is EcoZen Solutions, an India-based company that leveraged their participation in the OGCCC to successfully launch their product and start operations in a new market (Kenya)

by: a) They utilized deployment grants to cover shipping expenses and a portion of import taxes; b) They received guidance and assistance from the programme team in engaging and negotiating with Kenya Customs officials regarding import regulations; c) They leveraged having a physical product in the country to establish local partnerships for both sales and technical support; d) They refined their business approach and product design to enhance performance, transportability, and cost-effectiveness, all while making the most of locally available components, and e) springboarding from their participation in the challenge, they have continued to strengthen partnerships that have led to secured investments, including a notable \$25 million USD in a Series C funding round in 2023¹⁴. This comprehensive approach showcases the pivotal role of sustained support for emerging companies like EcoZen in achieving significant growth and impact.

Other similar examples include Ecolife, a Uganda based local company that participated in the first round of OGCCC and later become a delivery partner of Smart Villages Research Group's project supported by a grant from the EforA R&D Fund. More recently, Solar Cooling Engineering won the second round of OGCCC by deploying their latest cold storage technology – SelfChill, developed through their EforA R&D grant, and Promethean became one of the OGCCC finalists in 2022 after also receiving a grant from the EforA R&D Fund.



14. "Ecozen Funding: Agri-Focussed Cleantech Ecozen Closes \$25 Million in New Funding Round - The Economic Times," accessed April 20, 2023, <https://economictimes.indiatimes.com/tech/funding/agri-focussed-cleantech-ecozen-closes-25-million-in-series-c-round/articleshow/97277383.cms>.

RESEARCH & DATA

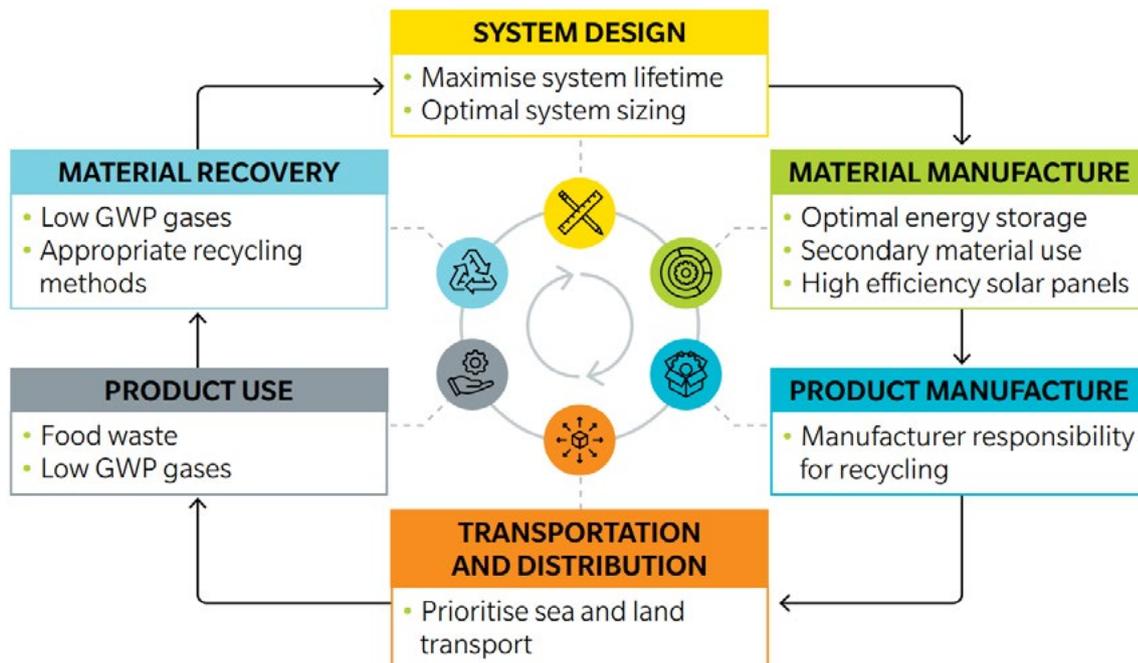
In addition to financial support through OGCCC and R&D grants, research is at the core of EforA's ambition to improve efficiency, performance, sustainability, market intelligence and localisation of cold storage technologies. One example is the Life Cycle Greenhouse Gas Emissions (GHG) Assessment of Off- and Weak-Grid Refrigeration Technologies report¹⁵, which provides a comprehensive assessment of the climate impact of two cold storage technologies - ColdHubs and SelfChill. The research

