COOL TALKS

The UNEP Cool Coalition webinar series

WITH

Alliance for an Energy Efficient Economy

Scaling Sustainable Packhouse Design for Agriculture:

Lessons from India for Global Cold Chains

27 OCTOBER 2026 | 13:00 CET

OPENING REMARKS

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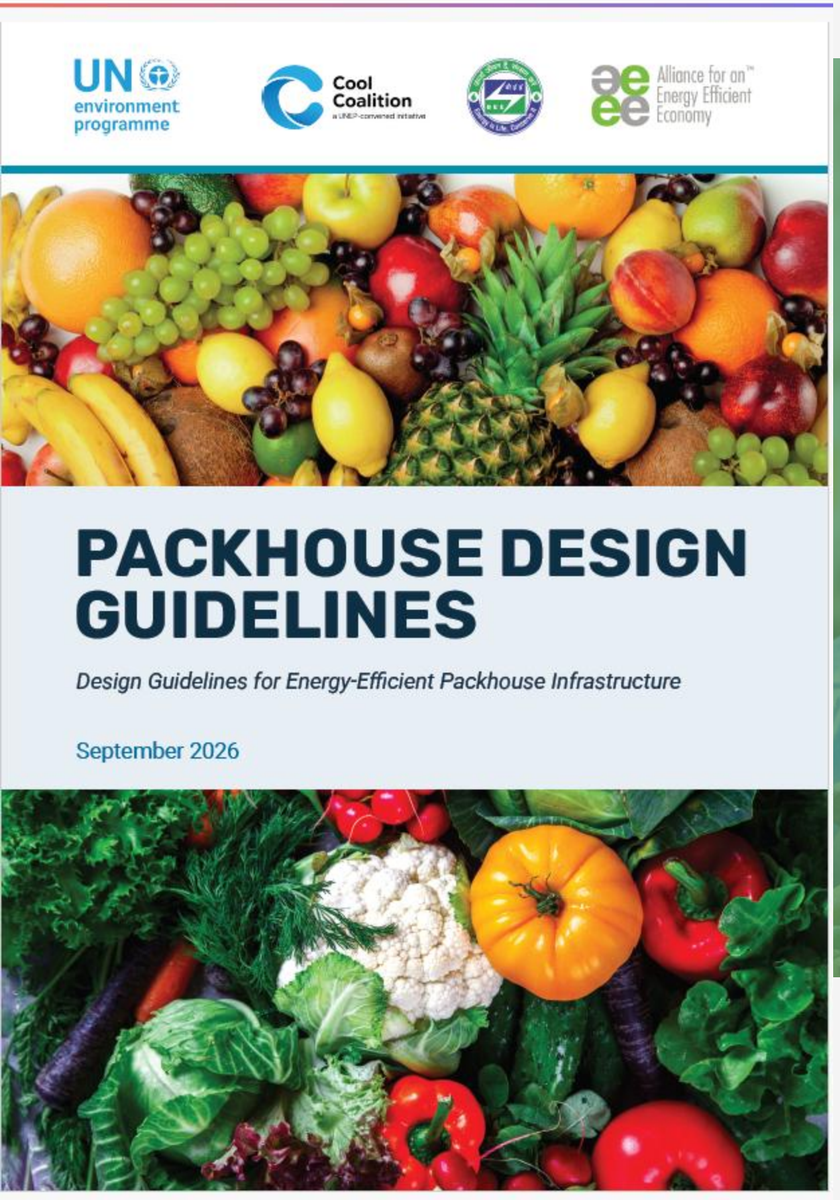
KEYNOTE | INDIA’S PACKHOUSE GUIDELINES – A MODEL FOR SCALE

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UNEP Cool Coalition



Packhouse Design Guidelines

27 October 2026

Agri Cold Chain: An Overview

- Cold chain is a climate- controlled logistics chain, ensuring uninterrupted connectivity of perishables & products from source to consumer, consisting of preconditioning and distribution-related activities
- Each step protects against **heat-driven spoilage**
- Cold chain impacts livelihoods, connects producers with markets, increases access to nutrition, mitigates food loss and drives productivity.
- Requires a programmatic approach.

