SUSTAINABLE ENERGY FOR ALL

Cooling for All Training

ECOWAS Regional Energy Forum and Training

19 November 2021

In Partnership With

Cool Coalition

Clean Cooling COLLABORATIVE

Sessions:	Trainers:
1. Global Cooling Collaboration	Ben Hartley (SEforALL) Mark Lister (Cool Coalition)
2. Cold Chains	**Toby Peters (Univ. of Birmingham)** **Issa Nkurunziza (UNEP / ACES)** **Luis Rincon (FAO)**
3. National Cooling Action Plans	Rosa Garcia (SEforALL) Marco Duran (UNEP/Cool Coalition)

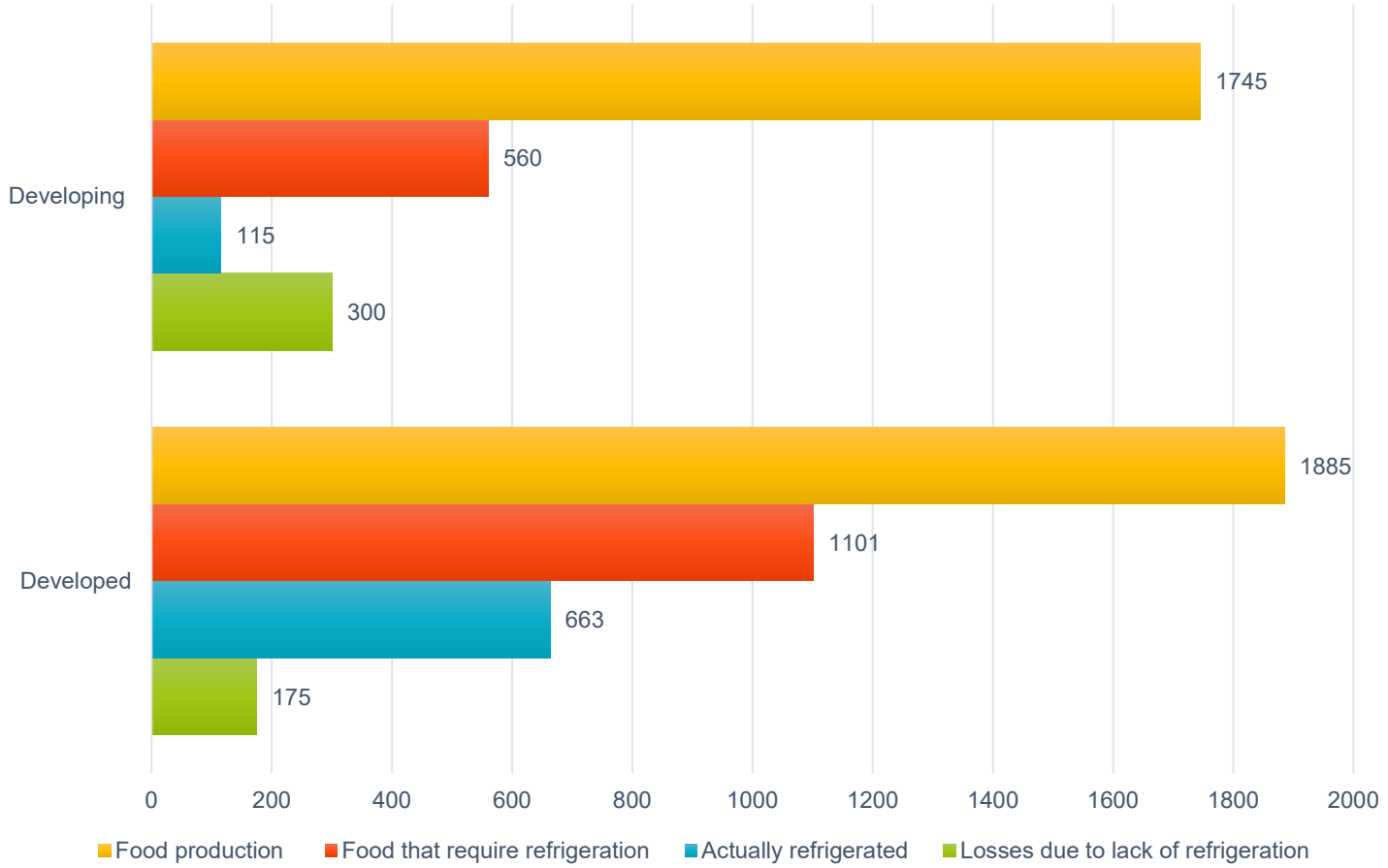
2 Cold Chains

ACES, University of Birmingham, FAO, SEforALL

Food loss due to a lack of refrigeration

Food losses due to lack of refrigeration in developed and developing world in 2013 (million tonnes)

- International Institute of Refrigeration



Centre for Sustainable Cooling

Snapshot: Key cold chain indicators in ECOWAS

	Perishable Food (2013)			Under-nourishment (2019)	Appliance Ownership	
	Production	Losses	Loss (%)	Prevalence (%)	Refrigerator	Year
Benin	1,244,000	458,948	36.89%	7.6%	4.6%	2018
Burkina Faso	1,044,000	279,180	26.74%	14.4%	3.9%	2010
Cabo Verde	112,000	-	-	15.4%	55.8%	2005
Côte D'Ivoire	3,378,000	1,162,290	34.41%	14.9%	11.3%	2012
The Gambia	82,000	20,890	25.48%	13.6%	22.7%	2013
Ghana	6,707,000	2,698,973	40.24%	6.1%	34.7%	2016
Guinea	2,199,000	836,848	38.06%	-	45.4%	2018
Guinea Bissau	197,000	68,896	34.97%	-	-	-
Liberia	361,000	132,160	36.61%	38.9%	4.1%	2013
Mali	3,258,000	1,058,210	32.48%	10.4%	10.3%	2018
Niger	3,066,000	1,028,174	33.53%	-	3.3%	2012
Nigeria	25,848,000	9,474,978	36.66%	14.6%	22.0%	2018
Senegal	1,868,000	547,798	29.33%	7.5%	33.1%	2018
Sierra Leone	882,000	293,278	33.25%	26.2%	12.2%	2019
Togo	313,000	90,268	28.84%	20.4%	6.7%	2014
Total/Average	75,615,000	26,270,310	34.74%			

Food Data based on FAO Country Statistics. FAOSTAT, FAO.
Perishable food includes Milk, Vegetables, Fruit, Meat, Fish.
Appliance ownership data based on countries' Demographic and Health Survey. The DHS Program, USAID.

For a basket of key crops, losses ranged from 25% to 40% in the ECOWAS region in 2013.