findings were instrumental in supporting the cold storage companies' ambition to reduce their embedded GHG emissions of their cold rooms and strive towards a circular economy approach (see Figure 4). We also produced a concise note for policy makers to improve the enabling environment on a national level¹⁶.

Furthermore, EforA recently produced a series of Key Cold Chain Infrastructure Markets reports¹⁷ that examined the fresh food value chains in India, Kenya, and Nigeria. These three countries are rapidly growing their access to energy and have a high potential demand for cold chain infrastructure (CCI). By using a combination of secondary research, modelling, and stakeholder consultations, we assessed the current state of cold chain infrastructure and identified gaps between the infrastructure that is currently deployed and what is necessary to meet these value chains' needs by 2030. The reports provide detailed country-specific insights on existing CCI for the fresh fruits and vegetables, dairy, fish and meat value chains (Figure 5); drivers and barriers for CCI uptake; existing business and ownership models; CCI policies and regulations; as well as proposed interventions for accelerated adoption of CCI technologies. By leveraging these insights, policymakers, investors, and other stakeholders can take concrete steps to improve food access, reduce carbon emissions, and promote sustainable development in these countries and beyond.

Research is at the core of EforA's ambition to improve efficiency, performance, sustainability, market intelligence and localisation of cold storage technologies.

Figure 4: Key learning points for cold storage circular economy

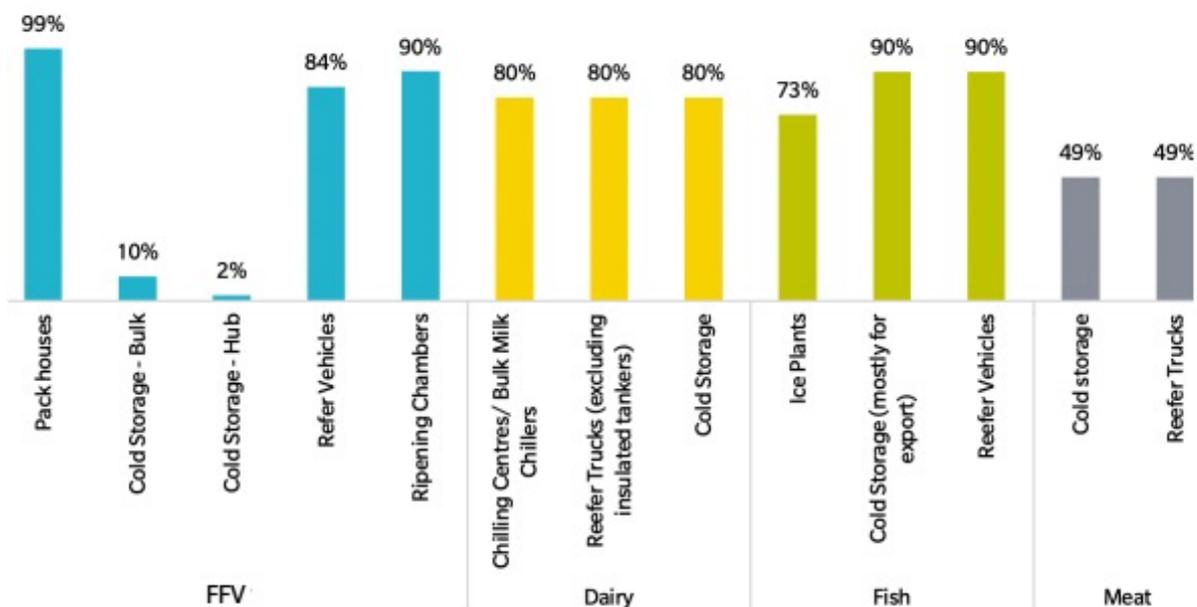


15. <https://efficiencyforaccess.org/publications/life-cycle-greenhouse-gas-emissions-assessment-of-off-and-weak-grid-refrigeration-technologies>