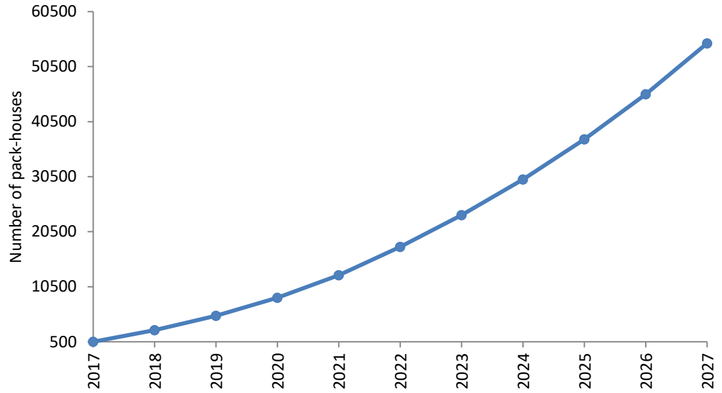


UN environment programme

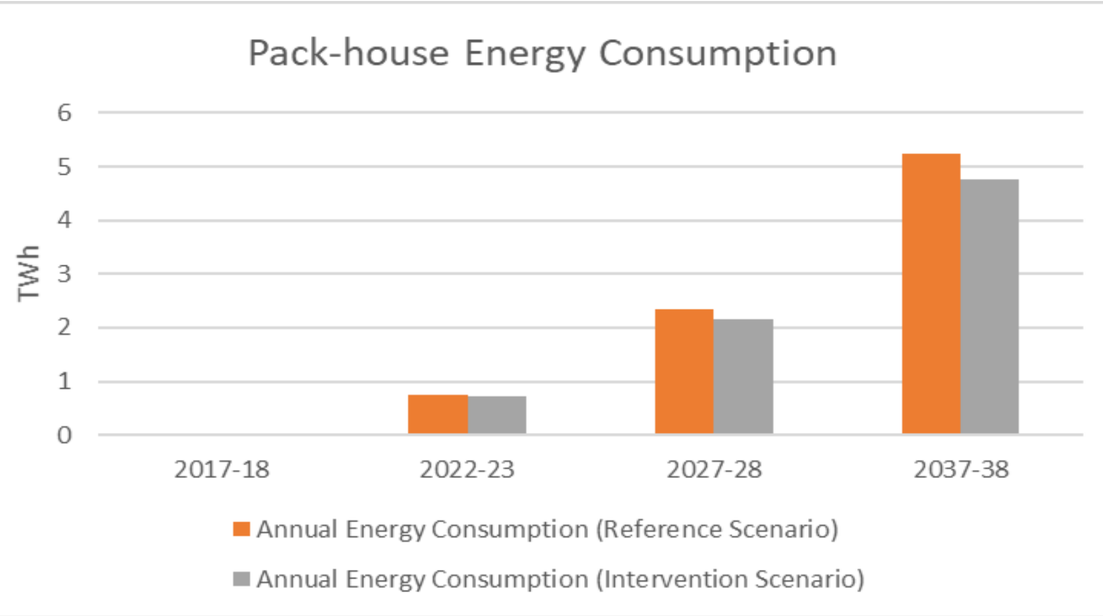
Cool Coalition
a UNEP-convened initiative

Need and Users of Packhouse Guidelines

	2017	2037
Estimated no. of packhouses in India (ICAP)	**500**	**125,000**



Users: Guidelines are for designing and constructing packhouses at first-mile, including cold-chain design consultants, developers and investors, cold-chain infrastructure owners and operators (which may also include Farmer Producer Organizations (FPO), Farmer Producer Company (FPC), Cooperatives), and government organizations



Brief Outline of the Packhouse Guidelines

- **Cold-chain and its Components**
- **About Integrated Packhouse**
  - Cleaning, Sorting, Grading and Packing
  - Pre-cooling Process
  - Staging Cold Room
- **Building Design and Construction**
  - Site Selection and Planning,
  - Landscaping,
  - Design of the Built Structure,
  - Orientation,
  - Passive Design Features
  - Building layout
- **Additional Components**
  - Receiving Platform, Ante-room, Dispatch Dock, Toilets and Changing Rooms,
  - Waste Disposable Area, Machinery and Equipment Space,
  - Clearance around Equipment, Safety and Firefighting system
- **Building Envelope and Construction Material**
  - Thermal Insulation for temperature-controlled area and Construction Features
- **Equipment and System Design**
  - Heat Load Calculation
  - Refrigeration System Sizing and selection criteria
  - Coefficient of Performance
  - Refrigerant selection
  - Variable Speed Operation
  - Thermal Energy Storage
- **Energy Efficiency Measures (EEMs)**
  - Scope of integrating EEMs in Pack-house building and design
  - Prioritization of EEMs in Pack-house building design
  - Energy Efficiency Interventions for Equipment and System Design
  - Prioritization of EEMs for Equipment and System Design
- **Renewable Energy Integration**
  - SWOT analysis for Solar PV, Biomass, Solar-thermal, hybrids and Geothermal