Undernourishment is particularly prevalent in Liberia, Sierra Leone, and Togo, and is likely underestimated given the poverty impact of the COVID-19 pandemic.

Refrigerator ownership varies dramatically, with market penetration remaining low in Niger, Burkina Faso, and Liberia, among others.

A lack of farm-to-table cold chain contributes to undernourishment and depressed economic growth in rural areas.

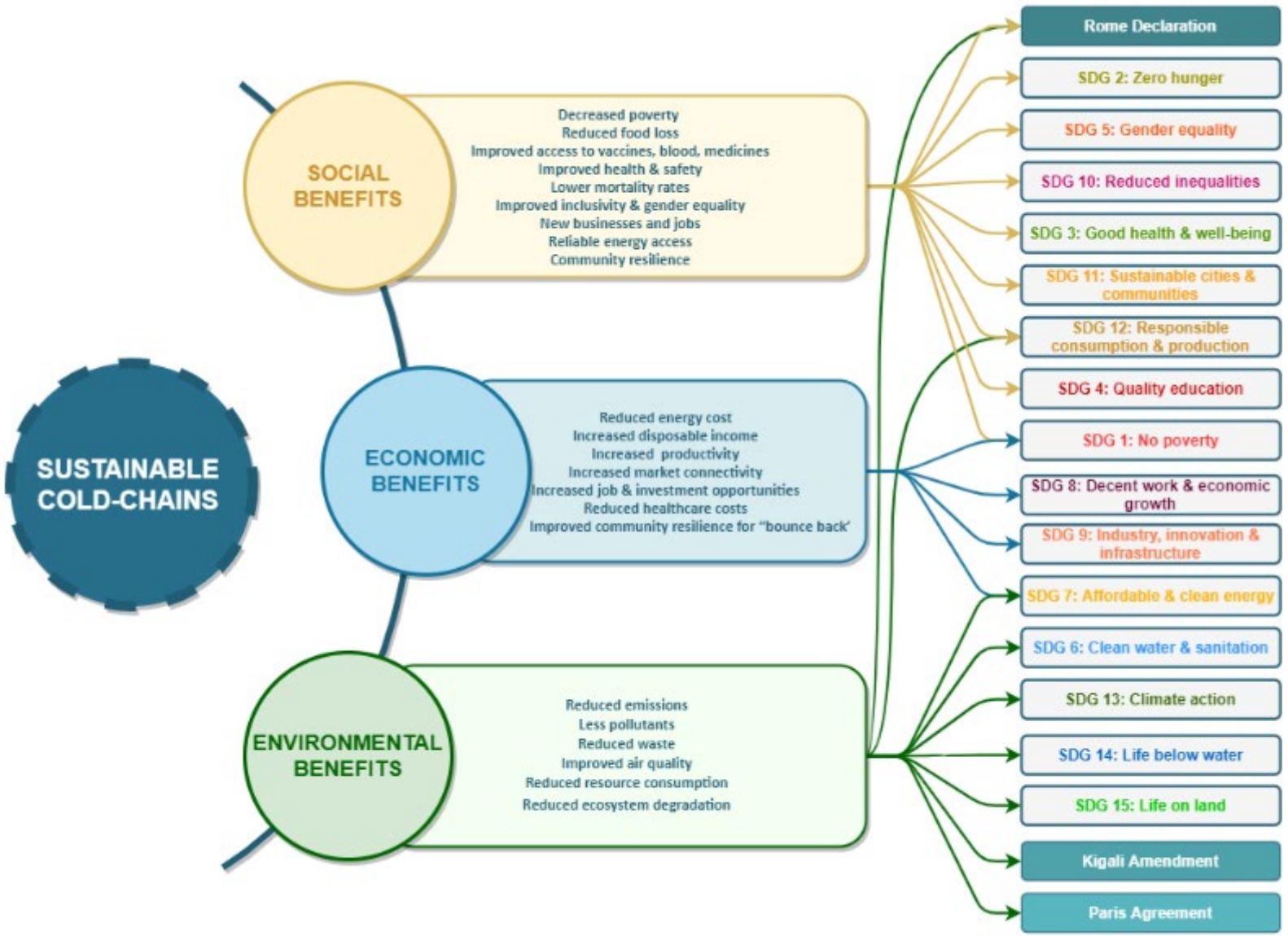
Postharvest food loss, for example, reduces income by at least 15% for 470 million smallholder farmers.

Multiple benefits of sustainable cold chains

Sustainable cold-chains are key for improving human well-being, boosting economic growth and delivering socioeconomic development through the SDGs, while simultaneously achieving the targets of the Paris Agreement and Kigali amendment to the Montreal Protocol and the Rome Declaration on the Contribution of the Montreal Protocol to Food Loss Reduction through Sustainable Cold Chain Development.

Delivering sustainable cold-chains requires balancing environmental, social and economic benefits.

This includes providing access for all (including poor and marginalized farmers and fishers); considering the cooling economy as a whole; and identifying synergies between sectors where cooling demand can be aggregated and/or capacity shared