16. <https://efficiencyforaccess.org/publications/note-for-policy-makers-lifecycle-carbon-emissions-assessment-of-off-and-weak-grid-refrigeration-technologies>

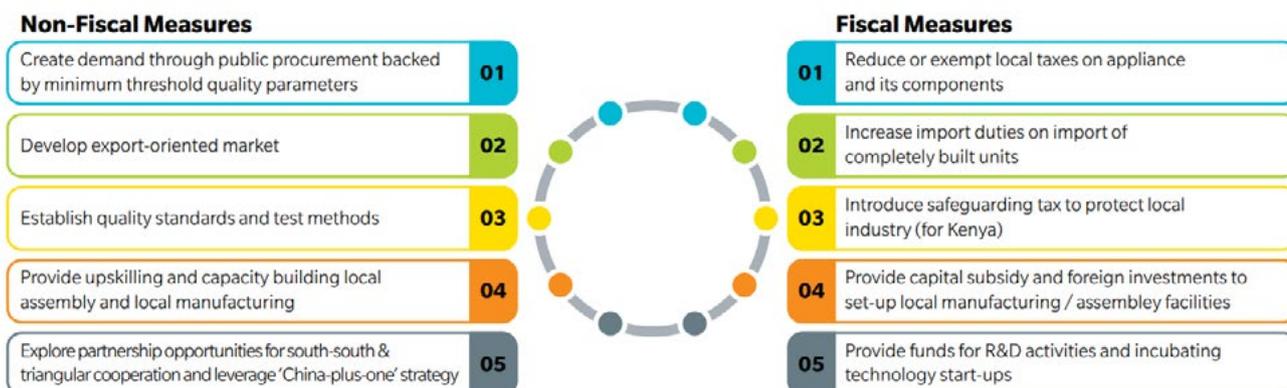
17. <https://efficiencyforaccess.org/publications/key-cold-chain-infrastructure-markets>

Figure 5: CCI Gap Across Value Chains in India, 2020



Technology and business model innovation is key to make the off-grid cold chain market viable, but it is not enough on its own. A supportive fiscal environment is another important piece of the puzzle needed to develop sustainable supply chains and support local job creation. Another recent EforA report focused on Examining Fiscal Environments for Increased Localisation of Solar Products¹⁸ to improve understanding of the localisation potential of off-grid cold storage technologies in India and Kenya. The report also considers areas of intervention to make supply chains more resilient to disruptions such as those experienced during and post the COVID-19 pandemic. The results of this study are intended to provide an important component of the evidence base needed by cold chain stakeholders and support the increased adoption of affordable off-grid cold storage technologies via an economically viable procurement strategy (see Figure 6).

Figure 6: Key fiscal and non-fiscal measures for increased localisation of cold chain technologies



18. <https://efficiencyforaccess.org/publications/examining-fiscal-environments-for-increased-localisation-of-solar-products>



The Cool Move Initiative

WAY FORWARD: THE COOL MOVE INITIATIVE

ABOUT

The Cool Move Initiative aims to promote the development of cold chain solutions in rural areas, based on bankable and scalable business models, via appropriate financial solutions backed by market linkages and data.

A first-of-its kind initiative, Cool Move works by establishing a multi-stakeholder partnership of key actors in the food and energy nexus encompassing farmers, research and educational institutions, public sector agencies, retailers, cooling, and logistics companies, as well as financiers and investors. Together, these entities work collaboratively to drive the development of sustainable and robust cold chain systems.

Cool Move is well-positioned to serve as a focal point for the multitude of parallel initiatives in the food and energy nexus, functioning as a coordination mechanism. It will provide an umbrella structure to connect the dots between existing projects, enable them to scale, and ensure that new interventions can be ideated to complement the current players and resources in the field.

Our goal is to become a central digital “food and cold chain transition hub” for cold chain investments in emerging markets, that are market driven, built for scale, and with substantial real-world impact.