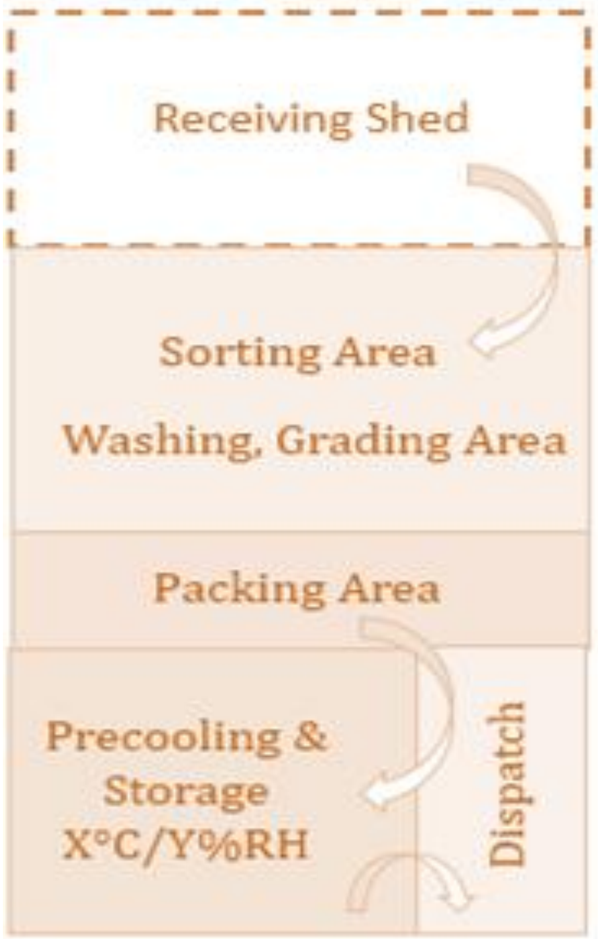


Snapshot of aspects covered

What is a Packhouse?

Modern packhouses are the first step in organized post-harvest management for horticulture and serve as the first-mile sourcing points