Why cold chains matter

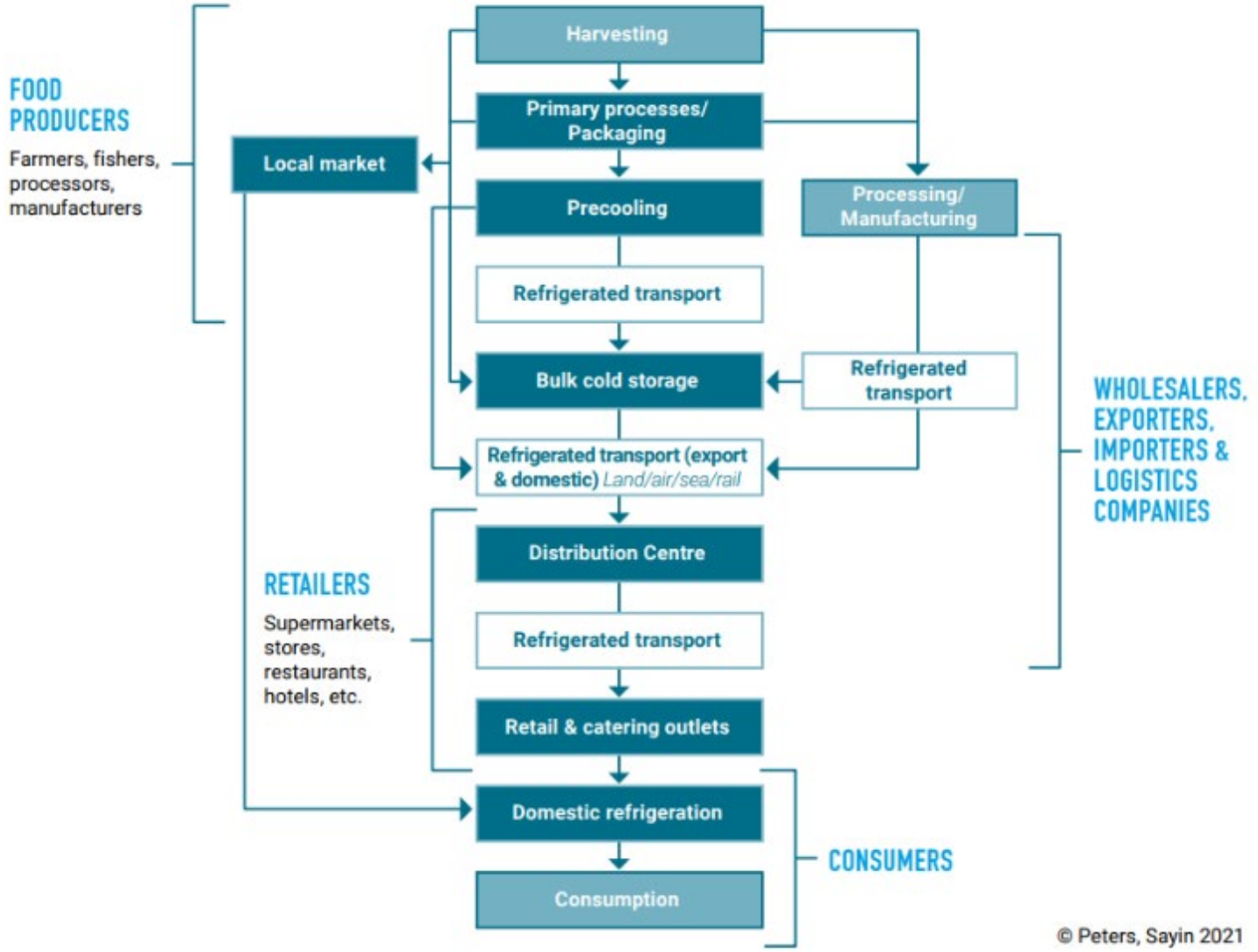
Food saved is as important as food produced

Ensure Safe & Nutritious Food for All	Shift to Sustainable Consumption Patterns	Boost Nature Positive Production	Advance Equitable Livelihoods	Build Resilience to Vulnerabilities, Shocks & Stresses
Help preserve food & its safety Maintain food's nutritional value Reduce food loss	Efficient use of farming inputs Reduce food loss	Additional income fosters more sustainable practices Supports local circular economy efforts	Increase farmers' incomes Reduce food access and income inequality	Stabilize food supply Increase supply chain resilience Contain changes in food prices

What is a cold chain? (1/2)

The global food cold chain is a functionally integrated temperature-controlled transport, storage and distribution system that ensures that perishable food and/or temperature sensitive products are kept at their optimum temperature and environment – different for each depending on specifications and characteristics – to maintain their quality, nutritional value, and safety, from source to destination.

Figure 2: **Typical food cold chain steps and stakeholders**



What is a cold chain? (2/2)

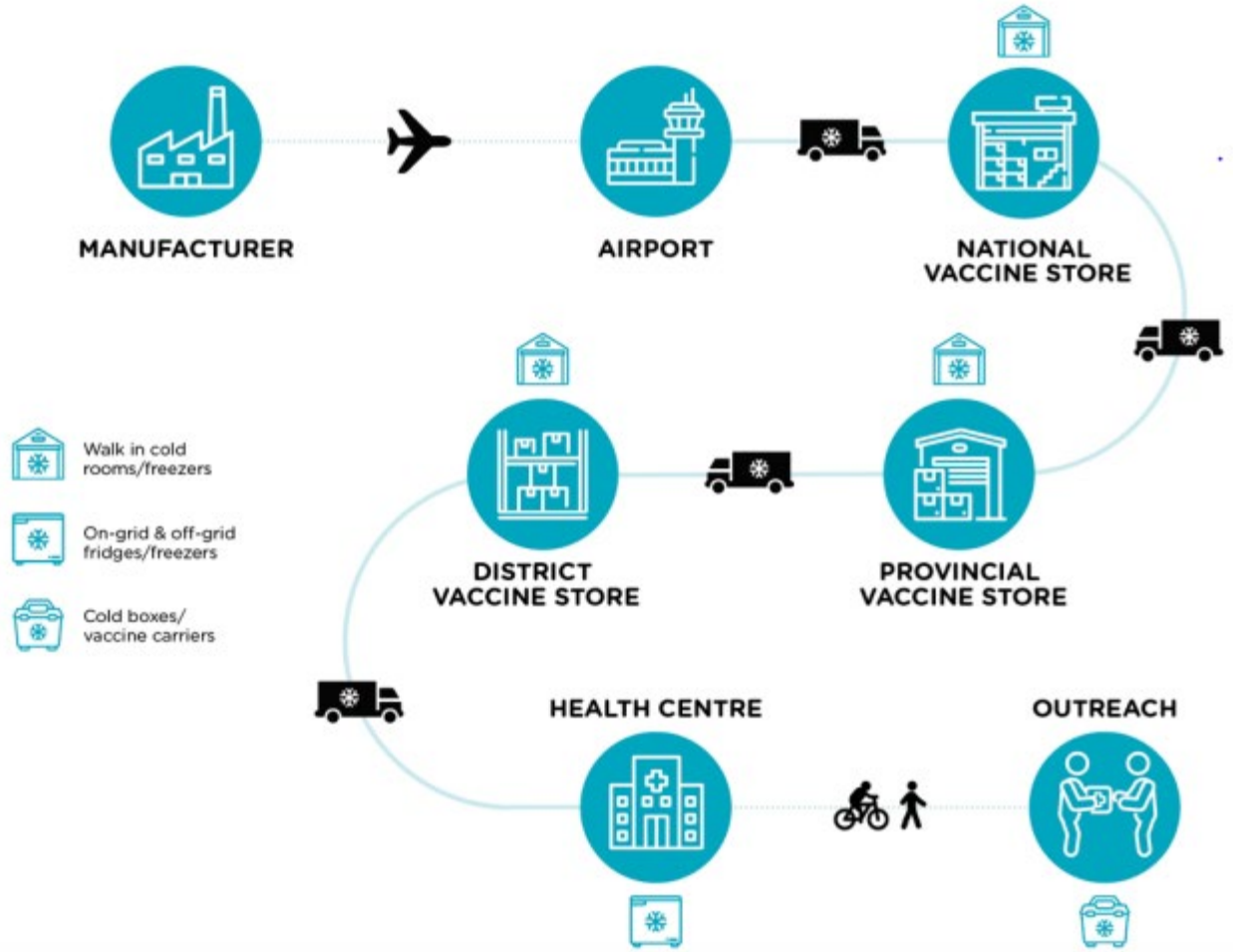


Figure 1: General structure of vaccine cold chain in routine immunization programmes

A health cold chain is typically used for the transportation and storage of temperature-sensitive health products that include but are not limited to vaccines, blood products, and a range of medicines that support common health services. These products are usually handled by medical staff logisticians in the cold chain and at the point of delivery but may also involve consumers if and when these products are to be taken home and kept cool for use over time.