BACKGROUND

As markets develop and grow in low- and middle-income countries, the transition from informal to formal market arrangements introduces a demand for structured supply chains and contractual agreements. This progression leads to more intricate and extended supply chains, necessitating robust cold storage and logistics systems to uphold food quality standards and minimize losses within the system. Consequently, there arises a critical requirement for cold chain infrastructure, entailing a substantial investment. Striking the right balance and timing for cold chain investments is an intricate task. Premature investments, or investments misaligned with the specific food types, can lead to underutilized infrastructure, the "white elephants". Conversely, delayed investments can hinder market development and result in avoidable food losses and associated carbon emissions within the system.

A first-of-its kind initiative, Cool Move works by establishing a multi-stakeholder partnership of key actors in the food and energy nexus.

The Cool Move Initiative aims to:

- Double the cold chain footprint and utilization in the countries involved in the next five years.
- Double it again in the following five years.
- Work with at least 20 different value chain projects in five different countries in five years.
- Create a cohesive programmatic framework and financing mechanism to grow the sector through investment-ready projects.

PROJECT APPROACH: PAVING THE WAY FOR SUSTAINABLE COLD CHAIN INTEGRATION

ECOSYSTEM APPROACH

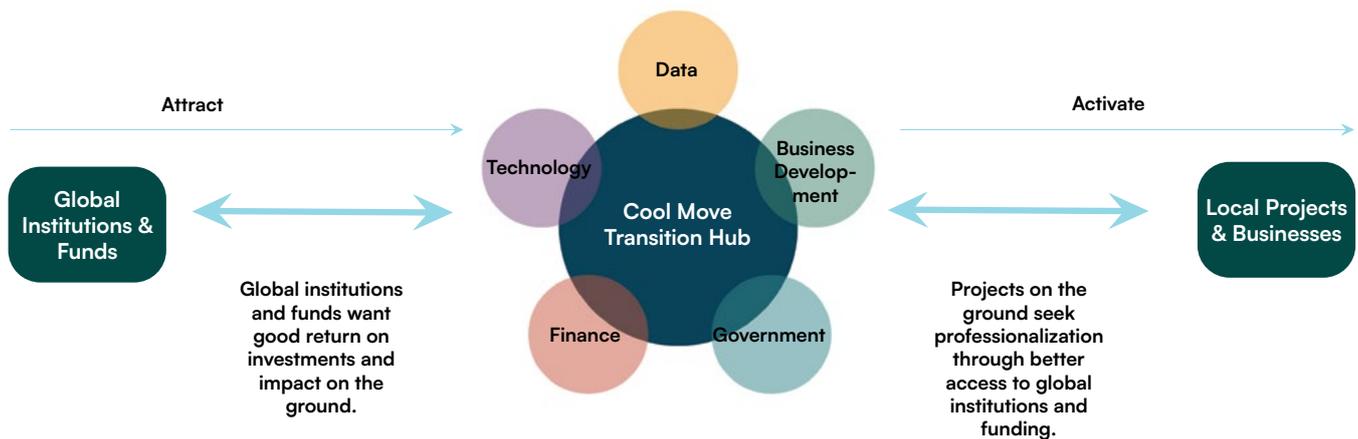
The Cool Move Initiative emphasizes an integrated value chain approach to facilitate the scalability of storage and cooling facilities. This necessitates the establishment of

a multi-stakeholder partnership among various actors in the food system. Rather than operating as a standalone programme, our aim is to foster an ecosystem that nurtures sector-wide growth.

CREATING SYNERGY

As identified by Efficiency for Access, in the dynamic landscape of cold chain development in LMICs, numerous initiatives, projects, and small businesses are already making significant strides. However, a comprehensive platform that unifies these efforts is conspicuously absent. The Cool Move Initiative steps in to bridge this gap. By harmonizing global institutions with local projects through five key work streams - Business Development, Data, Finance, Technology, and Policy Engagement - we endeavour to create an enabling environment for local entrepreneurship (Figure 7).

Figure 7: The Cool Move Initiative is bridging global institutions and local projects and businesses through five key areas.