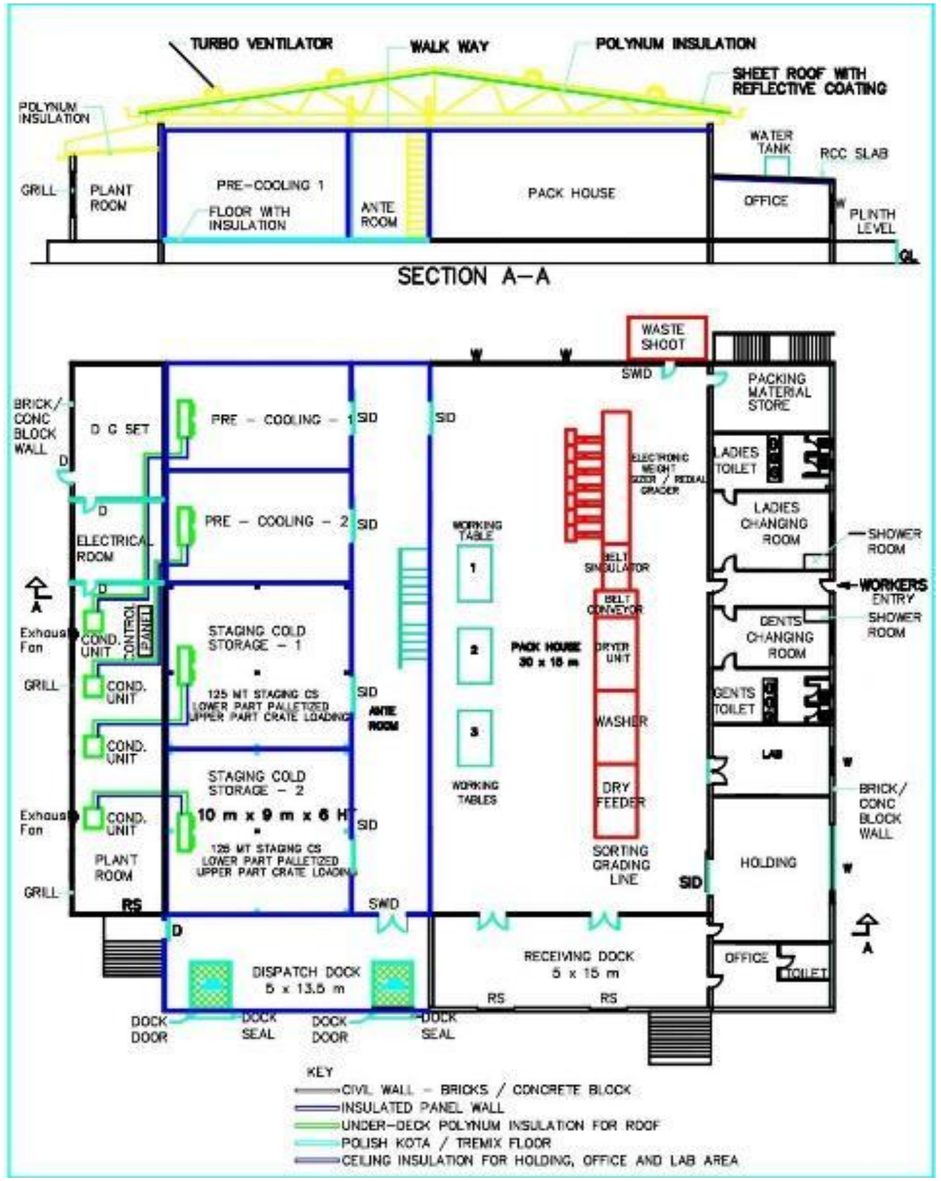


Illustrative layout of a packhouse

- **Central portion**
  - packing hall
  - demarcated passages
  - receiving and dispatch docks
  - refrigerated pre-cooling/staging cold rooms

- **Side rooms/areas**
  - plant room
  - electrical and genset rooms
  - toilets and changing rooms
  - packing material storage
  - lab

- This arrangement of rooms/areas avoids direct sunlight exposure and provides a thermal buffer to the working hall



Process in a packhouse

Receipt of incoming produce	Marshalling, weighing, recording
Preliminary cleaning as required for the produce	De-soiling/trimming/de-sapping
Sorting	Culling for quality & discarding rejects
Secondary cleaning or treatment as per need	Washing, brushing, drying, etc. Irradiation, hot water / vapour, fumigation, etc.
Grading	Classification of produce as per size, quality
Packaging	Marketable lots (primary), palletization (secondary) for transport
Pre-cooling	Remove field heat - pull down to storing temperature
Staging	Transient Storage in attached cold room (short term staging)
Dispatch	Prestaging in ante-room and loading onto reefer transport To cold stores - onward distribution to retail or long-term storage



Precooling

Precooling - Rapid cooling of the harvested F&V to pull down their temperature to a predetermined handling temperature

- F&V should be precooled as soon as it is harvested to remove field heat and reduce the **rate of respiration, deterioration, water loss, ripening, and decay**.
- F&V should not be pre-cooled to a temperature below their chill point as it will cause injury to the produce.
- Temperature of the produce is pulled down to **88%** of the required temperature; the time to pull down the temperature is 4-6 hours.



Packaged produce



Stacking in pre-cooling

- Increase in holding life
- Increase in marketability
- Reduction in cooling demand for staging, cold store, and transport

Staging

Staging - The staging cold room is an insulated, refrigerated chamber and serves as temporary storage while allowing the pre-cooler to be utilized for the next batch of produce.

The capacity or size of the staging cold room is designed to handle the output from the pre-coolers for pending transport – or contingent short storage if transport fail to arrive on time.

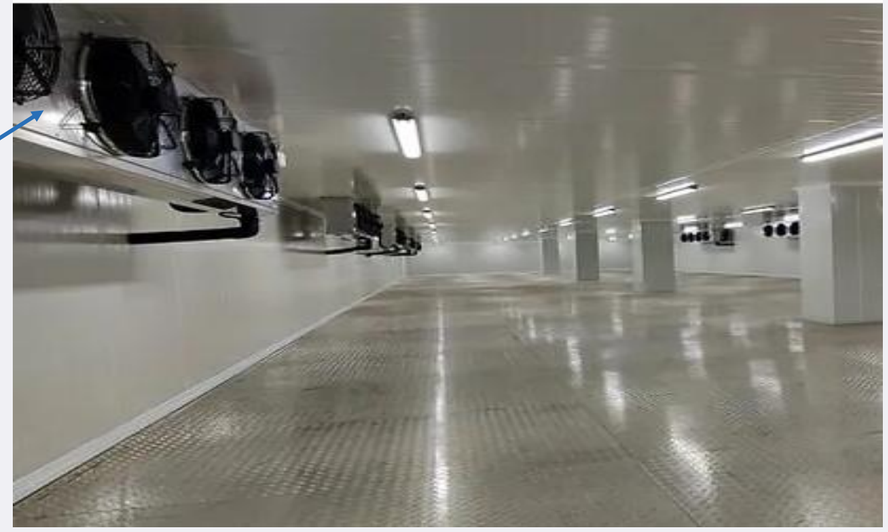
*** In a staging cold room of a packhouse the produce is stored maximum for 2-3 days**