State of the cold chain market

Domestic refrigeration, refrigerators and freezers	2 billion
Commercial refrigeration equipment (e.g. condensing units, stand-alone equipment, centralized systems)	120 million
Refrigerated vehicles (e.g. vans, trucks, semi-trailers, trailers)	5 million
Refrigerated containers (e.g. reefers)	1.2 million
Cold stores	50,000

The global cold-chain capacity has been growing in recent decades. Average cold storage capacity in North America or Western Europe is ~200 cubic metres per 1,000 inhabitants, in the least developed countries. it is only ~ 20 cubic metres per 1,000 inhabitants on average.

Food cold-chains are expected to expand significantly to cope with the increasing demand. industrial and transport refrigeration will be the fastest growing subsectors within the cooling sector, with average annual growth rates of 5.1 per cent and 4.8 per cent, respectively, between 2018 and 2030.

Conventional cold-chains are typically energy intensive and polluting. In total, this equipment alone is responsible for an estimated 1 per cent of global greenhouse gas emissions, globally accounting for both direct and indirect emissions and can be as high as 3–3.5 percent of GHG emissions in developed economies

Decisions on cold chain tend to be narrowly focused on measuring savings from efficiency and emissions impact. Economic benefits from access to cold-chains are typically not incorporated and are treated as a “soft win”, rather than as the core driver for provision.

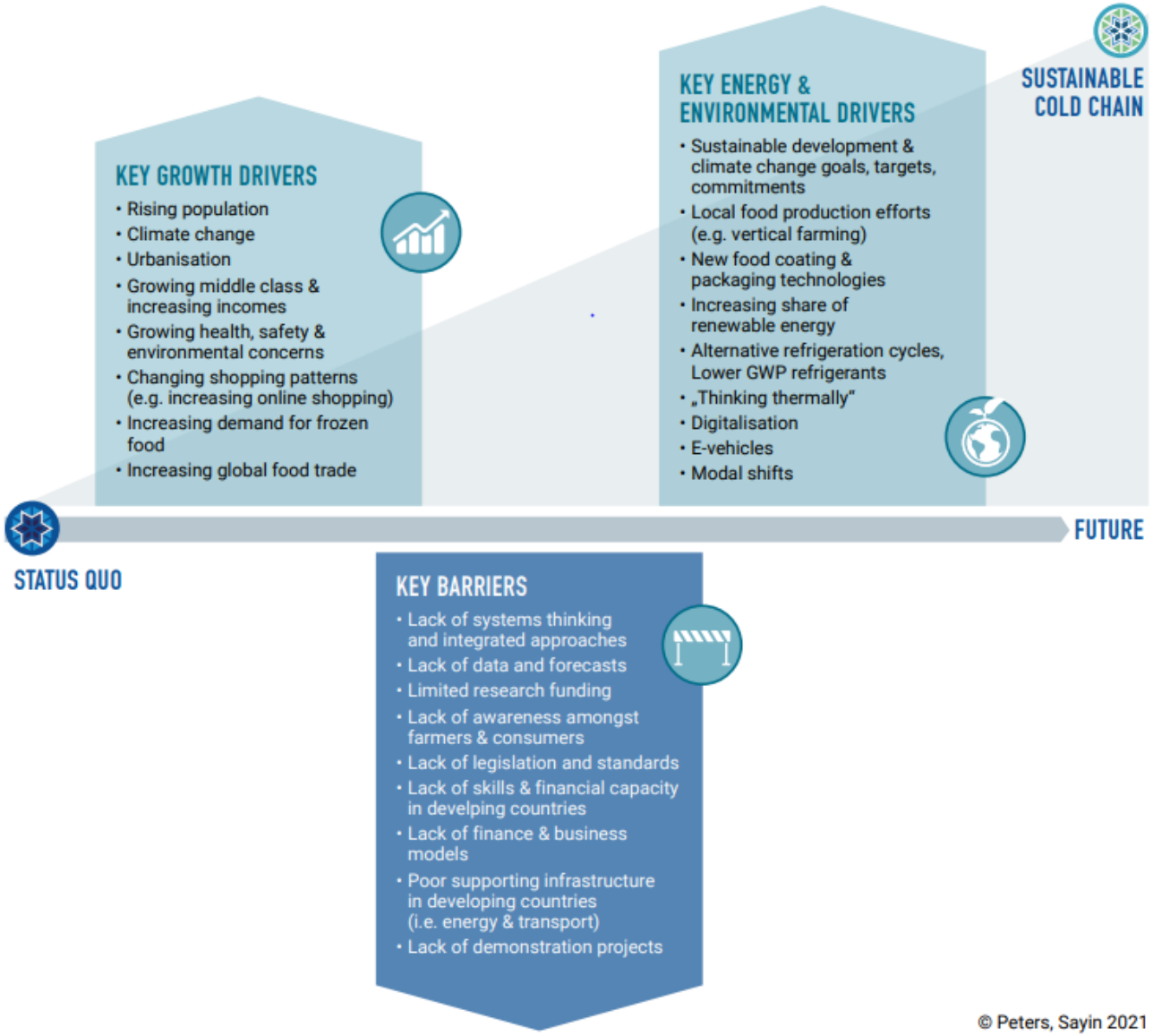
Key drivers and barriers to sustainable cold chain

More attention has been paid to agricultural cold chains in recent years in recognition of its role for increasing rural incomes, nutritional benefits, and climate change impacts – including food waste.

The COVID-19 pandemic and sub-zero cooling requirements for vaccines has also played an important role in driving demand for health cold chains.

Energy access is both a driver and a barrier. Rural health facilities and farms require sustainable access to electricity to power cooling, but reliability and economic viability of systems remains a challenge.