EMPOWERING LOCAL ENTREPRENEURS

At the heart of the Cool Move Initiative is deep engagement with the private sector and industry players. In a nascent sector marked by isolated innovation, the initiative offers a platform to not only connect networks but also actively collaborate with diverse projects and companies. These entities collectively form the backbone of the Cool Move Initiative, committing to bespoke projects, multi-stakeholder dialogues, business model experimentation, and the sharing of critical data. This collaborative endeavour ensures a steady flow of essential information to and from the Transition Hub.

CONNECTING THE DOTS

The Transition Hub serves as the nucleus for disseminating best practices, consolidating expertise in key cold chain aspects, and advocating for conducive government policies. It provides a structured framework for projects to align with established best practices, thus laying the groundwork for future investments.

A ROADMAP TOWARDS SUSTAINABLE COOLING

The Cool Move Initiative sets forth an ambitious roadmap to seamlessly integrate cold chain into resilient and secure food value chains in LMICs. Following a rigorous methodology - Count, Test, Change, Scale - we begin with

robust data collection and research, followed by piloting innovative business models. Subsequently, we leverage resources to influence policies and implement effective strategies. With successful outcomes in hand, we work alongside partners to expand our efforts regionally and globally, amplifying our impact and measuring success.

The overall goal is to reduce food losses and boost food security in emerging markets by integrating cold chain (both accessibility and utilisation) in fresh value chains in rural areas.

Activities of the initiative include:

- Facilitating sharing of best practices and learning
- Maintaining expertise in key cold chain aspects, including understanding the level of cold chain development within specific countries, the level of demand for infrastructure, and best practice in cold chain technologies and their application.
- Maintaining expertise and knowledge about key aspects of successful business models.
- Supporting technology development and innovation to drive continuous improvement and advancement of cold chain technologies.
- Providing a framework for projects to be developed and implemented in line with existing best practice and providing evidence for future investments.





Key deliverables of the initiative are:

- A business development tool for SMEs (including methodologies, best practices, benchmarking, scaling strategies, and a guide for attracting funding).
- A pipeline of investments in cold chain
- A financing and de-risking mechanism and five deals in the coming two years (involving both public and private sector).
- A (food) cold chain database (including country focused assessment financial and risk data, ag-system data, food loss data and greenhouse gas emissions data).
- A policy recommendation guidebook covering, for example, food safety, food quality and climate resilience.
- Case studies covering different technologies.

JOIN US

We believe that collaboration is key to the success of the Cool Move Initiative. We are actively seeking partners who share our vision and are eager to contribute to the growth and sustainability of the cold chain sector in emerging markets.

Whether you're a funder, a private sector entity, a project implementer, or someone with a passion for transformative change, we invite you to join us. Together, we can make a substantial impact on reducing food losses, enhancing food security, and driving economic growth. If you're interested in being part of this initiative, please reach out to us at FoodLossAndWaste@wri.org.

LOW ENERGY INCLUSIVE APPLIANCES (LEIA)

Low Energy Inclusive Appliances (LEIA) is a research and development (R&D) programme that seeks to improve the efficiency, performance, availability, and affordability of a range of household, community and light-commercial electrical appliances and solar-powered technologies particularly suited to off- and weak-grid settings, particularly in Sub-Saharan African, Southeast Asian and developing ASEAN countries. LEIA is the flagship program of the Efficiency for Access Coalition.

[Efficiency for Access](#) is a global coalition promoting energy efficient appliances as a potent catalyst in clean energy access efforts. Since its founding in 2015, Efficiency for Access has grown from a year-long call to action and collaborative effort by Global LEAP and Sustainable Energy for All to a coalition of 20 donor organizations. Coalition programmes aim to scale up markets and reduce prices for super-efficient, off- and weak-grid appropriate products, support technological innovation, and improve sector coordination. Current Efficiency for Access Coalition members lead programmes and initiatives spanning three continents, 62 countries, and 34 key technologies. Efficiency for Access is co-managed by CLASP and Energy Saving Trust.