Staging cold room with insulated sliding door

Temperature controlled ante-room



Cooling unit installed in staging room



Source: AEEE site visit

Selecting a site for a packhouse

Site selection and planning for a packhouse are crucial and can significantly impact the functionality, efficiency, and overall operation.

- Proximity to producing areas like farms
- Consideration for sourcing renewable or alternate energy for power generation
- Availability of skilled and semi-skilled workforce
- Proximity to highways and good roads to connect to key markets
- Compliance with regulations such as local zoning laws, environmental regulations, and other legal requirements
- Risk mitigation for flooding, natural disasters and other environmental hazards
- Plot size (sufficient to include all the necessary facilities)
- Availability of reliable utilities such as water and uninterrupted power supply
- Provision for expansion
- Access to critical infrastructure like roads, transportation system



Designing an energy-efficient and renewable energy-powered integrated packhouse

Lean, Mean and Green Packhouse Design

The “Lean Mean Green” philosophy aims to lower the demand for resources, provide efficient structures and deploy innovative technology.

To implement the philosophy in designing a packhouse:

- Efficient design - optimize layout
- Use energy-efficient technology
- Integrate renewable energy
- Monitor operations



LEAN

- Layout optimization
- Provision for natural lighting and ventilation
- Effective insulation and thermal barrier installation

Energy saving potential of ~ 6% by implementing the Lean philosophy



MEAN

- Low-energy evaporative cooling system for temperature control in the packing hall
- Semi-hermetic reciprocating or scroll compressor for pre-cooling and staging room
- Installation of Variable Frequency Drive (VFD) in the refrigeration unit
- Real-time monitoring and evaluation



GREEN

- Integration of grid-connected solar PV for energy sourcing
- Agri-waste/Biogas/Biomass powered vapour absorption refrigeration system
- Solar-thermal energy powered vapour absorption refrigeration system

Energy saving potential of ~ 30% by implementing the mentioned measures

EEMs in packhouse building and design

Natural lighting | **Proper orientation** | **Shading**

↓

Reduce lighting load | Minimize solar heat gains

↓

Indicative energy saving potential = **1-2% of total energy consumed**
Reduction in cooling demand = **around 1%.**