Figure 3: **Key drivers and barriers to a sustainable cold chain**



Forthcoming status report

Cold-Chain Food Status Report

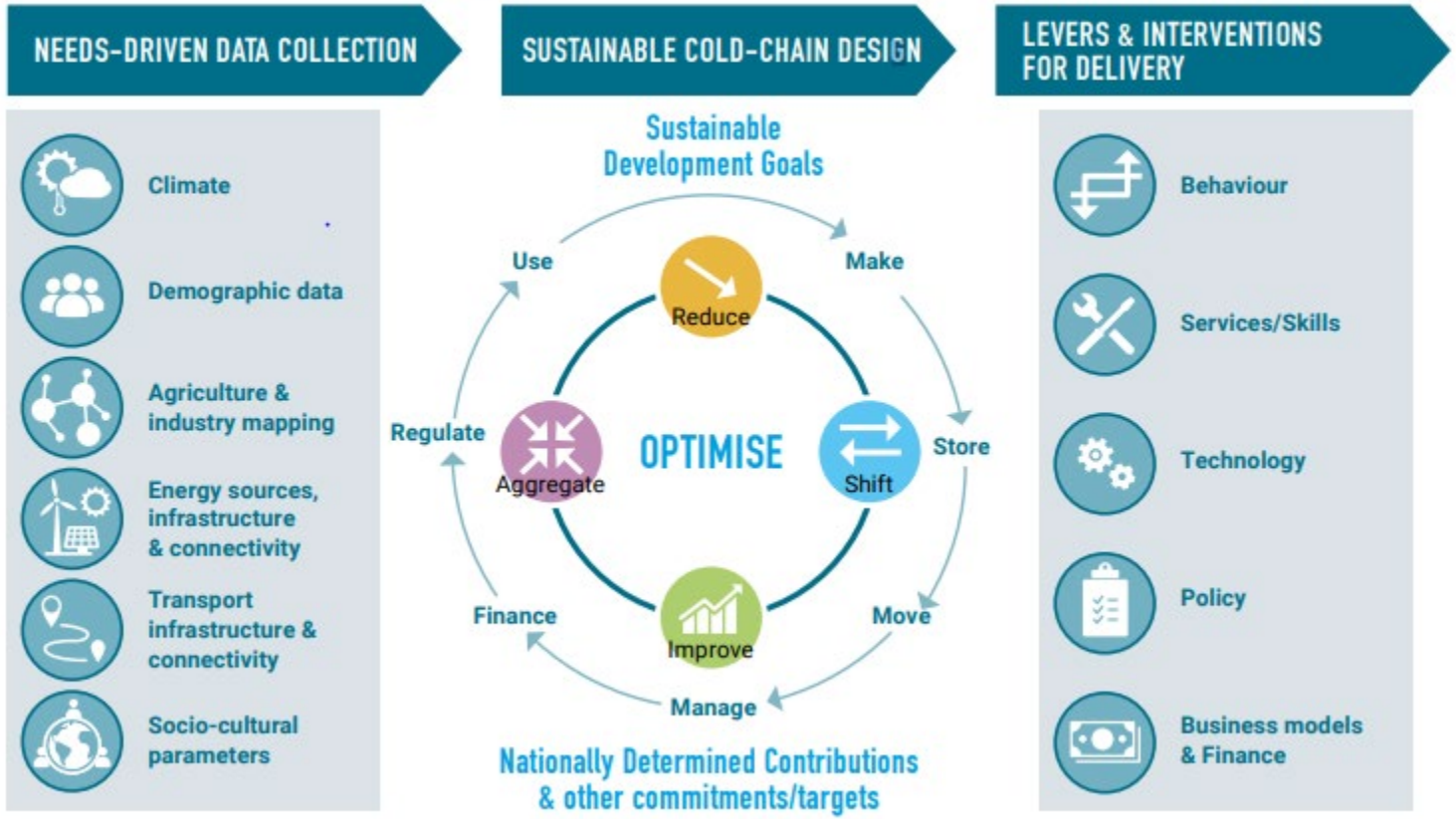
The ***Global Cold-Chain Food Status Report*** highlights the strategy towards sustainable food cold-chains and a long list of global actions and case studies including national approaches, policy, technology, financial, data collection efforts.

The report is being developed in the framework of the Cool Coalition, in collaboration with FAO, CCAC's Efficient Cooling Initiative, Ozone Secretariat, UNEP OzonAction, and with the support of Italy.

Cold chain opportunities (1/4)

Sustainable cold chain design

Figure 5: **Systems approach to sustainable cold-chain design**



Sustainable cold-chain design starts with assessing the end to-end cold-chain needs along with climatic, demographic, and socioeconomic statistics; infrastructure; industry mapping, and an audit of existing and emerging technologies

The optimum mix of fit-for-market solutions can be delivered through a "reduce-shift-improve" approach

Developing a sustainable food cold-chain is a multidimensional, multi-sectoral challenge. It requires tackling the interdependencies that exist among economic, environmental, energy, technological, social, and political systems, as well as designing and implementing policies to address them

Cold chain opportunities (2/4)

Policy Action

The model National Cooling Action Plan methodology includes a needs-driven approach to addressing cold chain through a holistic yet modular process in support of cooling for all.

Five-year cold chain plans, can support provide financial assistance and capacity building for all required cold-chain components, with the aim to bring mobility in cold-chain and achieve seamless movement of agricultural produce from farm to fork.

Example: Cold Chain in Indonesia's NCAP

- For the agricultural cold chains assessment, the following steps were undertaken to develop the NCAP recommendations:
  - Collection of food production, imports, local supply, export and food losses data from FAO Statistics (2018) for Indonesia
  - With expert review and stakeholder involvement, derived estimates of the share of the food stored in cold stores and other cold chain utilities from the total food produced and supplied.
  - Quantification of the cooling requirements of the food stored in cold chain (frozen/chilled)
  - Use of energy benchmarks to estimate energy consumption of the cold stores.
  - Forecast and scaling of the historical and current assessment to meet the 2030 country targets.
  - Calculation of energy and emissions to support the assessment.

Cold chain opportunities (3/4)

Technology

The digital economy has made cold chain logistics vastly more efficient, with impacts on business models, service standards, financing, production and technology.

However, barriers to market uptake of sustainable cooling solutions remain, especially in developing countries, due to issues such as lack of standards, infrastructure, reliable energy, financial capacity and local skills to develop and deploy such technologies

The opportunity is that developing countries may be able to leapfrog to more advanced sustainable solutions whenever possible

Example: Off-grid Cold Chain Technology

ColdHubs Ltd. operates solar-powered walk-in cold rooms at farm clusters, produce aggregation centres and outdoor food markets in Nigeria. The Hubs are used by smallholder farmers, retailers and wholesalers to store and preserve fresh fruits, vegetables and other perishable foods. Each ColdHub includes a cold room that can fit around 3 tons of perishable food arranged in 150 units of 20-kilogram plastic crates stacked on the floor. Users pay only 100 Nigerian naira ($0.26) to store one returnable plastic crate per day inside the cold room – a unique pay-as-you-store Cooling-as-a-Service concept

Sure Chill produces solar-powered refrigerators and freezers are designed to maintain vaccines at the prescribed temperature in off-grid settings. Even though the initial cost of solar-powered systems is higher than electric refrigerators and freezers, they offer significant energy cost savings and reduce emissions.