Contact: Nyamolo Abagi, Co-Lead Efficiency for Access, nabagi@clasp.ngo

WAGENINGEN UNIVERSITY & RESEARCH (WUR)

Wageningen University & Research (WUR) is a leading international education and research organization with the mission to explore the potential of nature to improve the quality of life. It is organized in a collaborative network comprising the Wageningen University and the Wageningen Research, linking education and training to fundamental, strategic, and applied research. This combination of knowledge and experience enables WUR with its 7,500 staff, 2,300 PhD candidates, and 13,000 students from over 100 countries to actively contribute to solving scientific, social and commercial problems in the fields of food and food production, living environment and health, lifestyle and livelihood. For more information visit www.wur.eu.

WAGENINGEN FOOD & BIOBASED RESEARCH (WFBR)

Wageningen Food & Biobased Research (WFBR) is one of the leading contract research organizations of Wageningen. The WFBR research team comprises over 250 scientists and consultants. WFBR helps to create viable and sustainable solutions for supplying a rapidly growing world population with healthy, delicious, sustainably produced food and high-quality materials, chemicals and fuels made from biomass. One of the leading research themes of the organisation is the 'Postharvest and cold chain', which helps the agri-food sector, via a multidisciplinary and chain-oriented approach, to make substantial progress in creating an energy efficient and climate-friendly and viable structure for economically, socially and environmentally sustainable food production and distribution.

WFBR offers a unique combination of expertise on domains related to cold chains, including postharvest physiology, postharvest technologies, Agro & food policy and financing & investment. This knowledge can easily be scaled through the collaborative approach within WUR.

Contact: Bas Hettterscheid, Program manager cold chain development, Bas.hettterscheid@wur.nl

GLOBAL FOOD COLD CHAIN COUNCIL (GFCCC)

Global Food Cold Chain Council (GFCCC) is an independent not-for-profit industry organization that seeks to simultaneously reduce food waste, and related greenhouse gas emissions in the processing, transportation, storage, and retail display of cold food by expanding and improving

access to energy efficient low-global warming potential technology. GFCCC partners with institutions associated with the Montreal Protocol on Substances that Deplete the Ozone Layer, including the Ozone Secretariat, the Multi-Lateral Fund (MLF), UNEP OzonAction, and UNEP Cool Coalition, to further expansion of sustainable cold chain as part of implementation of the Kigali Amendment to the Montreal Protocol, as well with other institutions and organizations seeking to further cold chain expansion, reduction of food loss and waste, and reduction of greenhouse gas emissions.

Contact: Kevin Fay, Executive Director, Global Food Cold Chain Council, fay@alcalde-fay.com

CHAMPIONS 12.3

The United Nations' Sustainable Development Goal 12 seeks to "ensure sustainable consumption and production patterns." The third target under this goal (Target 12.3) calls for cutting in half per capita global food waste at the retail and consumer level, and reducing food losses along production and supply chains (including post-harvest losses) by 2030. Champions 12.3 coalition was created to help ensure focus on this agenda. Champions 12.3 focuses on a simple strategy: Target-Measure-Act-Influence. Every year, the Champions 12.3 coalition produces a report on the progress that is being made to reduce food loss and waste globally. The report provides information about hot spots and where action is required. One of the conclusions from assessments of progress is that there is a clear need for cold storage and improved cold chains especially in specific circumstances. WRI (World Resources Institute) provides the secretariat for the Champions 12.3 coalition.

THE COOL MOVE

The Cool Move started as a multi-stakeholder partnership with a set of diverse organisations from different backgrounds. including World Resources Institute (WRI), The World Bank, Food and Agriculture Organisation (FAO), Rabobank, Enviu, Efficiency for Access (TBC), Wageningen University & Research (WUR) and the Global Food Cold Chain Council (GFCCC). The central coordination will be led by Champions 12.3¹⁹, carried out by WRI in its role as secretariat. This provides an overarching governance mechanism. In addition, many of the organisations leading the Cool Move Initiative are part of this Champions 12.3 coalition.

Contact: Liz Goodwin, Senior Fellow and Director of Food Loss and Waste for WRI (World Resources Institute), Liz.Goodwin@wri.org.

19. A coalition of executives from governments, businesses, and civil society dedicated to inspiring ambition, mobilizing action, and accelerating progress toward achieving SDG Target 12.3 by 2030.



CONTACT US

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