- EE Measure
- Integration measure impact
- Implementation outcome



Packhouse with natural lighting shading

Renewable energy integration in a packhouse

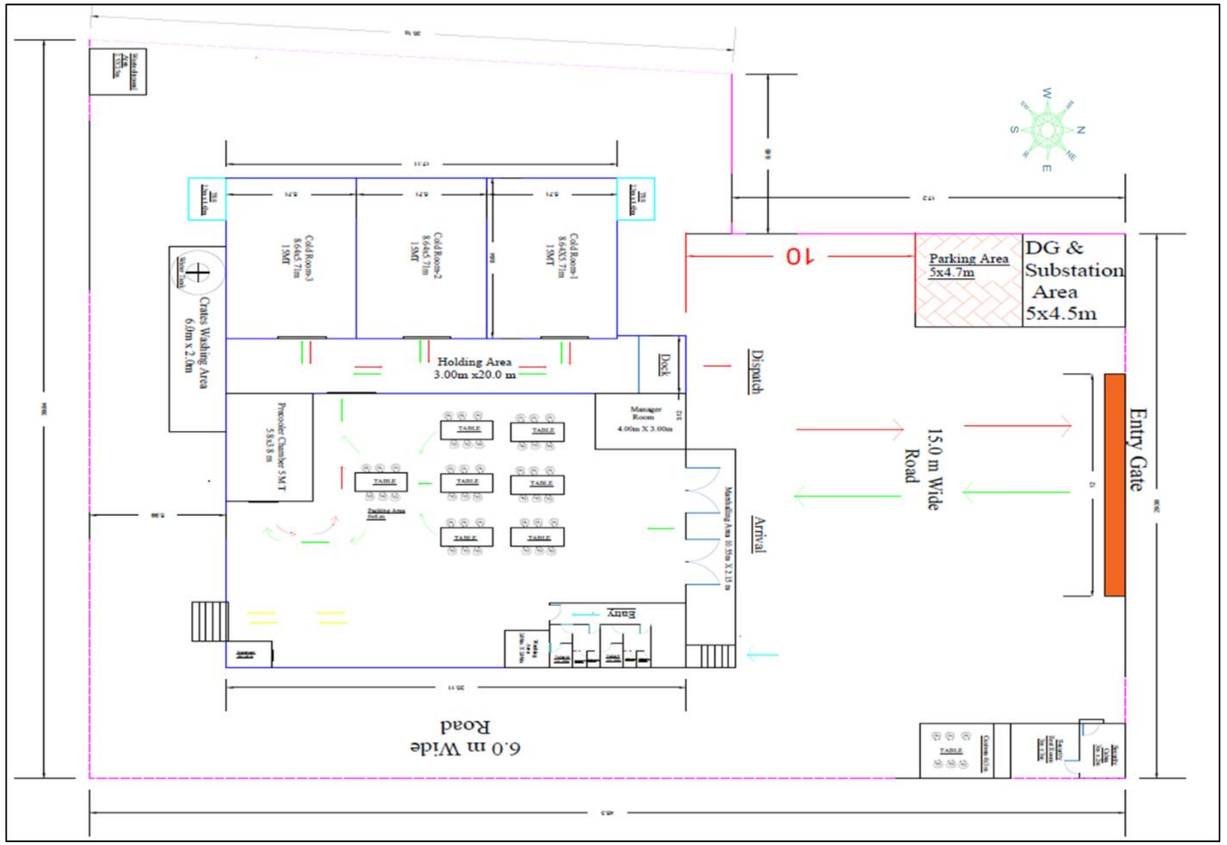
1. **Solar PV-powered refrigeration system and packhouse** – A proven, viable and fully commercialized technology
2. **Solar thermal energy-powered vapor absorption refrigeration system** – A direct source of heating, can power a heat-driven refrigeration system based on adsorption/absorption; high upfront costs and space constraints
3. **Agri-waste/Biogas/Biomass powered vapor absorption cooling system –** Continuous source of energy based on availability of feedstock (waste to energy)
4. **Geothermal based cooling system** – Low technology readiness, high upfront cost, and depends on geographical location.