Cold chain opportunities (4/4)

Services, maintenance and education

Services solutions support the organization and delivery of sustainable cold chain technologies and include:

1. **preparation activities (theory and practical skills) to create or deploy more sustainable cold chain solutions, and**
2. **operational activities (operation, management and maintenance) to deliver and use more sustainable cold chain technologies.**

Without these services more sustainable cold chain technology solutions may not be available; in other words, the manner in which technologies are developed, sold, installed or used all have a bearing on sustainability, which are all dependent on services.

Example: Africa Centre of Excellence for Sustainable Cooling and Cold Chain (ACES)

ACES was established in 2020 by the Governments of Rwanda and the UK, the UNEP U4E, the Centre for Sustainable Cooling, and the University of Rwanda (UR). With a growing array of regional and international partners, the aim is to **accelerate the development, education, demonstration, and deployment of sustainable solutions to simultaneously address the challenges of food loss and access to sustainable cold-chain and cooling**.

For more information about ACES, please visit https://coolingafrica.org/

Africa Centre of Excellence for Sustainable Cooling and Cold Chain (1/4)

ACES - Components

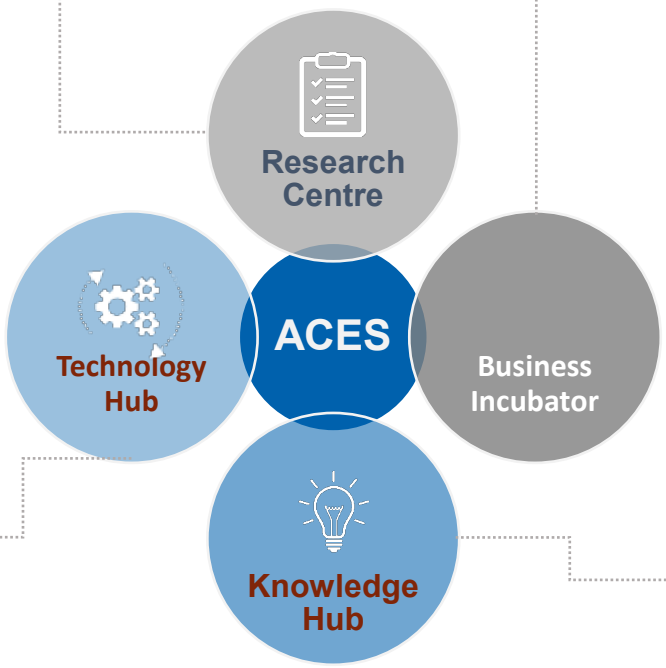
Holistic, needs-driven process to deliver the key interventions and levers for sustainable cooling

Comprehensive food and vaccine cold-chain design

- Research on future-proof, localised solutions for food loss reduction and supply chain resilience.
- Data acquisition and use.
- Sustainable low-carbon, pack-house and logistics design and best practices.
- Generation of design data and design of retail, professional and domestic refrigeration.
- Integrate renewable energy, E-logistics and other advanced solutions.

Demonstrate best available technologies

- Field and lab trial new technologies
- Support industry in adaptation to local needs
- Demonstration
- Identify market gaps



Increase market connectivity and investment

- Develop sustainable business models to attract uptake and investment.
- Create added value to farmers by turning food loss into sales, and new product opportunities.
- Standards and certifications.
- Support start-up companies and individual entrepreneurs to develop their businesses

Enhance capacity and raise awareness of rural communities

- Capacity building in the field.
- Skills development and innovation support.
- Chilling/freezing advice

Africa Centre of Excellence for Sustainable Cooling and Cold Chain (2/4)

ACES - Capabilities

Postharvest handling, storage, quality, process and packing zone with:
Off-grid mobile pre-cooling; Controlled Atmosphere systems; Refrigerated storage; Precision Cooling for soft fruit and perishable crops (blast chilling/vacuum coolers); Hydrocooling; Ripening Rooms; Sustainable packaging; modified atmosphere packaging.

*

Distribution, Cold-Chain and Logistics Zone with:
Ice-production; Zero-emission transport refrigeration; PCMs and small-scale rechargeable cooling boxes; Zero-emission refrigerated transport.

*

Energy and Energy Storage Centre with:
Integrated thermal systems; waste heat to cold (sorption cooling); Thermal storage (phase change materials).

Data and Digital Transformation
Needs assessment tools, data capture and use monitoring, virtual models, electronic trading and fulfilment platforms.

*

Business Start-Ups, and Incubation Suite with:
Design service, business models market engagement and finance, export distribution network, etc.
meeting and conference facilities; co-location space for business and industry partners.

*

Quality control and Certifications Centre addressing:
Codes and Standards; Setting quality thresholds for retail sector and export markets; Food safety.

*

Other areas – vaccine and health, retail domestic.

Africa Centre of Excellence for Sustainable Cooling and Cold Chain (3/4)

ACES University of Rwanda Rubiziri campus and design

ACES model farm

ACES Rubirizi Campus

ACES classroom

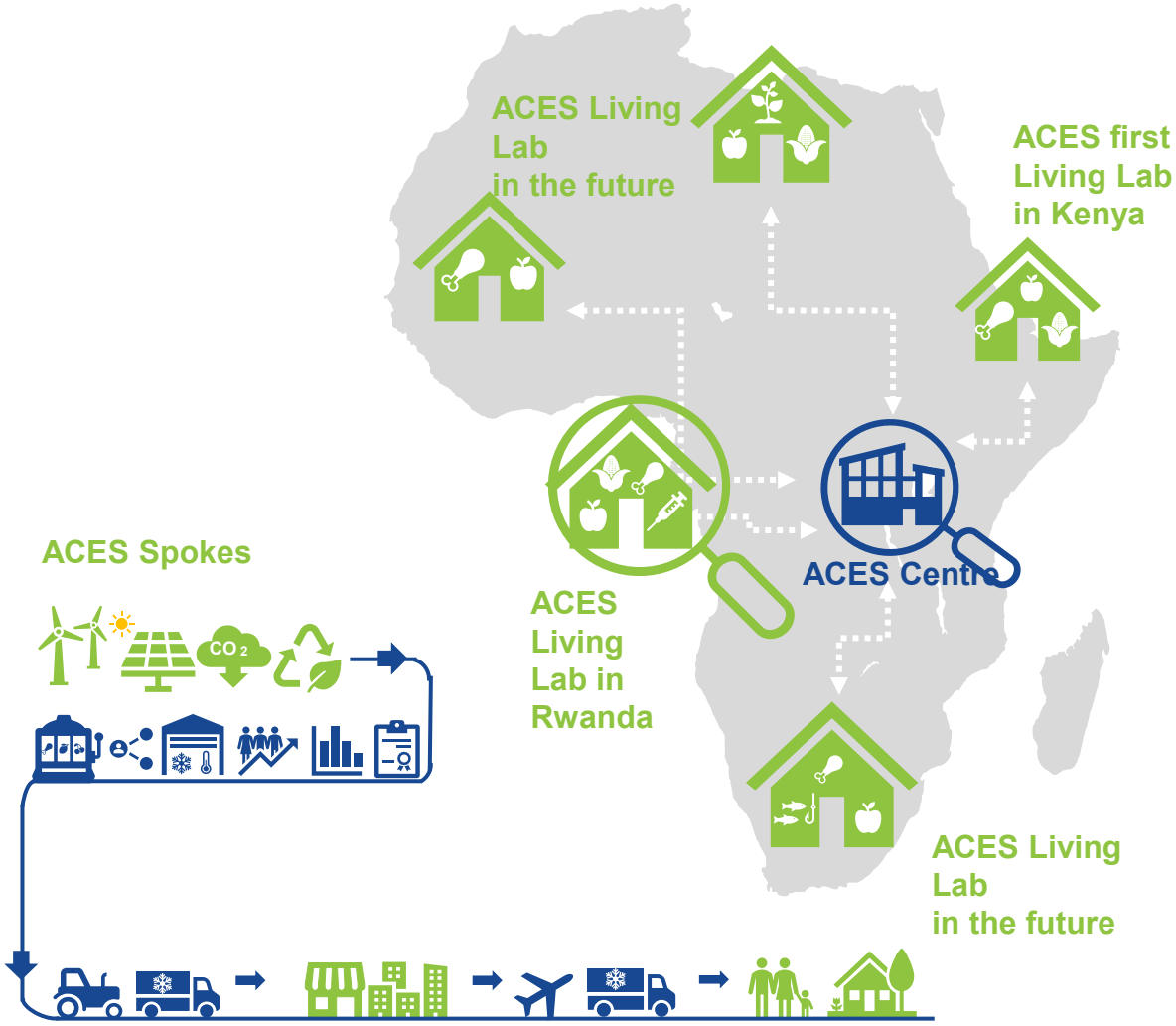
Model farm next to the Rubirizi campus will be usedshowcase an integrated sustainable food system to stakeholders, demonstrate technologies and support study of export opportunities & challenges.

Africa Centre of Excellence for Sustainable Cooling and Cold Chain (4/4)

ACES - Outreach

ACES is a pan-Africa impact programme, it uses a **“hub and spoke”** approach’ to provide advanced research, training programmes and testing facilities for integrated technology packages and business incubator support services.

Living Laboratories will be deployed in strategic locations in pan-Africa markets to showcase how such solutions can be deployed in practical applications as part of an inter-connected whole. The first Living Laboratory is in development for Kenya in 2021, with others to follow.



Food Value Chain

Production

- Electricity or Diesel for irrigation and pumping
- Diesel for harvesting equipment
- Electricity for storage if exists

Aggregation and Storage

- Electricity for temperature
- Electricity for moisture regulations
- Electricity to run any sorting/packaging equipment.

Processing

- Electricity for any grinding/milling
- Heating for dehydration
- Electricity to run any sorting/packaging equipment.

Marketing and distribution

- Electricity for packaging/branding
- Electricity for cooling in supermarkets
- Electricity to run any sorting/packaging equipment.

Consumption

- Heat for cooking
- Electricity household appliances
- Electricity for household refrigeration

Transport

Source: Food and Agriculture Organization of the United Nations

Food Value Chain

Define the value chain and the energy requirements

APPROACH

1 Mapping the Agriculture sector

- Understand which crops are grown in the country
- How does the value chain of those crop look like
- Who are the actors in the value chains

2 Identify critical stages of value chain

- Which stages of the value chain need the most energy
- An indication of current level of storage and processing done.
- Targeting which stage of the value chain would provide most benefit?

3 Match commercially available solar technology to the value chain

- Are there solar energy technologies that can be deployed to the identified stage of the value chain
- What are the costs of the technology and how much demand does Rwanda have for that technology

4 Estimate energy demand and market potential

- Based on the cost and potential demand for the specific technologies, estimate the total potential demand for each technology

Source: Food and Agriculture Organization of the United Nations

Food Value Chain

Example: Energy in the Rwanda Milk Value Chain

- Rwanda produced 246,143 ton of milk in the 2016/17 , mostly by small scale farmers (FAOSTAT, 2019)
- Largely sold informally, only around 55 percent in sold (IFAD, 2016)
- The Rwanda Livestock Master Plan 2018 aims to upgrade the dairy value chain by processing 955 tons/day by 2023-24
- Lack of cooling is a major challenge preventing this.

- Morning and evening milk
- Milk needs to be cooled to 4 degree to be safe
- Evening milk needs to be stored overnight before selling

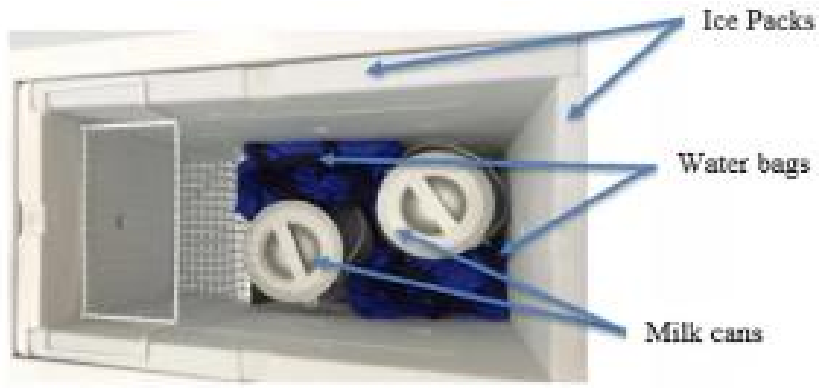
- Simple and modern milk collection centres exist
- Both need cooling, although at different scale
- Small scale solar cooler at simple and modern large Solar coolers at MCC

- To convert milk into other products
- Included in the analysis are UHT milk, Pasteurised milk and skim milk powder
- Both type and Type 2 solar interventions analysed.