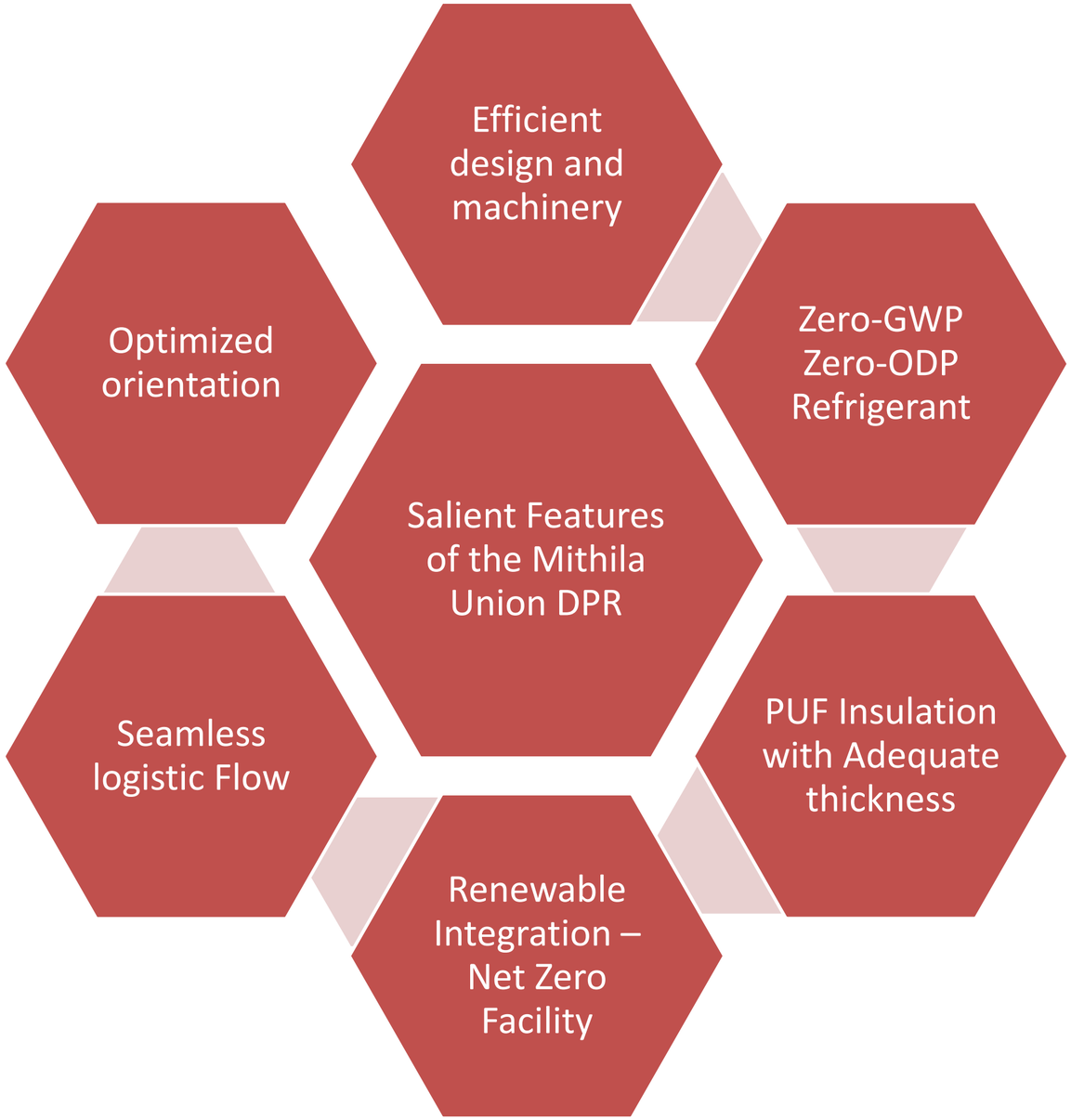
Significance of Renewable energy integration in a packhouse

- Minimizes reliance on grid
- Improved energy resilience
- Reduction in energy cost
- Reduction in operational risk
- Reduction in carbon footprint

Leveraging Packhouse Guidelines for Developing Site-Specific DPR

Beneficiary: Mithila Vegetable Union
Location: Darbhanga, Bihar
Throughput Capacity: 40 MT/day
Storage Capacity: 45 MT/day
Precooling Capacity: 5 MT





THANK YOU


Govt. of India
Ministry of Power
PACKHOUSE DESIGN GUIDELINES

PANEL DISCUSSION

Scaling Sustainable Packhouses Across Markets

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PANEL DISCUSSION | SCALING SUSTAINABLE PACKHOUSES ACROSS MARKETS

Stephanie Muchiri



Renewable Energy Specialist

Food and Agriculture Organization of the United Nations (FAO)

SUSTAINABLE COLD CHAINS FOR FOOD SECURITY

526 Mt
food lost or wasted in 2017 due to insufficient refrigeration

144 Mt
could be saved annually in developing countries with improved cold chains

4%
of global GHG emissions are associated with food cold chains

Solar-powered cold chain can extend shelf life, reduce food loss and improve market access, particularly where grid electricity is unavailable or unreliable.

HOW SUSTAINABLE COLD CHAINS FOR FOOD SECURITY REDUCE FOOD LOSS

Extends shelf life
Cooling food slows deterioration and decay

Protects quality and nutrition
Safe storage and transport preserves food quality and nutritional value

Supports farmers and incomes
More time to sell and access better markets



Renewable energy for cold chain- Case Studies

Horticulture value chains in the SEMED region, Tunisia

FAO assessed opportunities to reduce post-harvest losses and improve cold-chain use in Tunisia's tomato and potato value chains.

Tomatoes: Industrial tomatoes account for approximately 85 percent of national production. Overall post-harvest losses can **reach 10 percent**, particularly during transport and processing because of poor handling, limited storage and weak coordination.

Potatoes: Most potatoes are sold directly to consumers, with losses occurring mainly during storage. Losses can reach **30 percent in traditional storage**, compared with around **10 percent in cold-storage facilities.**

Small Scale Fisheries, Indonesia

Currently, the small-scale fisheries sector faces critical cold chain challenges, with inadequate refrigeration infrastructure causing post-harvest losses of up to **63 percent.**

A **solar-powered block ice system** was introduced in a remote tuna community to improve ice supply and fish quality.