Source: Food and Agriculture Organization of the United Nations

Food Value Chain – Solar Energy for Milk

Collection 1 : Farms and simple collection centers



20 liter, 515 USD

165 liter, 1619 USD

Collection 2: Modern collection

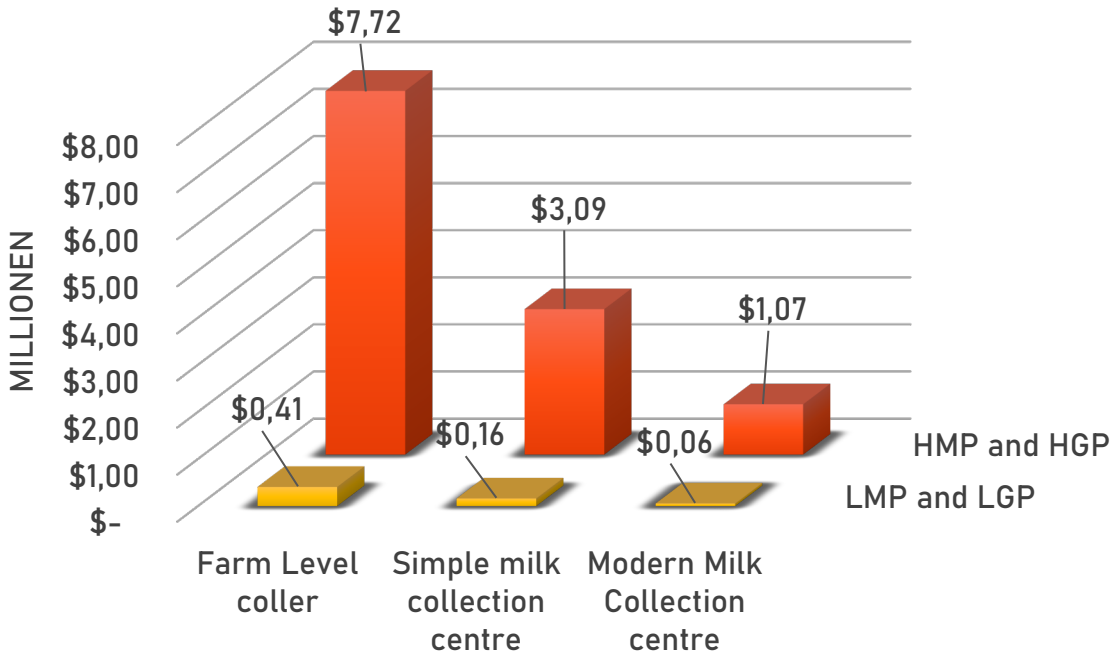
2 500 liter, 8 900 USD

Source: Food and Agriculture Organization of the United Nations

Food Value Chain – Solar Energy for Milk

SCENARIO ANALYSIS

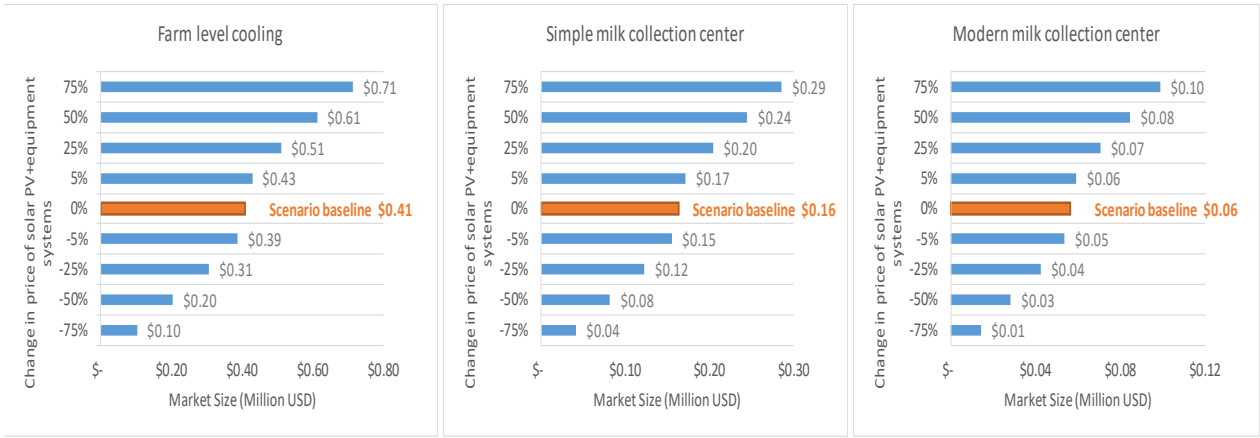
MARKET POTENTIAL IN SCENARIO 1 AND 6



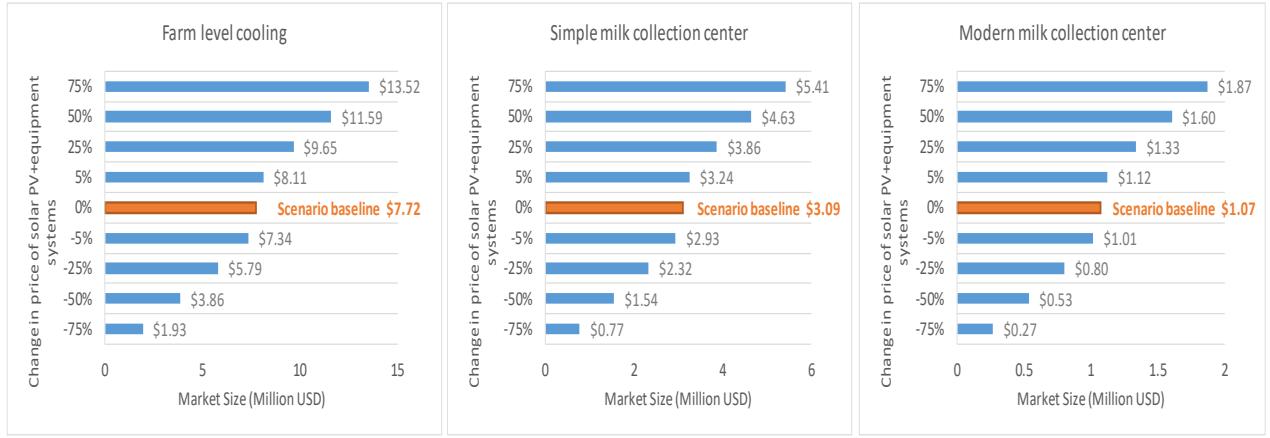
Source: Food and Agriculture Organization of the United Nations

SENSITIVITY ANALYSIS

Scenario 1 : LMP & LGP



Scenario 6 : HGP & HMP



Discussion:

What segments of your economy need sustainable cold chains?

Questions to consider:

What would you like to learn from ACES as it grows across Africa?

Are energy stakeholder coordinating with health and agriculture to examine the needs for cooling?

What is the most important catalyzer for improving cold chain equipment energy efficiency?

A. Improved minimum energy performance standards (MEPS)
B. Innovative business models such as cooling as a service
C. Interventions from government to subsidize upfront investment of efficient cooling equipment