The system is designed to produce **up to 1 tonne of ice per day** via a **25 kWp solar plant**, with an estimated added value to landed fish of **USD 70,000–140,000/year**.

RESULTS

- **Reduction in Food loss and waste**
- **Improved quality and nutrition**
- **Shelf life and market access enhanced**
- **Farmer income and livelihoods increased**

PANEL DISCUSSION | SCALING SUSTAINABLE PACKHOUSES ACROSS MARKETS

Jeremy Tait



Sustainable Products Director

Tait Consulting GmbH

WICR documents now available, free of charge:

Practitioner's Guide to WICR International Institute of Refrigeration (IIR) and Efficiency for Access

Search "Practitioners Guide" at www.iifiir.org or use QR:

https://iifiir.org/en/fridoc/walk-in-cold-rooms-a-practitioner-s-technical-guide-design-and-148065

1. ***Product Information Sheet template***
2. ***Field Test protocol***
3. ***Lab Test Protocol***

Search "WICR" at www.verasol.org or use QR:

https://verasol.org/publications/walk-in-cold-room-test-protocols/

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PANEL DISCUSSION | SCALING SUSTAINABLE PACKHOUSES ACROSS MARKETS

Öznur Öztürk



Super Pollutant Specialist

Climate and Clean Air Coalition (CCAC)

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS
a UNEP convened initiative

From project experience to policy and scale

CCAC's cold-chain work in India, Kenya and Armenia shows how governments can build low-emission, resilient and inclusive cold chains — and what it takes to scale.



India — Punjab

CCAC-funded project planning four decentralized cold-storage pilot units powered by solar, biomass or hybrid energy.

Assesses local needs, post-harvest losses, energy options, business viability and emissions; builds capacity to inform policy and replication.



Kenya — Siaya

CCAC-supported project involves two off-grid solar cold rooms with thermal energy storage.

Improves access to cooling for farmers, fishers and small traders; supports training, enterprise development and access to finance.



Armenia — Syunik

CCAC's work connects cold-chain improvements and food-loss reduction with organic-waste management, nutrient recovery and rural resilience.

Four key lessons for governments

1

Integrate into existing policy and investment frameworks

Link cold chains to agricultural, energy, climate and food security plans — not as a standalone infrastructure project.

2

Turn guidance into investment-ready projects

Adapt to local conditions — crop type, climate, electricity reliability, volumes and market access.
Use local evidence to choose the right technologies and business models.

3

Build capacity and viable business models

Train operators, ensure maintenance, make services affordable for farmers and secure sufficient utilization.
Use public support, private investment and service-based models.

4

Measure results and scale what works

Track food loss, energy use, refrigerant leakage, emissions and benefits for farmers, including women and smaller producers.
Use the evidence to guide investment and policy.

International cooperation can accelerate progress

Share feasibility studies, technical experience and lessons on financting and implementation — so countries can learn from what works, adapt it to their own context, and build the policies and programmes needed to scale low-emission cold chains.

PANEL DISCUSSION | SCALING SUSTAINABLE PACKHOUSES ACROSS MARKETS

Sunil Nair

Managing Director

Food Service Network



Right technology, size and business model make packhouses viable

India is price sensitive: least wastage and lowest cost per kilogram, from harvest to retail

Harvest	Packhouse	Refrigerated transport	Distribution centre	Retail
Cool-hour picking, crates	Pre-cool fast, grade once	Full loads, unbroken chain	First expiry first out	Order to actual demand

Business models

- **Cooling as a service**
  pay per crate per day
- **Anchor buyer contracts**
- **Farmer groups own,**
  operator runs
- **Part of a logistics network**

Size and use

- **Size to catchment volume**
- **Modular chambers,**
  add as you grow
- **Multi-product,**
  multi-temperature zones
- **Year-round utilisation,**
  crop calendar

Investment and subsidy

- **Agriculture Infrastructure Fund**
  3 percent interest subvention
- **Capital subsidy**
  35 to 50 percent of project cost
- **Agricultural power tariff**
  for example Maharashtra
- **Blended and climate finance**

Technology

- **Solar power with thermal storage**
- **Natural refrigerants**
- **Insulated envelope, dock shelters**
- **Forced-air pre-cooling**
- **Remote monitoring**

Used all year round. Tied to a buyer. Lowest cost per kilogram to retail.

OPEN DISCUSSION

Questions & Answers

Moderator

Angshuman Siddhanta

UNEP Cool Coalition

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Thank you

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